U.S. Department of Transportation

Federal Aviation Administration

Port of Seattle

FINAL ENVIRONMENTAL IMPACT STATEMENT

for

PROPOSED MASTER PLAN UPDATE DEVELOPMENT ACTIONS

at

SEATTLE-TACOMA INTERNATIONAL AIRPORT

VOLUME 6 OF 7

APPENDIX T

This statement is submitted for review pursuant to the requirements of Section 102(2)(C) of the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq); E.O. 11990, Protection of Wetlands; E.O. 11998, Floodplain Management; the 49 USC Subtitle VII; 42 U.S.C. 7401 et seq; 49 U.S.C. 47101 et seq; Washington State Environmental Policy Act (RCW 43.21C); and other applicable laws. The proposed action will impact the 100-year floodplain as indicated on the Federal Emergency Management Agency's Flood Insurance Rate Map. This Environmental Impact Statement (EIS) is a combined National Environmental Policy Act and Washington State Environmental Policy Act (SEPA) document. With regard to SEPA requirements, this EIS represents the second step of a phased environmental review which began with publication of the 1992 Flight Plan Final EIS, which assessed alternatives for addressing regional aviation needs. This Final EIS also contains the draft conformity statement, as required by the Clean Air Act amendments.

The Port of Seattle, operator of Seattle-Tacoma International Airport, has prepared a Master Plan Update for the Airport. The Plan shows the need to address the poor weather operating capability of the Airport through the development of a third parallel runway (Runway 16X/34X) with a length of up to 8,500 feet, separated by 2,500 feet from existing Runway 16L/34R, with associated taxiways and navigational aids. Other development needs include: extension of Runway 34R by 600 feet; establishment of standard Runway Safety Areas for Runways 16R/34L and 16L/34R; development of a new air traffic control tower; development of a new north unit terminal, Main Terminal improvements and terminal expansion; parking and access improvements and expansion; development of the South Aviation Support Area for cargo and/or maintenance facilities, and relocation, redevelopment, and expansion of support facilities. This Environmental Impact Statement assesses the impact of alternative airport improvements, including installation of navigational aids, airspace use, and approach and departure procedures. The proposed improvements would be completed during the 1996-2020 period, with initial 5-year development focused on the proposed new parallel runway, and existing passenger terminal, parking and access improvements. The proposed improvements and its alternatives would result in wetland impacts, floodplain encroachment, stream relocation, social, noise, water, and air quality impacts.

Responsible Federal Official:
Mr. Dennis Ossenkop
Federal Aviation Administration
Northwest Mountain Region
1601 Lind Ave, S.W.
Renton, Washington 98055-4056

SEPA contact:
Ms. Barbara Hinkle
Health, Safety and Environmental Management
Port of Seattle
P.O. Box 68727
Seattle, Washington 98168

Date: February, 1996

APPENDIX T

PUBLIC COMMENTS

As required by FAA Order 5050.4A, "Airport Environmental Handbook", a public hearing was held to provide an opportunity for the public to present oral and/or written comments concerning the social, economic, and environmental effects of the proposed Master Plan Update Environmental Impact Statement (Draft EIS). The first public hearing was held on June 1, 1995 at the SeaTac Red Lion Hotel from 1 p.m. until 10 p.m. Simultaneous with the conduct of the public hearing, a workshop was conducted to assist the public with understanding the contents of the Draft EIS. Testimony was provided by 77 individuals and the workshop/hearing was attended by about 150 people.

To further facilitate the receipt of comments, an additional public hearing was conducted on June 14, 1995 at the Calvary Lutheran Church in Federal Way from 6 p.m. until 10 p.m. Testimony was received from 15 individuals. This hearing was attended by approximately 40 people.

This appendix presents the entire public hearing transcripts from both hearings as well as approximately 250 correspondences received by Mr. Dennis Ossenkop, of the Federal Aviation Administration, Regional Airports Office and is organized as follows:

- Correspondence from the public and Federal, State, and local public agencies and private agencies
- Public Hearing Transcript (June 1, 1995)
- Public Hearing Transcript (June 14, 1995)
- Public Hearing submittals

Table T-1 provides an index to the individuals and organizations that either testified at the Public Hearing (listed as HT) or submitted written comments during the comment period.

A number of significant comments were received concerning six key topics:

- Aviation demand forecast relative to the Do-Nothing and With Project Alternatives
- The assessment of air pollutant conditions
- The assessment of surface transportation impacts
- The assessment of aircraft noise impacts
- Issues regarding the affected environs around the Airport
- The assessment the proposed project affects on human health issues

Once all the comments were received and the public hearing transcripts were prepared, responses to all appropriate public comments regarding the Draft EIS were prepared. To facilitate the review of comments and the preparation of responses, the comments were grouped by issue and/or chapter of the Final EIS. A code was then given to each unique comment to facilitate the review of the individual comment and the identification of the corresponding response. Each code corresponds to a comment noted in the public and agency correspondences and comments made and notated in the public hearing transcript. The code applied to each comment represents R-A-B, where R *indicates a response*, A is *the* *issue group*, and B is *a sequential number within the issue group*, representing a unique comment. The correspondences and public hearing transcript have been notated with brackets located in the right margins which refer to the appropriate response or responses to the comments. Due to the large number of comments received, the response to comments are included in a separate appendix, Appendix R - Response-to-Comments.

TABLE T-1

INDEX OF COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT SEATTLE-TACOMA INTERNATIONAL AIRPORT

Document Number [1/]	Page Number	Name	Organization
181	522	3 Signatures	Aircraft Noise Abatement Committee
30	23		Communities Against Noise (Beacon Hill)
38	28	7 Signatures	Glen Acres Homeowners Assoc.
47	39	5 Signatures	Glen Acres Homeowners Assoc.
116	212	25 Signatures	Glen Acres Homeowners Assoc.
147	499	A Concerned Citizen	
214	1339	Airport Commuties Coalition	ACC
27	21	Airport Commuties Coalition (Bob Olander)	ACC
31	23	Airport Commuties Coalition (Bob Olander)	ACC
124	217	Akers, Ray	Columbia City Neighborhood Coalition
125	218	Akers, Ray	Columbia City Neighborhood Coalition
73	110	Alishokis, Wayne & Sharon	Glen Acres
HT 88	2005	Allen, Frank	
103	129	Allen, Lynn	
HT 37	1933	Allmon, Rebecca	Expediters Inter. WASH
228	1753	Amelia, Marcelle	
57	45	Amero, Lynol	Mayor, City of Pacific
45	36	Anderson, Alvin	
90	122	Anderson, Joseph	
48	40	Anonymous	
67	106	Anonymous	
100	127	Ashunal, W.	Glen Acres
95	124	Austria, Almario	
HT 77	1988	Ayres, Marilyn	
115	209	Bader, Jorgen	
4	3	Bader, Jorgen	Revenna-Bryant Community Council
HT 20	1910	Bakst, Jay	Kent Chamber of Commerce
159	506	Balach, J.R.	
39	29	Bannon Residence	
149	500	Bartlemay, James	
150	501	Bartlemay, James	
HT 11	1897	Bartlemay, James	
188	528	Bass, Erika	
206	634	Batayola, Teresita	Seattle Water
81	116	Bedayan, K.	Glen Acres
237	1763	Benedum, Mark	Highline Community Hospital
133	223	Benjaminson, Michael	Customs Brokers & International Freight Forwarders
HT 118	2025	Berg, Avill	
44	35	Berg, Avill	
HT 25	1917	Berger, Dorian	Mt. Rainier High Student Body
96	125	Berho, Felipe	
230	1755	Bittendc, Linda	
177	520	Bittermann, Toby	
HT 112	2101	Bolles, R.C.	

[1/] "HT" Indicates that comment is located in the Hearing Transcript. The number following "HT" indicates the order of the individual's comment in either the transcript or receipt of letters.

136	225	Bolles, Bob	Southwest King County Citizens Group
HT 55	1958	Bonney, Ann	
136	225	Bonney, Ann	Southwest King County Community Group
163	508	Booth, Charles	City of Auburn
223	1750	Borgmann, Craig	
HT 35	1930	Brasher, Minnie	
136	225	Brasher, Minnie	Southwest King County Community Group
HT 28	1922	Brazil, Terry	
169	516	Brockey, Jerry	South Seattle Community College
205	571	Brown, A.	
HT 101	2060	Brown, Arlene	
HT 47	1949	Brown, Arlene	
HT 52	1956	Brown, Derek	
HT 98	2077	Brown, Derek	
248	1877	Browne, Almyra	
247	1877	Browne, Harriet	
246	1876	Browne, James	
196	557	Buckingham, Mark	
63	103	Bullard, Don	Queen Ann Community Council
56	45	Buller, John	Bon Marche
207	636	Burke, Herbert	
HT 49	1952	Burrage, Jannett	Des Moines City Council
153	503	Byington, Terry	American Electronics Association
82	117	Byrd, Barbara & Miller, Nelva	Glen Acres
HT 14	1902	Caldwell, Dan	
251	1879	Cannon, Robert & Ivanov, Barbara	Kent Chamber of Commerce
184	525	Carlson, Walter & Mary	
HT 72	1982	Carpenter, James	
120	215	Cauble, Gloria	
229	1754	Cegon, Robert & Grumm, Stephen	Prince of Peace Lutheran Church
HT 113	2022	Chapin, Ed	
HT 22	1913	Christy, Stephanie	
HT 114	2022	Clark, Margaret	
HT 67	1975	Clark, Rose	
HT 60	1965	Clifford, Chris	
37	27	Clymer, William J. & West, Ruth Catherine	
224	1751	Clymer, William J. & West, Ruth-Catherine	
80	115	Conner, Opal	Glen Acres
18	16	Cooper, John	
HT 96	2026	Copies of the Display Boards	
111	207	Coyote, Beth	
74	111	Creech, Greg	Glen Acres
213	653	Creighton, Stuart	RCAA
46	37	Creighton, Stuart	Regional Commission on Airport Affairs
HT 73	1983	Creighton, Stuart	
HT 23	1913	Cunningham, Guy	Pacific Northwest Lab/Batelle
HT 99	2053	Cunningham, Guy	Pacific Northwest Lab/Batelle
3	2	Dalbec, Fred	
70	109	Depner, Joe	
233	1758	Derrick, Robert	King County Depart. o Development & Env. Services
HT 89	2008	DesMarais, Debbie	
HT 13	1900	DesMarias, Debbie	
83	118	Dettman, Alan	
204	567	Dinndorf, Jerry	PSRC
HT 62	1969	Docherty, Don	
HT 58	1962	Dodge, Clark	Normandy Park City Council
HT 81	1996	Dolvey, Jack	Federal Way Council
176	520	Driscoll, Clarence	

148	500	Dulaney, Nancy	
76	112	Eaton, William	Glen Acres
72	110	Edwards, Gene	
HT 82	1997	Elder, Hope	Federal Way Council
33	24	Ellison, R.A.	
HT 54	1958	Ellison, Robert	
144	497	Engel, Virginia & William	
114	208	Engstrom, Frieda	
75	111	Erickson, Margaret	Glen Acres
HT 24	1915	Etkin, Mayer	
123	216	Feckley, Marie	
HT 53	1956	Feldman, Richard	King County Labor Co. AFL/CIO
208	637	Ferullo, E.J.	
HT 90	2011	Feuerstein, Joe	
232	1756	Ford, Angela	
HT 8	1894	Fornar, Elmira	
190	529	Forrey, Arden	
7	5	Forrey, Arden	Hawthorne Hills Community Club
195	534	Frause, Henry	
HT 110	2099	Frause, Henry	
HT 12	1898	Frause, Sophie	
22	18	Frutu, David	
HT 75	1986	Furney, Al	
HT 4	1890	Gates, Mary	Federal Way
HT 100	2055	Gates, Mary & Priest, Skip	
78	113	Gendo, Gladys	Glen Acres
85	119	Gibbons, Laura & Keyes, David	
50	41	Gilbreath, Janis L.	
HT 17	1907	Giles, Robert	Perkins & Coie
HT 32	1926	Gilespie, Bob	
68	107	Givens, John	Washington Public Ports Association
HT 69	1979	Gould, Trina	Air Washington
HT 87	2004	Graham, Jerry	
203	567	Green, Bob	Greater Federal Way Chamber of Commerce
17	13	Greene, James K.	
8	5	Griffith, Gregory	Office of Archaeology and Historic Preservation
36	27	Grubb, Ria	
229	1754	Grumm, Stephen & Cegon, Robert	Prince of Peace Lutheran Church
104	129	Gwinn, David	H.J. Gwinn & Company
99	126	Hablin, Arthur	Glen Acres
HT 59	1963	Hagstrom, Claes	Seattle RCA
222	1750	Hales, George	Glen Acres
2	1	Hall, Heidi	Department of Natural Resources
25	20	Hansen, Ingrid	
51	41	Hansen, Rodney	King County Solid Waste
84	118	Hansen, Rodney	King County Waste Division
197	560	Harding, Beverly	
218	1738	Harris, Keith	Highline Water District
102	128	Hatfield, M.E.	Glen Acres
215	1733	Hayden, John	Boeing
HT 45	1943	Heavey, Mike	State Representative
139	494	Heavey, Mike	State Senator
98	126	Helland, David	
86	120	Heslop, Serena	
134	224	Hess, James Dean	
HT 56	1960	Hetzel, Carol	ANAC
26	20	Hickman, James	
162	508	Hill, Jennifer	
121	215	Hitt, Ray	
138	493	Hoge, Michael	Seattle Public Schools

HT 39	1935	Hoglund, Eugene	Citizen
200	562	Hopkins, Henry	
89	121	Horne-Webster, Martha	
146	498	Horsley, Levi William	
HT 5	1891	Hoult, Linda	Snohomish County Citizens Group
53	43	Houser, Richard	Glen Acres Homeowners Assoc.
113	208	Hubbard, Minnie	
127	220	hultberg, Stephen	
251	1879	Ivanov, Barbara & Cannon, Robert	Kent Chamber of Commerce
19	17	Ivenson, Susan	
122	216	Jackson, Julie	
HT 41	1938	Jhaveri, Arun	Mayor, Burien
HT 97	2052	Jhaveri, Arun	
HT 33	1928	Jones, Bill	Sea-Tac Firefighters
178	521	Jones, Len	
93	123	Jones, Richard	
143	497	Judd, Adeline	
226	1752	Karlinsey, Joyce	
199	561	Kellogg, Kristine	
97	125	Kemron, Carol	
250	1878	Kennedy, Elizabeth	
HT 27	1920	Kennedy, Richard	Mayor, Des Moines
HT 105	2094	Kennedy, Richard	Talking Points
85	119	Keyes, David & Gibbons, Laura	
168	513	Kircher, David	PSAPCA
174	519	Kishida, Yone	
173	518	Kishida-Haley, Darlene	
179	521	Kittilsby, Lisa	
12	10	Klug, Bob	North East District Council
29	22	Klug, Bob	North East District Council
164	509	Ku, Peter	North Seattle Community College
108	132	Kumar, Ramendra	
68	107	Kuntz, Jim	WPPA Aviation Committee
HT 34	1929	LaFramboise, Bob	Heath Techna Aerospace
193	533	Lang, Elizabeth	
182	524	Lawder, William	Hertz Corp
137	489	Le Compte, Howard	
220	1748	Lepley, Jean	
54	43	Lewis, Randall	City of Tacoma
HT 16	1904	Lindsay, John N.	Tri City Industrial Dev. Council
1	1	Lund, Erik S.	
117	213	Luther, Rick	City of Black Diamond
160	507	MacPherson-Krutsky, Susan	
92	123	Maedche, Don	
158	506	Maes, Elaine	
191	530	Magnolia Community Club	Magnolia Community Club
9	6	Mandel, Eric	Leschi's Community Council
227	1753	Marshall, Viola	
234	1761	Mason, Dawn	State Representative
HT 43	1941	Matthews, Pierre	
HT 94	2017	Matthews, Peter	
HT 95	2019	Matthews, Vivian	
249	1878	Matthews, Vivian & Pierre	
14	11	Maurice, John	
151	501	McCollier, Elizabeth	
209	639	McDougall, CoCo	
HT 51	1954	McGeehan, Dr. Joseph	Highline School District
HT 102	2078	McGeehan, Dr. Joseph	
180	522	McGrath, Jeff	
59	47	McGwire, Elizabeth	
66	104	McKinney, Maureen & Buck	

HT 64	1971	Mealy, Carl	
243	1770	Means, Beth & Talbot, Chas.	Seattle Community Council
118	214	Mehlhoff, Mike	
69	108	Menorath, Pink Keo	
201	564	Miedema, Simon	
171	517	Miles, Frank	
238	1764	Miller, Alan	Trout Unlimited
HT 2	1888	Miller, David	Normandy Park
82	117	Miller, Nelva & Byrd, Barbara	Glen Acres
192	532	Miller, Raymond	The Church Council of Greater Seattle
HT 83	1998	Millsaps, Joe	John Graham Assoc.
HT 42	1940	Milne, Kitty	Burien City Council
HT 63	1970	Moeller, Jeanne	
217	1735	Montgelas, Renee	WS DOT
198	561	Moore, Barbara	
231	1756	Moriyason, Saya	
132	223	Motel, Cameo	
254	1880	Mueller, Thomas	
40	30	Mulder, Jan	Seattle City Light
61	101	Murphy, James	Fleet Glass Repair, Inc.
23	19	Murphy, Sherri	
129	221	Nelson, Katia	
HT 38	1934	Nelson, Robert	
5	4	Neuzil, Dennis	
HT 44	1942	Newby, Don	
155	504	O'Brien, Yvonne	
170	516	O'Keefe, Elise	
35	26	Okamoto, Dennis	U.S. West Comm.
107	132	Okamoto, Jean	
27	21	Olander, Bob	ACC
31	23	Olander, Bob	ACC
60	47	Osaki, Carl	King Co. Health Dept.
161	507	Osborne, Jennifer	
245	1874	Osterman, Doug, Julie & Mitchell	
212	650	Osterman, Doug, Julie & Mitchell	
HT 116	2024	Ott, Frank	
HT 115	2023	Overholt, Mark	
HT 76	1987	Parker, Kathy	
219	1739	Parkin, Richard	USEPA
HT 46	1945	Patterson, Julia	State Representative
165	511	Peterson, Bruce	
110	133	Peyton, Brian	Ravenna-Bryant Community Association
252	1879	Pichereau, Susan	
52	42	Platt, Tom & Marylin	
20	17	Plowman, Linda	
HT 31	1925	Pomeroy, Vernon	
HT 9	1895	Pompeo, Pat	
106	131	Powell, Mark	Unocal
64	103	Price, Mary	Glen Acres
HT 15	1903	Prichart, Janet	Tacoma Pierce County Chamber
HT 3	1889	Priest, Skip	Federal Way
HT 100	2055	Priest, Skip & Gates, Mary	
130	220	Ramirez, L. Dan	Greater Readmond Chamber of Commerce
96	125	Rannig, Majorie & Leslie	
HT 57	1961	Rants, John	Mayor Tukwila
HT 106	2096	Rants, John	Talking Points
126	219	Reardon, Ken	
28	21	Redlin, Victoria	Spokane Area Chamber of Comm.
HT 19	1908	Rees, Mike	Magnolia Community Club
HT 108	2098	Rees, Mike	
187	527	Rice, Norman	City of Seattle

175	519	Richardson, Earl	South East Effective Development Inc. (SEED)
HT 7	1893	Richter, Audrey	
240	1767	Riggs, Don	
210	640	Rohlfs, D. Scott	City of SeaTac
119	214	Rondaz, Seine	
HT 68	1977	Rosenberg, Matt	Regional Comm. On Airport Affairs
65	104	Rosenblatt, Roger	
140	495	Ross, Cheryl	
HT 65	1972	Rozdilsky, John	
225	1752	Saladis, John & Rose	
154	504	Sauer, Raymond	
43	32	Scarvie, Stanley	
216	1734	Schneider, S.G.	
152	502	Schreier, Eda	
145	498	Schuster, Andrew	Wedgewood Community Council
211	649	Schuster, John	John F. Kennedy High School
112	207	Scott, Nadine	
109	133	Scott, Ora	
21	18	Shawman, P.	
244	1874	Shinyeda, Amy	
87	120	Sican, Linda	
94	124	Sican, Lisa	
135	224	Simons, Richard	
HT 10	1895	Smith, Adam	State Senator
141	496	Smith, Audrey	
142	496	Smith-Buehler, Robyn	
194	533	Sobers, Frances	
15	11	Soltis, Jerry	
77	112	Sonislo, Barbara	Glen Acres
202	565	Southwest King County Chamber of Commerce - Nada Hughes	
136	225	Southwest King County Community Group	Southwest King County Community Group
236	1763	Spears, Patricia	
HT 36	1931	Springer, Elizabeth	
HT 107	2097	Springer, Elizabeth	
79	114	St. Laurent, Cornelia	Glen Acres
101	127	Stankey, Warren & Janice	Glen Acres
HT 74	1985	Stark, Ben	
13	10	Sternberg, Maxine	
88	121	Stonehocker, Patricia	
16	12	Stuhring, Barbara	
32	24	Stuhring, Barbara	
167	512	Suther, Suzanne	Issaquah Chamber of Commerce
156	505	Swhela, Tilesa	
243	1770	Talbot, Chas. & Means, Beth	Seattle Community Council
185	525	Talley, Karen Waddell	
183	524	Tang, David K.Y.	Washington Council on International Trade
166	511	Tate, Randy	Congressman
HT 48	1950	Tate, Randy	U.S. Congressman
HT 103	2091	Tate, Randy	
235	1762	Taylor, Laurie	
58	46	Taylor, Marie	
HT 111	2100	Taylor, Ralph	
55	44	Taylor, Willie	Department of Interior
221	1749	Terrell, Marion	Glen Acres
24	19	Thomas, Beverly	
HT 6	1892	Thompson, John	
HT 71	1982	Thompson, John	
HT 70	1981	Thompson, Lewis	

HT 50	1953	Thomson, Leslie	
HT 26	1919	Thornton, Dean	
6	4	Tilley, Steve	Puget Sound Water Quality Authority
HT 78	1990	Tinker, Carey	
HT 79	1992	Tinker, Jane	
71	109	Toepelt, Rovert	
HT 85	2001	Towe, Gary	DesMoines City Council
HT 93	2015	Townsend, Peter	
HT 104	2093	Tri Cities Industrial Development Council	
157	505	Uriyu, Hideko Sue	
41	30	Vaa, Robert	
HT 117	2024	Vaa, Robert	
HT 84	2000	Vance, Chris	King County Council
HT 66	1973	Vermeier, Kathleen	Normandy Park City Council
HT 1	1886	Vigilante, Mary	Landrum & Brown
HT 80	1994	Vigilante, Mary	Landrum & Brown
239	1766	Voeller, Ray & Judy	
HT 91	2012	Vonesh, Bob	
189	528	Wagner, David	
HT 18	1908	Walker, George	
11	7	Wantanabe, Stanley	
34	25	Wantanabe, Stanley	
HT 29	1923	Wantanabe, Stanley	
HT 109	2099	Wantanabe, Stanley	
241	1769	Webb, Kris	
HT 92	2013	Webb, Kris	
91	122	Webster, Lonnie	
105	131	West, Carla & Robert	
37	29	West, Ruth Catherine & Clymer, William J.	
224	1751	West, Ruth Catherine & Clymer, William J.	
62	101	Whitled, Vernon & Lori	
49	40	Whitlock, John	
HT 86	2002	Wiberg, Roy	
HT 61	1967	Wichert, Erhard	
10	6	Wieting, Donna	DOC, NOAA
128	220	Williams, Kari	
242	1770	Woodward, Bethany	
HT 40	1938	Woosley, T.J.	Greater Kirkland Chamber
HT 21	1911	Wordian, Laurie	
186	526	Wozniak, Joseph	
131	222	Yada, Joe	
HT 30	1924	Yamamoto, Amy	
172	517	Yanez, Tony	
253	1880	Yoshikawa, Troy	
42	31	Zembruski, Victor	
HT 119	2026	Zembruski, Victor	

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July 1995

REC'D ANM-610
PLAN, PGM, & CAP BR
AUG - 2 1995
ANM-610

Federal Aviation Administration
Dennis Ossenkop
Airports Division, ANM-611
1601 Lind Ave. S.W.
Renton, WA 98055-4056

Dear Sir:

As a part of the ongoing debate on the third runway issue and Environmental Impact Study comment period, I wish to register my objection to the change in air-traffic patterns over Southeast Seattle in advance of the final decision on the third runway.

Recent changes in air-traffic patterns are adversely affecting our way of life. Noise levels are increasingly oppressive. It is our understanding that changes in air-traffic patterns are prohibited without an Environmental Impact Study. We are concerned that our community was not included in any study of the air-traffic patterns current or future. R-5-4

Please record my objection to the change which has occurred in air-traffic patterns and which is adversely affecting the quality of life in and around the communities of Southeast Seattle. R-5-5

Respectfully,

Barbara Moore
Signature

BARBARA MOORE
Name

3010 S. COURT ST.
Address

SEATTLE, WA 98144
City, State, Zip

199

July 1995

REC'D ANM-610
PLAN, PGM, & CAP BR
AUG - 2 1995
ANM-610

Federal Aviation Administration
Dennis Ossenkop
Airports Division, ANM-611
1601 Lind Ave. S.W.
Renton, WA 98055-4056

Dear Sir:

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Please record my objection to the change which has occurred in air-traffic patterns and which is adversely affecting the quality of life in and around the communities of Southeast Seattle. R-5-5

Respectfully,

Kristine Kellogg
Signature

Kristine Kellogg
Name

5016 26th Ave. S.
Address

Seattle 98108
City, State, Zip

200

Henry R. Hopkins, P.E.
PO Box 5056
Lynnwood, WA 98046
206-743-4245

REC'D ANM-510
PLAN, PGM, & CAP CR
AUG - 2 1995
ANM-610

August 2, 1995

Mr. Dennis Ossenkop
Federal Aviation Agency
Northwest Mountain Region
1601 Lind Ave. S.W.
Renton, WA 98055-4056

RE: COMMMENT ON PRELIMINARY ENVIRONMENTAL IMPACT STATEMENT (PEIS)
FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT

Dear Mr. Ossenkop,

This letter is my comment on the subject project. I am a licensed civil engineer and have 30 years experience in engineering and construction. I have experience as CEO of an engineering-construction firm with large earthmoving projects in the Northwest and International projects. I offer the following information with the hope that this comment will be treated with serious consideration.

SEA-TAC AIRPORT EIS--The Port of Seattle has prepared a detailed PEIS. The 3rd runway project involves approximately 17,000,000 cubic yards of fill. The final EIS is scheduled to be completed November 1995.

Construction Method-- Approximately 800,000 round trips of double trailer trucks would be required. The PEIS also describes a combination of barging and trucking. This combination still requires over 600,000 round trips of trucks. These trucks are approximately 70-75 feet in length and have a gross weight of 105,000 pounds per unit. The PEIS assigns equality of one passenger car to one of these trucks?? Does a 105,000 pound diesel truck over 70 feet long equal one car? R-12-27

Soils--The glacial soils located on the Port's "borrow" sites identified in the EIS (Chapter IV, 19) are not "all weather" material. These soils cannot be placed into embankments during wet weather conditions without use of well drained material. This method uses intermittent layers of sandy gravel with material having more than 5% passing 200 Sieve. These factors are important because the EIS outlines a schedule which is directly increasing or decreasing impacts with time of construction of the runway embankments. There is a section of the PEIS which describes Geo Technical comments on the type of materials and their respective sensitivity to seismic forces. All weather material carries a bonus of more seismic stability (See attached Alternative). R-11-5

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SUGGESTED ALTERNATIVE

Time for Construction--Shortened with Barge-Conveyor System-- If the Port would use a borrow material with less than 5% passing 200 Sieve and sand equivalent of greater than 50%, the construction schedule used in the EIS could be accomplished, even with trucks. The Barge-Conveyor by way of Des Moines will provide an all weather material which yields a shorter construction schedule and superior quality of completed structural embankment.

Truck Traffic Nearly Eliminated--If the Port would use the barge-conveyor alternative through Des Moines as described herein, the issue of trucks hauling the embankment would be gone. By revising the methods to be used for constructing the runway, from trucks hauling the fill, to an alternate of using barges with a conveyor system, trucks are eliminated. This alternative is described in the attached pages. The sources for the borrow for this alternative would come from one or more of the borrow sources outlined in the Preliminary (PEIS).

Port of Seattle Mission Statement--One of the mission statements that the Port of Seattle proudly states, is "The Port of Seattle places a high value and priority on what benefits are generated by the Port to the community as a whole". This is a good and desirable position for the Port to practice. R-12-22

Project Cost Savings--The Port has also committed to seek savings of 20% in their projects and operations. Even though the EIS process does not assign economic values to considerations, this Alternative will provide a bonus in project cost savings depending on how it is used.

By using the suggested Alternative, the Port would be providing many more benefits to the general community as well as specific improvements to their immediate neighbors; like the City of Des Moines, Burien, Sea Tac, Federal Way, Tukwila, Highline School District, King County, and others.

The attachment, "Alternative to Transportation of Earth Fill Using a Barge-Conveyor System" describes a comparison of impacts between trucks and the barge-conveyor system. A qualified group of experienced people with credentials in the disciplines of engineering, permitting, and construction of airports have studied this project thoroughly to determine that this proposed Alternative is feasible.

Should the Port not include the Barge-Conveyor Alternative in the Final EIS, it would be environmentally and economically detrimental to the community. It also would be inconsistent with the mission as publicly stated by the Port of Seattle.

Thank you for the opportunity to comment.

Very truly yours,

Henry Hopkins

Henry Hopkins, P.E.

PROPOSED ALTERNATIVE TO TRUCK TRANSPORTATION OF EARTH FILL USING A BARGE-CONVEYOR BELT SYSTEM

PRESENT PLAN FOR SEA-TAC AIRPORT CONSTRUCTION

According to the Draft Environmental Impact statement, approximately 17 million cubic yards of fill will be required to complete the Port's third runway project. If trucks transport that fill, the communities adjacent to the airport will suffer up to 800,000 round trips by heavy construction trucks, with the resulting impacts of traffic congestion, air pollution and damage to infrastructure.

ALTERNATIVE TO PROPOSED TRUCK METHOD

The Port should include as an alternative to truck transportation a proven system that eliminates those negative impacts, reduces project costs, and that, if selected, will provide income and other benefits to local communities. This system utilizes a conveyor belt in conjunction with barges on Puget Sound to bring required fill to the project site. The conveyor belt would transport fill along an existing Midway Sewer District utility easement that extends two miles from the Sound to the Airport. The Sewer District has agreed to the use of the easement, and the use is permitted as a conditional use under the City of Des Moines Shoreline Master Program.

Barges transporting fill to the terminus of the conveyor belt on Puget Sound would discharge fill directly to the belt for the two mile trip to the Airport. This conveyor belt system is patented and has been used successfully in major earthmoving projects such as the Tom Bigbee Dam and construction of SR167. Use of this belt system would provide the following environmental benefits:

IMPACTS AND BENEFITS OF ALTERNATIVE TO COMMUNITIES:

A. ELIMINATION OF TRUCK TRAFFIC FOR REQUIRED FILL:

Elimination of the safety hazards associated with 800,000 round trips;

Elimination of traffic congestion and disruption on public roads associated with 800,000 round trips;

Elimination of disruptions to private property access associated with 800,000 round trips;

Elimination of damage to public roads associated with 800,000 round trips;

Elimination of noise pollution associated with 800,000 round trips;

Elimination of truck exhaust and fuel consumption associated with 800,000 round trips;

Elimination of dust pollution associated with 800,000 round trips.

B. COMMUNITY BENEFITS OF THE CONVEYOR SYSTEM:

PROPERTY SAVED--Elimination of property acquisition planned by the Port to mitigate the impacts associated with 800,000 round trips of trucks;

PARKS--Restoration of the conveyor belt route to a park path identified in the City of Des Moines Comprehensive Plan;

REDUCED COSTS FOR SEWERS--Conveyor usage fees will provide income to the Midway Sewer District to offset improvement costs for new trunk line;

TAX SAVINGS--Reduction of project costs for the Port and tax relief for residents in adjacent communities who would pay for road maintenance.

C. PROJECT BENEFITS:

Superior quality of fill material to provide better seismic resistance.

All Weather material allows construction through all weather.

Shorter construction time required for project.

Shorter time for construction impacts.

Significantly reduces impacts; such as, drainage, access, soil erosion, etc for Port's properties identified in PEIS as borrow sources.

Preserves Port's borrow properties for future usage with more options.

Safer working conditions on site.

The conveyor belt system is feasible, environmentally responsible, and economical. The use of the system as an alternative to eliminate the substantial adverse impact on the environment from heavy construction truck traffic cannot be ignored and must be considered as an alternative in the final EIS. Failure to include the conveyor belt system could be fatal to this EIS process and would certainly jeopardize the community benefits that would result from use of the system.

COMMENT SHEET

Public Hearing
June 1, 1995

SEATTLE-TACOMA INTERNATIONAL AIRPORT

Draft Environmental Impact Statement for the Master Plan Update

REC'D ANM-620
SAFETY & STANDARDS BR
AUG - 2 1995
ANM-620

SEE ATTACHED SHEET

(Please Print) Name: SIMON MIEDEMA
Address: 639 S. 144 ST.
City: BURIEN WA.   Zip Code: 98168-3550

Please return comments by August 3, 1995 to: Mr. Dennis Ossenkop, Federal Aviation Administration, Airports Division, ANM-611, 1601 Lind Ave SW, Renton, Washington 98055-4056 *or leave in the box as you leave the meeting.*

1. The E.I.S. states that there are about 60 airlines using Sea-Tac airport; by actual count, there are only 37. R-2-12

2. The E.I.S. states that in poor weather flight arrivals come from the south; actually during poor weather conditions the prevailing winds come from the south and the planes approach from the north. R-4-13

3. The E.I.S. states the existing water usage is 640,000 gallons per day and the future usage would be 4.3 million gallons per day. An increase of 700%. Where is all this water going to come from? Has any study been made with the water department to see if this is possible? R-13-4

4. The E.I.S. stating the possibility of displacing the present wetlands to somewhere in the Green River Valley is ridiculous. This changes the whole ecology of the region. R-14-7

5. Several airlines fly their planes to Portland overnight and bring them back to Sea-Tac the next day to avoid the very high cost of overnight gate parking that Sea-Tac charges; These take-offs and landings are completely unnecessary if Sea-Tac had competitive pricing.

6. Other major airports have beenusing demand management for over 17 years; The port's lame excuse is that it will not work with our 40% (as they claim) poor weather. If Sea-Tac is plagued with such a high percentage of bad weather, then building the third runway is throwing away good money after bad money. R-4-7

7. In chapter IV (noise), it is claimed that "areas affected by DNL65 and greater are expected to decline in the future in comparison to 1994." The claim is due to the port's noise reduction (noise insulation) programs and the phase-out of stage 2 aircraft. The airport expects everybody in this DNL 65 area to sit in their houses with all the windows closed. This deprives them of the outdoor enjoyment of their property. It stands to reason if you move a noise source 2,500 feet, a new area will be affected. (e.g.) DNL 65 or more will become DNL 70 or more. R-6-18

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Tukwila-SeaTac Office
PO Box 58591, Seattle, WA 98138
16400 Southcenter Parkway, Suite 210, Tukwila, WA 98188
Tel 206 575-1633 • Fax 206 575-2007 • TDD 1 800 949-4232

Burien Office
15030 8th Avenue SW, Burien, WA 98166 • Tel 206 241-1723

Southwest King County Chamber of Commerce

REC'D ANM-610 PLAN, PGM, & CAP BR AUG - 2 1995 ANM-610

August 2, 1995

Mr. Dennis Ossenkop
ANM-611
Federal Aviation Administration
1601 Lind Avenue S.W.
Renton, WA 98055

Dear Mr. Ossenkemp:

The Southwest King County Chamber of Commerce represents 535 member businesses in the communities of Burien, SeaTac, and Tukwila. The three cities immediately surround Seattle-Tacoma International Airport and are the recipients of the greatest impacts generated by the Airport.

The Chamber established a sub-committee of volunteers to review the Seattle-Tacoma International Airport Master Plan Draft Environmental Impact Statement. This sub committee was comprised of business representatives from our three communities and staff members from the City of SeaTac, all of whom serve on one or more of the Chamber's three government affairs committees. In addition, the sub-committee included staff members from the Port of Seattle, who were instrumental in providing technical data on airport related issues. This coalition met on a weekly basis over a period of six weeks to review the individual sections of the DEIS. The Chamber wishes to acknowledge these representatives for their efforts and commitment to this process.

The Chamber continues to recognize the critical value of the Seattle-Tacoma International Airport on the region's economy. These comments are neither for nor against the expansion of Seattle-Tacoma International Airport as it relates to the addition of a third runway and/or terminal/operational expansion. Our comments are only in response to items identified as impacts to our communities due to the addition of a third runway and/or terminal/operational expansion.

As a result of our review of the Airport Master Plan Draft Environmental Impact Statement, the Southwest King County Chamber of Commerce would like to respond to the following:

NOISE

* Upon review of Section I, we do not feel that the issue of noise frequency has been adequately addressed. While the DEIS demonstrates that noise contours will shrink as a result of the airlines converting from Stage 2 to Stage 3 aircraft, it does not address how the increased frequency of noise, resulting from use R-6-27

Advocating Business Advancement

RECYCLED PAPER

202

of the additional runway and increased airport operations will be mitigated. R-6-27

* In our review, we have found that, should the third runway be built, the noise impacts to business have not been adequately taken into consideration. The Chamber supports the option of business relocation and/or insulation in the Approach Transition Zone (ATZ) to the north and south of the third runway for businesses which are materially impacted by noise should they elect to participate in such a program. Furthermore, we recommend that in the case of relocation, the Port of Seattle actively relocate businesses within as close proximity as possible in order to maintain jurisdictional revenues. R-7-22

* The DEIS suggests that the proposed runway be used almost exclusively as a landing-only runway; however it can/will accommodate all landing and departure maneuvers if needed. The DEIS does not adequately respond to the noise impacts resulting from a permanent change in use of the runway from a landing-only to a landing/departure use. R-6-13

* If master plan development occurs, property owners will need to respond to noise impacts as a part of future property development. We recommend that the Port of Seattle work with local jurisdictions to develop further permitting requirements that will help mitigate the impacts of noise and occur at the expense of the individual owner. R-7-38

LAND USE

* Should the decision be made that the third runway is acceptable but is not to be built immediately, immediate action should be required to address and mitigate the concerns of those who will eventually be impacted in order to eliminate any uncertainty in respect to a decrease property value, restrictions on for future property expansion, and potential buyout/relocation.

* The Chamber does not support terminal expansion to the South (Alternative 4) as it will force eight businesses to relocate and will affect sales and property tax revenue to the City of SeaTac.

* The Chamber recommends that in any case in which businesses that are not on Port property are forced to relocate due to proposed terminal build-out/expansion, the Port of Seattle actively relocate those businesses within as close proximity as possible to preserve jurisdictional revenues. R-7-36

SOCIO-ECONOMIC IMPACTS

* If master plan development occurs, there is a concern that the surrounding jurisdictions may suffer loss of revenue due to loss

of business, loss of residential properties, and lowered property values due to the business and residential buyout and relocation.

AIR QUALITY

* Section 9 does not adequately address the issue of air quality as it relates to the effects on individual properties. Expansion of terminal gates would allow for the use of an increased number of airplanes causing greater impacts to immediately surrounding areas such as those directly adjacent to these terminals along International Boulevard. We recommend that appropriate mitigation measures be developed in order to alleviate resultant impacts. R-5-9 R-10-43

TRANSPORTATION

* The Chamber questions the assumption that (based on a market economy) the increase in passenger and cargo traffic will occur to the extent projected in the DEIS in the "do nothing" option. R-3-7 R-9-21

* The Chamber recommends that under all four alternatives, the extension of SR 509/South Access should occur concurrently with master plan development.

* If master plan development occurs, local transportation infrastructure will be impacted as a result of increased use of the airport due to an increase cargo and passenger trips. The assumption that the southern entrance to the airport will remain at level of service "C" through the year 2010, when it will be located one block from an intersection that today is at level of service "F", does not seem reasonable nor accurate (absent SR 509/South Access development). R-9-12

* Mitigation measures to pay for transportation/expansion related improvements, both local and regional, must be regionally supported by those communities opposed to having a supplemental airport in their communities. The residents and businesses in the City of SeaTac and the surrounding communities have been asked over the years to absorb all of the costs and impacts. The region must now be accountable for its decision to locate all future air transportation plans at Seattle-Tacoma International Airport. R-9-20

CONSTRUCTION IMPACTS

* Construction called for in the master plan will have tremendous impacts to the local communities surrounding the airport. It is our opinion that the DEIS does not clearly identify the social and economic disruptions resulting from construction activity. R-12-19

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* Roads used for construction must receive regular maintenance throughout the project and full overlay at project completion to bring roads back to preconstruction standards. R-12-22

AESTHETICS AND URBAN DESIGN

* The Chamber of Commerce recommends that the DEIS should identify plans for development that are aesthetically consistent with the international gateway theme and the surrounding communities' visions for local and regional image enhancement. R-18-23

MISCELLANEOUS

* It is our opinion that the DEIS does not adequately identify measures of mitigation as related to water usage. If master plan development occurs, it should be better defined as to what will be the source for increased water usage, how rates may be affected for businesses in the community, and how future property development may be impacted. R-13-4

Thank you for this opportunity to comment on the Airport Master Plan DEIS. If you have any further questions or need clarification on any of the above items, please contact the Southwest King County Chamber of Commerce at 575-1633.

Sincerely,

On behalf of the Executive Committee and Board of Directors of the Southwest King County Chamber of Commerce

Nada Hughes

Nada Hughes
President

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GREATER FEDERAL WAY CHAMBER OF COMMERCE

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August 2, 1995

REC'D ANM-610
PLAN, PGM, & CAP BR
AUG - 2 1995
ANM-610

Mr. Dennis Ossenkop
Federal Aviation Administration
Northwest Mountain Region
1601 Lind Avenue, SW
Renton, Washington 98055-4056

Subject: Draft Environmental Impact Statement for
Proposed master Plan Update Development Actions

Dear Mr. Ossenkop:

The Greater Federal Way Chamber of Commerce has reviewed the Draft Environmental Impact Statement and the Board of Directors has recommended that the following comments be made regarding the proposed development actions at SeaTac Airport.

1. The Port of Seattle should consider using King County Airport (Boeing Field) as an alternative to constructing the third runway. This alternative appears to have the potential to accommodate commuter aircraft activity thus increasing the operational capacity of the region. R-4-4

2. The Draft Environmental Impact Statement should revisit the impact of construction on those communities which will be affected by the transportation of fill to SeaTac Airport. The Chamber believes that there are inaccuracies in the calculation of equivalent vehicle trips to represent truck/trailer trips. Alternative truck routes should be provided to lessen the impact of truck traffic by providing temporary direct access to freeways. R-12-27 R-12-15

3. The Port of Seattle must be directed to mitigate and be held accountable for mitigating homes, businesses and schools by the airport expansion (noise, vehicle traffic, construction impacts). R-10-8

4. The Environmental Impact Statement implies that the third runway will be used for landings of smaller aircraft during poor weather operations. If the third runway is used for additional aircraft operations, additional mitigation must be stipulated up front. R-6-13

5. The extension of the existing runway(s) for operations without load restrictions and for Runway Safety Areas is not recommended unless tied to the construction of the third runway.

We appreciate the opportunity to comment on the DEIS. The Federal Way Chamber of Commerce believes a strong viable SeaTac International Airport is in the best interest of our community and the Puget Sound region. We are however concerned about the physical impact the airport and the four post plan has on Federal Way and the surrounding communities. Every effort must be made minimize this impact. R-5-4

Sincerely,

Bob Green
President/CEO

Vision:
The Greater Federal Way Chamber of Commerce provides dynamic leadership for the business community in economic, political, educational and social decisions.

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Puget Sound Regional Council
PSRC

RE[illegible]
PL[illegible] [illegible]R
AUG - 4 1995
A[illegible]

August 3, 1995

Mr. Dennis Ossenkop, Airports Division
Federal Aviation Administration
1601 Lind Avenue SW, Suite 540
Renton, WA 98055-4056

Dear Mr. Ossenkop:

Thank you for the opportunity to comment on the Draft Environmental Impact Statement (DEIS) for the Master Plan Update for Seattle-Tacoma International Airport. This response is separated into two parts: General Comments, to be reflected where appropriate in the Final Environmental Impact Statement (FEIS), followed by Specific Comments on sections in the DEIS. Our comments, for the most part, are focused on regional planning issues, rather than site-specific impacts.

GENERAL COMMENTS

THE REGIONAL COUNCIL DECISION

Puget Sound Regional Council (PSRC) Resolution A-93-03 and subsequent Resolution EB-94-01 affirm support for a third runway, subject to conditions of noise reduction and feasible demand and system management actions. A determination of whether these conditions are satisfied is to be made no later than April 1996.

In response to the PSRC resolution and subsequent Implementation Steps, an Expert Arbitration Panel on Noise and Demand/System Management was established to determine whether noise reduction objectives and demand or system management actions have been scheduled, pursued and achieved. R-2-5

The FEIS should discuss how the Port of Seattle will apply the noise reduction goals it submits to the Panel to future noise mitigation efforts, as well as any feasible demand/system management actions identified to make the airport operate more efficiently. The FEIS should incorporate the latest information developed as part of the Expert Panel process. The Port should consider whether to obtain the Panel's final report (due by April 1996) prior to finalizing the FEIS.

As part of its mitigation program, the Port should consider continuing to track the additional noise metrics, as well as the other mitigation goals, beyond 1996 to assess success over time, relative to the goals it will establish. R-4-5 R-4-31E

In affirming its support for a third runway for Sea-Tac, the Regional Council also called upon the region to work with the state to enact legislation allowing for substantial and equitable incentives and compensation for communities impacted by the proximity of essential public facilities. The Regional Council is following through on this decision and, while legislation can't be guaranteed, it may be appropriate to discuss such legislation as a possible mitigation measure. R-7-38

1011 Western Avenue, Suite 500 • Seattle Washington 98104-1035 • (206) [illegible] • FAX [illegible]

THE RELATIONSHIP TO REGIONAL COUNCIL'S FLIGHT PLAN FEIS HEARING EXAMINER'S FINDINGS

The Flight Plan EIS deferred many issues to the site-specific project review level. In particular, in our scoping letter of February 10, 1994, the Regional Council commented that the Sea-Tac Environmental Impact Statement should respond to site-level issues identified by our hearing examiner during the appeal of the Regional Council's Flight Plan non-project Final EIS. R-2-8

The FEIS analysis of public services/utilities impacts (including solid waste and local transportation impacts) should be more specific. The analysis should include a jurisdiction-by-jurisdiction breakout of the expected impacts. There are several small suburban cities in the vicinity of the project and the impact on them may not be spread uniformly. The analysis should also include an estimate of the cost of the additional public services and utilities, and an assessment of the ability of the affected jurisdictions to fund those projects consistent with the capital facilities elements of their comprehensive plans. R-18-18

Similarly, the analysis of socio-economic impacts should be undertaken on a jurisdiction-by-jurisdiction basis. Like the public facility costs, the socio-economic impacts may vary significantly from jurisdiction to jurisdiction.

THE REGION'S LONG-TERM AIR TRANSPORTATION CAPACITY NEEDS

The previous Flight Plan study concluded that the addition of a new runway at Sea-Tac would not, by itself, meet the region's long-term air transportation capacity needs, based on forecasts of 524,000 annual operations by the year 2020. Subsequent studies of a Major Supplemental Airport to augment Sea-Tac found that there are no feasible sites for such a facility within the four-county region.

Current Master Plan Update Forecasts project 441,600 annual operations for Sea-Tac by the year 2020. While the DEIS discusses how the addition of a new runway will improve the poor weather operating capability of Sea-Tac, it does not discuss the overall capacity that will be achieved by the addition of a new runway. Previously, the efficient operating capacity for Sea-Tac was estimated to be 380,000 operations per year. R-3-24

The FEIS should discuss what the operational capacity of Sea-Tac is with the addition of a new runway and the implications and timing for future air capacity, so that the region will have a clear understanding of any remaining unmet need.

TRAVEL DEMAND

The DEIS analysis of surface transportation impacts is based on forecasts of travel demand derived from the preferred alternative as described in the December 1994 Draft Metropolitan Transportation Plan (MTP). This alternative included a strong transportation demand management and pricing emphasis. The plan ultimately adopted by the Regional Council does not include pricing. The analysis of regional system performance under the adopted plan indicates higher levels of vehicular traffic and congestion on the freeways and arterial system. R-9-2

The impact of this change should be carefully reviewed in preparing the FEIS, but may be somewhat mitigated by the generalized manner in which the airport is treated in the PSRC regional travel demand modeling process, and the specific site-level analytical techniques used by the DEIS consultants. The Regional Council is available to help develop this new information, if requested. R-9-1

Further, as one method to help manage travel demand and improve air quality, ground transportation strategies discussed in the FEIS should include review of remote terminal possibilities (e.g., see Geoffrey Gosling, ed., Proceedings: Ground Access to Airports, ITS with FAA support, October 31-November 2, 1994). Remote terminals might be included with proposed multimodal terminals underway in Seattle (King Street Station) and Tacoma (Tacoma Dome). This could be discussed in Chapter 9 - Air Quality, and elsewhere as appropriate. R-10-47 R-9-20

SPECIFIC COMMENTS

The following comments are given in order by section.

Section I Chapter 1 - Background

Paragraph 1 (3), Regional Airport Planning, in order to be complete, should include the following additional statements:

> This resolution establishes three conditions for proceeding with a third runway at Sea-Tac: (1) the feasibility of a major supplemental airport, and whether it could be put into service in time to eliminate the need for a third runway; (2) implementation of noise reduction objectives; and (3) feasible demand and system management actions.
>
> In response to the requirement in A-93-03 for independent evaluation of demand/system management and noise reduction action for Sea-Tac, the Executive Board established an Expert Arbitration Panel to make decisions in these areas binding upon the Regional Council. R-2-9

The description of Resolution EB-94-01 (on page 1-5) should include additional paragraphs on noise, demand management, and incentives/compensation:

> BE IT FURTHER RESOLVED, that the decision of the Executive Board of the Puget Sound Regional Council is to affirm the General Assembly's approval of a third runway for Sea-Tac, provided the project meets the independent evaluation of the noise and demand management conditions set out in Resolution A-93-03, and satisfies the environmental impact review process.
>
> FURTHER, the Executive Board recommends that the region work with the State to enact legislation allowing for substantial and equitable incentives and compensation for communities impacted by the proximity of essential public facilities.

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On page I-6, the population and employment forecasts are referred to as the "most recent" in the aviation demand section. These forecasts should be referenced as four-county regional forecasts, as noted in Table I-1 on the same page.

Section II Chapter 2 - Alternatives Considered

On page II-15,the paragraph that begins, "The O&D air service area..." should include the word "population" in the following sentence: R-4-5

> During the PSRC study, one of the site evaluation criteria was the percentage of the Puget Sound Region <u>population</u> that was 10 minutes closer to a site than are presently closer to Sea-Tac.

Section IV Chapter 1 - Noise Impacts

On page one, the population located within the 65 DNL contour in year 2020 is expected to be roughly 10,000 under all alternatives. This is *half* the figure forecasted in the Flight Plan PEIS (Table C-1). Please explain the cause for this reduction. R-3-7

Section IV Chapter 2 - Land Use

R-7-26

On page 1, the Regional Council, rather than the U.S. Census, is cited for Census Summary Tape File 1B.

On page 7, item 5, please mention the 1995 Update of VISION 2020 in the first paragraph under "Compatibility of the Sea-Tac Airport Master Plan Update With Local and Regional Land Use Plans."

Page 11 through 13. Please add a footnote to your statement that the draft Comprehensive Plans for Des Moines (p. 11), Normandy Park (p. 12), and Burien (p. 13) "may be inconsistent with...PSRC resolutions and VISION 2020 policies." The footnote should include the following language:

> The Regional Council is currently engaged in a process to review local comprehensive plans. The plans for Des Moines, Normandy Park and Burien have not been adopted and thus have not been reviewed for consistency with VISION 2020 policies.

Page 15. In the text and footnote, please cite the initial version of VISION 2020 as "VISION 2020: Growth and Transportation Strategy for the Central Puget Sound Region, Puget Sound Council of Governments (1990)."

On page 15-6c, there seems to be a problem with the year 2020 Alt 2 volume for South 154th St near International Blvd. Should the volume read 17,500, not the 175,000 shown?

Page 16.

1. Please correct the title of VISION 2020 and MTP in the footnote as follows: "VISION 2020: 1995 Update, Puget Sound Regional Council (1995)," and "1995 Metropolitan Transportation Plan."

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2. Please update the number of RT-8.28 to reflect the number in the 1995 Update, which is RT-8.31. R-7-26

3. Please discuss how the proposed action relates to the following policies. If it is addressed elsewhere in the DEIS document, please reference the specific location. These are policies we have identified as most relevant to the Draft EIS. There may be others you deem pertinent to this project to which you may also want to respond. R-7-30

   - RC-2.6 -- This policy addresses the need to protect public health and the environment when providing services and facilities.
   - RC-2.7 -- This policy promotes coordination of urban development with natural resource conservation and planning.
   - RC-2.10 -- This policy addresses the need to equitably distribute public costs and benefits among jurisdictions.
   - RH-4.4 -- This policy addresses the need to preserve existing and promote additional affordable and special needs housing and to provide affordable housing in or near urban centers and transportation corridors.
   - RO-6.6 -- This policy encourages environmentally sensitive development practices.
   - RE-7.11 -- This policy fosters land management practices that preserve natural resources.
   - RT-8.6 -- This policy promotes efficient multimodal access to facilities, such as airports, seaports, and inter-city rail stations.
   - RT-8.11 -- This policy promotes demand management programs to shift demand away from single-occupant vehicle travel.
   - RT-8.14 -- This policy emphasizes transportation investments which provide alternatives to single-occupant vehicle travel within urban centers and along corridors.
   - RT-8.40 -- This policy encourages the use of local labor when building transportation facilities.

4. Impacted area roadway (facility) improvements for the years 2000, 2010, and 2020 (pages IV.16-6e, IV.15-6f, IV.15-6g, respectively) are consistent with those assumed in the Metropolitan Transportation Plan. Roadway improvements in the FEIS should reference which local or county plan they are being taken from, including the year of anticipated completion. This is handled differently throughout the report. Overall, references can be found, but one must read thoroughly. R-9-19

Mr. Dennis Ossenkop
Federal Aviation Administration

Page 6

The Do-Nothing alternative, page II-35 and other pages, assumes that the Sea-Tac airport would remain as it is today. This implies that there would not be a south access road. The travel demand data provided by the Regional Council does assume the south access road. This may be inconsistent with the DEIS Do-Nothing alternative's assumptions. If so, it would have been more appropriate to use a modified Regional Council alternative when analyzing the DEIS Do-Nothing alternative. The exclusion of the south access road would most likely show more serious congestion in those areas cited in the Level of Service (LOS) and Air Quality sections. R-4-13 R-9-16

Appendix B - Alternative Airport Sites

Page B-6 lists the sites screened for the supplemental airport study. It should be noted that the Stanwood/Conway, Maryville East, and the Thun Field sites include two sites each, as shown on the attached Summary of Initial Site Screening. R-4-6

Again, thank you for this opportunity to comment on the DEIS - Master Plan Update. Please contact me at 464-6663 if you have any questions regarding these comments.

Sincerely,

Gerald Dinndorf, Director
Growth Management Planning

Attachment

cc: Doug Sutherland, President, Puget Sound Regional Council
Gary Locke, Vice President, Puget Sound Regional Council
Bob Drewel, Chair, Puget Sound Regional Council Transportation Policy Board
David Russell, Chair, Puget Sound Regional Council Growth Management Policy Board
Barbara Hinkle, Port of Seattle

Summary of Initial Site Screening

(Ordered North to South)

SITE		LOCATION	COMMENTS
1	Samish Bay	Northwest of Mount Vernon	Out of four county area
2	Skagit Regional Bay View Airport	Existing Airport, Northwest of Mount Vernon	Out of four county area
3 & 4	Stanwood/Conway	Two sites in area. West of I-5 near Snohomish/Skagit county line	One site carried through
5	Arlington Airport	Existing Airport Site	Site carried through
6	Marysville West	West of Marysville & I-5	Site carried through
7 & 8	Marysville East	Two sites in area. East of Marysville, N. of Lake Stevens	One site carried through
9	First Air Airport	Existing Airport, West of Monroe	Dropped due to size constraints
10	Campbell Airfield	Existing Airport, East of Fall City	Dropped due to size constraints
11	Harvey Field	Existing Airport, S. of Snohomish	Dropped due to size constraints
12	Bothell	North of Bothell (Mill Creek Area)	Site carried through
13	Martha Lake Airport	Existing Airport, Northwest of Mill Creek	Dropped due to size constraints
14	Duvall	Northwest of Duvall	Site Carried through
15	Redmond	East of Redmond	Site Carried through
16	Boeing Field	Existing Airport	Dropped due to size constraints
17	Renton (Boeing) Airport	Existing Airport	Dropped due to size constraints
18	Port Orchard Airport	Existing Airport, West of Port Orchard	Dropped due to size constraints
19	Lake Sawyer	West of Lake Sawyer & Black Diamond	Site Carried through
20	Enumclaw	West of Enumclaw	Site Carried through
21	Auburn Municipal Airport	Existing Airport, North of Auburn	Dropped due to size constraints
22	Lake Tapps	East of Lake Tapps	Dropped due to instrument approach capability
23	Buckley	West of Buckley	Dropped due to instrument approach capability
24 & 25	Thun Field	Existing Airport, two sites in area	Dropped due to instrument approach capability
26	Shady Acres Airport	Existing Airport, East of Spanaway	Dropped due to size constraints
27	Spanaway	South of Spanaway	Dropped due to local airspace evaluation
28	Bremerton National Airport	Existing Airport, West of Sea-Tac	Dropped due to size constraints
29	Gig Harbor	Gig Harbor Area	Dropped due to construction costs
30	Tacoma Narrows Airport	Existing Airport	Dropped due to size constraints
31	McChord AFB	Existing Airport	Site Carried through
32	Fort Lewis Gray Field	Existing Airport	Dropped due to local airspace evaluation
33	Kapowsin Airport	Existing Airport, North of Kapowsin Lake	Dropped due to size constraints
34	Frederickson	Southeast of Spanaway	Site Carried through
35	Harts Lake	South of Fort Lewis Military Reserve	Dropped due to local airspace evaluation
36	Tanwax Lake	South of Fort Lewis Military Reserve & West of Lake Tanwax	Site Carried through
37	Vashon Island	Vashon Island Area	Dropped due to size constraints
38	Lacey	Northeast of Olympia	Out of four county area
39	Olympia Airport	Existing Airport	Out of four county area
40	Tenalquot	East of Olympia	Out of four county area
41	Sunnydale	South of Olympia	Out of four county area

TAMS Consultants, Inc.

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A. Brown
239 SW 189 Place
Normandy Park, WA 98166
August 2, 1995

REC'D ANM-610
PLAN, PGM, & CAP BR
AUG - 2 1995
ANM-610

Dennis Ossenkop
FAA Airports Division
ANM-611
1601 Lind Ave SW
Renton, WA 98055-4056

Dear Mr. Ossenkop,

The Regional Commission on Airport Affairs will be including my comments to the DEIS with their formal submittal. I've also enclosed a copy of my report to be certain it reaches you on time.

I'd like to add the questions enclosed with this letter.

Thank you for taking the time to read this and for your efforts on this subject.

Respectfully yours,

A. Brown

A. Brown

Enclosures
Report
Additional Questions

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Topic 1 : Economic Practicality (SEPA term)

(1a) Why hasn't the Sea-Tac Third Runway Alternative been dropped now that the Draft Environmental Impact Statement (DEIS) has identified exorbitant costs for such a small increase in air traffic ?

(1b) Do the airlines realize that the cost of the Third runway is equivalent to paying somewhere between $ 19 and 40 Billion dollars for a full time runway? Has the impact on airline user fees been fully considered ?

(1c) Considering these high costs, shouldn't the Third Runway be denied based on its failure to meet the State Environmental Act's economic practicality requirement (WAC 11-440 (6) c iv and WAC 197-11-660 (2)) ?

R-18-2

Justification for the above questions:
On a per aircraft basis, the Third Runway would be the most EXPENSIVE runway in the WORLD. Using even the incomplete cost estimates in the DEIS, the Third Runway will be about DOUBLE the average cost of the runways at the new Hong Kong Airport when calculated on a per aircraft or per passenger basis. Considering that Hong Kong's $21 billion effort [1] included not only an airport with two runways, but also a new suspension bridge, highways, railway link, creating a man-made island, and a new town, the projected costs of the Third Runway should cause quite a scandal when they become publicized.

R-18-3

Paying about $1.5 Billion [2] for a <u>part</u> time runway that increases departures by only 2.8 % and arrivals by 12.1 % [3] is equivalent to paying about $ 19 BILLION dollars for a <u>full</u> time runway.

The additional runway at Tampa cost about $ 48 million and one at Baltimore cost $ 55 million[4]. Denver's new 5 runway airport, INCLUDING support facilities

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for baggage, and rental cars, etc., averaged about $ 700 million per runway[5]. Note, these costs are in the **millions, not the billions like Sea-Tac.**

If all the "Third" runway costs were considered, including those that will be borne by Department of Transportation as well as the decrease in residential real estate tax revenue, than the actual costs will exceed the total costs of the new Denver Airport [6]. On a per aircraft basis, it will be almost four times the cost of the expensive Hong Kong runways that are on a man-made island. That's the equivalent of about **$ 40 BILLION dollars** if it was a full time runway.

Ironically, we will be paying a huge cost, both in dollars and environmentally, to achieve an improvement in air traffic that is so small, it could be obtained by implementing Localizer Directional Aid (LDA) technology instead [7].

Considering the Port's debt has risen to 35% can we really afford the Third Runway ?

R-18-2

1 Travel Weekly Sept. 19,1994 page 73 and April 15,1993 page 14.
2 Sea-Tac Airport Master Plan Update Draft Environmental Impact Statement (DEIS), Ch. II pg. 43.
3 Ibid. Executive Summary page xi.
4 Highline Times, May 14,1995.
5 GAO/RCED-95-35BR, Gives costs for 5 runway airport including Rental car agencies etc.
6 Engineer's Personal Assessment of the Sea-Tac Airport Master Plan Update Draft Environmental Impact Statement (DEIS) - Proposed Third Runway, The United States' Most Expensive, Limited Capacity Runway", A. Brown, 19 July 1995. See enclosure (note also contains more information on the other footnotes above)
7 Implementation of LDA/DME Approach to Runway 16R in lieu of a Third Runway", G. Bogan & Associates, La Quinta , CA , June 26,1995.

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Topic 2 Controversy

(2a) Why doesn't the last section of DEIS Chapter 5 (4. Degree of Controversy) mention the allegations of improper procedures ?

Justification for Question:
There have been numerous allegations published in the newspapers regarding improper conduct where even WA elected officials such as Vance accuse the process of being "rigged" (Highline Times April 29,1995). It is not just the activists in the anti-runway organizations making these very serious allegations. Also, see testimony from the Arbitration Panels and the DEIS June 1,1995 hearing (bribery questions).

(2b) Can the project be delayed if it can be proved the public was given misleading information ?

R-18-19

Justification for Question:
DEIS Chapter 5 appears to assume that the information provided by the Port to the public is comprehensive and accurate. It assumes the University sessions and meetings, were information tools. According to newspaper accounts, participants at the University Sessions said the teachers were unable to answer important questions. Were the sessions similar to the Forum newsletter that is published by the Port ? The Forum newsletter summarizes the DEIS fill transportation issue as "57 trucks an hour" which paints a different picture than the actual DEIS data that indicates over 3000 truck trips a day. Or, were the University sessions more like the DEIS Open House, just an exercise in frustration because your asking questions the consultants are unwilling to answer ?

(2c) Can the project be delayed if it can be proven it was inadequately review by governmental agencies?

Justification for Question:
At least one governmental agency as of July 10,1995 still had not distributed the DEIS to its technical personnel for review. At some reviewing agencies, tha people responsible for distributing the DEIS to technical people for review, are very open about being FOR the Third Runway because "we need it for growth".

Could their personal bias impact the quality of the review process ? Also, the DEIS could lead you to believe something is not an issue by reading one section but actually, there is an issue, it is just reported elsewhere in the document. The reviewer really needs to read the entire DEIS to find all the relevant data on their area of expertise.

Topic 5: Salmon

The salmon in the impacted creeks, with the help of organizations like Trouts Unlimited and Marvista School, are now recovering from the mid-1960s aviation fuel spill.

(5a) What will the environmental impact be on the salmon?

(5b) If the salmon are added to the endangered list prior to next April, what will the impact be on this project ?

(5c) Will rerouting creeks, inadequately controlled sediment from the fill, less pollution mitigation from current wetlands (because they'll be gone), lead to killing all the salmon in Miller creek?

R-15-3

Topic 6: Bald Eagles

(6a) What will the environmental impact be on the bald eagles?

(6b) If I can get pictures or a video of the bald eagles that live by the airport, will that delay the approval process ? Could it lead to the denial of the Third Runway project ?

Justification for Questions:

At least once a month, I see bald eagles near or on airport property (almost every time I drive near the airport with my child in the car)

R-15-1

Topic 7: Chemical Pollution

(7a) If it can be shown that the current air toxin annual levels are exceeded, what mitigation, if any, are required ? A decrease in air traffic ?

(7b) If the air toxin standards are tightened, would air traffic have to decrease ?

Justification for Questions:

DEIS indicates we probably already exceed annual safe levels for air toxins but the tests were discontinued prior to obtaining the necessary data.

Spider web patterns in the flight path are irregular due to the pollution. Unlike the current air toxin level chemical tests that the public normally does not become involved with, things like spider web patterns[1] anyone can monitor. As the public becomes more aware of the hazards of pollution and easier ways to detect it, such as spider web patterns, more public attention is likely to focus on chemical pollution issues. Things like Material Data Safety Sheets make it easier for the non-chemist to find out the harmful side effects of aviation fuels, de-icers and other aircraft related materials.

[1] "Using Spider-Web Patterns to Determine Toxicity", NASA Tech Briefs, April 1995, page 82.

R-16-47

Topic 8 : Third Runway Construction

(8a) Have Third Runway or lengthening existing runway construction related activities begun ?

(8b) Has airport related construction that is needed to meet the 1988 safety codes begun, that would not be required if the Third Runway is denied ?

(8c) Is the July 1995 surveying on 192 Street and Des Moines Memorial Drive (starting at 192 and moving north from there) related to the Third Runway, the runway extension, or any other unapproved project ?

Note : the term "related activities" was used so the question is broader in context then just "construction" which could be interpreted to not include surveying, moving fill to the area, making improvements in the land adjacent to where the Third Runway will go, etc.

R-12-1

Topic 9 : Car and Truck Accidents

(9a) Has the fact that key intersections for transport of fill such as S 188th and Pacific Highway South as well as the south bound ramp of SR 518 where it meets SR 509, are rated as "high accident locations" been fully considered ?

(9b) Don't the mitigation measures fill transport need to be more fully addressed to determine if it's even feasible to transport the amount of fill necessary ?

R-16-13

Justification for Questions:
Department of Transportation accident data

**Engineer's Personal Assessment
of the
Sea-Tac Airport Master Plan Update
Draft Environmental Impact Statement (DEIS)
Proposed Third Runway, The United States'
Most Expensive, Limited Capacity Runway**

July 19,1995 -- For submittal to Dennis Ossenkop, Federal Aviation Administration, Airports Division, ANM-611,1601 Lind Ave SW, Renton, WA 98055-4056 by Aug. 3,1995

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Abstract

Contrary to Third Runway proponent claims, the Third Runway will severely stifle air traffic growth in the region. Sea-Tac airport can't possibly take advantage of the incredible world wide growth predicted - 5.1 % passenger and 6.1 % cargo ANNUAL growth well into the next century. The Third Runway will increase departures by ONLY 2.6 % and arrivals by 12.1 % TOTAL according to the Draft Environmental Impact Statement (DEIS). Compare those numbers to the Sea-Tac airport's current ANNUAL growth of about 11% for 1993-1994.

Because the area is unsuitable geologically, environmentally, and is already populated by endangered species, homes and businesses, the cost for this project is at least 30 TIMES what a typical runway construction project should cost. **It may even be cheaper to build a whole new airport !** To extend one runway and create land for a part time runway by bringing in about 1 MILLION truck loads of fill to the wetlands and residential neighborhoods surrounding the airport is NOT a cost-effective solution.

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Acknowledgments

Many thanks to all the various engineers, construction experts (owners to flagmen), Realtors and government officials who volunteered their time to discuss these issues with me. Also, I'd like to express my appreciation to my family who donated some of our precious time together so I could prepare this. Although this contains the author's opinions, the information that led to those opinions has been included.

Note to the FAA

Every effort was made to supply sufficient information to justify the questions herein. It is my belief that this report, and the questions it contains are "substentive". It is hoped that you will share this opinion.

The long term economic welfare of our region is in your hands. The air traffic growth estimates clearly indicate that the Third Runway will stifle growth in our region rather than promote it. Either expanding other airports, or building a new one, will have a higher return on investment and be lower risk than the Third Runway project. The estimates for Third Runway construction have more than tripled over the last year and are still incomplete. Although a QUANTITATIVE cost-benefit analysis is not required for an EIS, a " weighing or balancing alternatives" with respect to economics is REQUIRED by SEPA. The prior Alternative Site evaluations grossly underestimated the Sea-Tac environmental and fill source issues. Therefore, a supplemental EIS (SEIS) that addresses other alternative sites, Sea-Tac fill issues, and other issues identified herein is now REQUIRED. (Economics : SEPA WAC 197-11-726,197-11-448 (1), 197-11-197-055 (6), 197-11-440 (6) c iv , 173-806-125, Alternatives : SEPA 197-11-030 g,197-11-060 (4) c),197-11-060 (4)d, 197-11-070 (1), 197-11-440 (5) b, 197-11-786)

Note to Legislators

Please take the a few minutes to at least review the enclosed tables and figures even if you don't have time to read the entire report.

Abbreviations and Acronyms

CASE	Citizens Alternatives to Sea-Tac Expansion
DEIS	Draft Environmental Impact Statement
DNL	Day-Night Average Sound Level
DOE	Department of Ecology
EIS	Environmental Impact Statement
ES	Executive Summary of DEIS
FAA	Federal Aviation Authority
KC	King County
KCCP	King County Comprehensive Plan
Ldn	Day-Night Average Sound Level
LOS	Level-of-Service
NEPA	National Environmental Policy Act of 1969
NPDES	National Pollution and Discharge elimination ()
SEIS	Supplementary Environmental Impact Statement
SEPA	State Environmental Policy Act of 1971
SR	State Route
WAC	Washington State Administrative Code (SEPA rule)

Definitions

Airport Communities Coalition	Group consisting of Burien, Des Moines, Normandy Park, Tukwila, and the Highline School District
Arbitration Panel	Panel appointed by State Transportation Sec. Morrison
Cost-Benefit Analysis	See WAC 197-11-726
Port	Port of Seattle
Reasonable	See WAC 197-11-786
Significant	See WAC 197-11-794

Table of Contents

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List of Tables and Figures

Tables and Figures in Appendices

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1.0 SUMMARY

Is it irresponsible to build a runway project at Sea-Tac that
costs over 30 times more than comparable runways (see Figure 1),
by transporting 923,000* truck loads of fill,
to a high probability landslide area that's by an earthquake fault
on wetlands,
where people and endangered species are living ?

This creates
More pollution that exceeds safety standards,
Destroys Wetlands** and increases flooding,
Devalues property by 20% to 80%,
Drastically reduces the local residential real estate tax revenue base,
Uproots thousands from their homes and businesses,
Subjects thousands of more people to sleepless nights because the noise measuring system allows the equivalent of a motor bike to be turned on regularly in your bedroom, just so long as it doesn't run continuously.

The Sea- Tac Third Runway will:
Be inadequate about 10 years*** after completion,
Postpone addressing real air traffic regional growth needs,
Cause a NATIONAL SCANDAL when the economic truth becomes known.

* May not include the 15% additional fill indicated in DEIS appendix
* Excavate about 10 acres but pollute far more than the 152 acres in the study area.
* * Official Port estimate in "The Third Runway Watch", distributed July 1994. Produced by the Airport Communities Coalition. Author believes it will be inadequate before completed if National growth projections are correct.

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The Third Runway only increases Departures by 2.6 % and Arrivals by 12.1 %[1] Will this limited capacity runway be the Most Expensive Runway in the World, or just the United States ?

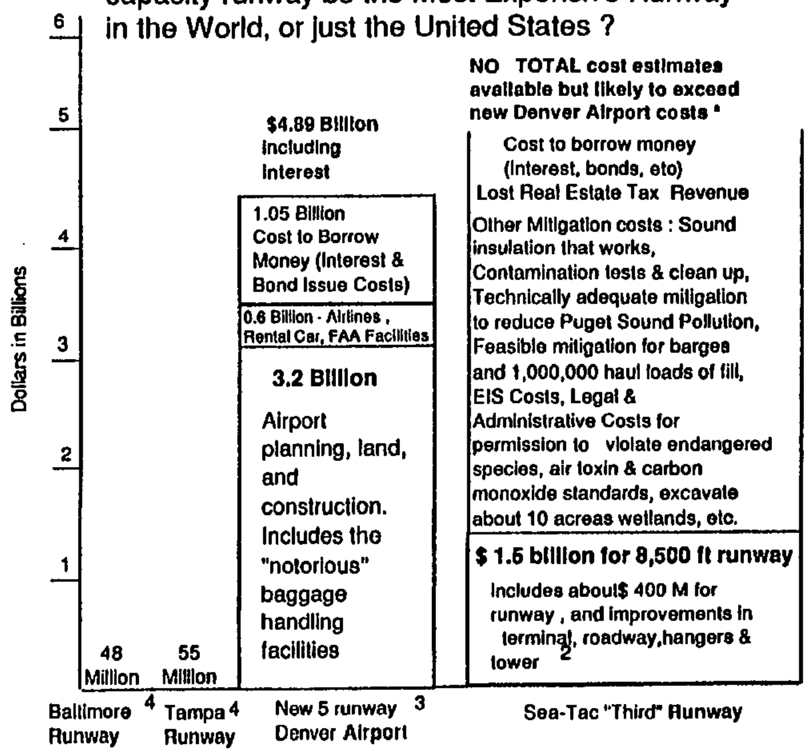

Figure 1 : Will the Third Runway cost more than the New Denver Airport?

1 Per Draft Environmental Impact Statement Executive Summary
2 Per Draft Environmental Impact Statement Chapter II, pg 43
Note, 1994 $500 million estimate no longer valid
3 Denver numbers from GAO/RCED-95-35BR
About $ 18 enplanement fee ($22.50 cap plus inflation). 14.6 to 17 Million per year enplaned. User fees about 3 times old airport.
4 Baltimore & Tampa data from Highline Times, May 14,1995
* Neither total costs or cost-benefit analysis in DEIS

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The Third Runway will cause a scandal that leads to billions of dollars in law suits to recover the billions of dollars in lost real estate revenue and accusing the EIS of failing to adequately address the environmental, health and economic impacts as required by SEPA and other regulations.

Ironically, the 8500 foot Third Runway option is still too short for fully loaded cargo planes to use in warm weather. Consequently, another runway has to be lengthened by 600 feet. Also, an improved tower, assorted other buildings, safety upgrades etc., are needed. Because the Third Runway is projected to be able to handle **ONLY 2.6 % of the departures** and 12.1 % of the arrivals, the Port projections indicate this multi billion dollar project will be **inadequate about 10 years from the time it is finished**[1].

Appendix C contains articles on world wide growth projections for air traffic. They forecast an ANNUAL growth for **passengers** of 5.1 % which means doubling by 2007 and **tripling by the year 2014.** Even larger growth is predicted for cargo ! For cargo, the annual growth of 6.6 % translates to an **increase of 3 1/2 times by 2014.**

Considering Baltimore's new runway cost only $48 million, and Tampa's cost $55 million, how can we justify paying **OVER A BILLION** dollars for an **INEFFICIENT runway that can't possibly handle the potential growth ? If all the costs are considered, the Sea-Tac Third Runway will cost more than Denver's entire new airport** (See Appendix B for Denver costs). R-18-2

[1] Official Port estimate in "The Third Runway Watch", distributed July 1994. Produced by the Airport Communities Coalition.

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Even the man-made island near Hong Kong, the $ 21 billion Chek Lap Kok International Airport project, is more attractive financially than the Third Runway. To obtain 35 million passengers annually, they paid $ 7 million for a 3000 acre airport . Also, $14 million was spent on land reclamation, railway link, suspension bridge, highways, and a new town. [1] The Third Runway is going to reduce delays, NOT significantly increase business, and will cost over $1.5 billion. This estimate EXCLUDES billions in lost tax revenue and some mitigation costs that were not included in the DEIS's estimate (II-43).

Considering the FAA's recent denial of more slots for New York's JFK and LaGuardia, Washington National and Chicago O'Hare[2], does it really make sense to try to squeeze most of Washington's air traffic into just Sea-Tac ?

Either the project proposal should be denied or, a Supplementary Environmental Impact Statement (SEIS) should be prepared. The SEIS could correct the inaccuracies in the DEIS, address Alternate Sites, address feasibility of obtaining the huge amount of fill, identify credible mitigation measures[3] , and identify ALL significant Adverse Impacts. Chapter V, "Adverse Impacts", needs to add the following : air toxins, endangered and threatened species, construction vehicle congestion, property tax value devastation and, the significant reduction in the tax revenue base of Burien, Normandy Park and Des Moines. This is required to be compliant with the State Environmental Protection regulations (SEPA)[4] which are discussed herein.

[1] Travel Weekly Sept. 19,1994 page 73 and April 15,1993 page 14.

[2] "Four Busy Airports Denied More Slots", Aviation Week & Space Technology , June 26,1995, Page 31.

[3] The term "credible mitigation" is used here to summarize the SEPA criteria i.e. "feasible" and "economically practicability" and also includes technical adequacy.

[4] Economics : SEPA WAC 197-11-726,197-11-448 (1), 197-11-197-055 (6), 197-11-440 (6) c iv, 173-806-125, Alternatives : SEPA 197-11-030 g,197-11-060 (4) c),197-11-060 (4)d, 197-11-070 (1), 197-11-440 (5) b, 197-11-786 etc.

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2.0 DISCUSSION OF DEIS VALIDITY

Table 1 summarizes just some of the issues. It would take man years of effort to dispute all the misleading statements in the DEIS report. Consequently, this only addresses those that time permitted.

A. Most of the DEIS data does not support the conclusions.

Data indicates the Third Runway is bad for the environment, people's health and the location is geologically unsuited. The remainder of this report provides data that supports this opinion. See Table 1 for a summary of some of the issues.

B. DEIS conclusions are based on false premises

Assumes "virtually all of the available air traffic improvements and technical improvements have been implemented". Compare ES pg. iii with the Arbitration Panel findings or testimony of the pilot at the DEIS 1 June 1995 hearing evening session. R-3-218

Assumes that there are NO reasonable alternative sites based on prior out-of-date comparison studies. R-4-3

Assumes both the current and projected noise contour maps are correct.

Uses a tiny study boundary area that neglects the majority of area impacted both from economic and environmental standpoint (i.e. neglects those areas outside the official study area that are regularly exposed to unsafe noise levels and pollution, and whose property values are being devastated), R-5-3

Dismisses or ignores the geological and environmental hazards (landslide, erosion, earthquake FAULT, "at risk" property such as gasoline stations to be acquired, etc.).

Assumes problems can be mitigated without impacting schedules.

Assumes problems can be mitigated cost effectively.

Assumes mitigation measures will be implemented in a timely manner and that they will be effective even though the mitigation measures from the runway completed in 1973 still aren't fully implemented, and were not as effective as planned.

C. When data is incomplete or missing, the issue is dismissed rather than pursuing data that will NOT justify the Third Runway. This is inconsistent with SEPA regulations which require critical data be obtained when it can be done so economically (WAC 197-11-080 (1)).

No data on erosion hazard north of South 192 per IV pg. 4 was available, according to the DEIS, consequently it assumed erosion would not be a problem. This conclusion is contrary to the implications of DEIS Appendix F data. [R-11-1]

Estimated average values for MANY air toxins above the allowable annual limits and aircraft per cent contribution projected to increase (IV pg. 7-8) but tests were not run long enough to prove the area already exceeds the allowable annual limits.

Appendix indicates 15 % more fill is needed than originally assumed, to compensate for shrinkage, but not all the other areas of the DEIS may have been updated to reflect this significant increase.

TABLE 1 Assessment Summary of DEIS Sheet 1 of 14

Legend: Not an issue ○ Some Concern ◒ Significant Problem ●
? Insufficient data

Topic	DEIS Reference	DEIS Data	DEIS Conclusion	Assessment Conclusions	Comments
Endangered Species (Bald Eagles, Peregrine Falcons, Blue Heron, Spotted Frog etc.)	ES xi, App K Exhibit 3, pg. 15, 31 App M pg M-3	●	○	●	Bald eagles living on west and north side of airport. Coastal survey spotted eagles but ES concluded they weren't in the study area. Study area not visible from survey sites I - see DEIS Appendix K for endangered, threatened and candidate species being impacted.
Landslide Hazards	IV 19-4	?			The Third Runway location is a landslide hazard area See DEIS Appendix F and King County Hazard map
	App F (Miller Creek)	◒	○	●	
Erosion Hazards	IV 19-4	?	○	●	West side airport problem

TABLE 1 Assessment Summary of DEIS Sheet 2

Topic	DEIS Reference	DEIS Data	DEIS Conclusion	Assessment Conclusions	Comments
Earthquake fault	Not addressed specifically see below	not addressed - see below	not addressed see below	●	Contact U of WA, Geophysics or see Science News Vol. 147
Seismic Anomalies	IV 19-4 IV 19-11 IV 19-12	◓	◓	●	Mitigate by removing & replacing unstable soil per DEIS
Wetland destruction	ES xv Chapter IV, section 11	◓	◓	●	"Significant Adverse Impact" . Mitigation doesn't address impact on bald eagles, etc. Improving wetlands in the south Green basin won't help the frogs at Sea-Tac. See Port's NUMEROUS citations for violations of their National Pollution and Discharge elimination (NPDES) permit (Pollution Monitor, summer 1995, Vol 1, Issue 1, CASE)
Wetland boundary area	ES x IV 7-9	Based on Noise contour ?		●	The real area impacted is much larger than the "152 acres" because of KNOWN pollution problems. The almost 10 acres to be excavated does not represent the entire impact.

TABLE 1 Assessment Summary of DEIS Sheet 3

Topic	DEIS Reference	DEIS Data	DEIS Conclusion	Assessment Conclusions	Comments
Floodplains	ES xv	◓	◓	●	"Significant adverse impact" - Permits & Compensatory mitigation required
Flooding	ES xiv Table IV 10-1	◓	○	●	Detention storage volume required. Minimum size required by regulation technically inadequate for this location.
Thermal Pollution from Impervious Land	Table IV 10-2			◓	Additional 193 acres of watershed to be made impervious. Runoff water is a different temp when it comes off tar & concrete instead of grass. Can be colder or hotter depending on season
Storm water flows	ES x, xlii	●	○	●	Flows will increase and can't be fully mitigated
Higher % pollution in creeks and Puget Sound	ES xiii indicates decrease but see, ES xv and IV10-1, IV 10-5, IV10-6 (falls side), IV 10-10, IV 10-12	●	○	●	Creeks were repopulated after aviation fuel spill in 1980's killed fish. See Port's NUMEROUS citations for violations of their National Pollution and Discharge elimination (NPDES) permit (See Appendix WQ)

TABLE 1 Assessment Summary of DEIS Sheet 4

Topic	DEIS Reference	DEIS Data	DEIS Conclusion	Assess-ment Conclu-sions	Comments
Suspended solid levels in water	IV 10-9, IV 10-10, IV 10-11, IV 19-12	◓		●	Considering the depth of the fill is as much as 160 feet, "Best Practices" may not provide adequate protection
Traffic Accidents	IV 23-2			●	Over 3000 truck trips per day on already congested roads will increase the number of accidents
Traffic Improvements Needed	see below	◓	○	●	Assumes govt. funded improvements like SR 509 extension will occur.
Traffic Congestion	ES xiii IV 23-2 Surface Trans App J	◓	◓ Mitigation Not required	●	Doesn't admit to current traffic problems already occurring on Perimeter Rd from current airport construction - 5 minute delays at 5:30 AM even. Doesn't address on-site or off site haul routes adequately. Main intersections already operating at E and F LOS levels.

TABLE 1 Assessment Summary of DEIS Sheet 5

Southcenter Mall area economy	see above			●	Potential of about 2000 truck trips per day between Black Diamond /Enumclaw and Sea-Tac area which will increase traffic. Will shoppers still come?
Water transport of fill	App J Fig C-2			●	What are the environmental and economic costs ?
Air Toxins	IV 7-6 thru 7-9 ES xiii* (missing from Chapter V)	●	○	●	Will increase per DEIS. Probably already above safety standards (DEIS IV 7-8 (c)). Need construction contribution too. Should be addressed in DEIS Ch V, "Adverse Impacts"

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TABLE 1 Assessment Summary of DEIS Sheet 6

Topic	DEIS Reference	DEIS Data	DEIS Conclusion	Assessment Conclusions	Comments
Carbon monoxide levels due to the slight increase in air traffic	ES xiii ES xiv IV 23-2	◓	◓	●	DEIS mentions mitigation but some areas already exceed safety standards
Carbon monoxide levels due to construction	IV 23-2 ES xiii* see data in App J Table C-3 on pg 6	●	◓	●	DEIS data uses wrong baseline assumptions such as year 2000 pollution controls for construction that is suppose to be complete by then. DEIS mentions mitigation that is implemented would extend the schedule by 3 to 10 years! Some intersections already above safe levels. Calculations need to use existing background pollution quantities and add the contribution from ALL construction vehicles & equipment to that amount. Also, need more calculations for the REAL haul routes.

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TABLE 1 Assessment Summary of DEIS Sheet 7

Topic	DEIS Reference	DEIS Data	DEIS Conclusion	Assessment Conclusions	Comments
Total noise projections	ES xi and ES xiii* declines but IV 7-5 says increase		○	●	Does not consider any aircraft going to alternative sites or using demand mgmt to increase passenger/cargo efficiency.
Noise contour software	App C pg 34 Table C-8	○	○	●	New version reduces existing noise by 18 % using inappropriate assumptions.
Costs to provide noise insulation	ES xiii*, IV 2-5, IV 7-4, V-3,		○	●	Much larger than DEIS assumed. Most homes not "cold climate" construction so boundary needs to be enlarged to account for 25 dBs. Even fairer, insulate all over 45 dBs (see IV 7-4) ! Also, costs to redo existing homes that had the lower quality insulation packages need to be addressed, not just the $35 million (V-3)
Noise measurement methodology	IV 7-2		○	●	65 DNL not safe criteria due to terrain. Cold climate construction assumption invalid.

TABLE 1 Assessment Summary of DEIS Sheet 8

Topic	DEIS Reference	DEIS Data	DEIS Conclusion	Assessment Conclusions	Comments
Noise impact on health	IV 7-2 ES xiii*	●	○	●	Already unacceptable for most of the surrounding cities when based on dBs rather than noise models
Noise impact on accident rate	IV 7-3	●	○	●	Can't hear cars on streets over 2 miles from 65 DNL - see Arbitration testimonials - Airplanes so loud children can't hear cars
Noise impact on communication	IV 7-2	●	○	●	45 dBs and above causes measurable detrimental impact
Lost school time due to noise	IV 7-2 IV 7-3	◓	○	●	Lose 45 minutes each day average for Highline school district per Arbitration hearing 12/1/94. Third runway is beside at least one elementary & 2 High Schools
Noise will be less with Stage 3 aircraft	C pg 26 ES xiii*	◓	○	●	B747 stage 3 are noisier than Stage 2 (C pg 26). Other Stage 3's may be less dBs but last longer. Increased quantity of cargo planes increases noise too.

TABLE 1 Assessment Summary of DEIS Sheet 9

Topic	DEIS Reference	DEIS Data	DEIS Conclusion	Assessment Conclusions	Comments
Noise impact on crime	ES xiii*		○	●	Areas exposed to aircraft noise have higher crime rates. Note, Sea-Tac airport is zoned "Adult Entertainment so crime risk is even higher than some studies indicate (Highline Times 1/11/95 pg 1).
Official Noise sensitive areas	IV 7-2 ES x		○	●	Full time daycares like YMCA and Kindercare are excluded. Not a consideration when regulations written.
Property values	ES xiv IV 7-2, 7-5 IV 7-4	◓ ○	○	●	Already devalued 10 - 50 % in last few years and still plunging - see enclosed NP data and King County Court House records
Burien, NP, Des Moines Home Real Estate Tax Revenues excluding acquisitions	IV 7-2, IV 7-4	No area data provided	○	● ●	Billions of dollars over the next 15 years will be irrevocably lost.

TABLE 1 Assessment Summary of DEIS Sheet 10

Topic	DEIS Reference	DEIS Data	DEIS Conclusion	Assess-ment Conclu-sions	Comments
Sea-Tac Real estate tax revenue due to acquisitions	ES xiv	◓	○	Not researched to date by author	DEIS says about 5% loss so insignificant
Uprooted businesses	ES xiii	◓	○	◓	Per DEIS: 105 businesses 822 jobs $292 million property tax
Uprooted families	ES xiii	◓	○	◓	per DEIS: 389 homes & 260 condos/apartments so thousands of people
Neighborhood physical safety	IV 7-2	◓	○	◓	History of parts falling on our school grounds. Additional risks due to unapproved parts on planes, see Aviation Week May 22,1995 pg 33 Most fatal accidents around airport, see Aerospace 5/22/95
Runway accidents due to congestion				◓	FAA beginning to focus on this as a concern, see Aviation Week April 24, 1995 pg. 31
Cargo plane capability	II-6	●		●	Third runway too short for fully loaded cargo planes when warm so need to extend another runway 600 feet

TABLE 1 Assessment Summary of DEIS Sheet 11

Topic	DEIS Reference	DEIS Data	DEIS Conclusion	Assess-ment Conclu-sions	Comments
Departure Capability	ES xi	●		●	**Provides only 2.6% increase - See** Appendix C growth estimates of tripling by 2014
Arrival Capability	ES xi	●		●	**Provides only 12 % increase - See** Appendix C
FAA contribution to funding				●	Due to changes in funding policies, only a very small amount of this project will have FAA assistance, unlike the new Denver airport
Public road repairs due to high usage of heavy haul trucks				●	According to King County official, Port not planning to pay for these costs. Also see Appendix E article herein.
Planning and Construction costs	II - 43	$ 1.5 billion (estimate appears to have tripled over the last few months)		●	**Probably 100 times higher cost than comparable runway projects due to unsuitable location. DEIS $1.38 Billion construction estimate excludes many costs**

TABLE 1 Assessment Summary of DEIS Sheet 12

Topic	DEIS Reference	DEIS Data	DEIS Conclusion	Assess-ment Conclu-sions	Comments
Construction risks		Not addressed ?		●	How long does it take for 8 Kingdom's worth of fill to "settle" so its safe to start construction? Denver airport's construction is now settling, leading to repairs. We need 160 foot deep fill in some locations.
Ongoing Repair Costs of all solid surfaces put on wetlands or clay like soil				●	Repair frequency & costs? The area where fill covers wetlands will fluctuate as the underground water levels change.
Fill dirt contamination risks	IV 7-9, IV 21-1	◓		◓	Any contamination in fill dirt will end up in Puget Sound. Should add budget for tests. Will the fill from airport area be too contaminated to use?

TABLE 1 Assessment Summary of DEIS Sheet 13

Topic	DEIS Reference	DEIS Data	DEIS Conclusion	Assess-ment Conclu-sions	Comments
Availability & Cost of Fill				●	Due to environmental issues the amount of airport owned land available for excavation was cut to a third of what was planned (Corp. of Engrs recommendation). Alternative sources are needed. Not all area sources are willing to sell to the Port the amount needed. See Appendix E
Test costs & Clean up costs of "at risk" sites	IV 21-1	◓		◓	High probability of contamination at acquired gas stations etc.
Asbestos removal in acquired buildings				●	Have the hundreds of buildings been inspected to determine if asbestos or other hazards present?
Claims that black speckled black particles are burnt fuel	Residue Sampling discussion D63	○	○	●	Slight rewording of lab report misleading -"inconsistent" is different than "More consistent with fireplace soot" when referring to samples taken from a house rafter Invalid test methodology. Uncontrolled samples (house rafter, clothesline) instead of fungi inert collector plate
	Lab report D95 - D96	◓			

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TABLE 1 Assessment Summary of DEIS Sheet 14

Topic	DEIS Reference	DEIS Data	DEIS Conclusion	Assessment Conclusions	Comments
37,300 TEMPORARY construction jobs	ES xiii	○	○	●	What % of the temporary jobs will be filled with people new to the area that will file unemployment within a few years
Demand Management	ES		●	○	See Arbitration Panel data and RCA comments
Sea-Tac 4th and 5th runway impact	Not mentioned ?			●	SEPA requires this be addressed particularly, if alternative sites not addressed
Alternative Sites	Based on prior studies		●	○	Alternative sites were dismissed because of an 1994 **inaccurate** assessment of feasibility of Sea-Tac Third runway
Port failure to implement mitigation measures properly for 1973 2nd runway				●	Performance bonds for all mitigation measures should be required considering past performance (sound insulation, pollution, growth underestimated, etc.)

ES xiii" " In general, adverse environmental impacts are expected to decrease..."

Legend: Not an issue ○ Some Concern ◒ Significant Problem ●
? Insufficient data

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D. When the data is conflicting as to the extent of damage something inflicts, the report concludes that there is no detrimental impact.

If it doesn't deafen you, noise is OK (the essence of the last sentence pg. 7-5 section IV, contradicting many of the preceding pages).

E. The study area is much too small to provide an accurate assessment of the damage to be inflicted by the Third Runway.

Wetlands well beyond the study area will be impacted because of the creek and underwater paths. It appears the study area was dictated more by the noise contour map than potential wetland impact. It is NOT just the approximately 10 acres that are to be excavated that are in jeopardy. R-14-1

Losses in real estate revenue alone will be in billions but the report states, there is no change in property value on IV pg. 7-4 when assessing economics. However, on IV pg. 7-5 the report states "noise property value related stress" will continue upon implementation of the Third Runway.

F. Falsely assumes that all problems can be mitigated satisfactorily and economically

How can carbon monoxide levels that already exceed safety standards be "mitigated" when about 200 haul trucks an hour, 16 hours a day must travel around in a tiny area ? The 57 "haul truck" number quoted in the Port's "Forum" dated May 1995 is misleading because it is for one direction of off-site haul trucks only. "On-site" trucks are those that drive only on the PUBLIC streets of Burien and Sea-Tac (see IV 23-2). How can the harmful pollution be reduced without either, (1) significant pollution control devices being placed on hundreds of trucks or, (2) increasing the length of construction time ? The suggestion to move the employee parking area can't compensate for pollution from **about 200 haul trucks that are constantly moving 16 hours a day plus all the other construction vehicles.** The giant puffs of black smoke coming from the existing airport construction are already enough to gag those unfortunate enough to be trapped behind them. See area map Figure 2 and construction vehicle estimates in Table 3 (section 3.6). R-10-47

R-10-47

How can you mitigate air toxins like benzene considering the large number of construction vehicles running at least 16 hours per day for years ?

Based on the Port's past mitigation record, can anyone really believe the mitigation measures will ever be fully implemented unless they are tied to performance bonds ? People are still waiting for sound insulation for the runway completed in 1973. The DOE is still citing the Port for permit violations related to pollution. Imagine what the level of compliance would be if the Port wasn't trying to get a Third Runway approved.

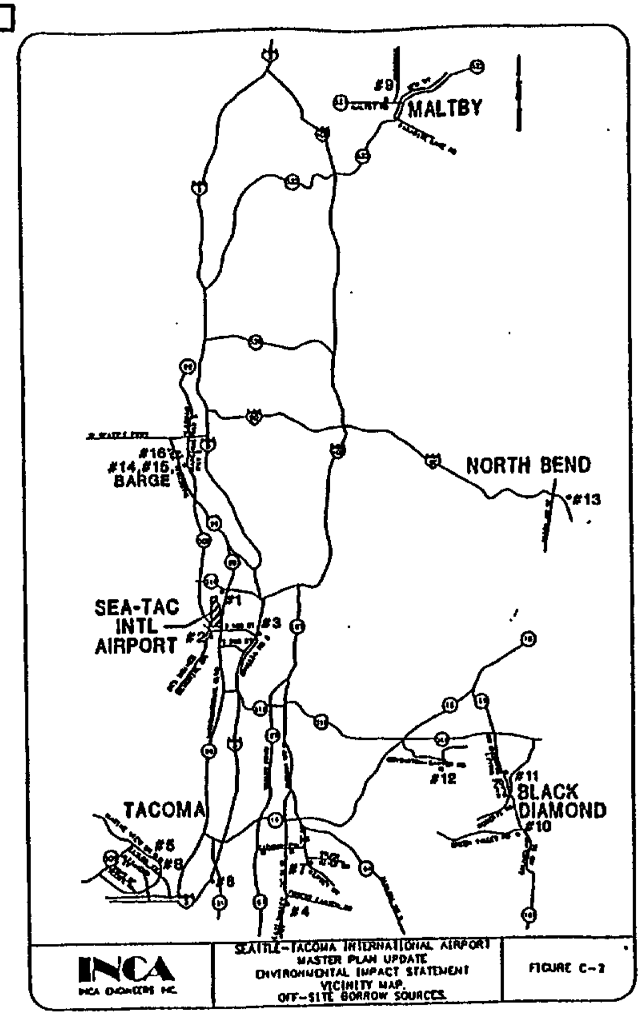

Figure 2 Area Map

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G. Doesn't address the differences in community's perception of noise and vibration with the highly disputed computer noise contour models

Why aren't the results from the Arbitration hearings, particularly those related to noise addressed ? R-3-5

Property values are determined by single event dBs not statistical models that use DNLs. Please see section 3.4 herein.

The noise monitoring stations are so close to the airport that the data collected can't be used to validate the noise models. Please see section 3.5 herein.

Is increasing the number of people exposed to the type of noise depicted in Figure 3 really logical considering only a **2.6 % increase in departures and 12.1 % increase in arrivals** is projected ? Considering the Sea-Tac's Air traffic growth for 1993-1994 was about 11%, having an additional 2.6 % departures available sometime early in the next century seems short sighted, particularly when it's going to cost in the billions just for the construction. See appendix C which contains world wide growth projections of ANNUAL growth of 6.6 % for cargo and 5.1 % for passenger air traffic. This potential business will bypass Seattle if we build a Third Runway instead of positioning Washington to meet air traffic demand. R-3-7

H. Not fully compliant with Regulations

To be a fully compliant with policies and regulations many issues need to be addressed more fully. Table 2 lists some issues that the EIS needs to address to comply with SEPA. These are in addition to the other issues addressed elsewhere within this report.

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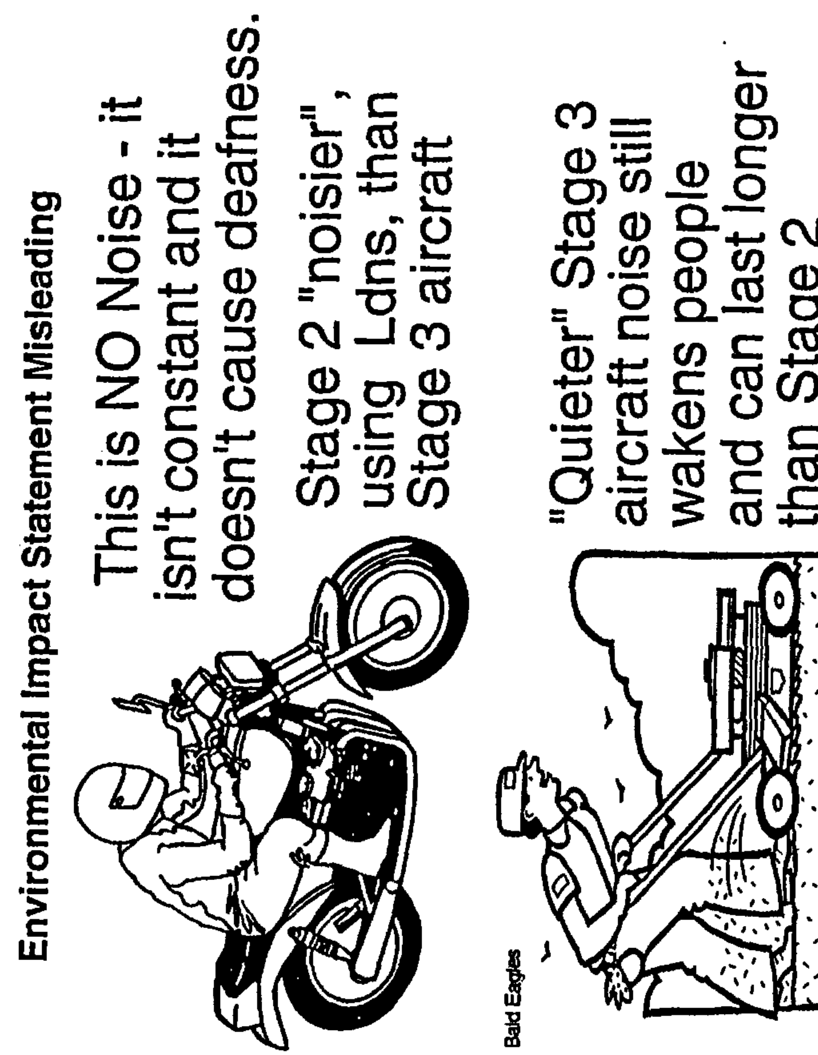

Figure 3 How Statistics and Computers Make Noise Disappear

I. There were significant changes to underlying critical assumptions during the preparation of the DEIS that a Supplementary Environmental Impact Statement (SEIS) is needed.

The significant increases in projected economic and environmental costs for the Third Runway identified in the DEIS, invalidates the prior comparisons with Alternative Sites. If the DATA in the DEIS is considered, it no longer appears to meet the "economically practicability" criteria (SEPA WAC 197-440 (6) c iv). The issue of Alternative Sites needs to be reopened. R-3-9

As of July 10, 1995 at least one CRITICAL government agency still had not distributed the DEIS to the engineers responsible for evaluating their respective sections.[1] He said that he did not intend to distribute it until "later in the week". He said they would be reviewing it, to determine if their prior comments had been incorporated.

Isn't there a high probability that the engineers will be unable to do a thorough assessment due to the short time they will have the DEIS to review ? Unless they are planning to go without sleep, less than two weeks isn't enough time to read the other disciplines' sections to discover all the inconsistencies that are RELEVANT to their section, and then reassess their section in light of the new data.

When I described how the Wildlife and Fisheries Department told me that Department of Ecology (DOE) was handling certain issues, the DOE said the Corp. of Engineers was handling them, and the Corp. of Engineers said Wildlife and Fisheries was handling them, in other words I was sent full circle, he explained that because of the political controversy surrounding the DEIS, they would address only areas that were very clearly within their jurisdiction.[1] R-1-7

What happens to the issues in the "gray areas", or those that impact more than one discipline or more than one agency ?

[1] Dates and names were recorded for all conversations but if I 'm avoiding divulging them because it is not my intent to hurt anyone's career. I just want to ensure technically competent people are given adequate time to do their job AND that each issue is fully addressed, i.e. doesn't fall through the crack because of jurisdictional misunderstandings.

Table 2: Regulatory Compliance Issues Page 1 of 4

Issue	SEPA Regulation
FULLY address other REASONABLE alternative sites	WAC 197-11-070 (1) WAC 197-11-060 (4) c& d WAC 197-11-030 item g WAC 197-11-440 (5) b WAC 197-11-786
The "weighing and balancing" with respect to economics and the logistics of the additional off-site fill now required for Sea-Tac must be compared to the other Alternative sites.	WAC 197-11-448 (1) first sentence
Fully address Demand Management alternative	WAC 197-11-786
Address probable impact from 4th & 5th runways	WAC 197-11-060 (4) c, d
Address impact of "reserving for some future time" the implementation of this project	WAC 197-11-440 (5) viii
Add cost-benefit analysis. Considering cost estimate tripled over several months and will be the most expensive US runway, and has a limited capacity (too short for cargo planes in warm weather)	WAC 173-806-125 WAC 197-11-726 WAC 197-11-055 (6) WAC 197-11-600 (4) c)ii
Address Property devaluation of ALL significantly impacted locations - Burien, Normandy Park, Des Moines, Sea-Tac, Tukwila	WAC 197-11-600 (b) i, and (d), ii
Address the ACTUAL transportation plans for the about 1,000,000 haul loads of fill. Is it possible to be economically practical? Barges are NOT fully addressed in DEIS.	WAC 197-11-660 (2) WAC 191-11-440 (6) c, iv
Acquire missing critical data such as erosion, landslide & earthquake hazards, air toxins, ground water movement/quality, etc.	WAC 197-11-080 (1) WAC 197-11-660 WAC 197-11-444 (c),iv WAC 197-11-600 (b), ii and (d), ii

Table 2: Regulatory Compliance Issues Page 2 of 4

Issue	SEPA Regulation
Investigate noise projections	WAC 197-11-600 (b) ii, (d) ii
Address impact on existing "brown-out" problems related to electric utilities	WAC 197-11-600 (b), ii and (d), ii
Address pollution and safety impacts of aircraft crashes	WAC 197-11-794 WAC 197-11-600 (b), ii and (d), ii
Address air toxin levels in Chapter V, Item 4. Data suggests it already exceeds annual safety levels and will not be mitigated	WAC 197-11-080 (1)
Revise misleading calculations such as carbon monoxide levels	WAC 197-11-080 (1)
Add SPECIFIC mitigation measures	WAC 173-806-100 (c) WAC 197-11-660
Proposed mitigation measures UNREASONABLE (feasible ones could double construction schedule and some aren't feasible)	WAC 197-11-660 (1) f ii
Fully address mitigation using the "appropriate technology". No mention of new technology like infrared hangers for deicing[1] and concrete barriers for running off runways[2].	WAC 197-11-768
Suggest REASONABLE and feasible mitigation measures. Example: Can over 3000 trucks per day really avoid rush hour near businesses and an airport that are open 24 hours a day ?	WAC 191-11-440 (6) b,i and (6) b ,iv WAC 197-11-660
Address "Economic Practicability" of mitigation measures. Note, some required mitigation for the 2nd runway completed in 1973 are still incomplete.	WAC 11-440 (6) c iv WAC 197-11-660 (2)

[1]Aviation Week, "FAA Tests Infrared Deicers", May 1,1995, pg. 30
[2]Aviation Week, 1995

Table 2: Regulatory Compliance Issues Page 3 of 4

Issue	SEPA Regulation
Provide mitigation schedule and bonds considering the decades old mitigation agreements still have not been fulfilled (pollution and noise related)	See King County Rules in addition to SEPA rules
FULLY address monitoring of environmental impacts	WAC 197-11-660
Publicly retract published misleading information - see Forum	WAC 197-806-130
Revise conclusions not supported by date for which the data is readily available from court house records, government documents, and libraries.	WAC 197-11-080 (1)
Revise ES Summary to reflect the data in the report such as Chapter V disturbance-sensitive species perishing (see Biological Appendix K)	WAC 197-11-440 (6)
Address other related documents such as the Arbitration Panel results	WAC 197-11-055 (6) WAC 197-11-402 (6)
Identify all those impacts which will not be fully evaluated further because regulations governing "on-site" construction are significantly different. Evaluate, conduct tests, and assess these before EIS approval. Example: Excavation and repositioning of contaminated fill that then can contaminate creeks leading into Puget Sound regulation is permitted unless EIS requires mitigation.	WAC 197-11-660 (2)b
Determine if the term" on-site" is appropriately used for sites that are geographically separated by public roads. Identify differences in policies and regulations for on-site compared to off-site.	WAC 197-11-660

Table 2: Regulatory Compliance Issues Page 4 of 4

Issue	SEPA Regulation
Determine the correct Lead and Cooperating agency relationships. SEPA requires DOE to be Lead agency when over 1,000,000 gallons of fuel are involved. Not all agencies provided adequate review of DEIS because they each thought another agency had prime responsibility for that section and they wanted to avoid duplication.	WAC 197-11-938 (10) Note, WAC 197-11-942 does not apply to items listed under 197-11-938.
Consider a NEPA. Current DEIS contains too many fallacies to use it to justify the Third Runway.	WAC 197-11-610
Include a map identifying all the environmental sensitive area issues [1>	WAC 197-11-908
Fully address pollution from aircraft crashes and major fuel spills	WAC 197-11-794 (2)
More fully address aircraft parts falling onto school grounds now that even more schools are in the "fall-out" zone	WAC 197-11-794 (2)
EITHER DENY THE PROPOSAL or require a SEIS to identify feasible, technically adequate, and economically practicable mitigation measures. Present DEIS mitigation measures are TECHNICALLY INADEQUATE such as the water pollution control methods ,not all Significant Unavoidable Impacts have been addressed such as the homeless endangered species and (3) inadequate information regarding fill source locations which will certainly create a "Significant Adverse Impact". The SEIS needs to address Alternative Sites.	WAC 197-11-600 (4)d ii WAC 197-11-660 WAC 197-11-330 WAC 173-806-100 (c) WAC 11-440 (6) c iv See Alternative Site rules first Table 2 entry

[1> The author recognizes that such a map would need to be very large in order to be legible because most of the area is sensitive for MULTIPLE reasons (unsteble soil, threatened & endangered species, wetlands, sloped, etc.)

3.0 ADDITIONAL DETAILS

3.0 ADDITIONAL DETAILS

Note, not all items in Table 1 are addressed in this section.

3.1 Inaccurate Geological Information

There is a high probability of landslides according to King County report, but none according to DEIS section IV, except possibly one school. However, DEIS Appendix F page 8, discusses landslides. See Figures 4 and 5. R-11-1

The airport is by an earthquake fault of the type that is more destructive than the typical type (a magnitude 6 will do the damage of a typical magnitude 8 originating offshore) according to various scientific journals including Science News Volume 147. However, the DEIS report mentions only two minor seismic anomalies that will require removing and replacing the soil.

What will the effect of the increased vibration from increased volume of cargo planes be on the ground in the vicinity of the 600 foot extension as well as the Third Runway ? Houses shift continually, as well as creak and groan, in the Burien and Normandy Park regions because of the soil type, water level under the ground, and seismic activity. R-11-4

Fill that is on top of clay and wetlands can not be packed down to prevent future settling. What percentage of the new hard surface areas fall into this category of soil? How much will the ongoing repairs cost ?

To be compliant with SEPA, the landslide, erosion, and earthquake FAULT hazards need to be fully addressed and mitigation measures identified.

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...aline is subject to the same ... as the rest of the county," Shad Burcham, program specialist at the King County Office of Emergency Management.

... From bridge and overpass col... possible landslides, folks prepare to be on their own,

A KING County Sensitive Areas map, used as a general planning and development tool, indicates potentially hazardous areas.

Highline has several areas where soil could liquefy during seismic activity. The strong shaking action of an earthquake causes wet or moist soil to behave like a liquid.

Structures on top of the soil sink or shift with landslide action. Liquefaction usually causes the worst structural damage.

The map outlines the tip of Three Tree Point and areas on both sides of First Avenue South just west of Sea-Tac Airport as seismic hazard areas subject to liquefaction.

Houses on the shoreline stretching from Three Tree Point northward are also at risk for landslide.

Due for a shake

Pacific Middle School principal Lamar Strain talks about earthquakes every fall to his students. He does it, not because he holds a masters degree in geology from the University of Washington, but as a

See Big One, page A2

Seahurst Elementary School third-graders Kathleen Costello (front) and Nicole Dydasco dive under their desks during a class earthquake drill.

CONT. # 2

Boy waits as Dad helps out L.A. quake victims

Marc Stiles

BURIEN—Ryan Graves has a simple birthday wish.

The Burien boy wants his dad, Roy Graves, to return home from his medical mission in quake-ravaged Los Angeles.

... birthday is in four more days ... he's not going to be here for it, and I'm kind of sad," said Ryan, who often mulls the perils his father now faces.

He's particularly concerned about an aftershock. "It could really kill him," said the Valley View Elementary School student who turns 8 Monday.

Dr. Graves, a member of the Seattle-King County Disaster

Ryan Graves

See Graves, page A2

Council members examine new city headquarters

By Jennifer Steiner

SEATAC—City hall could have a new home as soon as March if the city council approves a new lease at its Tuesday meeting.

City headquarters are currently housed in a converted elementary school just south of the airport. But City Manager Scott Rohlfs told the council it should expect significant remodeling costs, as well as serious growing pains, if it wants to stay put while staff looks into building a new city hall.

"We are already out of compliance with our own codes," Rohlfs said of the city hall at last Tuesday's study session. "If we're really going to stay here three more years, we have to say we're not special."

Rohlfs predicted it would cost the city about $143,000 to bring the building up to code. And it would take at least three years to construct a new city hall, he said, considering council members haven't even chosen a site on which to build.

Rohlfs showed the council a cost breakdown of renting three different buildings for the next three years. The Alaska Airlines Plaza Building, Sea-Tac Office Center Tower and from its current home, the Angle Lake School Complex were presented over three years.

Remodeling costs at the SeaTac

See City hall, page A10

YOUR COMMUNITY NEWSPAPER-PHONE 241-2722 OR SEE COUPON PAGE 2

Figure 4 Hazard Map

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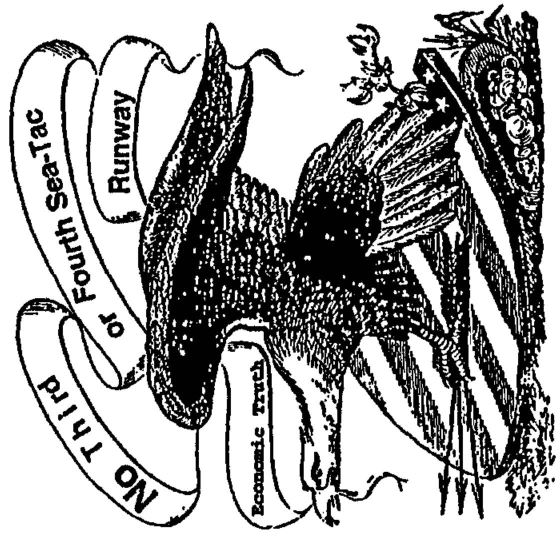
Environmental Impact Summary Misleading

No Endangered Species : Bald Eagles [1]

No Westside Landslides [2]

No Earthquake FAULTS [3]



[1] DEIS Biological Appendix - coastal surveys couldn't see Airport area

[2] King Dept. Parks, Planning and Resources hazards map contradicts IV pg 19-4 or DEIS Appen.F pg 8

[3] Contact U of WA, Geophysics Dept. about faults under Seattle. Also see Science News Vol 147

Figure 5 Inaccurate Biological and Geological Conclusions

3.2 Inaccurate Conclusion on Endangered Species

The DEIS Executive Summary states that bald eagles don't live and breed around the airport. (occasional "transients" exist according to the report - ES pg. xi). After an aviation fuel spill killed the fish in the mid 1980's (see ES pg. x), with the help of some organizations, the creeks were repopulated with fish. The BALD EAGLES moved back and now even at least one baby eagle lives on the west side of the airport along with its parents. They are seen in the spring and summer months so they aren't just wintering here ! These eagles are in addition to the ones at Seahurst that the DEIS Chapter IV mentions.

The DEIS Appendix K mentions the Reba lake observations (north of the current runways) and DEIS Appendix M mentions the southend observations by Tyee Golf course, but they aren't considered in the DEIS Executive Summary because only the official flight paths observed during the COASTAL survey were considered as evidence. The coastal survey sites can't even see the Airport study area to know if there are any eagles. R-15-1

One of my more memorable recent bald eagle observation was in May 1995. A mature BALD EAGLE played in the wind currents of a jet aircraft as the plane took off to the north. The bald eagle was on the south side of Perimeter road (south of Reba Lake, by the north end of runway). That event was definitely more spectacular than watching a baby bald eagle by my home in June 1995. See DEIS Biological Appendix K which shows the coastal survey sites that spotted bald eagles.

In addition, to bald eagles, residents also observe Blue Heron in the vicinity of the airport.

The DEIS Chapter V (Unavoidable Impacts) in combination with the Biological Appendix K, indicate that there is a long list of endangered , threatened or candidate species that may be in the area and will "PERISH" as a result of this project. One can argue that the bald eagles shouldn't be the airport anyway because of flight safety issues, but that argument certainly doesn't apply to spotted frogs[1]. The Executive Summary should reflect this information to be compliant with SEPA WAC 197-11-440 (4) ,assuming the responsible governmental agencies confirm that bald eagles are LIVING and BREEDING near the airport.

Considering state and federal government spent about 3.5 million just on bald eagle protection in fiscal 1990[2], the issues and costs associated with endangered species should not be overlooked. All construction may have to come to a halt if it can be proved that the eagles that are seen regularly by Reba Lake and Tyee Golf Course actually live there. One peregrine falcon stopped the industrial development of Bowerman Basin in 1979[3]. R-15-1

It is important to put the Endangered Species act in perspective. This is Washington State, the home of "tree huggers". There will be more opposition to violating the Endangered Spécies Act here than in some other states, particularly considering we are in easy driving distance of a camp that specializes in teaching environmental activists "how to lie down before road graders and commit other acts of civil disobedience".[4]

[1] Note, bald eagles historically have not been a flight safety issue, for whatever reason, be it their sight or their intelligence, they avoid being hit by aircraft (see DEIS Appendix K).

[2] Strangled by Red Tape, by Craig E. Richardson, Geoff C. Ziebart, The Heritage Foundation, 1995, page 57.

[3] Seattle Times, "Endangered Species Act, Giving Nature a Hand", July 16,1995, pages A1, A8.

[4] Seattle Times, "Environmental Tactics are too staid for some", July 16,1995, pg. B1.

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3.3 Inaccurate Economic Assessment (see also 3.4)

Report ignores that BILLIONS in real estate tax revenues that will be irrevocably LOST. See data in enclosed Appendix B. R-8-10

Report ignores that BILLIONS (possibly trillions if future value of money is used or if include all impacted property) in real estate property values that will be irrevocably LOST. See home devaluation discussion 3.4 that follows and enclosed Appendix B. R-16-9

Report ignores the costs associated with the current 45 minutes a day lost to aircraft noise in Highline Schools, not all of which are scheduled for noise insulation (see Highline School district representative's testimony at Arbitration hearing on 1 December 1994). DEIS just mentions there is an impact. R-7-9

Report ignores the development and implementation costs for sound insulation that really works as opposed to the current methods. As reported at the 1994 noise panel hearings, some times the insulation only provides about a 1 dB improvement - not enough for people to notice, but enough that the Port can declare victory by using sensitive equipment to measure the reduction.

The Port was installing at least three different levels of insulation depending on location and now has switched to using the "best" insulation for all homes. What is the cost to "redo" the homes with the lesser insulation? What quality insulation was assumed in the cost estimates ? The report mentions the costs to redo homes that have already been insulated but now will require more is about 35 million dollars (DEIS V-3), but that doesn't cover all the homes that need more insulation, particularly, if an accurate noise assessment is done (cold climate assumption false etc.). R-7-32

Report ignores the development and implementation costs of pollution control assuming you really are to mitigate the carbon monoxide levels that already exceed safety limits and which will be increased when the 16-57 dump trucks per hour (Port Forum May 1995 estimate) come to dump about 8 Kingdom's worth of fill. The DEIS clarifies that the 57 truck loads for 16 hours per day are probably from the Black Diamond and Enumclaw locations. If you include the

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on-site locations, the total number truckloads of fill is almost 1,000,000 truck loads. In addition, there are an assortment of many other trucks including semi-trailers that will also be working in the area. Note "on-site" haul trucks travel on public roads to get from one airport property location to another. See area map Figure 2. Table 3 identifies some of the public roads that will be used by the "on-site" trucks. Note all these numbers may be too low because they came from the body of the DEIS rather than the Appendix J (Surface Transportation-Construction Impact Report January 11,1995) which indicates larger quantities of fill, and consequently more haul truck trips are required.

What will the fill cost and where will it come from ? Highline Times reports that not all Off-site sources are willing to sell ALL their fill to Sea-Tac, because it would not leave any for their other customers. An article on the first page of Federal Way News (see Appendix E) quotes the president of Milton Gravel Pit which the DEIS assumes will supply 7 million cubic feet of fill as saying,

> *"I probably wouldn't sell all my gravel to one source. It's CRAZY for them to speculate that I have that much gravel available".* R-12-6

If the Sea-Tac fill is too contaminated to use, then even more off-site fill will be needed. Where will that come from, and at what cost ?

Do the cost estimates include ALL the road repairs that the DEIS indicates will be needed because of the high volume of trucks ? No mention is made of the current road improvements both at the north and south sides of the airport. Are they due to the construction as well ? What is their cost ? Is the King County's official's comment to me that the Port does not intend to pay for road construction true? The Appendix E article appears to confirm the Port won't pay. Considering the Road Adequacy standards in Appendix B, shouldn't the Port be required to pay for repairs and improvements ? R-12-15

Report ignores the costs associated with increased crime that studies show accompanies aircraft noise. R-5-2

Report ignores the costs associated with health care for increased cases of depression, stress and allergies from the construction activity and the increased aircraft activity. R-16-5

Report ignores unemployment costs for the temporary construction workers when the job is complete. What percentage of the temporary jobs will be filled by people living within 20 miles of the airport, or within 50 miles of the airport ? What percentage of permanent jobs will be filled with people living within 20 miles of the airport, or 50 miles of the airport ? R-12-19

Report inadequately addresses costs to "remediate" the risk areas such as the contaminated gasoline stations. Did the "at risk" assessment inspect the hundreds of old buildings for asbestos ? Has the price to remove asbestos from the buildings that are being acquired been included in the cost estimate ? Are the costs to clean up the "At risk" sites (gasoline contamination) really so small they're irrelevant at this time? R-12-23

Have contamination tests for fill been planned or priced ? The DEIS indicates it hasn't, but it would be prudent to perform these tests. Any contamination in the fill has only a few miles of creek to travel before it empties into the Puget Sound. Considering the amount of fill that is to come from the airport area, and therefore, some level of contamination is to be expected, tests need to be conducted. Because this fill is on-site, there are not as many regulations governing its use. It is essential that the testing be a condition of the EIS to ensure it will be done. All of Des Moines, Burien and Normandy Park rely on water from the Sea-Tac airport area. R-12-24

What about the hidden costs of people delayed in traffic ? It is already hard to get from one end of Perimeter Road to the other without being stopped for about five minutes to wait for an airport construction truck on week days.

What are the hidden costs from inefficiency ? It takes on the average about 9 minutes to become fully focused on a task. Aircraft noise prevents uninterrupted concentration in the cities surrounding the airport, even well outside the study area. It isn't just learning in schools that is impaired. The efficiency of many job related tasks is reduced by the constant interruptions. R-8-5

What are the ongoing repair costs going to be for all the hard surfaces (like the runways and taxi ways) that alternate between settling and raising as the water level underneath changes ? Fill on top of clay and wetlands can't be permanently compacted.

How much will it cost Department of Ecology and other government agencies to monitor the mitigation measures. Considering the number of citations already received by the Port related to pollution, costs to process violations must be considered are to be expected.

What will the costs be if there are any accidents during construction such as contaminated fill being excavated a few feet above the ground water and then that contamination leaching into our water system.

What about cost of accidents if problems arise with the construction by the water main. Who pays for those problems ? R-8-5

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3.4 Property Values and Local Tax Revenues being Devastated

Typically, the DEIS ignores the devaluation of property outside the boundary area and underestimates the impact inside the boundary area.

The devastation to the real estate revenue to Burien, Normandy Park, Des Moines, and other towns, has been grossly underestimated in the impact report. DEIS mentions only a possible five per cent reduction in real estate revenue because of displaced businesses for Sea-Tac and then dismisses this as insignificant. The impacts on other communities are ignored in this paragraph of the DEIS.

The DEIS doesn't cover the current impact or forecast the future impact even though SIGNIFICANT devaluations have already occurred on home sales in the surrounding communities, particularly outside the boundary study area. Many of the areas whose homes are already devalued because of Third Runway discussions, are OUTSIDE the study boundary area. Aircraft are so loud people can't converse in these locations, but the noise isn't constant, so the Port doesn't consider it a significant problem. R-16-3

Some expensive homes have already experienced a 50 % drop in sales price compared to what a normal appreciation value should be. Even the "average" homes have depreciated and are now worth less than what they were when purchased in the early 1990's. This data is available by reviewing King County Court House sales records.

The average Normandy Park house sales price has gone down dramatically. See Figure 6 and the supporting data in Appendix B. These homes are OUTSIDE the study area, but just the threat of a Third Runway has caused significant decreases in home values. Is it still a preferred community ?

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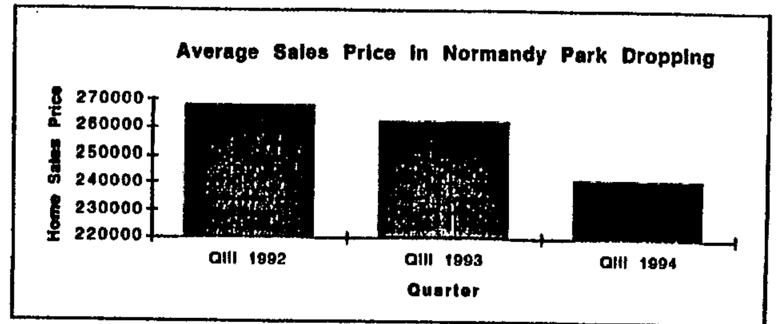

Figure 6 : Average Normandy Park Home Sales Price Dropping ☞

☞ Excludes waterfront homes - see Appendix B for a description of the homes sold.

The reduction in home values began at about the time Burien rebelled against Seattle and became a city in an effort to fight the Third Runway. As shown in Figure 7, the homes in the Normandy Park area stopped appreciating as compared to the average for all the homes in the Puget Sound Multiple Listing (PSML) Association. The difference is actually even greater because the Normandy Park homes are in the multiple listing average as are the other cities surrounding the airport whose property values are also dropping. See Appendix B for substantiating data, note some Normandy Park data excludes waterfront homes.

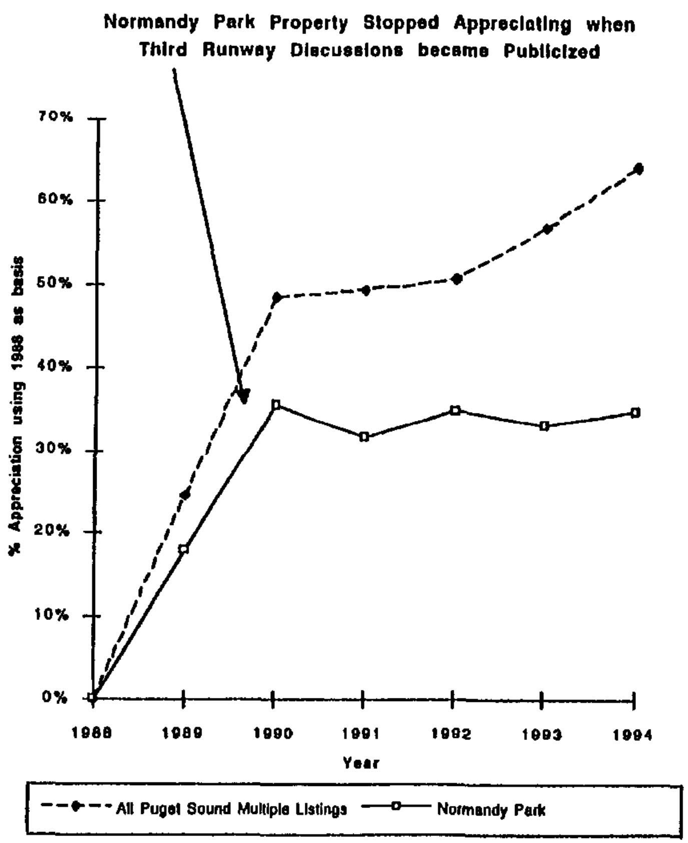

Figure 7 Third Runway Threats Stopped Property Value Appreciation

It is estimated that between now and the year 2020 the amount of **lost real estate revenue will be approximately 10 million dollars** for **a small single family home development near Marvista School** in Normandy Park (Normandy Province). These homes have already gone down in value rather than appreciating, and are expected to fall further when the runway is officially approved. See calculations in Appendix B which are very conservative considering some of the 50 homes have really been devalued by more than the amount used in the calculations ALREADY and a below average appreciation was used for the "without the Third Runway" calculations !!!!. See Figure 8 and the enclosed Appendix B for supporting data.

Imagine what the total loss in property values and real estate revenues would be if all the homes, apartments, and businesses impacted were really considered! **The number would easily be at least in the billions for the tax revenues** alone !

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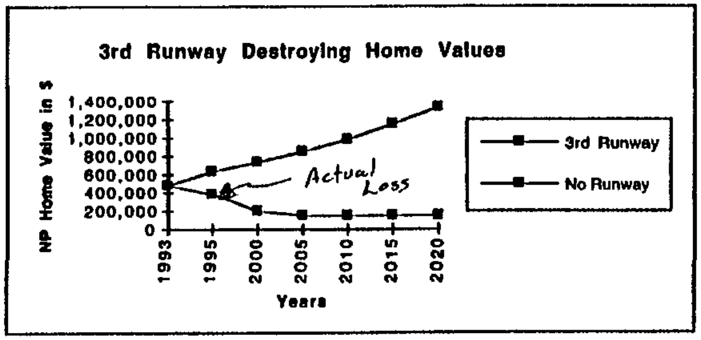
50 Homes adjacent to Marvista School have been devalued by over 33% in the last 2 years because of Third Runway fears. These Normandy Park homes are outside the Generalized study area. For **just 50 homes**, over the next 15 years, this leads to **over $10 million dollars in lost real estate tax revenue.** See graphs below, calculations in Appendix B and house sales records at the King County Court House.



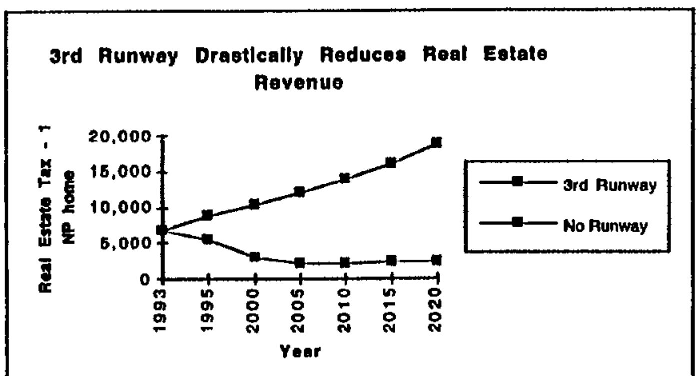


Figure 8 Property Values and Real Estate Taxes Devastated

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3.5 Increasing Noise (See Appendix A also)

The INCREASING noise levels being experienced by the surrounding communities are inconsistent with the noise models that form the basis for the DEIS evaluation. Therefore, the noise projections, must also be incorrect.

What percentage of the homes really are "cold climate" homes so the use of 65 DNL is at least justifiable when comparing to other airport assessments (see IV pg. 7-4). The DEIS assumes most homes are "typical cold climate" and therefore, they would experience a 20 - 25 dB reduction in noise inside compared to outside. Insulation was not required when most of the homes in the impacted area were built, so the cold climate assumption is FALSE in many cases. A much larger area should be eligible for sound reduction. See Appendix D pg. D2. R-7-34

The "upgraded" noise contour model 4.11 reduced the area impacted by noise as much as 16 %, partly due to its new terrain and altitude assumptions, compared to the older model, number 3.9 (See DEIS Table C-8). Residents didn't agree with the earlier model and now it is less realistic. There is noise, despite what the model says, even when the aircraft is not "direct line of sight". The new airport concrete walls do a superb job at bouncing noise all over ,instead of absorbing like the woods and trees did back in the 1980's. R-4-5 R-4-6

The revised noise contour model predicts up to 16% LESS area is impacted by noise for the current conditions. Have ALL the calculations been done with only one version of noise software ? Or, are there some unfair comparisons in the DEIS that use model 3.9 as the baseline noise levels and model 4.11 levels for the future ?

Why are the noise monitoring stations positioned so they can't be used to evaluate the validity of the noise contour model ? See map in Appendix A.

Why has the noise INCREASED when Stage 2 aircraft have been reduced to an "average of less than one per night"[1] ? Does this mean Stage 3 are really louder than Stage 2 ? The DEIS mentions only one aircraft model that the Stage 3 version is louder than the Stage 2. R-6-1A

Do the projections of types of planes to be used include all the projected increase in cargo planes that are really projected ? Do they consider the new cargo planes under current consideration ? Have the impacts of the airlines changing their implementation schedule for Stage 3 been considered [2]? R-6-11

Are heavily loaded cargo planes really considered in the noise contour maps, both for the 600 foot runway extension as well as the Third Runway ? R-6-12

Are the current increase in noise that occurs with the large number of cargo planes at Christmas time and the significant noise increase that occurs when temperatures exceed 70F fully considered in the noise model ?

The construction of retaining walls and nearby buildings on the north end of the runway about doubled the noise over a mile away. Has the effect of bouncing noise off buildings and walls been accounted for ACCURATELY in the noise model ? See Appendix A. R-6-20

Is it the loss of natural sound absorbers that were replaced with concrete, the unstable ground, and/or the shape of the terrain that makes the sound travel so much further than the noise models predict ?

Why is vibration a problem over 1.3 miles OUTSIDE the 65 DNL boundary ? R-6-22

Why is noise a significant problem over 1.3 miles OUTSIDE the 65 DNL boundary ? See Arbitration hearing information.

[1] Forum , Published by Port, June 1995
[2] See Aviation Week, Sept. 27,1993, "Airlines Renew Interest in Keeping Stage 2 Aircraft", pg. 32

Why are 60 to 80 dBs common for miles OUTSIDE the 65 DNL area ? R-6-9

How much land is subjected to 45 dBs or above (the level one can no longer communicate accurately according to the DEIS) ?

Do vibration models fully address are unstable, seismically active soils ? R-11-6

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3.6 Inadequate Mitigation for Increasing Pollution (see 3.7)

Carbon monoxide calculations are based on year 2000 assumptions according to the DEIS text, but all the construction is supposed to be done by then. Pollution levels from the vehicles on our roads, not Chicago's, should be used with a realistic number for all construction vehicles anticipated (see Table 3 herein). It is important to remember that the term "on-site" means trucks are traveling from airport owned property to some other airport property via Burien or Sea-Tac PUBLIC roads. Also, the impact on all the roads on the route from Sea-Tac to Enumclaw and Black Diamond as well as any other probable fill locations needs to be fully considered. Special attention needs to be given to hilly, curvy or narrow locations where the trucks are forced to slow down or areas with a large number of traffic lights.

The traffic congestion is also a consideration. Some of the roads already have bumper to bumper traffic at certain times of the day and it may be PHYSICALLY IMPOSSIBLE to fit the all the additional construction vehicles along with the existing traffic. Does the construction schedule slide or will the main public roads like Des Moines Memorial Drive be closed to the public for several years ? Can the I-5 and 188th intersection really handle the traffic load, considering the three traffic lights already located there ? Those roads are already busy even at 2 AM in the morning so how effective can the suggested mitigation measure of avoiding rush hour really be ? Are the claims in the Highline Newspaper that only 1 car length, instead of 3, was used for some of the haul truck calculations true ?

What are the costs and environmental risks associated with bringing the fill in by water and then trucking it the remainder of the distance (see DEIS Appendix) ? What roads are impacted by those haul routes and what are their Level-of-service (LOS) values ? How many already have E and F LOS levels ? How many will have E and F LOS levels as a result of the construction ?

R-12-11

The truck estimates are confusing and vary by section of the DEIS and fill source assumptions, but the following table will give the reader a rough idea of the additional traffic. The Appendix states that the fill had to be increased by

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15 % to account for shrinkage but there may not have been enough time to correct some other portions of the DEIS report . The final DEIS needs to prepare a table similar to Table 3 herein to ensure the correct numbers are used for pollution estimates as well as traffic congestion estimates.

The EIS should address the routes and clarify that "on-site" routes use public roads. Compare the numbers in Table 3 which follows to the impression received when reading the following excerpt from the "Forum", Published by the Port for the Neighbors of Seattle-Tacoma International Airport, May 1995 regarding the impacts identified by the DEIS :

> *"Depending on where the earth comes from, there would be* ***32 to 57 trucks an hour carrying it to the airport "***

where "it" and "earth" refer to 23 million cubic yards of fill.

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Table 3 : Incredible Number of Construction Truck Trips

Construction Vehicles (Incoming route listed)	Hourly Incoming	Hourly Outgoing	Hourly Total	Daily* Total
Northern "On- site" Haul Trucks Southbound on 24 St. to 154 th/ 156 th (D pg 69)	13	13	26	416
Southern "On-site" Haul Trucks Northbound on Des Moines Memorial Drive From S 200 to SR 509 (IV 23-2 B 1 text)	29	29	58	928
Off- Site Haul Trucks Southbound ramp from SR 509 to 160 St. then eastbound originating from fill sources such as Enumclaw, Black Diamond, etc. (IV 23-2)	57	56	113	1606
Non-haul Vehicles like graders, bulldozers, cement trucks, etc. that DO cross public roads such as Perimeter Rd	?	?	?	?
Other construction vehicles that use public roads	?	?	?	?
Total for Sea-Tac Airport Construction on public roads	Greater than 99	Greater than 98	Greater than 197 per Hour	Greater than 3152 per DAY

See DEIS IV 23-2, D-69 through D-72 * 16 hours per day per DEIS

Note, DEIS appendix page 6 indicates the consecution period is for 6 days per week, 50 weeks per year for 2 1/2 years. Elsewhere DEIS recommends only working during the dry season so does the 2 1/2 years become 5 years to mitigate water quality issues ? Then does the 5 years need to become 10 years to mitigate carbon monoxide emissions that are already above safety standards as well as traffic congestion issues ?

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3.7 Detrimental Impact on Health Virtually Ignored

The only health concern the DEIS recognizes is if it is so loud it makes you go deaf (see IV 7-5). Although it mentions MANY other effects in section IV, it dismisses them. See enclosed Appendix A.

A study of the children in the airport area will reveal they have more headaches, cry more often and suffer clinical depression more often than children who are not subjected to 60 dBs or more every week (not the 65 DLN noise measurement). According to the DEIS report , 45 dBs is the maximum for normal voices to achieve reliable communication yet the study area is set by the DLN level. Considering the information in section IV, 7-2 through 7-4, the whole DNL system should be re-evaluated ! See Figure 3 for a description of life in Burien, Des Moines, Sea-Tac, and Normandy Park as well as certain areas of Seattle and Tacoma (hill top locations for Seattle and Tacoma).

Isn't the intersection by the Red Lion, which is across from the airport and has above safety standards carbon monoxide, one of the high frequency traffic accident locations for the area ? I have seen more bicycles hit by cars at that location than anywhere else.

What mitigation measures can be taken to reduce the increased cancer risks related to the air toxin levels that the DEIS suggests may already exceed safe levels ? The DEIS projects an increase in these toxins as air traffic increases but the impact of the hundreds of construction trucks per hour, at least 16 hours per day is of particular concern (see DEIS IV 7-6 and Table 3 herein) ? R-16-17

Residents for many years have claimed that black residue from burnt aviation fuel collects on property under the flight path, so the DEIS conducted a test. Is it really any surprise that you'd get more fungus, paint and wood than soot, by scraping a sample off a house rafter ? The test was considered inconclusive, so the DEIS concluded it isn't a problem. A clean fungi inert material should be mounted on a roof if you want to determine if the black speckles are burnt fuel. In addition to the tests described in the DEIS lab report, the sample should be dissolved in a solvent such as toluene and than analyzed using infrared R-5-1 spectroscopy. Depending on the results of that test, additional tests may be warranted.

The increased pollution as well as the increased dust in the air related to the construction, particularly the fill, will aggravate allergies. According to the National Institute of Health, "Issues and Challenges in Environmental Health," NIH Pub. # 87-861.."Allergic reactions and hypersensitivity diseases, for instance, are among the MOST COSTLY of U.S. health problems inflicting at least 35,000,000 Americans".

3.8 Safety

The question of safety is becoming an even greater issue as more of the "unapproved parts" on aircraft problem becomes publicized. It is no longer just in Aviation Week (May 22,1995) but is now making front-page news in newspapers such as the Seattle-Times (June 4,1995).

Safety issues are mentioned by the DEIS and their potential to cause stress in people. Because of the unusually close proximity of Sea-Tac Airport to the surrounding residential communities, safety is a concern even for the existing airport which has a history of parts falling off airplanes and just missing children, sometimes by less than a foot. One of the more recent occurrences was the part that dropped on Rainier High School. A student provided testimony at the June 1 DEIS hearing relating the most recent terrifying accident.

Data indicates that most fatal accidents are during take-off or landings (Aerospace America, April 1995). Third Runway accidents would lead to aviation fuel being spilled into Puget Sound (the proposed Third Runway location is on existing wetlands near Kennedy, Highline and Sunny Dale Schools). The opposite side of the airport would be safer environmentally, and its land is much closer in elevation to the existing airport. However, hotels are more important apparently than homes, small businesses, bald eagles, and Puget Sound. R-16-1

SEPA 197-11-794 requires occurrences such as aircraft crashes, major fuel spills and aircraft parts falling on schools to be addressed because of the severity of their consequences. Considering we have a history of Sea-Tac's aviation fuel killing off most of the fish in the creek and parts almost hitting children, these situations are not as improbable as one might hope.

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3.9 Other Risks

There are enormous environmental risks because of the way are regulations are written. In some cases, "Best Management Practices" are technically inadequate for a project of the magnitude of the Third Runway[1]. Also, some regulations give a minimum size before they apply. We can impact numerous locations across Puget Sound by arranging to be just under the threshold at each location. In the case of some regulations, just so long as the areas are discontinuous, each separate area on Airport property can be treated as a separate project. To complicate matters further, there are items that if only done on existing airport property won't go through the same permit process that it would if we were building a new airport.

Has sufficient time been scheduled to let the 27 million cubic tons of fill settle before proceeding ? Has the amount of extra dirt that should be piled on top to help pack it down been considered ? Denver's new construction at their airport is settling and now must be repaired. Isn't their ground more stable than Sea-Tac's ? Isn't it impossible to fully stabilize fill that is on top of wetlands ?

What will the schedule impact be if any of the "At risk" hazardous sites need to be "cleaned up" (land and buildings being acquired include gasoline stations and old buildings that may contain asbestos) ?

Have the difficulties associated with constructing 60 foot retaining walls been adequately forecast in the cost estimates and the schedule?

R-12-10

Are the floodplain regulations restrictive enough to provide the level of protection the DEIS implies is needed?

R-13-32

[1] For instance, consider the 160 feet deep fill technical and environmental issues and see Appendix WQ for pollution control issues

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Aren't the detention storage regulations and the technology inadequate to provide the level of protection the DEIS implies ? It can easily take 40 years for the vegetation in a detention pond to grow to the needed amount.

Have all the emerging concerns of the FAA regarding runway accidents due to congestion been fully addressed (see Aviation Week, April 24,1995).

R-3-23

Have the reduction in funding from the FAA been fully considered ? Particularly considering the large increase in costs the DEIS has uncovered , it doesn't make sense to destroy the environment to do something that won't be profitable for decades. If TOTAL costs are considered, rather than just the Port's balance sheet, will it ever be profitable ?

R-4-22

Have the risks of either delaying or permanently halting construction if it is proven that endangered species, namely bald eagles, are living in the study area ?

R-15-1

Considering the Port's citations for pollution violations, what assurance is there that the Third Runway will be able to mitigate pollution to the level assumed by the DEIS ?

R-6-43

How much further behind would the implementation of the 2nd runway mitigation measures be, if the Port wasn't trying to get the Third Runway approved ?

Considering the incredible delays in implementing the mitigation measures from the 2nd runway, what assurance is there that the required mitigation for the Third Runway will ever be implemented, even if required ? People are still waiting for sound insulation for the runway project completed in 1973.

R-6-27

The report on the economic impact of the Denver airport schedule slides should be reviewed when considering the Sea-Tac risks. ("New Denver Airport : Impact of the delayed baggage system". General Accounting Office. GAO. 95-35BR, GAO RCED. October 1994).

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Have the schedule risks of lawsuits been considered. Lawsuits are a very real risk considering the quality of the DEIS as illustrated by :

a) Incomplete geological and biological data such as the erosion data,
b) Manipulation of baseline assumptions such that "apples and oranges" are being compared (example - carbon monoxide calculations),
c) Inappropriate test methodology such as that used to evaluate the black residue,
d) Inadequate time to perform the necessary evaluation tests such as the air toxins.
e) Insufficient information to assess (fill source transportation route issues crucial to determining the feasibility the Third Runway)
f) Not fully compliant with regulations and policies such as SEPA.

Considering the DEIS report even appears to contradict itself, what is the risk that the DEIS report inadvertently omitted something important or reached the wrong conclusions ? The DEIS data does not appear to be fully reflected in the Executive Summary.

Considering this will be the United States most expensive limited capacity runway, won't the delays caused by lawsuits and the permit process eliminate any schedule advantage that this project had over the Alternative Sites that were dismissed ?

R-18-26

For this project to make fiscal sense, it needs the same amount of air traffic on the Third runway, as Denver has on all five runways. Since that is impossible, this project is destined to be scandal after the huge costs become known. People have already provided testimony regarding bribery but not many people listen to the early morning public radio news. News coverage of the project has been mostly limited to three local newspaper : Federal Way, Des Moines and Highline News. Very little coverage has been given by the major newspapers that reach the beyond the west side of the airport. Consequently, most of the public is unaware of the issues. The Port says it needs the third runway for growth, and the public believes it. The public doesn't know about the DEIS figures of only 2.6% increase in departures or all the haul trucks. If they did, there would be an uproar. It is only a matter of time before "word-of-mouth" informs the public. The uproar will follow, making the Kingdom problems look insignificant.

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4.0 CONCLUSIONS

This report provides data that supports the following conclusions about the DEIS report:

- Full of false premises
- Lacks vital data
- Dismisses or ignores the accurate data it contains
- Full of unsupported conclusions
- Provides ammunition for drawn-out anti Third Runway lawsuits
- Not fully compliant with regulations and policies

The report supports the following assessment of the Third Runway:

- Exorbitant economic cost with a guarantee of overruns
- Provides inadequate air traffic growth
- High geological risk
- Increases pollution which in some cases currently exceed approved levels
- Uproots families, businesses and endangered species to create 37, 300 TEMPORARY construction jobs

Bottom line, the Third Runway is preposterous, it is no wonder people are being accused of being bribed to support the Third Runway (see DEIS 1 June 1995 testimony concerning the all expense paid "business' trips to Europe. This testimony was also aired on radio station 88.5 the next day).

Burien already rebelled against Seattle and became its own city because of the Third Runway and the belief that the local government in this area is "By the Port and For the Port".

The Airlines, Washington and King County all lose if the Third Runway is approved. Who gains ? What other airports benefit from the business Sea-Tac won't be able to handle ?

To put things in perspective, it is important to remember the original 906 acre airport was for small propeller driven aircraft. The number of flights per day increased from 10 to 40 per day when the terminal opened in 1949. Back then, airports were considered a "losing proposition", not a common transportation method.

The 5 year $175 million expansion project completed in 1973 built the second north-south runway and two terminals. It did NOT build a Third Runway for many of the same reasons that still exist today. That Environmental Report said "NO" plus the " the Port was embroiled in the noise problem " (Seattle-Times December 11,1994). Had the 1968 growth projections been correct instead of being grossly underestimated, would they have faced up to building a new airport then ?

The Third Runway combined with the existing runways may allow 1,224 flights per day. The number of flights in 1994 was 950. The Sea-Tac traffic growth for 1993-1994 was 11%. Air traffic is projected to grow steadily for the next 20 years (see Appendix C). Does paying over a billion dollars for a Third Runway, and then having the public find out we also need a fourth as well as a fifth runway really make sense ? Can the airlines really afford the third, fourth and fifth runways or is a new airport the least expensive and quickest alternative ? Demand management techniques could be used in the interim. R-3-35

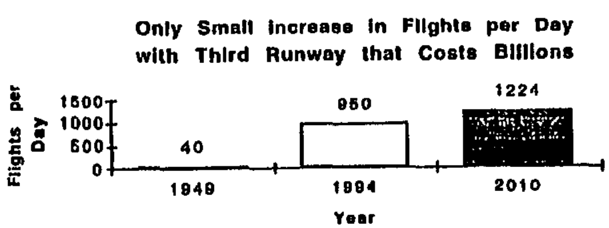

Figure 9 Third Runway Capacity Inadequate

We need to address the LONG TERM NEEDS of the Airlines, not spend a fortune on a "quick fix" that may even be inadequate by the time construction of the Third Runway is completed.

The Third Runway

Doesn't permit adequate air traffic GROWTH

But it will cost billions.

PLEASE consider the return on investment aspects of the Third Runway.

The planning, land and construction for Denver's new airport with 5 runways was only 3.2 billion[1] - an incredible bargain compared to the Third Runway

1 "New Denver Airport : Impact of the delayed baggage system". General Accounting Office. GAO/RCED- 95-35BR, October 1994), pg. 10-11.
See appendix C herein for additional cost details.

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Appendix A

Noise

Enclosed are maps and correspondence that indicate that the construction around the airport significantly changed the acoustics. The noise models do not predict the change. A huge concrete wall replaced trees and bushes so noise bounces around rather than being absorbed. Since these charts were prepared last year, additional construction has gone on both on the north-end and south-end of the airport making the noise even worse.

Enclosed is correspondence that indicates that there are so many airplanes already going in and out of Sea-Tac, the noise line is unable to identify the offending aircraft.

Enclosed is a noise monitoring map that shows the noise monitoring sites are too close to the airport to measure the noise in the areas that residents claim are too noisy. There is no way to validate noise models with actual data.

19 July 1995

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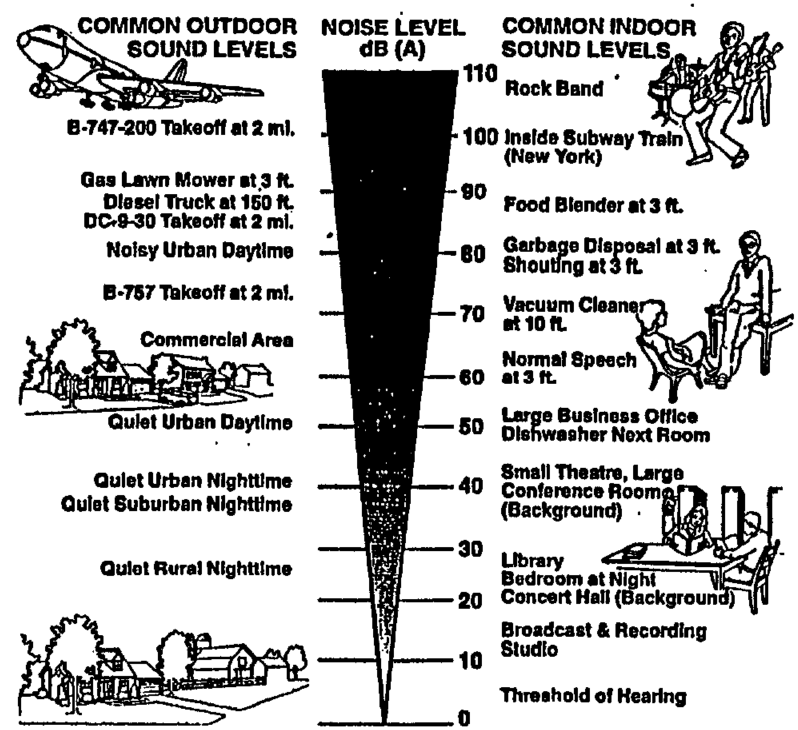
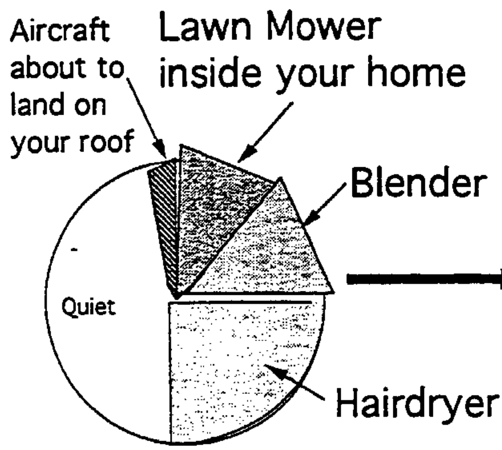


Seattle - Tacoma International Airport	Common Sound Levels	EXHIBIT: C-1

PAGE A2

Don't Buy your Home based on a Noise Contour Map



Aircraft Noise Profile ↕ REALITY

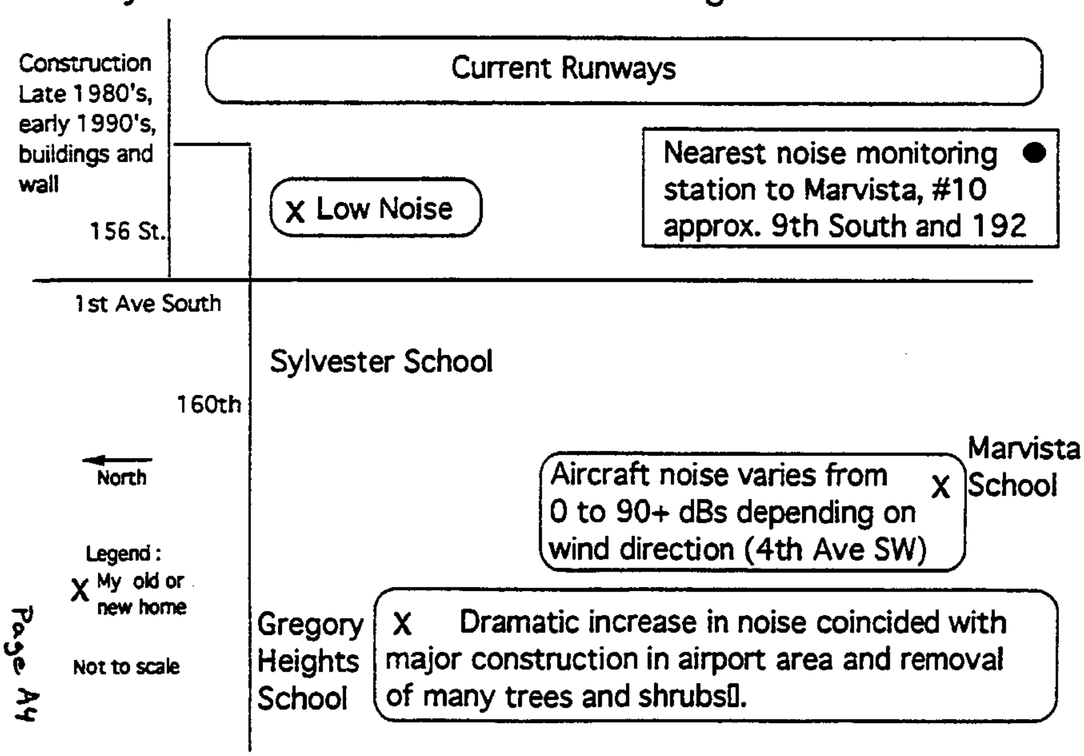
Interrupted Learning
Loss of Sleep
Increased Stress and Crime

Contour Map defines many of these situations as:
Low or No noise.
Is the Contour Map based on
1) Insufficient noise monitoring stations,
2) Inadequate information on impact of terrain and wind on acoustics, and
3) Average dBs instead of maximum decibels ?

Most of Burien, Normandy Park, Des Moines and Sea-Tac need noise insulation IF you want our children to grow up in an environment with a reasonable noise level.

Page A3

Can sound like airplane is about to land on your roof, many blocks west of noise monitoring stations.



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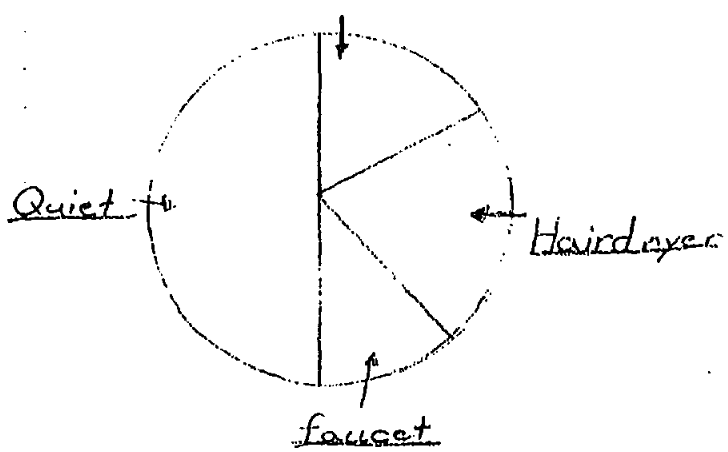
Lawn Mower in your House



Son's Graff

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Port of Seattle

October 18, 1994

Ms. Arlene Brown
239 SW 189th Pl
Seattle, WA 98166

Dear Ms. Brown:

Thank you for contacting the Sea-Tac Noise Abatement Office with your call concerning an aircraft overflight. Your call was about a flight that occurred on October 7, 1994 at 0805 hours. We have conducted research regarding the overflight and were not able to identify an aircraft that corresponded with the information provided.

The Port utilizes the Airport Noise and Operations Monitoring System (ANOMS) to monitor Sea-Tac's noise abatement programs and operational trends. ANOMS uses air traffic control data provided by the Federal Aviation Administration (FAA). On occasion, data is lost due to the FAA's equipment being shut down for maintenance purposes or technical difficulties with the ANOMS system itself. In addition, military and other high security operations are filtered from the data we receive, and jet flights operating out of airports other than Sea-Tac do not always appear in our data. However, please contact our office again should you observe another aircraft overflight you would like us to research. Please be as specific as possible about the time of the event you would like us to investigate when you call.

Informational presentations about the Port of Seattle's noise reduction programs and the use of ANOMS are scheduled frequently. If you have any questions concerning this information, or if you are interested in visiting the Noise Abatement Office for a presentation, please give me a call at 431-4091.

Sincerely,

Stephanie Shadle

Stephanie Shadle
Noise Abatement Specialist

cc: FAA Air Traffic Control

nomatch

On 10/7/94 between 07:50 and 08:15 am Sea-Tac had a high level of operations i[n] that amount it is difficult to asso[ciate] one particular flight to the times provided of: 08:05, 08:10, and 08:50. I have provided you a listing of jet activity from this time, and a pr[intout] from the noise monitor nearest your hou[se]

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10/7/94 Sea-Tac Jet Operations between 07:50 and 08:15 a.m.

ACTUALTIME	AIRLINE	AIRCRAFTTYPE	ADFLAG
10/07/94 07:50:24	QXE	FK28	D
10/07/94 07:51:33	LHN	B727	D
10/07/94 07:55:05	UAL	B73S	D
10/07/94 07:56:05	ASA	B73F	D
10/07/94 07:58:23	ASA	B73F	D
10/07/94 07:58:24	TWA	L101	A
10/07/94 07:59:45	ROA	MD82	D
10/07/94 08:00:51	ASA	B737	D
10/07/94 08:05:08	AAL	MD80	D
10/07/94 08:05:39	NWA	B757	A
10/07/94 08:06:02	ASA	MD80	D
10/07/94 08:08:20	QXE	FK28	D
10/07/94 08:09:05	ASA	MD80	D
10/07/94 08:12:43	UAL	B73S	A
10/07/94 08:15:47	UAL	B73S	D

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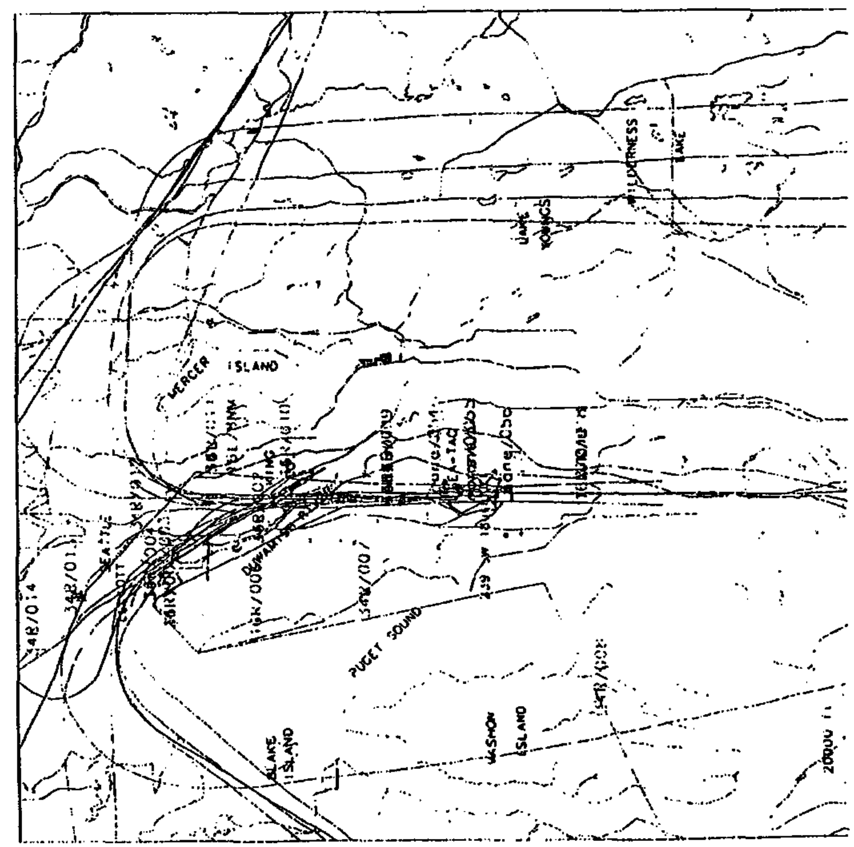
Port of Se

10/7/94

07:50 - 08:15 a.m.



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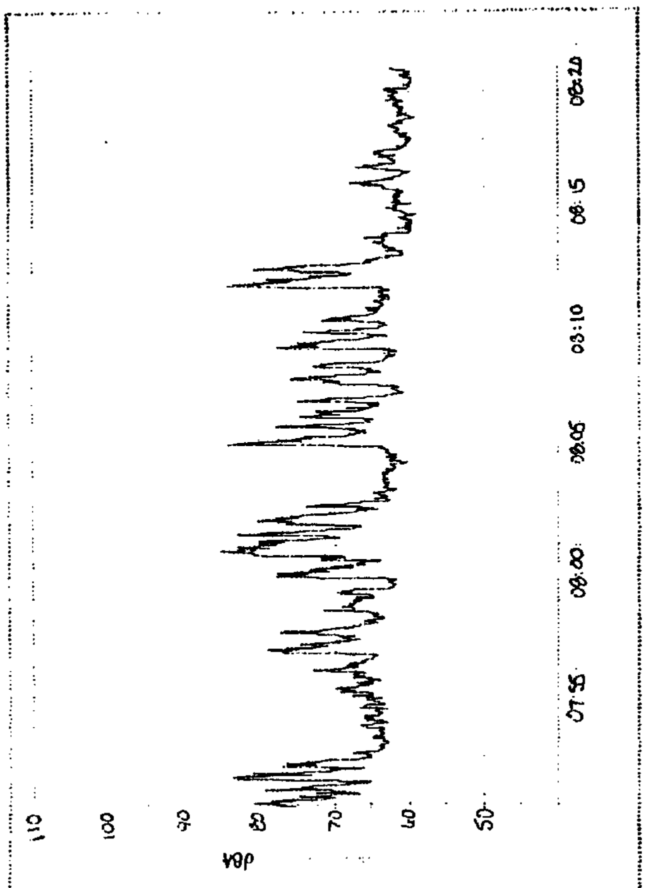

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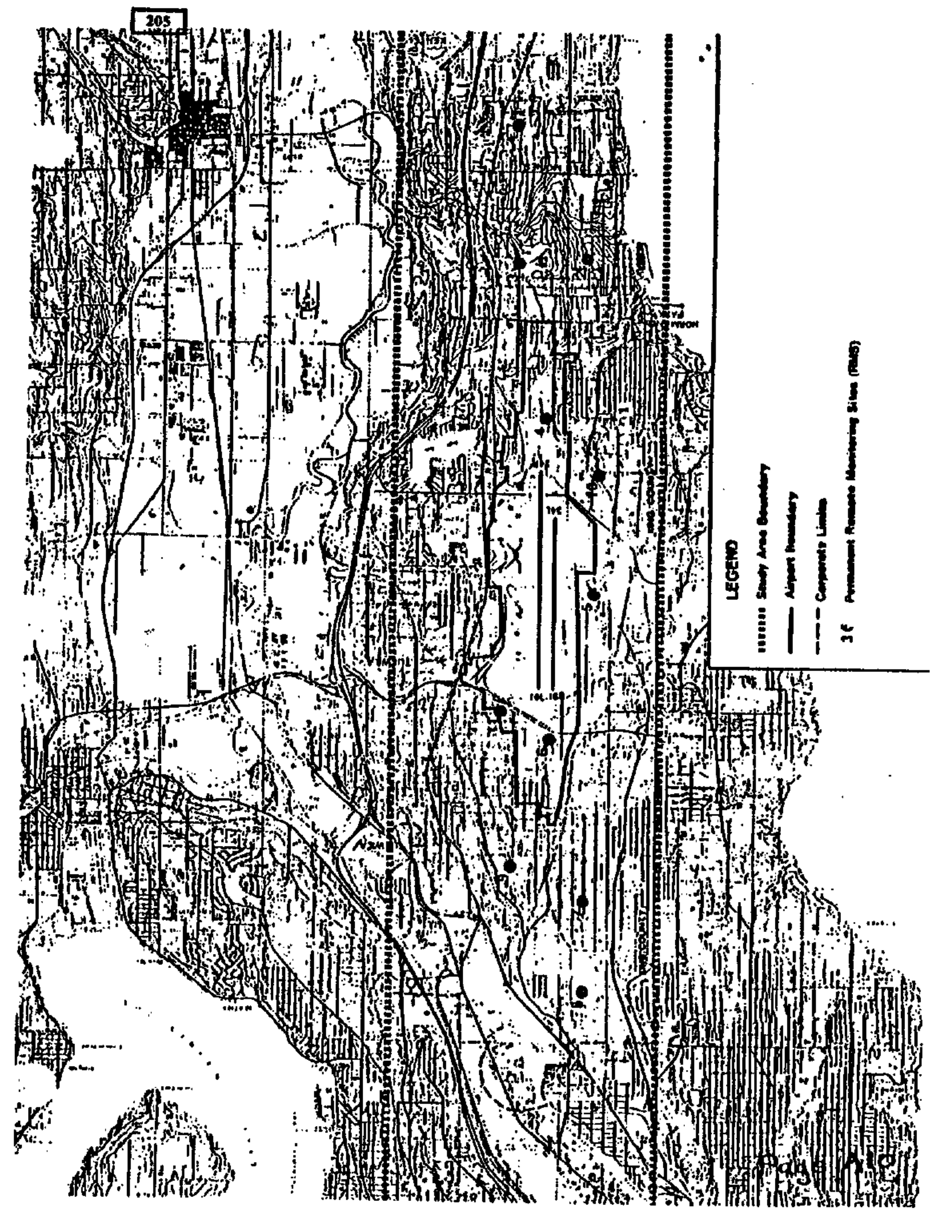

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LEGEND
Study Area Boundary
Airport Boundary
Corporate Limits
Permanent Remote Monitoring Sites (RMS)

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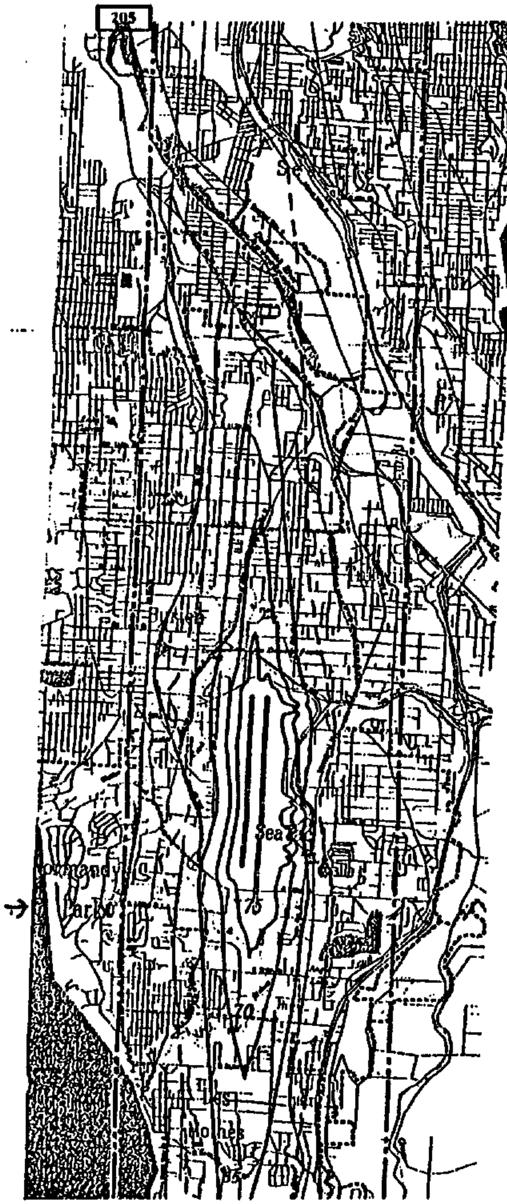
Appendix B

Property values

Calculations and data supporting the report section 3.4

19 July 1995



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Report Ignores that Billions In Real Estate Tax Revenues will be Lost

In last 2 years, property values have already decreased drastically
but DEIS report found no impact (IV pg 4-4).
Calculations just based on small area beside Marvista School in Normandy Park

Third Runway kills Home Values				NO third runway	
Year	Home Value	Real Estate Tax 1.4% value		Home Value	Real Estate Tax 1.4% value
1993	485,000	6,790		485,000	6,790
1995	390,000	5,460	Real	533,500	7,469
1996	280,000	3,920	Loss	549,505	7,693
1997	240,000	3,360		565,990	7,924
1998	230,000	3,220		582,970	8,162
1999	220,000	3,080		600,459	8,400
2000	210,000	2,940		618,473	8,659
2001	200,000	2,800		637,027	8,918
2002	190,000	2,660		656,138	9,186
2003	180,000	2,520		675,822	9,462
2004	170,000	2,380		696,096	9,745
2005	160,000	2,240		716,979	10,038
2006	160,128	2,242		738,489	10,339
2007	160,256	2,244		760,643	10,649
2008	160,384	2,245		783,463	10,968
2009	160,513	2,247		806,967	11,298
2010	160,641	2,249		831,176	11,636
2011	160,770	2,251		856,111	11,986
2012	160,898	2,253		881,794	12,345
2013	161,027	2,254		908,248	12,715
2014	161,156	2,256		935,495	13,097
2015	161,285	2,258		963,560	13,490
2016	161,414	2,260		992,467	13,895
2017	161,543	2,262		1,022,241	14,311
2018	161,672	2,263		1,052,908	14,741
2019	161,801	2,265		1,084,496	15,183
2020	161,931	2,267		1,117,031	15,638
1995 -2020 totals					
1 house		68,396		1 house	287,953
50 houses		3,419,792		50 houses	14,397,634
Economic loss for one Normandy Province hom				955,100	13,371
% loss in 2020 using today's dollars				86%	86%
50 houses in Normandy PROVINCE				47,754,987	10,977,641
For 1995 through 2020				Lost Value	Lost Real Estate Tax

Note : from 2005 assumed .08% appreciation per year for third runway houses
For no third runway, used 3% appreciation per year except used actual Pugot Sou
Multiple listing appreciation for 1993 & 1994. Considering before the runway
appreciation, 3 % is VERY CONSERVATIVE.

Property value485cals 6/22/95

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PUGET SOUND MULTIPLE LISTING ASSOCIATION — SUMMARY REPORT

		Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yr 2 Dt.
1995	Sales Assoc.	9,294	9,173	9,165	9,173									9,201 A
	Lstg Inventory	19,489	20,724	21,606	22,331									21,040 A
	New Listings	7,677	6,454	8,026	7,349									29,500 T
	Pndg Units	2,379	2,991	3,599	3,318									11,875 T
	Avg Pndg Price	$170,413	$165,389	$173,779	$188,213									$169,161 A
1994	Sales Assoc.	9,499	9,521	9,515	9,499	9,552	9,510	9,463	9,465	9,508	9,619	9,457	9,294	9,510 A
	Lstg Inventory	17,237	18,153	18,559	19,383	20,777	20,545	20,793	20,284	20,814	20,515	20,025	16,761	19,731 A
	New Listings	7,771	6,457	7,315	7,500	7,730	7,900	6,884	6,808	6,804	6,209	5,025	3,430	78,401 T
	Pndg Units	3,232	4,003	4,940	4,132	4,228	3,984	3,320	3,582	3,579	2,842	2,893	2,061	40,335 T
	Avg Pndg Price	$166,131	$159,937	$174,922	$167,900	$171,252	$170,562	$168,855	$166,305	$167,742	$211,373	$171,730	$173,605	$171,522 A
1993	Sales Assoc.	9,474	9,421	9,439	9,474	9,474	9,439	9,479	9,415	9,428	9,435	9,424	9,366	9,441 A
	Lstg Inventory	20,135	21,667	21,932	21,775	23,076	22,006	21,646	21,284	20,295	19,729	19,729	16,626	20,842 A
	New Listings	6,997	7,277	8,002	6,475	6,709	7,520	7,211	6,815	6,083	6,121	5,744	3,870	78,904 T
	Pndg Units	2,673	3,095	4,145	2,494	3,938	4,389	4,154	3,972	3,458	3,904	3,641	2,856	43,708 T
	Avg Pndg Price	$158,582	$156,610	$164,038	$161,635	$165,458	$168,007	$162,516	$168,428	$164,211	$164,831	$164,519	$163,300	$163,822 A
1992	Sales Assoc.	9,413	9,437	9,487	9,528	9,604	9,642	9,632	9,679	9,664	9,652	9,597	9,516	9,575 A
	Lstg Inventory	21,272	21,828	22,842	23,927	25,158	26,179	25,509	24,780	24,080	23,340	22,673	18,539	23,332 A
	New Listings	8,814	7,979	8,658	8,389	7,907	8,164	7,539	7,341	7,828	7,247	5,357	4,102	89,686 T
	Pndg Units	3,234	3,682	3,331	2,888	2,528	3,086	2,946	3,081	3,200	3,215	2,424	1,178	33,723 T
	Avg Pndg Price	$148,192	$158,151	$159,117	$158,988	$156,569	$161,303	$168,591	$155,430	$160,296	$154,843	$153,763	$153,937	$157,428 A
1991	Sales Assoc.	9,670	9,514	9,544	9,553	9,576	9,583	9,739	9,898	9,914	9,904	9,719	9,414	9,674 A
	Lstg Inventory	18,066	19,149	19,506	20,889	22,216	22,486	22,807	23,649	23,937	24,302	22,936	19,622	22,865 A
	New Listings	7,817	7,274	7,853	8,353	8,580	7,596	7,922	7,498	7,281	7,137	5,402	4,379	88,880 T
	Pndg Units	2,317	3,008	3,927	4,039	3,459	2,683	2,847	1,838	2,133	2,703	2,110	1,816	32,920 T
	Avg Pndg Price	$153,864	$151,615	$154,413	$160,213	$160,027	$160,482	$157,744	$154,401	$153,773	$154,584	$158,675	$152,375	$156,012 A
1990	Sales Assoc.	9,992	10,166	10,297	10,442	10,549	10,519	10,516	10,489	10,419	10,316	10,035	9,891	10,302 A
	Lstg Inventory	7,200	7,789	9,444	11,734	15,108	18,141	19,298	20,805	21,036	21,036	20,148	16,723	15,818 A
	New Listings	5,447	5,536	7,440	8,112	9,303	8,498	7,826	8,338	7,306	7,302	5,712	3,888	84,498 T
	Pndg Units	4,058	3,607	4,153	3,844	3,478	2,612	2,578	2,490	2,236	2,236	2,087	1,648	34,825 T
	Avg Pndg Price	$141,214	$147,625	$153,251	$153,821	$156,886	$163,866	$158,286	$154,931	$159,648	$159,648	$155,216	$155,847	$155,003 A
1989	Sales Assoc.	8,485	8,531	8,732	8,674	8,969	9,110	9,224	9,358	9,563	9,861	9,833	9,883	9,167 A
	Lstg Inventory	12,698	12,753	13,143	13,158	13,127	12,755	12,858	11,603	10,519	9,980	8,584	6,862	11,400 A
	New Listings	5,063	4,746	6,143	5,649	6,250	6,093	5,304	6,021	4,983	5,362	4,148	3,096	62,818 T
	Pndg Units	2,867	3,113	3,915	3,940	4,450	4,437	4,155	4,638	4,167	4,616	3,912	3,166	47,185 T
	Avg Pndg Price	$111,873	$112,533	$116,890	$116,174	$121,237	$124,754	$125,982	$130,281	$129,706	$133,974	$142,228	$143,565	$129,932 A
1988	Sales Assoc.	7,958	8,033	8,261	8,371	8,239	8,280	7,898	7,898	8,375	8,442	8,329	8,406	8,207 A
	Lstg Inventory	16,174	17,089	17,624	18,092	18,025	17,597	17,403	17,403	16,956	15,054	14,860	12,391	16,572 A
	New Listings	5,723	6,216	7,003	5,935	5,638	5,901	5,467	5,467	5,836	4,771	4,345	3,392	65,688 T
	Pndg Units	2,179	2,995	3,811	3,338	3,257	3,368	3,048	3,048	3,608	2,940	2,886	2,834	37,334 T
	Avg Pndg Price	$94,849	$101,311	$100,701	$97,884	$105,878	$106,699	$106,659	$106,659	$108,449	$107,362	$108,745	$108,194	$104,414 A
1987	Sales Assoc.	7,898	7,840	8,011	8,169	8,197	8,149	8,090	8,148	8,116	7,886	7,898	7,794	8,000 A
	Lstg Inventory	17,924	18,352	18,352	18,538	19,250	19,425	19,058	18,882	18,218	17,330	17,031	14,973	18,100 A
	New Listings	6,190	6,229	6,808	6,300	5,852	6,054	5,802	5,675	5,402	4,888	4,328	3,831	67,940 T
	Pndg Units	2,270	3,297	4,298	3,907	2,851	2,938	2,802	2,654	2,587	2,414	1,947	1,898	33,825 T
	Avg Pndg Price	$98,527	$92,158	$94,323	$91,537	$102,385	$98,782	$100,732	$98,208	$101,572	$100,069	$101,146	$102,620	$97,922 A

This report includes all property types and all areas, including out-of-area. All pending dollar figures shown are based on list price.

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Windermere

Windermere Real Estate/South, Inc.

MARKET FLASH

VICKI JOHNSON
Associate Broker

Average Sale Price for Homes in Normandy Park

1988 -	$178,416
1989 -	$210,312
1990 -	$241,858
1991 -	$235,034
1992 -	$240,699
1993 -	$237,919

Statistics compiled from properties sold through the Puget Sound Multiple Listing Association.

For additional information, please call:

Vicki Johnson 441-8932

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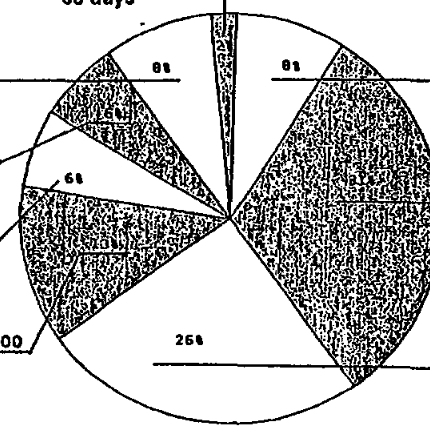
NORMANDY PARK UPDATE

Normandy Park homes had an average of 15% appreciation in 1990.

The chart below shows last years sales by price range and the average market days.

Average Price 241,858



FOR MORE INFORMATION, OR A MARKET ANALYSIS OF YOUR HOME, PLEASE CALL:

VICKI JOHNSON

NORMANDY PARK RESIDENT AND YOUR NEIGHBORHOOD REAL ESTATE SPECIALIST

OFFICE 874-3200 DIRECT ACCESS 441-8932

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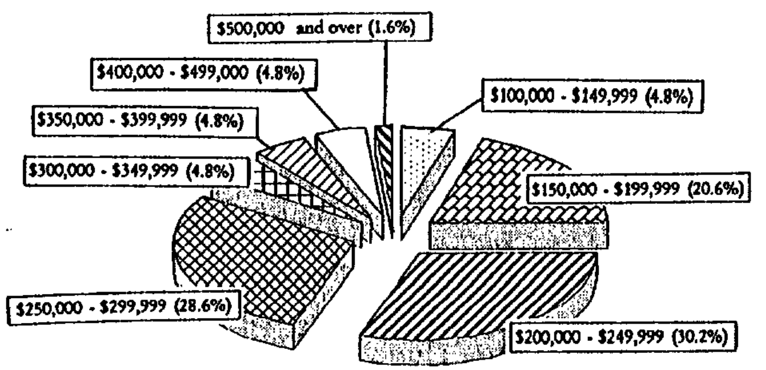
Normandy Park Update

1994 Home Sales Report

The average sale price in Normandy Park (excluding waterfront homes) for 1994 was $238,429. Normandy Park enjoyed a slight increase in the average sale price during 1994, and the greater Seattle Metropolitan Area had an increase of 3% in the average sale price.

The chart below shows last year's percentage of sales by price range. Sixty-three homes changed ownership in Normandy Park during 1994. The largest number of sales were in the $200,000 to $249,999 range.



For more general real estate information or a market analyis of your home, please call:

Vicki Johnson, Associate Broker
718-8932 Direct Access 244-5900 Branch Office

Normandy Park Resident and Your Real Estate Specialist

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NORMANDY PARK UPDATE

1992 THIRD QUARTER HOME SALES
JULY - AUGUST - SEPTEMBER

Sales Price	Bedrooms	Baths	Sq.Ft	Age	Market Days
$ 161,350	4	1.75	2700	38	105
$ 197,500	5	3	2452	32	52
$ 200,000	3	2.5	1800	33	159
$ 220,000	5	2.5	2470	30	103
$ 220,000	3	3	2280	33	70
$ 245,000	4	2.5	2600	22	31
$ 245,000	5	3	2740	19	16
$ 325,000*	3	1	2000	36	22
$ 325,000	5	3.5	3620	42	48
$ 402,500	4	2.5	3616	53	20
$ 464,000	4	2.5	3777	0	629
$ 625,000*	4	3.5	3500	43	15
$1,195.000*	5	3.5	5660	64	45

* Indicates Sound Waterfront Homes
The Average Sale Price, excluding waterfront homes, was $267,985.
Homes Sold for an Average of 96% of their asking price.

For general Real Estate information, or a market analysis of your home, please call: Vicki Johnson, Associate Broker
441-8932 Message Center 874-3200 Branch Office

NORMANDY PARK RESIDENT AND YOUR REAL ESTATE SPECIALIST

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NORMANDY PARK UPDATE

1993 FOURTH QUARTER HOME SALES

OCTOBER - NOVEMBER - DECEMBER

Sales Price	Bedrooms	Baths	Sq.Ft	Age	Market Days
$106,000	3	1.00	1,630	40	54
$135,000	5	1.75	2,120	34	395
$187,500	4	2.00	2,060	30	299
$190,000	3	1.75	1,920	36	27
$208,000	5	2.25	2,530	31	122
$228,500	5	1.75	2,530	31	178
$229,950	3	2.50	2,900	36	277
$252,000	4	2.25	2,980	16	8
$275,000	3	2.50	2,540	6	495
$292,500	3	2.50	2,470	5	54
$355,000	5	3.50	4,970	52	174
$364,000	5	2.50	3,560	5	71
$379,950	4	3.50	3,410	6	210
$465,000	4	2.50	3,770	0	177
$825,000*	4	2.75	3,500	31	261

The Average Sale Price, excluding waterfront homes, was $262,028.
The Average Market Time was 182 Days.
Homes Sold for an Average of 96% of their Asking Price.

* Sound Waterfront

NORMANDY PARK UPDATE

1994 THIRD QUARTER HOME SALES

JULY - AUGUST - SEPTEMBER

Sales Price	Bedrooms	Baths	Sq.Ft.	Age	Market Days
$129,500	3	1	1,090	43	30
$139,500	3	1.5	1,640	35	14
$170,000	3	1	2,300	42	66
$178,000	4	1.75	2,300	42	151
$205,000	3	1.75	2,320	36	143
$205,000	3	2.5	2,930	43	115
$210,000	5	3	2,510	26	183
$222,000	3	1.75	1,880	38	18
$237,000	5	2.5	2,990	37	12
$245,000	3	2.5	2,280	36	97
$249,950	3	2.75	2,430	41	4
$250,000	4	2.5	3,140	15	398
$289,500	4	2.75	3,790	39	34
$290,000	4	4.5	3,410	15	68
$290,000	6	2.5	3,120	17	111
$310,000	4	3.5	3,530	11	4
$360,000*	4	2.75	2,600	34	21
$362,000*	3	2.5	3,500	34	139
$425,000**	2	1.75	2,080	53	32

*Exceptional Sound View **Sound Waterfront

The Average Sale Price (excluding waterfront) was $241,247.
The Average Market Time was 86 Days.
Homes Sold for an Average of 96% of their Asking Price.
There are currently 42 homes for sale in Normandy Park.

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Appendix C

Air Traffic Growth & Denver Airport Costs

Growth

Sea-Tac airport can't possibly take advantage of the incredible world wide growth predicted. The Third Runway will increase **departures by ONLY 2.6 %** and arrivals by 12 % total (not an annual increase).

Compare those numbers to Sea-Tac airport's own growth of about **11%** for **1993-1994.**

Compare the Third Runway capacity numbers with the growth projections in the enclosed articles - short summary below:

Cargo Growth : **6.1 % cargo ANNUAL** growth well into the next century - see Article 1.

Note, the new 600 foot extension of the existing runway will be the ONLY Sea-Tac runway that can always handle fully loaded cargo planes. Even the long version of the new Third Runway will be too short.

Passenger growth : 5.1 % ANNUALLY for the next 20 years - see Article 2
3.8 % for North America - see Article 3

Note : Boeing permission to copy articles was obtained

Denver Airport Costs - See enclosed pages extracted from New Denver Airport : Impact of the delayed baggage system". General Accounting Office. GAO/RCED- 95-35BR, October 1994)

C1

19 July 1995

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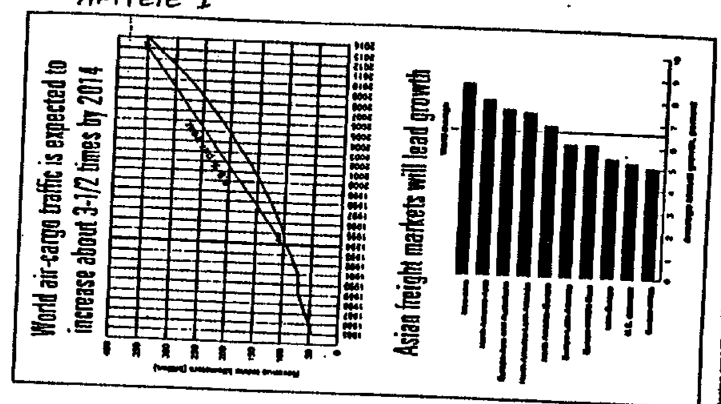
Article 1



World air-cargo traffic to more than triple by 2014

Air cargo traffic in 1994 reflected a recovering world economy. Boeing expects growth to continue at a rate that will more than triple world air-cargo traffic over the 20 years through 2014.

Growth over the forecast period will require more than 1,000 additional freighter aircraft, according to the annual Boeing Air Cargo Forecast released late last week.

The freighter requirement is in addition to the need for more than 15,000 passenger aircraft forecast for the same period by the Boeing Current Market Outlook (Boeing News, June 9).

"Air-freight growth is an indicator of wider economic trends, which often lead the world into and out of recessions," said David Pierce, Boeing Commercial Airplane Group regional director of Marketing and the cargo forecast's author.

"A key reason for the growth last year was that most countries had moved through their economic low point and had begun to grow," Pierce said.

He said the 1994 growth of air-cargo traffic worldwide, excluding countries of the former Soviet Union, averaged more than 12 percent.

Growth is expected to continue at an average 6.6 percent annually over the forecast period.

Fastest cargo growth over the 20-year forecast period will be on Asian routes and in international express traffic.

The Asian cargo traffic will reflect the region's rapidly developing economy, Pierce said.

"Asia is rapidly becoming industrialized and by 2014 will be producing 35 percent of the world's manufactured goods. In addition, disposable income is up, so the people of Asia are becoming major consumers."

Growth in international express service is mirroring success of the service in the United States, Pierce said. International express traffic grew 25 percent in 1994. It is expected to grow at an average annual 18 percent over the forecast period, capturing 31 percent of the air-cargo market by 2014.

Boeing News

C2

Boeing News

JUNE 9 | 1995

Article 2

With few exceptions, most predict positive jet market

Boeing is not alone in looking ahead at the commercial jet airliner market.

Airbus, for instance, has its Global Market Forecast.

Like Boeing in its Current Market Outlook (Page 1), Airbus sees a solid 20-year market growing at an average 5.1 percent a year, with highest growth in the Asia-Pacific area and China, creating a demand for about 15,000 jet airliners.

With a notable exception, a sampling of other observers seems to reflect a shared optimism.

The exception is Robert Crandall, chairman of American Airlines' parent AMR Corp.

Crandall said after the company's shareholder meeting in Chicago last month that an industrywide recovery that has brought airlines into the black after years of losses "is close to a peak."

"It's possible we're close to the best days we're going to see," Crandall said, according to the Wall Street Journal.

He predicted the economy may be weaker later this year and in 1996.

Earlier in the month, Reuters reported an American Airlines spokesman as saying the carrier has no plans to buy more planes "to increase overall capacity."

"We have six 757s coming to us this year," said Hans Mirka, American's senior vice president for international operations.

"That's it as far as new airplanes are concerned."

Gerald Greenwald, chairman of UAL Corp., of which United Airlines is a subsidiary, was more upbeat.

He said at the carrier's shareholder meeting in Los Angeles, the day after Crandall's forecast, that he expects the airline industry's recovery to continue.

"I don't share the view that 1995 is the end of the recovery," Greenwald said, according to a Reuter news agency report.

"I think, if anything, there is a momentum building...that means more air traffic."

United, Greenwald said, plans to order 50 new airplanes by 2000, six of which already have been ordered from Boeing. Of the 50, 19 are for expansion and 31 for replacement of older equipment.

Greenwald did not say whether the 44 aircraft yet to be ordered will include Boeing 777s, for which United holds options, according to the Wall Street Journal.

He did say that orders for some Boeing aircraft are expected to be placed by late summer or sooner.

Southwest Airlines Chairman Herb Kelleher also talked of better times to come.

At the carrier's annual meeting this month, Kelleher said the all-Boeing airline's "process of earnings recovery will have begun in the second quarter (of 1995)," Bloomberg Business News reported.

At Southwest, which has consistently earned money in recent years while other airlines posted losses, the emphasis on boosting profits will focus on cost-effective operations.

Southwest's operating costs, already lowest in the airline industry, will continue to decline, Kelleher said. Fares in some markets will be raised. Reservation problems caused by rapid route expansion last year will be ironed out.

The airline reported April traffic up more than 9 percent from a year earlier and traffic for the year through April up almost 5 percent.

Far out on the upbeat side, Prudential Securities Vice President Gary Reich said earlier in the year that the long-awaited recovery in commercial aircraft demand not only will begin this year but will be stronger than ever before.

"As a result of traffic growth, obsolescence and aging aircraft — and the fact that the world's population now grows by about 1 billion people every seven years or so — the world has entered the nirvana age for commercial aircraft products," Aerospace Daily reported Reich as saying.

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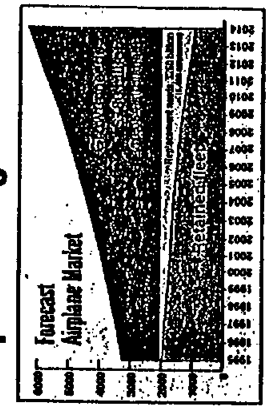
ARTICLE 3

Boeing must reduce costs to capture promising market



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Total Cost of Denver International Airport

Table 1.1: Cost of Denver International Airport

Dollars in millions

Cost category	Cost
Costs to Denver Airport System	
Airport planning, land, and construction	$3,214
Capitalized interest	919
Bond discounts and issuance expense	136
Total costs to Denver Airport System	**4,269**
Costs to others	
FAA facilities	224
United Airline's special facilities	261
Continental Airline's special facilities	73
Rental car facilities	66
Total costs to others	**624**
Grand total costs of Denver International Airport	**$4,893**

Legend

FAA = Federal Aviation Administration

Pg 10 ↑

Pg 11 ↓

two half full pages combined onto 1 page

If Denver International Airport (DIA) opens by February 28, 1995, we estimate that the costs of the airport, including facilities funded by airlines, rental car companies, and FAA will be about $4.9 billion. Of this amount, the Denver Airport System (airport system) has funded $4.269 billion, including capitalized interest and Airport Improvement Program (AIP) grants. Details on AIP grants and FAA facilities and equipment funds are in table 2.1, page 12. FAA, the airlines, and rental car companies have contributed another $624 million for their facilities.

The total cost encompasses all projects approved as of September 1, 1994 It excludes costs for a sixth runway, which has not yet been authorized, and other potential costs or recoveries arising from future legal settlements between the airport system and its contractors. Since September 1, 1994, Denver has agreed to build an alternative baggage system estimated to cost $51 million and has agreed to further modifications to the automated baggage system, which will cost an estimated $35 million.

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Appendix D

1 June 1995 DEIS Hearing and Open House

Page

Comments on 1 June 1995 "Open" Forum at Red Lion Inn

The representatives of the DEIS consulting firms greeted me cordially when I arrived at the DEIS open forum on 1 June 1995.

I tried to discuss the noise assessment. I asked the noise expert, "man A", who said he personally wrote the noise section about the definition of a cold climate home (see DEIS pg. IV 7-4) because the use of the 65 DNL contour lines is based on that assumption. Another men, "man B", who was standing beside man A, made a few remarks that indicated he was familiar with at least a portion of it, but then walked away. Man A wasn't familiar with "cold climate home" so I showed him that page in the DEIS. It turned out that particular noise discussion was in the health section and was "probably written by someone else in his company". I pointed out thet the majority of the homes impacted are older and therefore have zero insulation in their walls, no storm doors, no storm windows or thermopanes and only a token amount of attic insulation. Therefore, the 20 to 25 dB noise reduction assumption for interiors is incorrect. From there on out, I got either "No comment" or "I can't comment on that" for responses from him. Rather than pointing out that the false assumption means that the area that should be eligible for sound proofing is much larger that the currently assumed, I tried a different tact to see if I could get more cooperation.

When I asked why the data from the Arbitration hearings had not been considered, he said unless it was formally submitted as part of the DEIS comment process, it would <u>never</u> be considered. I asked specifically about the men that testified Dec. 1 1994, that after having his house "soundproofed", there was only about a 1 dB improvement, so only the officially provided noise measurement device could detect the improvement. I also mentioned the woman who had measurements at her house that read over 60 dBs but when the report came out, listed her house as ZERO noise much to her shock. To each of those, he said he could not comment.

I then asked about the vibration levels in my area and whether they are just transmitted through the air or if the unstable ground is contributing (houses shift continually throughout Burien and Normandy Park) so he sent me to the "Earth

man" (Man C). Man C brought me over to Exhibit C-1 and said that there should be vibrations along with New York Subway train noise, 2 miles away from the airport as long as its "line of site" even if we were on stable ground. (Exhibit C-1 is included in Appendix A herein)

They refused to answer my "substantive" question about the "cold climate house". The answer will rock the very foundation of the noise contour model and the soundproofing program. Will my DEIS comments be treated the same way too ?

<u>Commentary</u>

The forum was a great concept, it's a sheme there couldn't be a two way exchange of information.

Note, this is the first time I've ever met professionals that didn't introduce themselves. Why?

Has the DEIS been edited to the point that it no longer says what the engineering assessments originally intended them to? At least that would explain why it's so filled with contradictions, wrong baseline assumptions, and unsubstantiated conclusions.

Why wasn't the section that says there are no landslide hazards (IV pg. 19-4) revised to match Appendix F, page 8, the Miller creek assessment that gives exact locations for some. It's obvious the report was not cross checked against itself. I know the DEIS ignores the King County hazard assessment data and the Arbitration Panel data but the report even ignores itself. R-11-1

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Author's testimony at June 1,1995 hearing

Considering I've spent the last 17 years in the aerospace industry as a Materials Engineer, the health of the Airlines, not just the surrounding communities, is important to me. The data says it will be a mistake if we continue to try to put a huge square peg into a tiny round hole (or , in this case, a build up a tiny thin valley that's about 2 stories below the existing runways).

The DEIS report's conclusions are not supported by the data.

For example, the report assumes there is no depreciation in property values. Depreciation then leads to a reduction in real estate tax revenues. Just considering the 50 homes in the building project beside Marvista school, homes have already been devalued by 33 to 50 %. over the last few years. The calculations I brought used 33 % and led to a projected loss in revenue of 13.8 million over the next 15 years for a tiny x on the enclosed map that is outside the generalized study area. Imagine the billions it must be when you consider that most of Normandy Park and Burien are impacted. The lower house sale prices are on record at King County Court house.

NOISE - Although it contains pages of data that says noise above 45 dBs is a problem , it then contradicts itself by only considering noise that makes you go deaf.
Then there is the whole issue of noise contour maps and measuring systems. Within 1 hour you could have 5 motor bikes for 30 seconds each as well as 5 lawn mowers for 1 minute each, and it could still be considered ZERO noise using the DNL/Ldn system. I don't think a jury would embrace the DNL noise measuring system as enthusiastically as the Port does. Do you? Considering the drastic drop in home values, obviously noise is a problem.

The report is missing vital data. For example , bald eagles are living and breeding by the airport. I wasn't going to bother bringing them up but as we drove home from the library after studying the DEIS there

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was a bald eagle under an airplane that was taking off to the north so I figured I was obligated to mention it.

Then of course there are the landslide, erosion and earthquake fault high hazard areas where the 8 Kingdom's worth of fill is being dumped that the report failed to mention.

It is fitting that I spent Memorial day preparing for this. I know that most people in the area feel that the government here is "By the Port and For the Port" but I KNOW the Third Runway won't meet the Airlines needs so it is not worth destroying anyone's home - man or beast. Or, for that matter, subjecting us to more carbon monoxide and air toxins which are already above established safety standards. The Third Runway only increases capacity by 2% departures and 12 % arrivals but will cost over an order of magnitude more than a standard runway.
The Third Runway is extravagance Washington can't afford.

The only real questions are:

Are we going to have to go to court to stop it ?

How big a scandal is the EIS going to cause if it isn't revised to address comments such as those you've heard today ?

When are we going to put together a plan that really meets the Airlines' long term needs?

Added subsequent to hearing :
I sometimes paraphrased so this isn't identical to my speech but its very close. For example in my speech, I asked how long it was going to take the 8 Kingdom's worth of dirt to settle and pointed out the mistake the Denver airport made. There's is now settling and has to be repaired. I provided a 33 page draft report with data substantiating my comments such as the King County hazard map, a Science News Vol. 147 article on Seattle faults, detailed tax revenue calculations, etc. It also references the specific locations in the DEIS that I'm referring to.

Marvista Student Demonstration at June 1,1995 DEIS hearing

It will cost about one billion dollars to make the third runway. Most runways cost about 50 million dollars. The third runway will not be able to carry fully loaded cargo planes. It will only be able to increase by 2 % the take-offs, and it will only be able to increase by 12% the landings. Plus, it will also annoy the people, animals like dogs, cats and most importantly bald eagles. When I am at school I hear airplanes very often so probably other schools do too.

The grass filled part of the box is the woods and grass. The empty part of the box is the concrete walls, new buildings, and runways. The ball will substitute the noise of the planes. See how the ball will make more noise on the concrete walls, buildings and runways than it will on the woods and grass.

Thank you for your time.

Parents note : This was written by our 9 year old son, who obviously has been listening to us discuss the third runway during meals. I added this post script, he did the rest. He attends Marvista School in Normandy Park which is well OUTSIDE the study boundary. This was prepared for the DEIS June 1, 1995 hearing.

About the author : A. Brown

Education
BS Materials Engineer, Psychology minor from Rensselaer Polytechnic Institute, Troy, NY - - Dean's List
MBA from City University -- President's List

Employment
Current : over 15 years as engineer at Boeing with assortment of Boeing/NASA/Air Force recognition awards
Other Employment has included unemployment counselor, sales clerk and college teaching assistant

Outside Interests
Active in Engineering, Scouts, Church, PTA and Children's sports organizations

Residences -- over 15 years Burien/Normandy Park
Current : Near Marvista Elementary in Normandy Park just north of Normandy Province
Prior : 2 blocks south of Gregory Heights Elementary School in Burien
2 blocks west of Hazel Valley Elementary School in Burien
4 blocks south of Highline High School in Burien
Troy, NY
St. Louis, MO
Quincy, MA (by Boston)
Frequently drive on Des Moines Memorial Drive, 200th and 188th

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Appendix E

Fill Source Availability and Transportation Issues

"Don't bet on "river" of trucks say a pit operator" news article

Road Adequacy Standards Chapter 21.49 - Annotated with comments applicable to the DEIS

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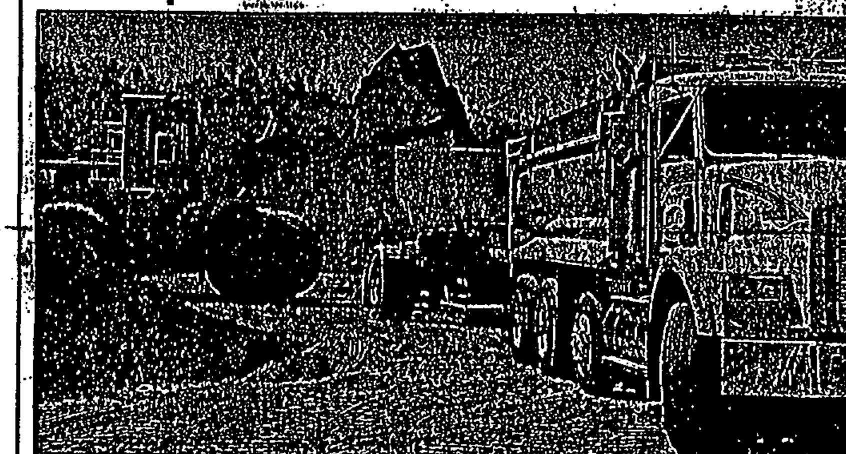
FRONT PAGE
FEDERAL WAY NEWS
27 JUNE 1995

Fill 'er up



Lloyd Sand and Gravel in Milton could end up supplying some of the dirt for Sea-Tac Airport's proposed third runway.

Don't bet on 'river' of trucks, says pit operator

He says early reports about the possible number of trips to the airport and their routes are speculative

By Lori Corso
STAFF WRITER

Bob Lloyd doesn't blame people for questioning plans to haul dirt from his Milton gravel pit to build a third runway at Sea-Tac Airport.

In fact, he has some questions of his own, such as why does the Port of Seattle think he would exhaust his entire supply of dirt to satisfy one customer?

And why does the port assume his trucks would enter Interstate 5 via the busy South 348th interchange?

The draft environmental impact statement (EIS) for the proposed third runway estimates that Lloyd Sand and Gravel could supply 7 million of the more than 17 million cubic feet of fill necessary to build the runway. According to the EIS, that translates to 488 round trips of truck traffic a day entering I-5 at South 348th Street for up to 2½ years.

These numbers scare Federal Way city officials, who fear city streets would crumble under a river of heavy trucks. Because the draft EIS ignores potential road damage, the city wants the port to compensate it for any repairs made necessary by increased truck traffic.

Lloyd also has some concerns about the port's trucking proposal, but for now he's more perturbed by what he says are premature news reports predicting a river of truck traffic.

"It draws attention to the fact that trucks are in the way out there, and they are. But they're a necessary evil," said Lloyd, president of Lloyd Sand and Gravel.

Trucks are being dealt a "black eye" in the debate over the third runway, he said.

"I hate to have the trucks used as a pawn because we are already getting beat up from a lot of different angles and we'd need to deal," Lloyd said.

Lloyd Sand and Gravel is just one of 16 gravel pits identified by the port where trucks could pick up loads of fill dirt. Other potential pits are Auburn and Tacoma.

[illegible]

See Trucks, page .

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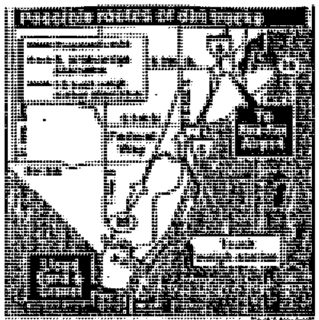

Trucks: Alternate routes would help

Continued from page A1

"I probably wouldn't sell all my gravel to one source. It's crazy for them to speculate that I have that much gravel available," Lloyd said. "I don't want to impact the area with that many trucks either."

Lloyd said he would still consider selling some of his dirt to the port if he could work out some reasonable truck routes within the city.

Now, truck traffic travels past Enchanted Parks on State Route 161. Lloyd said he wishes he had some other options.

"I don't feel that dump trucks or theme parks are compatible neighbors," Lloyd said.

HE ALREADY has some alternate routes in mind. One would call for the construction of a temporary entrance from Milton Road into the truck weigh station just south of Enchanted Parks off of I-5.

That way, trucks would bypass [illegible] South 348th Street and stay clear of the amusement park.

Another option would be to route trucks [illegible] the less-traveled [illegible] 376th Street I-5 overpass to South 373rd Street which connects with Pacific Highway South.

But there [illegible] South 373rd Street [illegible] designated truck route [illegible]

To move all the earth needed to build a new runway and expand the airport, the EIS estimates it will take 571,000 truck trips about 2½ years, with trucks traveling between various gravel pits and the runway six days a week, 16 hours a day.

Port officials point out that the number of truck trips could fall significantly if dirt is taken from port-owned property near the airport.

For now, the port doesn't plan to pitch in to pay for road repairs, the result of added truck traffic.

"The haul routes are something that are permitted locally," said Mike Feldman, manager of aviation planning for the port. "If they are a permitted activity and they are operating within their permits, no mitigation (should be required)."

BESIDES, mitigation fees to improve damaged roads should be the responsibility of the trucking companies or gravel pits, not the buyer of the material, Feldman suggested.

That doesn't mean the port wouldn't do anything to diminish the impact of truck traffic.

Port officials expect to develop a detailed plan to reduce the effects of truck traffic on local neighborhoods.

City officials want a written commitment from the port that it would address mitigation issues, such as paying to repair sections of damaged roadway and limiting hauling hours to off-peak traffic periods.

The port [illegible] it would be willing to negotiate haul routes with affected jurisdictions. But that step isn't stated in the draft EIS.

Lloyd contends that trucking companies already pay their fair share to maintain roads through fuel and motor vehicle excise taxes.

ONE HUNDRED percent of the fuel taxes that trucking companies pay and about 30 percent of the motor vehicle excise tax trucks pay is used for road construction and repair, said Jim Tutton, vice president of the Washington Trucking Association, which has headquarters in Federal Way.

"The trucking industry is a big contributor to road construction and maintenance," Tutton said.

Barring any legal challenges or significant environmental obstacles, construction on the third runway is expected to begin next April.

Federal Way News
27 JUNE 1995

Continued from page A1

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"The haul routes are something that are permitted locally," said Mike Feldman, manager of aviation planning for the port. "If they are a permitted activity and they are operating within their permits, no mitigation (should be required)."

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Chapter 21.49
ROAD ADEQUACY STANDARDS

Sections:

21.49.010 Definitions. For purposes of this chapter, the following definitions shall apply:

A. Proposed Development. "Proposed development" means a subdivision, short subdivision, planned unit development, master plan development, a conditional use permit, or an unclassified use permit or any development proposal requiring a building permit exclusive of any use which is categorically exempt under the State Environmental Policy Act as implemented by King County. The renewal of permits or the issuance of a new permit for existing uses constitutes proposed development only if it will generate additional traffic above that currently generated by the use.

B. Approved Development. "Approved development" means a plat or short plat which has received final approval; PUD, conditional use permit or unclassified use permit which has been authorized by King County, or a development for which a building permit has been issued.

C. Direct Traffic Impact. "Direct traffic impact" means any new increase in vehicle traffic or increase in vehicle traffic generated by a proposed development which equals or exceeds ten (10) peak hour, peak direction vehicle trips on any roadway or intersection.

D. Level-of-service (LOS). "LOS" means a measure of traffic congestion along a roadway or at an intersection identified by a letter scale from A to F as calculated by a methodology endorsed by the Institute of Transportation Engineers.

E. Calculated LOS. "Calculated LOS" means a calculation that includes existing traffic, the traffic anticipated to be generated by previously approved developments as determined by actual land development information, if available, otherwise growth rates based on land development information, and the anticipated traffic from the subject and other requested proposed developments.

F. Peak Hour. "Peak hour" means the hour during the morning or afternoon which experiences the most critical level-of-service for a particular roadway or intersection.

G. Ultimate Roadway Section. "Ultimate roadway section" means a designation by King County that the maximum roadway or intersection capacity has been reached and further right-of-way acquisition and/or improvements are not feasible to increase peak hour vehicle capacity.

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Third runway construction will make some intersections LOS F and increase traffic in intersections already at LOS F.

H. High Occupancy Vehicle (HOV) Incentives. "HOV incentives" means improvements, policies, or actions which would enhance or stimulate use of transit, carpooling, vanpooling, or other methods of ridesharing.

I. Transportation System Management (TSM). "TSM" means low-cost projects that can be implemented in a short time frame designed to increase the efficiency of existing transportation facilities. This also includes transit and/or ridesharing measures to decrease single occupancy vehicle trips.

J. Pro-rata Share. "Pro-rata share" means the fair and equitable cost obligation assigned to a proposed development which is attributable to the peak hour, peak direction vehicle trips generated by it on the affected roadway or intersection. The share will be determined by dividing the number of peak hour, peak direction vehicles being added as result of the proposed development by the calculated total peak hour, peak direction vehicles using the affected roadway or intersection. (Ord. 7544 § 3, 1986).

21.49.020 Purpose. The purpose of road adequacy standards is to assure adequate levels-of-service on roadways and intersections. Road adequacy standards shall be used to evaluate the impact of proposed developments' traffic on roadways and intersections, to apply conditions assuring that road capacity will be adequate, and to deny proposed developments which would have unacceptable impacts on road safety or levels-of-service. (Ord. 7544 § 4, 1986).

21.49.030 Standard established. A calculated LOS F shall be considered inadequate. A calculated LOS E shall be considered undesirable but tolerable. A calculated LOS D or better shall be considered desirable. These standards will be subject to review when a mitigation payment system is developed by King County. (Ord. 8052 § 1, 1987; Ord. 7544 § 5, 1986).

21.49.040 Application of standards established. The road adequacy standards established in this chapter shall apply as follows:

A. This chapter shall apply to any proposed development which has a direct traffic impact on any road section or intersection, when such impact results in or adds to a LOS of F for that road section or intersection.

B. These standards shall apply to all public county, city and state roads, other than freeways.

Provided, that:

1. No improvements to state facilities shall be required by King County by operation of this chapter unless the state requests such improvements and an agreement to provide the improvements is executed between the state, county and applicant.

2. No improvements to city roads shall be required by King County by operation of this chapter unless the affected city requests such improvements and an interlocal agreement exists between the city and King County. An interlocal agreement adopted by county and city ordinances may allow for the application of different standards than established in Section 21.49.030 within the city limits when such standards have been adopted as an official control by city ordinance.

3. An interlocal agreement adopted by county and city ordinances may provide that in a designated area within the city's planning area, a different standard than established in Section 21.49.030 may be applied.

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Port should fund improvements and spread out the haul truck deliveries at least 10 years.

4. The standard to be applied to a project shall be the standard established in K.C.C. 21.49.030 unless a different standard, as provided for in subparagraphs 2 and 3, has been adopted prior to the project date, or in the case of plats, before their legally established approval dates.

C. The provisions of this chapter shall be applied only once to any project, unless changes or modifications requiring county approval are proposed which result in greater direct traffic impacts than were considered when the proposal was first approved.

D. The provisions of this chapter shall not be applied to any project approved prior to the date of adoption of this chapter for which conditions were imposed mitigating the off-site traffic impacts of the project, unless project changes or modifications requiring county approval are proposed which result in greater direct traffic impacts than were considered when the project was first approved. (Ord. 8052 § 2, 1987; Ord. 7544 § 6, 1986).

21.49.050 General conditions established. A. Proposed development which will have a direct traffic impact on a roadway or intersection with a calculated LOS F shall not be approved unless:

1. The applicant agrees to fund improvements needed to attain LOS D or better, unless the calculated non-project LOS is E or F, in which case LOS E must be attained; or

2. The applicant reduces his traffic impacts to achieve a level-of-service E by scaling his project down or by using Transportation System Management techniques to reduce the number of peak hour trips generated by the project, or

3. For subdivisions and planned unit developments only, King County establishes a date for final approval to become effective which corresponds to the anticipated date of award of a construction contract for county, city, or state improvements needed to provide LOS D or better, unless the calculated non-project LOS is E or F, then LOS E must be attained; provided such effective approval date may be established only when the anticipated date of award of construction contract is within twelve months; or

4. The roadway or intersection has already been improved to its ultimate roadway section and the applicant agrees to use TSM incentives and/or phase the proposed development as determined by King County.

B. Proposed developments which will have a direct impact on city traffic facilities or designated areas pursuant to Section 21.49.040 B.3 shall not be approved unless the applicant complies with K.C.C. 21.49.050 or 21.49.070 in order to attain the LOS specified in the pertinent adopted interlocal agreements. (Ord. 8052 § 3, 1987; Ord. 7544 § 7, 1986).

21.49.060 Special conditions established. The condition set forth in Section 21.49.050 C. of this chapter shall be considered fulfilled for all proposed developments except building permits if the following conditions are met:

A. Intersection improvements only are necessary to attain LOS E or better and a construction contract is scheduled to be awarded within twelve months, and

B. Complete funding for the necessary improvements is assured by the county, city, state developer, or any combination thereof. (Ord. 7544 § 8, 1986).

21.49.070 Pro-rata share payments. A. As an alternative to meeting one of the criteria in 21.49.050, the applicant shall be allowed to pay for a pro-rata share of the direct traffic impacts of his development, Provided that:

1. King County concludes that the total improvement needed can be provided for or funded within five years of approval of the subject development or the applicant waives the operation of the time limit established in RCW 82.02.020. Consideration of a proposed pro-rata share payment shall be treated as an exception under 21.49.080.

2. Any contribution collected under this section shall be subject to all applicable state laws relating to management, time periods for expenditure, and refunds. Where not inconsistent with state law, such contributions may be used to fund pre-construction costs such as engineering and design.

B. King County shall establish the specific amount or maximum required amount of a pro-rata share payment as a condition of preliminary approval of a proposed short subdivision, subdivision or PUD, and upon final approval for any other proposed development. Fair share contributions only shall be pro-rata share payments.

C. The applicant shall fulfill the pro-rata share payment established by the county for proposed development as follows:

1. For short subdivisions, subdivisions or PUD's, the payment shall be made in full upon recording or, in lieu of payment, the applicant may post a performance bond or other security found acceptable by King County.

2. For all other proposed development, the pro-rata share payment shall be paid upon issuance of a building permit where applicable, or when the applicable permit is issued where no building permit is required.

D. King County reserves the right to require 100% of any on-site improvements or improvements to streets immediately adjacent to the proposed development site as a condition of approval.

E. King County will not collect pro-rata share payments for improvements to city facilities. In cases where pro-rata payments are required for improvements in cities pursuant to the inter-local agreements referenced in Section 21.49.040, the payments shall be made to the appropriate city directly by the applicant. Pro-rata payments for improvements to state facilities may be made directly to the state or indirectly through King County. The applicant must submit confirmation that payment has been made prior to issuance of permits.

As an alternative, the applicant may be allowed to establish an escrow account, payable to King County or the affected jurisdiction, which can be used for mitigation project costs which occur in a specified time period, per RCW 82.02.020. (Ord. 8052 § 3, 1987; Ord. 7544 § 9, 1986).

21.49.080 Exceptions. A. Exceptions from these standards may be granted only when extraordinary circumstances make compliance with the standards infeasible, or when a pro-rata share payment is proposed.

B. For those proposed developments where the zoning and subdivision examiner makes a recommendation to the council, the record must reflect the basis for the exception, and the approving ordinance must grant the exception in order for it to be effective. The ordinance approving the proposal shall be determinative and conclusive as to the development's compliance with this chapter.

KING COUNTY SHOULD DENY PERMIT UNLESS HAUL TRUCK DELIVERIES ARE SPREAD OUT OVER AT LEAST 10 YEARS.

C. For proposed developments for which the zoning and subdivision examiner or zoning adjuster decision is final, the decision of the zoning examiner or zoning adjustor shall be determinative and conclusive as to the development's compliance with this chapter.

D. For proposed developments for which the zoning adjustor's decision is final unless appealed to the zoning examiner, the adjustor's decision on the exception is subject to appeal to the examiner, whose decision shall be determinative and conclusive as to the developments' compliance with this chapter.

E. For permits which are administrative and ministerial for which no appeal is normally available, the issue of the application of the standards in this chapter to a proposed development may be appealed to the zoning and subdivision examiner for a final decision. Such an appeal together with appeal arguments shall be filed with the building and land development division within 10 days of the parks, planning and resources department's decision.

F. Any proposed developments which are being delayed because of inability to comply with Ordinance 6677 may be considered for an exception under this section for a period not to exceed six months from the date of adoption of this chapter. (Ord. 7544 § 10, 1986).

21.49.090 Latecomer charges. State statutes allow for "latecomer" agreements whereby a developer who constructs a road facility which benefits other property owners or the public generally may later recoup part of the costs of the improvements from the other benefitted properties or the county. The county acknowledges that this tool should be available as one way to provide road facilities. The department of public works is directed to work with the transportation planning section of the planning division of the parks, planning and resources department to prepare procedures for considering proposed latecomer agreements. Until such procedures are established, any applicant may propose such an agreement as part of any development application, so long as the proposal conforms to state statutes. (Ord. 7544 § 11, 1986).

21.49.100 King County Authority. The procedures set forth in this chapter do not limit the authority of King County to deny or approve with conditions:

A. Zone reclassification requests based on traffic impacts, or

B. Proposed developments or zone reclassifications if King County determines a hazard to public health, safety or welfare would result from direct traffic impacts without roadway or intersection improvements, regardless of LOS, or

C. Proposed developments reviewed under the authority of the Washington State Environmental Policy Act. (Ord. 7544 § 12, 1986).

21.49.110 Severability. If any provision of this chapter, or its application to any person or circumstance is held invalid, the remainder of this chapter and the application of the revisions to other persons or circumstances shall not be affected. (Ord. 7544 § 13, 1986).

21.49.120 Administration. A. The department of public works shall develop administrative procedures necessary to implement the requirements of this chapter. (Ord. 7544 § 14, 1986).

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Appendix WQ

Water Quality

Attachment 1 : PSWQA Non Point Source Pollution - Annotated with comments applicable to the DEIS

Attachment 2 : Pollution Monitor (Port Pollution Violations)

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WATER QUALITY ATTACHMENT 1: PSWQA NON POINT SOURCE POLLUTION

Annotated with respect to DEIS

Knowledge of the water quality problems caused by urban runoff first began emerging in the 1960s. In the 1970s the U.S. Environmental Protection Agency (EPA) began the National Urban Runoff Program (NURP) specifically to research the water quality aspects of urban runoff. Through NURP 28 cities around the nation, including Bellevue, Washington, investigated the nature and extent of urban runoff water quality problems.

PROCESSES AND IMPACTS OF URBAN RUNOFF

DEIS admits surface runoff will increase and can NOT be fully mitigated

Pollutants from nonpoint urban land uses may enter the waste stream from air pollution and urban runoff. Atmospheric inputs which find their way to the Sound include hydrocarbons, from automobiles, as well as dust and certain aromatic chemicals released by industries but not covered by permits.

Surface runoff is the principal mechanism by which toxic pollutants are transported to surface water. In cities, precipitation falling on roofs and impervious land surfaces is transformed into urban runoff and picks up sediment and surface chemicals as it makes its way toward collection systems (roadways, streets, gutters, and drains). From these collection systems, the polluted surface water travels to the sewage system or stream network.

POLLUTANTS IN URBAN RUNOFF

DEIS admits this will be increased. Can't be fully mitigated.

Suspended Solids

Street dust and sediment from urban erosion may make the water turbid or cloudy. In streams sediment particles settle to the bottom as the water moves downstream, smothering incubating fish eggs, filling spaces between rocks used for cover, and reducing aquatic insect habitat. Sediment particles are also important to urban runoff processes because pollutants tend to adhere to them. Concentrations of pollutants tend to be highest in finer-sized particles.

Nutrients

The discharge of sediments and other drainage containing fertilizer stimulate the growth of algae and other aquatic weeds. A small quantity of these plants is necessary and beneficial to aquatic life. However, too many nutrients may contribute to massive fish kills (mostly in lakes) as a result of high oxygen consumption from plankton blooms or rotting vegetation.

Bacterial/Virus Contamination

The presence in urban runoff of excessive concentrations of bacteria and virus organisms from pet wastes can cause decertification of shellfish beds and the closing of swimming beaches.

Toxicants

Toxic materials often found in urban runoff include lead, cadmium, mercury, organic pesticides, ammonia, and oils. The Metro Toxicants Pretreatment Study found 19 of 111 priority pollutants in local samples; however, except for one value, all were at or near detection limits. Although these chemicals are typically present only in small amounts, under certain conditions they can be concentrated in organisms and build up in sediments near storm water outfalls.

Two categories of toxicants are found in urban runoff:

a. Six metals (arsenic, cadmium, chromium, copper, lead and zinc) were detected in 100 percent of the Metro's toxicant study stormwater samples (Galvin and Moore, 1982). Nickel was detected in 57 percent of the Metro samples. Average stormwater concentrations exceeded chronic water quality criteria for cadmium, copper, lead, nickel, and zinc. Potential sources include tire wear particles (which can represent up to 7 percent by weight of street dust) and brake fluid (copper, chromium, nickel).

b. Organics. Lubricants, hydraulic fluid and fuel leaks from motor vehicles are common and form noticeable coatings on urban streets and parking areas (Galvin and Moore, 1982). These petroleum based products contain significant amounts of both inorganic and organic toxicants. Gasoline, for example, contains benzene, toluene, phenols, and polycyclic aromatics.

In a study by the city of Bellevue, polynuclear aromatic hydrocarbons (PAHs) comprised the majority of organic compounds detected in samples of atmospheric dustfall (Pitt and Amy, 1973).

Table 1 shows the most frequently detected priority pollutants in urban runoff.

IE NATURE OF URBAN RUNOFF

Additional 193 acres of watershed to become impervious. Deis admits will NOT be able to fully mitigate.

The construction of buildings, parking lots, and streets increases the amount of impervious surface within a watershed, increasing both the volume and velocity of stormwater draining directly to streams, lakes, or bays without any measures to retard or reduce flow. Volume is increased because less water percolates into the ground water for later release through streams or transpiration from vegetation. During major storms, effects may include heightened flooding and its consequent economic losses. Bank instability can result as well as more scouring of stream bottoms. Aggradation of the streambed may cause disruption to aquatic insect habitat and impairment of fish productivity by way of siltation of spawning gravel.

For the City of Bellevue, streets, sidewalks, driveways, parking lots, and rooftops were identified as the sources of 60 percent of the total volume of urban runoff (Pitt and Bissonnette, 1984). For most rain events, street surfaces contributed about 25 percent of total runoff flows.

Pollutants in urban runoff come from both existing land uses and land development and construction. Existing land uses include a variety of activities occuring on residential, industrial, municipal, and commercial lands. These during the progress of a storm. Traffic during the dry periods generated winds that actually cleansed the highway of most small particles. Traffic during the storms scrubbed the pavement and released small particles that could absorb pollutants. The traffic also sprayed water on the undersides of vehicles which scoured dirt from the undersides.

The Highway Runoff Project also studied the transport and fate of pollutants from the highways. Pollutants were found to be associated with the finer particles, and flow over vegetation was the most effective method of removal.

Land Development And Construction

Land development and construction have two common characteristics, namely: (1) They involve soil disturbance, resulting in modification of the physical, chemical, and biological properties of the land; and (2) They are short-lived in the sense that the "construction phase" closes when the development and building activities are completed.

Sediment, resulting from erosion of disturbed soils on construction sites, is the principal pollutant. It includes solid mineral and organic materials which are transported by runoff water, wind, ice, or the effect of gravity. Excess stormwater runoff resulting from changed conditions due to construction activities can exacerbate the natural erosion processes that occur when vegetation is removed. The runoff of sediments generated by a construction project is strongly dependent on weather factors such as rainfall or snowmelt. In general, the runoff is intermittent and does not provide a continuous discharge. The amount of erosion is also dependent on factors such as soil types, topography, and project characteristics. such as fill 160 feet deep! That's about the height of a 16 story building. ~10 acres excavation

ETHODOLOGY OF ɌBAN RUNOFF CONTROLS

The following discussion is provided as an overview of the various physical techniques to control urban runoff. The discussion is not meant to be comprehensive nor to serve as a guide for planners faced with a particular problem. Several such guides are available and were used by PSWQA staff in preparing this paper. They include the Department of Ecology's Shorelands Division (1985) Technical Advisory Papers No. 4 entitled "Urban Runoff Water Quality: Effects and Management Options" and "Stormwater Management Procedures and Methods" prepared by URS Company (1977) for Snohomish and King County. PSWQA staff also relied upon EPA's (1983) "Results of the Urban Runoff Program;" Metro's (1982) report, "Toxicants in Urban Runoff;" and a University of Washington "non-thesis" paper by Joan Lee (1985).

The basic approaches to control of water quality in urban runoff are to remove pollutants prior to their entering the major body or stormwater through "good housekeeping" practices; to reduce the volume of urban runoff through decreasing the amount of impervious surfaces; and to hold back runoff water in order to cause pollutants to settle out of the water before the water

reaches a natural water course. The last approach is the most common and is usually a secondary or incidental benefit from volume or flow control designed to prevent flooding.

ɌEET SWEEPING

The theory behind street sweeping as a pollutant control method is to remove the accumulation of contaminants from city streets before they enter the stormwater. Street sweeping was evaluated by the NURP study and found to be ineffective in four of the five areas where it was studied, including Bellevue. The apparent reason for this finding was that street sweeping does not remove the finer particles to which pollutants adhere.

L-WATER SEPARATORS

Limited effectiveness for runways. Mitigation calculations should NOT assume "average" reductions can be achieved.

Oil-water separators are typically placed in storm drains of parking lots and other areas with high vehicle use. They rely on the principle that oil floats on water and typically contain a "T" outlet which excludes floatables. To be effective, however, the oil and grease must be removed between each storm event or they will become resuspended or re-emulsified and discharged through the outlet on subsequent storms. Particularly intense storms may also cause failure of the separators by flooding the traps and not allowing oil time to separate. Although oil-water separators are frequently required in parking lots around the Sound, their effectiveness is questionable because maintenance, if any, is only erratic.

A recent (but expensive) innovation from industrial pretreatment and bilge water control technology is beginning to be applied to stormwater runoff in special high-risk locations. Called a coalescing plate separator, this unit uses packs of corrugated plates to coalesce small oil and grease droplets into larger droplets which can be skimmed off the top. The coalescing plate separator has been used at the Boeing Computer Center in Bellevue (Horner and Wonacott, 1985) and at Metro's eastside bus base where it was found to be quite effective as long as it was properly maintained and the debris retention and overflow structures performed as designed (Lettenmaier and Richey, 1985).

ɅSSY SWALES

Grassy swales or grass-lined channels have been shown to be generally effective for the removal of pollutants from stormwater (Ecology, 1985). They function primarily by settling out suspended solids and pollutants. The velocity of water flowing through a grassy swale is reduced sufficiently to promote sedimentation. The University of Washington's highway runoff study (Wang et al., 1981) documented significant removals of total suspended solids and metals in grass channels. A 200-foot long channel is considered by the State Department of Transportation to be sufficient to remove pollutants. Periodic maintenance is required to remove the accumulated materials in order to prevent a delayed release of the contaminants in a later storm.

ːTLANDS

The use of natural and artificial wetlands for the control and treatment of stormwater runoff has recently gained attention in the Northwest. The interest has been based on the use of wetlands elsewhere in the country for the treatment of sewage effluent.

About 10 acres of wetlands that are helping (i.e. mitigating) the pollution from the existing airport will be destroyed. The Lower Green basin mitigation won't improve the Sea-Tac airport area problem,

The primary method of water quality improvement by wetlands is probably sedimentation. As stormwater enters wetlands, its velocity diminishes because of the vegetation and generally shallow depths. Suspended solids settle to the bottom. Since many of the contaminants are attached to sediment particles, sedimentation clears the runoff not only of the solids but also of some heavy metals, phosphorous, organics, petroleum hydrocarbons, and bacteria and viruses.

Heavy metals in stormwater are absorbed by peat in wetlands as well as by particles. Petroleum hydrocarbons in runoff may be evaporated, dissolved in the water, or digested by bacteria. Most hydrocarbons, however, will become loosely bound to the sediments. A 1976 study of Wapato Lake in Tacoma found that the upper 3 cm of the sediments of this 20-acre lake contained at least 19 tons of oil. Nutrients such as phosphorous and nitrogen will be taken up by the wetland plants.

Since wetlands are highly variable, their ability to improve water quality of stormwater will also be highly variable.

The use of natural wetlands for stormwater control is highly controversial because of the possibly cumulative effects of pollutants in stormwater on wetland vegetation and wildlife. These effects are still not clear from the literature. The Department of Ecology, charged with the management of wetlands through the Shoreline Management Act, does not have an official policy on the use of natural wetlands for stormwater control, although it has awarded a Coastal Zone Management Grant to King County to design a study to evaluate the effect of stormwater on wetlands. The discharge of stormwater to a wetland would legally have to meet the water quality standards of the water body with which the wetlands are associated, and therefore would not technically be legal in most cases. The use of artificial wetlands for stormwater control would not be illegal. However, the use and design of artificial wetlands is still experimental.

In Puget Sound the city of Bellevue and Pierce County have both purchased wetlands for the specific purpose of stormwater control. The use of natural wetlands is integral to Bellevue's stormwater management program.

ILTRATION DEVICES

Infiltration devices, including infiltration trenches and dry wells, work on the principle of returning stormwater directly to the ground water. The NURP study found them to be effective when accompanied by sound design and maintenance (EPA, 1983). They do have a potential for contaminating ground water if the stormwater they collect is contaminated. Infiltration devices can only be used in areas of good soil permeability. In many areas of Puget Sound where impervious clay soils or high water tables are found, they are not effective. In areas of steep slopes, they can contribute to the landslide potential (Talbot, personal communication, 1986).

describes construction area →

DUCTION IN THE AMOUNT OF 'ERVIOUS SURFACES

By using semi-impervious surfaces instead of totally impervious surfaces on parking lots, driveways, and play areas, a reduction in the amount of surface water runoff and therefore a reduction in pollution can be achieved. Porous

asphalt paving and precast lattice concrete and bricks ("grasscrete") are two such alternate surfaces (URS, 1977). Under certain circumstances porous asphalt can become clogged. "Grasscrete" is expensive, requires maintenance, and may not be as effective as porous asphalt. Therefore it would generally only be used where the appearance of a lawn is desired (grass can be grown in the latticework).

ETENTION/RETENTION BASINS

Proposed detention design inadequate,

Runoff detention or retention basins have become the most frequent method for control of runoff quantity and quality in the Northwest. Detention basins are designed to detain or hold back a portion of the runoff for delayed release to receiving waters to prevent flooding. Sedimentation occurs during detention which improves water quality. Retention basins are similar to detention basins but are designed to retain a portion of the runoff for evaporation or infiltration to the ground water. As ponded runoff infiltrates the ground, pollutants may be filtered out or adsorbed onto soil particles.

The choice between detention and retention basins involves tradeoffs between risking contamination of ground water, adding pollutants to surface waters, and preventing damage to fish habitat. Retention basins reduce contamination of surface waters (because contaminants remain in the basin or enter the ground water instead of flowing with stormwater into streams), reduce the volume of streams during and after flooding, and "save" the water as ground water for later recharge of streams during dry seasons. Retention, therefore, provides greater protection to both spawning and rearing habitat for salmon. Unfortunately, retention basins can potentially cause contamination of ground water as dissolved contaminants from stormwater filter down. Detention basins, on the other hand, do not contaminate ground water. However, they do not reduce the total volume of stormwater to streams nor do they help to prevent streams from drying out during the summer.

Detention basins are more common in Puget Sound than retention basins because of the area's impermeable subsoils. The principal fault with current detention basin design is an inadequate detention period for effective sedimentation. The traditional detention basin is designed to control flood volume, not water quality. The design storm for which detention basins are sized is the 25-, 50-, or 100-year storm which causes flood damage. However, most pollutants are washed off the landscape by the smaller, more frequent storms with a recurrence interval of two years or less. To control water quality, therefore, a detention basin must be designed for the prolonged detention of small storms. However, the prolonged detention of large storms is incompatible with flood control. To be a dual purpose basin and accomplish both water quality control and flood control requires multiple outlets and routine maintenance. The lower or retention outlet should be sized for the slow release of the smaller, water quality design storms. An average time of 18 to 24 hours is generally considered adequate. According to Ecology (1985) a determination of the optimal sizing of detention basins for water quality control in the Northwest has not been made. Research is needed to determine the pollutant loadings of various intensity storms on a subregional basis. !

OPTIMAL DESIGN UNKNOWN FOR Sea-Tac →

The EPA NURP projects looked at the effectiveness of detention basins for pollutant removal. The EPA's conclusion was that detention basins are capable funded by its stormwater utility), performance of on-site systems can be more satisfactory (Bissonnette, personal communication, 1986).

When detention basins are built without coordination with a comprehensive basin drainage plan, they can be ineffective for both flood control and water quality control. This problem was found in Washington County, Oregon, where on-site ponds were built adjacent to streams so that flows were detained which should have been released quickly prior to the arrival of upstream peak flows. King County has also had problems with uncoordinated detention ponds resulting in the simultaneous (but delayed) release of large volumes of stormwater. Basin drainage plans can prevent these problems by taking into account the needs of the entire basin and the hydrologic impacts of the detention ponds themselves.

For reduction of nonpoint sources of pollution, regional detention facilities can be of much greater value than on-site systems (Lee, 1985). Longer detention times in regional ponds allow more settling to occur. Maintenance is facilitated when only one site instead of several is involved. More flexibility can be provided in a larger facility to respond to changing conditions. One way of accomplishing regional facilities without large expenditures of public monies is to charge developers an "in-lieu-of" fee rather than requiring construction of an on-site system. Snohomish County is moving toward that approach.

Neither "in-lieu-of" fees nor on-site detention requirements take care of drainage problems in already developed areas. For developed cities, regional detention or retention basins or outright treatment of stormwater may be the only methods available.

[INV]ESTIGATIVE MONITORING

How much is it costing the taxpayer for DOE etc to handle PORT'S "NUMEROUS" VIOLATIONS?

This technique is a method for an enforcement agency to identify the source of a pollutant in stormwater in order to require control. Storm drains are sampled and when more than typical amounts of pollutants are found, the pollutant is tracked up the line until, by process of elimination, the source is identified. Sampling sediments in storm drains is effective because, unlike water samples, sediment samples integrate pollutant inputs over time. Both Metro and Bellevue have used this technique with some success in reducing specific contaminant inputs.

[SIT]E VISITS AND DESIGN OF BEST MANAGEMENT PRACTICES (BMPS) [FO]R SPECIFIC INDUSTRIES

Once an industry has been identified as a contributor of contaminants to a storm drain, an enforcement or technical assistance agency can visit the site, identify the particular practices that are leading to contamination, and assist the industry in designing an effective program of BMP's to reduce contaminant input. (This issue will be discussed more thoroughly in a later issue paper on municipal and industrial discharges.)

How much is it costing the taxpayer for government agencies to try to help the Port devise economic and technically feasible mitigation measures for a construction job of this size? (moving 1000 feet creek, 160 ft deep fill, destroying ... past and present pollution record)?

WQ-8

of providing very effective removal of pollutants in urban runoff. However, both the design concept and the size of the basin in relation to the urban area served have a critical influence on performance capability. Wet basins which maintained a permanent water pool had the greatest performance capability. When basins were adequately sized, particulate removal in excess of 90 percent could be attained. Because pollutants adhere to sediment particles, particularly the finer grained particles, removal of particulates also results in an improvement in water quality. Dry basins (conventional stormwater management basins), designed to attenuate peak runoff rates and only very briefly detain flow from larger storms, were found by the NURP data to be ineffective for reducing pollutant loads. Dual purpose basins (described above) were suggested by limited NURP data to provide effective reduction in urban runoff loads.

Two important points emerge from an analysis of the effectiveness of detention basins. The first point is that because it is the fine particles that must be settled out to remove pollutants, a very long detention period is needed. Mar (1983) has stated that the only practical way to remove fine particles from stormwater is by flow over vegetation. The second point is that a detention basin will not provide water quality control if each subsequent storm flushes the pollutants removed during the previous storm. Fine particles carrying pollutants will settle in collection systems as runoff subsides and will create first flush problems in subsequent storms. Therefore, for detention basins to be effective, regularly scheduled removal of sediments is necessary.

A potential side effect of using detention basins for pollution control by sedimentation is the problem of disposal of the sediment removed during maintenance. Because the concentrations of contaminants are apt to be unacceptable for use of the sediments as clean fill, the sediment may have to placed in a municipal or solid waste landfill where leaching to ground water might occur.

Detention basins can be either on-site (designed as part of a development project to take care of the runoff on a single site) or regional. On-site detention systems are attractive to cities and counties because they can be required at time of permit issuance for the development and, therefore, their construction does not require expenditure of public funds. However, a number of jurisdictions are now moving away from requiring on-site detention/retention systems towards regional systems. Snohomish County did a survey of on-site systems and found that 85 percent of 504 such systems were not functioning properly. King County (Simmler, personal communication 1986) has also found on-site detention/retention systems to be unsatisfactory.

One reason for the ineffectiveness of on-site detention systems is lack of maintenance. Typically, permits require bonds to ensure maintenance for the first two years of operation and then they leave the responsibility for maintenance either to the property owner or the county. Neither maintenance approach is entirely satisfactory; the first because property owners do not always understand the need for maintenance, the second because the number of on-site detention systems in a growing area can soon outstrip the ability and budget of a public works department to maintain them. Where the budget is sufficient for adequate maintenance (as in Bellevue where maintenance is

Considering the Port's past performance, an agreement should be set up with ongoing performance bonds for the life of the airport.

Page WQ-8

Citizens Request Prosecution of Port Officials

A citizens group has asked the chief enforcement officer of the Environmental Protection Agency's (EPA) Northwest region to investigate alleged illegal acts by Port of Seattle employees and elected officials responsible for or having knowledge of on-going violations of the Clean Water Act on Port property at SeaTac airport. The request to Dickson McCleary, of the Criminal Enforcement Division of the EPA, noted that Port officials and employees have failed to make mandatory reports as required under its discharge permit, and that wastewater discharges exceeding effluent limitations, etc. had occurred with full knowledge of Port officials that their acts were in violation of their permit.

The request, which was also forwarded to the State Attorney General, asked the Criminal Enforcement Division of the EPA to investigate the claims, and take all necessary steps "to prosecute Port employees, and/or elected Commissioners having knowledge of these ongoing violations of applicable federal laws." The federal Clean Water Act contains provisions for criminal prosecution of violators. Criminal penalties for violations of the Clean Water Act can range up to one year imprisonment.

Excerpts from Letter to EPA

Mr. Dickson McCleary
Criminal Enforcement Division
Environmental Protection Agency
1200 6th Ave MS SO-074
Seattle, WA 98101

Dear Mr. McCleary,

I represent CASE (Citizens Alternatives to SeaTac Expansion (CASE) an organization concerned with issues related to SeaTac airport. ...

Recently, it has come to our attention that the Port of Seattle's industrial wastewater treatment (IWS) facilities at SeaTac airport have been responsible for numerous spills into Des Moines Creek as well as the waters of Puget Sound. Further, after reviewing Port studies and documents issued by Washington State's Department of Ecology, it has become apparent that the Port's IWS treatment facility is not only currently out of compliance with its permit, but that the facility has been effectively in non-compliance with federal and state laws since it was originally constructed in 1965. (See enclosed DOE letter dated February 27, 1995) Additionally, documents recently obtained (See enclosed Port of Seattle memo dated July 12, 1994 show that both senior level Port staff members, as well as elected Port commissioners have had knowledge of the non-compliance of their facilities, and have subsequently failed to take immediate steps to cure the problems associated with their water treatment facilities. ...

Our organization has been extremely patient in working with governmental agencies including Washington State's Department of Ecology and the EPA in order to preserve water quality in our local local streams as well as Puget Sound. However, recent revelations that the Port has had knowledge of the improper operational conditions of its facilities, and yet has failed to immediately correct and remedy repeated violations occuring over many years indicate that stronger measures are needed to correct these problems.

Please consider this letter a formal request to the federal Environmental Protection Agency (EPA) to investigate this matter and take the necessary steps required to enforce civil and criminal provisions of the Clean Water Act and if deemed appropriate take all necessary prosecute Port employees and Commissioners having knowledge of these ongoing violations of applicable federal laws at the Port's facilities.

Sincerely,

Frank Jovanovich
President, CASE

Enclosures:
Department of Ecology Letter dated Feb. 25, 1995
Port of Seattle Memorandum dated July 12, 1994

cc: Washington State - Office of Attorney General
Office of Inspector General, EPA

(See Cleanup pg. 1, col. 1)

monitoring by local citizens. Attorney Richard Smith, counsel for the Waste Action Project, represented the appellants in the NPDES appeal.

Shawn McEvoy, president of the Normandy Park Community Club, stated "Richard and his associates bring a tremendous amount of technical knowledge and expertise concerning civil and criminal laws regarding polluters and will provide excellent representation for citizens concerned about water quality in these creeks."

Burien resident, Minnie Brasher, who participated in the recent NPDES permit appeal said "our appeal forced numerous additional conditions concerning water quality in the Port's permit and uncovered a host of previously unseen problems".

CASE is requesting a donation of $50.00 from members to support this effort. Members may contribute monthly or quarterly. Contributors are not obligated to participate as litigants. The civil complaint is scheduled to be filed upon expiration of the statutory notice period.

Persons interested in additonal information about the cleanup program can contact CASE at 824-3120. CASE meets the first Wednsday of each month at 7:00 PM at the Highline Educational Resouces Center (ERAC) located at 15675 Ambaum Blvd SW (Next to Hi-Line Lanes) in Burien.

Water Quality Attachment 2

Pollution Monitor

Summer 1995 Volume 1 Issue 1

CASE Assists Airport Cleanup

Citizens and community organizations concerned about pollution in local streams have announced a renewed effort to clean up pollution in the Miller and Des Moines Creek basins. The effort, sponsored by the Waste Action Project, a non-profit organization focusing on cleaning up pollution, involves a legal challenge alleging violations of the Clean Water Act by the Port of Seattle, the operator of SeaTac airport.

Members of the Waste Action Project have previously been involved in investigating complaints that oil, grease and suspended solid material contained in stormwater outfalls from Port of Seattle property are being discharged into both Des Moines and Miller creeks and into the waters of Puget Sound.

The cleanup effort follows a recent appeal of the National Pollution Discharge Elimination System (NPDES) wastewater discharge permit issued to the Port of Seattle. Issuance of this permit was appealed by concerned citizens and community organizations and supported by the cities of Burien, Des Moines, and Normandy Park, the Normandy Park Community Club, Citizens Alternatives to SeaTac Expansion (CASE), as well as many concerned citizens. The appellants demanded that conditions in the permit be strengthened and enforced both through more rigid inspections by the State Department of Ecology, as well as through increased

(Cont'd pg.2, col.1)

Group Notifies Port of Intent to Sue

(Port has sixty days to cure many Clean Water Act violations at airport)

Waste Action Project, an environmental organization based in Seattle, has served the Port of Seattle with a sixty day notice of intent to sue for violations of the Clean Water Act. Waste Action Project ("WAP") focuses on citizen enforcement of environmental laws and includes a coalition of citizens from the south King County area. The Port of Seattle operates the Seattle-Tacoma International Airport, the site of the violations, and is responsible for compliance with the Clean Water Act discharge permit issued for the airport by the Washington Department of Ecology for the airport's discharges of wastewater to Puget Sound and Des Moines and Miller Creeks.

The sixty day notice takes the form of a June 13 letter from WAP's attorney, Richard A. Smith, which describes the numerous violations of the discharge permit that have occurred at the airport. The citizen suit provision of the Clean Water Act requires a citizen enforcer to give notice to the defendant, the state and EPA sixty days before a complaint can be filed in federal district court.

(Cont'd pg. 3, col. 2)

State DOE Blasts Port for Permit Violations

A State Department of Ecology (DOE) official has cited numerous violations of the National Pollution Discharge elimination (NPDES) permit recently issued to the Port of Seattle which controls water outfalls from Port property flowing.

According to a February 27, 1995 letter to Port of Seattle Facilities and Maintenance Director William B. Brougher, Department of Ecology engineer John Drabek cited numerous violations of the conditions of the permit. Dravek wrote that the Port has failed to "properly operate and maintain ... treatment systems ..." and noted that "some of the improper operations and maintenance have been occurring since 1985."

Dravek stated the Port of Seattle must develop and follow an operating plan and submit an inspection schedule by April 1, 1995.

Dravek apparently agreed with a Port consultants recent findings which recommended that the periods of detention of wastewater undergoing treatment in the IWS facility be increased and required the Port to submit a revised test plan to determine concentration of total suspended solids in the effluent from the system by May 1, 1995.

Dravek wrote "Discharges that result from a failure to follow the requirements of the plan may be considered proof that the equipment was not properly operated and maintained and may be considered a violation ...".

> *"It appears the cozy relationship between the Port of Seattle and the state Department of Ecology has been fractured."*
>
> - Richard Smith, Esq.

The DOE letter also stated that the lagoons used to collect sludge removed from wastewater by the Port's IWS system "needed immediate cleaning" and required a monitoring and cleaning schedule for all three lagoons associated with the IWS system to be submitted by the end of June 1995.

In noting the Department of Ecology's apparent renewed commitment to regulate environmental matters at SeaTac airport, Attorney Richard Smith, said "It appears the cozy relationship between the Port of Seattle and the state Department of Ecology has been fractured."

Pollution Monitor

Address Correction Requested
CASE - Waste Action Project
19900 4th Ave SW
Seattle, WA 98166

Bulk Rate
U.S. Postage
PAID
Seattle, WA
Permit No. 1875

Inside...

A member of Waste Action Project collecting water samples in Miller Creek for testing in conjunction with the airport cleanup program.

(See 60 day Notice, pg. 1, col. 2)

WAP's lawsuit against the Port is scheduled to be filed in early August. The lawsuit will seek injunctive relief in the form of a court order to fix the violations, civil penalties of up to $25,000 per violation per day, and recovery of litigation expenses, including attorney's fees.

Included in the twelve page letter are alleged violations of effluent limitations for discharges into Puget Sound and many violations of monitoring and reporting requirements. In addition, WAP alleges that inadequacy of the airport's treatment system results in illegal bypasses of untreated wastewater to Des Moines and Miller Creeks. The letter also alleges that the airport discharges from eleven unpermitted outfalls and that the Port has illicitly allowed jet fuel-laden sludge to accumulate in wastewater treatment lagoons for nine years.

Smith, who represented citizens and the City of Des Moines in an appeal of the airport's discharge permit settled earlier this year, states, "It must just have been low priority to keep the wastewater system up to date. This is one of the worst situations I've encountered, especially considering that it's gone on for years. We're going to realign the Port's priorities. Any judge we get is going to slam them."

Greg Wingard, WAP's President, also worked on the earlier permit appeal as a consultant and has had increased access to the airport as part of the appeal settlement. According to Wingard, "Every time we turn over another rock at the airport, another appalling environmental problem crawls out. While our lawsuit can't address all of the airport's environmental disasters, it's a start. Maybe after this the Port will take environmental responsibility more seriously."

Wingard also feels that, "Some of the violations can't be attributed to negligence or stupidity alone. Not only has the situation been bad for a long time, but it seems that they have misled the agencies about what they've got there. The Port may ultimately be looking at criminal charges if the agencies get interested." Both EPA and the Department of Ecology have discretion to bring criminal investigations and prosecutions for knowing violations of the Clean Water Act.

For more information contact Greg Wingard (622-7803) or Richard Smith (624-0893).

Yes! I would like to clean up the mess the Port is making in Miller and Des Moines creeks and Puget Sound! Let's hold the Port accountable for environmental damage to our water sources. Enclosed is my contribution to CASE on behalf of the the Waste Action Project (WAP)

Name: ______________________
Address: ______________________
City: __________ Zip __________
Phone: ______________________

I Would Like to Contribute the Following Amount:

___$10.00 ___$20.00 ___$50.00 ___$100.00 ___ Other

For your convenience contributions may be made monthly or quarterly.
Make Checks Payable to CASE - Waste Action Project. Thank you!
(Contributions are not tax deductible)

Return this form and your check to:
CASE - Waste Action Project
19900 4th Avenue SW
Seattle, WA 98166

groundwater systems, which are critical to us because of the Highline Aquifer's presence under the airport. Please include such analysis in the final EIS. R-13-31A

2. Page IV. 10-1, 10-5, 10-6 In the discussion of water quality, the document states that "some shallow, perched groundwater has been contaminated by leaking fuel distribution systems and underground storage tanks at the Airport... [but] compliance with mitigation requirements is expected to prevent significant pollution or degradation of surface and groundwater sources." The document indicates that there are three locations in the process of being cleaned. We believe that the EIS should provide confirmation from the State of Washington agency in charge of overseeing the cleanup that the cleanup is in fact progressing toward a successful conclusion. R-13-17

3. Page IV.10-6 The document discusses the two production wells owned and operated by Highline Water District but fails to mention the three production wells owned and operated by Seattle Water. These should be fully addressed in the final document. R-13-20

4. Page IV.10-6 The reader's understanding of the aquifer system that underlies the Des Moines Upland in the airport vicinity would be enhanced by the inclusion of cross sections based on well logs. Reliance solely on words to describe the geohydrology is confusing. Such cross sections should be included in the final document. R-13-31A

5. Page IV.10-10 In discussing possible mitigation measures, the document states that "where feasible, infiltration of stormwater should be used to the maximum extent allowed by the soils." This demonstrates a weak commitment to the issue of groundwater recharge, given that there are technological means available for infiltration enhancement. We believe that the project proponents should commit to the evaluation, design, construction, and operation of facilities for the injection of stormwater, and include this information in the final EIS. R-13-32

6. Page IV.11-2 The document indicates that borrow pits (areas from which large amounts of soil are taken to be used somewhere else) are being considered north of SR518. Our analysis indicates that this area lies within the 10 year time of travel zone of Riverton Heights Wells 1 and 2. We want to express our concern about removal of large volumes of soil as it may affect underlying aquifers. The potential exists for both increasing the well field's exposure to pollutants and changing the pattern of groundwater migration. Also, we are concerned about the potential for disruption of local wetlands, since their role in the natural recharge/discharge of the aquifer system is not fully understood. We want to ensure that these issues are adequately studied and that potential impacts on aquifers will be addressed in the final EIS; furthermore, plans to mitigate such impacts should be made clear in the final document. R-3-21A R-3-21B

7. Page IV.11-6 The document indicates that loss of wetlands within the Miller Creek and Des Moines Creek drainage areas could potentially be mitigated by construction and enhancement of wetlands outside the boundaries of these drainages. Seattle R-14-7

REC'D ANM-610
PLAN, PGM, & CAP BR
AUG - 4 1995
ANM-610

Seattle Water

Diana Gale, Superintendent
Norman B. Rice, Mayor

August 3, 1995

Dennis Ossenkop
ANM-611
Federal Aviation Administration, Northwest Region
Room 540
1601 Lind Avenue SW
Renton, Washington 98055-4056

Dear Mr. Ossenkop:

In response to your April 27, 1995 cover letter we are providing the following comments on the Draft Environmental Impact Statement for Proposed Master Plan Update Development Actions at Seattle-Tacoma International Airport. In general, we are extremely disappointed in the draft Environmental Impact Statement's failure to adequately address areas of potential concern to Seattle Water and our regional customers. In the bulk of the document, consideration of water-related matters is limited to possible surface water impacts on the Des Moines and Miller Creek Watersheds. The amount of analysis evaluating potential groundwater impacts, water conservation opportunities, and impacts on our wellfield appears to be minimal. The exceptionally narrow scope of the EIS pertaining to water-related matters is profoundly disheartening, and we are hoping it will be corrected in the final document.

Inattention to the matters listed below in the EIS, combined with a persistent inability on the part of members of the Port staff to communicate effectively with our staff regarding several of these matters raised in earlier circumstances, have contributed to our strong concern that our interests are not being sufficiently addressed in this process. To that end, we would like to be contacted directly at the telephone number listed below, in addition to any written response you might have to our comments. We believe that previous written responses provided by Seattle Water concerning several of these issues have not received appropriate attention from Port of Seattle staff.

Specific comments include the following:

1. Page IV.10-1 Based on the discussion of the methodology used in the hydrology analysis, it would appear that most attention has been given to surface water effects. Also important, but less well understood, are the aquifer recharge processes. We believe that more analysis by the project proponents is needed on the impacts on the R-13-31A

Dexter Horton Building, 10th Floor 710 Second Avenue Seattle, WA 98104

9. Page IV.22-1 The section entitled "Energy Supply and Natural Resources" does not take into account any water conservation measures. The *Seattle-Tacoma Airport Comprehensive Water System Plan* described above, from which water use projections have been taken, strongly recommends the implementation of a detailed conservation plan addressing additional metering, irrigation, public information, low water-use fixtures, and water reuse if possible. The plan also states, "(These) program(s) should be coordinated with the City of Seattle's Water Conservation Office in order to achieve regional consistency and benefit from the accomplishments made in this area by the City and water purveyors." (pages 7-2, 7-3)

   Unfortunately, our Conservation Office has not made satisfactory progress with the Port of Seattle in this area over the past several years. We believe that the current Environmental Impact Statement review process provides an excellent opportunity for the Port of Seattle to develop a meaningful and cost-effective water conservation plan for the airport. R-17-6

10. Page IV.18-4 As design for the third runway progresses, we request that the Port of Seattle coordinate with Seattle Water in dealing with relocation of the 36-inch Bow Lake line discussed. Seattle Water will require that its standards be incorporated into pipeline design, and also that it be fully reimbursed for all costs associated with relocation including staff time, construction coordination, and any other costs. R-18-5

11. Appendix A Seattle Water prepared a response, dated February 23, 1994, to the original EIS scoping notice, which was apparently lost in the process. As a follow-up Seattle Water made another written inquiry, dated December 21, 1994, which was cited in a footnote but not listed in the Appendix. We would like to see our correspondence included with other agencies' correspondence in the appropriate sections. R-3-21A

Please contact Bill Alves, our Planning Supervisor, at 684-4678 to address these concerns.

Sincerely,

TERESITA BATAYOLA
Director of Water Management and Planning

Water does not support this concept, because it would not mitigate impacts on the natural recharge/discharge to the local aquifers, portions of which are an important Seattle Water resource for meeting the region's demand for water. We believe the Port must do additional analysis to enable a better understanding of the aquifer recharge system and develop a mitigation scheme to compensate for wetland loss with in-drainage wetland mitigation. The substance and results of this analysis should be included in the final document. R-14-7

8. Page IV.18-1 The projected water demand for the year 2020 is listed as 4.3 million gallons of water per day. However, a close reading of the document from which that figure was cited (the *Seattle-Tacoma Airport Comprehensive Water System Plan*, prepared by Horton-Dennis Associates, 1991, p. 2-17) shows that this figure appears to be the projected level of use for a *peak summer day based on moderate growth projections* rather than the projected *average daily water use* figure. Furthermore, even the methodology used to determine this particular number is questionable. The table from which this number was taken in the *Comprehensive Water System Plan* bases its projected water use numbers on the figure of 15 gallons per passenger, which is reasonable based on historical water use but unreasonably high given the greatly increased water efficiency, required by code since 1993, of any new or replacement plumbing fixtures which might be installed as a result of either an increase in either passenger or facility volume, or normal maintenance.

   It is also unclear from the EIS how much of the projected increase in water demand is a direct result of the new runway and subsequent increased passenger volume/maintenance work and how much is due to normal, non-expansion related growth. The final EIS should contain a tabular breakdown showing the level of additional water demand directly attributable to the third runway. Projected increases in water use by passengers, maintenance, and irrigation should be noted.

   Finally, we are concerned that the water demand forecast contained in the *Comprehensive Water System Plan*, which was completed in 1991, may not accurately reflect the third runway's impact on projected water demand. The "low" estimate for number of passengers by 2020 according to the *Comprehensive Water System Plan* is 25 million passengers per year (p. 2-17). This does not correspond to the draft Environmental Impact Statement's "moderate" projection number of passengers by 2020, 19 million per year (Executive Summary, p. ii). Because the passenger estimates do not correspond with one another it is impossible to take the water use projections listed in both the Plan and the draft EIS at face value. It is important to include realistic water use projections in the final EIS. When these numbers are satisfactorily established, it will be possible to understand what would be required as part of a meaningful and proactive water conservation plan. Such mitigation is notably missing from the document as currently written, and should be incorporated (see below). R-13-4

What is needed in the final EIS is real time air pollution monitoring which can measure air pollutants on a real time basis. This has to be done over a long enough period of time, through all kinds of wind and weather, to create data to compare to government air pollution limits. R-10-47

The chart on page IV 9-10K shows the location of air monitoring stations. None were directly under the flight path where they would get the highest readings. The final EIS should include real-time air and noise measurements from under the flight path. R-10-50

I had the occasion to talk to a chemist for one of the state's oil refineries who related that the refinery was prohibited by the EPA from allowing some known carcinogenic chemicals in gasoline but they could and did leave them in jet fuel. Is this true? Are we who live near the airport living in a chemical dumping ground? R-17-4

I also notice on page IV 7-8 a mention that air pollution caused about 1800 to 2400 deaths nationwide each year. This number seems low. What is its source and what do other organizations quote for the annual death rate due to air pollution? R-10-57 R-10-35

As a resident of the airport area, I am most familiar with the sound pollution from the airport. Reading the EIS, I felt that the real impact of the noise was hidden in pages and pages of tables of average of sound levels. As a physics teacher, I am aware the sound level standards are averages. For example one gun shot in the night might not be considered too much noise, but ten would be, as would a much quieter lawnmower running for an hour. But in the real world a single gun shot will disturb you!

How about relating the sound data as the amount of time you can't hold a conversation outside in your yard? This would be much more meaningful to the average citizen than tables of db levels.

I looked for data on peak noise level and found none. There was a mention that the peak data was an average peak and could be 10 db (or ten times) less loud than the real peak. Nowhere did I find a graph showing the measured sound intensity over time. If a report does not show the actual measured data one may think something is being hidden. The EIS should include graphs of actual sound levels over time. R-6-8

Other important factors about the noise pollution were not addressed. Any resident near the airport knows that the direction of takeoff, moisture content of the air, and especially the existence of cloud cover affect the level of sound at a moderate distance from the airport. None to the sound tables mentioned what the weather conditions were when the measurements were taken. So were the measurements taken on a clear day or one where the cloud cover deflected the sound back to earth? Or were they just averaged? R-6-19

August 3, 1995

Dennis Ossenkop ANM-611
FAA NW Region RM 540
1601 Lind Ave SW
Renton, WA 98055-4056

REC'D ANM-610
PLAN, PGM, & C... R
AUG - 3 1995
ANM-610___

Dear Mr. Ossenkop:

This is my formal reply to the Airport draft EIS.

The first and most important problem with this Draft EIS is that it misses the whole point of an EIS which is to provide the appropriate governmental officials the facts needed to decide about if and in what form they should go ahead with a planned project. This EIS is so voluminous and presents so little comparative data that few if any elected official could seriously understand it. I am a science and math teacher who has commented on several major EIS documents and never felt so lost as in this one. R-1-10

The key to making an EIS which is easily understood is to present key data in a graphic format. This EIS needs graphs to compare air pollution standards with the pollution from the worst monitoring stations. Graphs should be present data for both average and worst case conditions.

This EIS did just the opposite. For example, I found table IV 9-1 for government limits for air pollutants, in one part of the report. And in another part, pages and pages of tables of measurements of different toxins at the numerous locations. Comparison was difficult because the tables differed in toxins listed, periods of exposure and units of measure (ppm or ug/cubic meter). R-10-23

Again it is hard to be sure, but I believe that the table on page D120 indicates that the concentrations of carbon tetrachloride measured was 10 times greater than the WDOE ASIL limits. Is this right?

Also on page D120 the amount of Benzine in ppb was 70 times the ppb annual limit. But this comparison is of a peak measurement with a annual standard. Measurements and standards must match if one is to make any meaningful comparisons. R-10-33

I noticed a testing of the soot from a home near the airport. The report was a white wash and seem to say that the soot was not due to the airplanes. Hogwash, one only has to watch any of the older jets take off to see the soot coming out the engines. Does it disappear by the time it falls to the ground? R-5-1 R-10-36

How about comparing the amount and kind of deposits with those from a home in a neighborhood away from the airport. R-10-4

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August 2, 1995

REC'D ANM-610
PLAN, PGM, & CAP BR
AUG - 2 1995
ANM-610

Mr. Dennis Ossenkop
Federal Aviation Agency
Northwest Mountain Region
1601 Lind AVE SW
Renton, WA 98055-4058

RE: Alternative to truck transportation of
earth fill using a barge-conveyor belt

Dear Mr. Ossenkop:

I am a contractor and have 40 years experience in construction. I have personal experience as owner and CEO of a construction company with large earthmoving projects in the Northwest. Following are my comments to the construction of the third runway at Sea-Tac airport:

The Draft Environmental Impact statement states that approximately 17 million cubic yards of fill will be required to complete the Port's third runway project. If trucks transport that fill, the communities adjacent to the airport will suffer up to 800,000 round trips by heavy construction trucks with the resulting impacts of traffic congestion, air pollution and damage to infrastructure. R-12-22

The Port should include an alternative to truck transportation. The alternative utilizes a conveyor belt in conjunction with barges on Puget Sound to bring required fill to the project site. The conveyor belt would transport fill along an existing Midway Sewer District utility easement that extends two miles from the Sound to the Airport. This eliminates negative impacts, reduces project costs, and that, if selected, will provide income and other benefits to local communities. The Sewer District has agreed to the use of the easement, and the use is permitted as a conditional use under the City of Des Moines Shoreline Master Program.

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The EIS should include chart recordings of sound levels from several neighborhoods under "good" conditions, "average" and under "worst" conditions. R-4-9

One suggestion to mitigate the noise would be to mount pop up blast/sound deflectors at the end of the runways. These could be elevated behind a jet as they run up their engines prior to takeoff and at the start of takeoff. R-4-31B

Another factor not mentioned was the necessity for a 2500 foot runway separation. It is the FAA standard for "Heavy" jets. But the mix of aircraft at SeaTac includes a majority of "Not So Heavy" planes. Could a closer runway alignment suffice. I noticed that the EIS included the number and length of runways at similar airport around the country as part of determining future operational characteristics. But the table conveniently left out the separation of the runways at these other airports. R-3-5

The final EIS should include the separation of runways at other airports and how it effects their operation and safety.

In the executive summary, the EIS should boil down all the data to several graphs which compare the air and noise pollution to that of a similar neighborhood away from the airport. For example, a location in West Seattle at the same elevation and distance from the water. This would be a much better way to present the impact of the airport to the decision makers.

Sincerely,

Herbert Burke
3225 South 146th Street
SeaTac, WA 98168-4237
433-0613

3

Preserves Port's borrow properties for future usage with more options;

Significantly reduces impacts; such as drainage,

access, soil erosion, etc. for Port's properties

identified in PEIS as borrow sources.

A conveyor belt system is feasible, environmentally responsible, and economical. The use of the system as an alternative to eliminate the substantial adverse impact on the environment of heavy construction truck traffic cannot be ignored and must be considered as an alternative in the final EIS. Failure to include the conveyor belt system could be fatal to this EIS process and would certainly jeopardize the community benefits that would result from use of the system. R-12-22

Thank you very much for the opportunity to express my opinion on the Sea-Tac project.

Sincerely,

E.J. Ferullo

Barges transporting fill to the end of the conveyor belt on Puget Sound would discharge fill directly to the belt for the two mile trip to the Airport. The conveyor belt system is proven and has been used successfully in projects such as the Tom Bigbee Dam and construction of SR167. Use of this belt system would provide the following benefits:

Elimination of:

1. Noise pollution;
2. Truck exhaust and fuel consumption ;
3. Traffic congestion and disruption on public roads associated with 800,000 round trips;
4. Safety hazards;
5. Damage to public roads associated with 800,000 round trips;
6. Dust pollution associated with 800,000 round trips;
7. Disruptions to private property access; R-12-22
8. Property acquisition planned by the Port to mitigate the impacts associated with 800,000 round trips;

All weather material allows construction through all weather;

Restoration of the conveyor belt route to a park path identified in the City of Des Moines Comprehensive Plan;

Shorter construction time required for project;

Superior quality of fill material to provide better seismic resistance;

Conveyor usage fees will provide income to the Midway Sewer District to offset improvement costs for new trunk line;

Shorter time for construction impacts;

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2.

After living under 50,000 or more jets in the past five years I can assure you it doesn't get better, it gets worse. You become conscious of how much better you feel when it gets quiet or when you go somewhere else, almost anywhere else, only to be reminded of how deleterious the affects of airplanes are when you return home. I'm also aware that I have a much greater dust problem than I've ever had, which I attribute to the planes, but I'm not sure. R-4-1A

Besides frequency, there is the factor of duration; and I didn't see that in your draft EIS either. It seems obvious to me that close to the airport the sound comes in short, loud bursts, while farther away it lasts far longer. At our house the sound of a stage two aircraft lasts at least four minutes. It is common for us to hear three planes at the same time, one coming, one overhead, and one leaving to the south or east. R-6-4 Close to the airport I notice you usually hear one plane at a time, and while they come fast, there is an interval of silence inbetween. I also notice that a few blocks away from planes near the airport they are audible, but not loud, because they are so low. Evidentally, the higher the aircraft, the longer the sound lasts, I suppose, up to a point when it becomes too far away to hear; there must be some formula in physics. But the fact is that we regularly have had over 150 planes a day overhead during a north flow in the past five years, which translates to five to ten hours of airplane noise a day. Often the planes are loud enough for a person at the other end of the phone to comment on them.

Our Medina neighborhood is a quiet, 100-year old community surrounded by Lake Washington on three sides. It and nearby south Bellevue are some of the finest residential areas in the state. When there is a south wind this is a happy and peaceful community, with a decidedly rural feel to it. It is a place where we definitely have roots; my husband's family goes back five generations and mine goes back three. I can think of many other places that are beyond your "Affected Environment" boundaries but are still greatly harmed by airplanes, including Capitol Hill, the Mt. Baker district, and the Washington Park Arboretum--all of which begin to sound like war zones when there is a south flow. Obviously there are many, many areas that are adversely and severely affected by being under an established flight path, but too far away to have been included in your draft EIS study area. I think these places are too valuable to be forgotten and too impacted by aircraft overflights to be overlooked and should be included in your final EIS. R-5-2

Sincerely,

Coco McDougall

(Mrs.) Coco McDougall
P.O. Box 413, Medina, WA 98039
7857 NE 12th St, Medina 98004
206 - 454-0154

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August 2, 1995

REC'D ANM-610
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AUG - 2 1995
ANM-610

Mr. Dennis Ossenkop
Federal Aviation Administration
Northwest Mountain Region
1601 Lind Ave. S.W.
Renton, Washington 98055-4056

Dear Mr. Ossenkop:

Since I live in the Medina/south Bellevue area and am aware of a very serious jet problem here, I was surprised to see that your draft EIS does not mention areas more than a few miles from the airport and does not include anything east of Lake Washington at all. We live just over twelve miles northeast of the airport and have the misfortune of living under a very busy flight path. Your EIS should include diagrams of flight paths and show the negative affects of jets, due to noise and other pollution, even at considerable distances from the airport as a result of those flight paths. Omitting the existence of flight paths from your report makes me feel that I am reading an EIS for an office complex or an industrial project rather than for an airport. R-5-4 Your "Affected Environment" of approximately 30,000 acres is far too small and contained, considering the unique configuration of aircraft patterns and their resulting farflung impacts.

The fact is that the airplanes travel single file, one after another, with little variation in position, causing a very big negative affect over time on the specific area directly under the flight path. A mile away from the path the affects are minimal, and this appears to be true whether you are two miles from the airport or twenty. In other words, the flight paths extend for very long distances over very narrow and specific corridors and their impact is limited to an area directly beneath the airplane and a few blocks on either side. I know your geographical study area is based on the limits of the DNL 60 zones, according to the results of the noise monitors. I also know that as of three weeks ago no aircraft noise has ever been tested by noise monitors east of Lake Washington. R-5-2 But decibels of noise is only one factor, anyway. Your EIS should also study the affects of frequency and duration.

No one minds the noise of one airplane or worries much about its pollution. If you're woken up at night, you can always go back to sleep, and if you're right under one at the airport you can always cover your ears. Singly, airplanes are interesting and often appealing; look at how much fun air shows are and how much we loved the Blue Angels. But the Blue Angels didn't stick around until the wind shifted and the north flow became the south flow or visa versa, which might take weeks or even months, with only eight hours of relief at night. It is the repetitive, incessant, cumulative nature of the noise and pollution under the flight path that is the problem. R-6-4

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Thank you for the opportunity to respond to the Master Plan DEIS. If you have questions please contact Michael Knapp, Planning & Community Development Director or Bruce Rayburn, Director of Public Works at (206) 241-9100.

Sincerely,

D. Scott Rohlfs, City Manager

cc.: SeaTac City Council Members
Michael Knapp, Director of Planning & Community Development
Bruce Rayburn, Director of Public Works

g:\group\planning\mike_k\psmpdeis\psmpdeis.ltr

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CITY OF SEATAC

City of SeaTac
17900 International Blvd., Suite 401 · SeaTac, Washington 98188-4236
City Hall: (206)241-9100 · Fax: (206)241-3999 · TDD: (206)241-0091

August 3, 1995

Mr. Dennis Ossenkop
Federal Aviation Administration
Northwest Mountain Region
1601 Lind Ave. S.W.
Renton, Washington 98055-4056

SUBJECT: CITY OF SEATAC COMMENTS ON THE MASTER PLAN UPDATE DEIS FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT

Dear Mr. Ossenkop:

The City of SeaTac staff, Planning Commission and City Council have reviewed the Master Plan Update DEIS for the Seattle-Tacoma International Airport and enclose the attached City response to that document. While the City recognizes the importance of regional air passenger growth, the impacts of that growth directly impact both positively and negatively the City of SeaTac. In that regard the City has responded to various issues, concerns and questions regarding SeaTac Airport Master Plan DEIS and the need to adequately mitigate those impacts.

Also, the City has included further discussion of the City of SeaTac position on the third runway. That discussion is included in Section 25 of the response as well as in the original letter attached herein.

2.3 A major portion of the City's industrial area (South of S 188th St., between Des Moines Memorial Drive and 16th Ave. S) appears to be in danger of being acquired by the Port in all of the "With Project" alternatives. Although this is acknowledged in Section 6-Social Impacts, the land use section should at least summarize all acquisitions. The use of aviation easements to allow businesses to remain would be the preference of the City.

2.4 **Alternative 4, South Unit Terminal, would require the acquisition of several properties on the north-west corner of the intersection of International Boulevard and S 188th St.** These properties are currently occupied by La Quinta Inn and a number of smaller businesses, including several restaurants. **None of the maps showing acquisition areas (Exhibit IV.6-2, IV.3-2) acknowledge this. The preference of the City would be alternatives that would not acquire these properties. Also, the DEIS needs to include a short and long term fiscal impact analysis of the economic and tax impacts to the City of SeaTac for the acquisition of this area. This would include an analysis of present versus future value.** R-7-2

2.5 The "L" shaped Port buy-out area north of SR 518, east of 24th Ave. S, identified as Business Park in the City of SeaTac Comprehensive Plan is identified on all "with project" alternatives as airport maintenance. **"Airport support facilities" such as airport maintenance facilities would not be allowed in the current BP zone.** R-7-3

2.6 The maps of the "with project alternatives" (Exhibits II.3-2, II.3-3, II.3-4, and II.3-5) show West SeaTac as unchanged residential areas. This understates the extent of the impacts that the "with project" alternatives would have on the West SeaTac area and should graphically reflect the impacts intended. R-3-34

2.7 The plan does not identify the development capabilities of any of the property east of Des Moines Memorial Drive at the completion of a third runway project. This issue should be addressed as part of the plan. R-7-4

2.8 The DEIS understates the impacts to parks and should provide a more indepth discussion of impacts and mitigation to parks. For example Des Moines Creek Park will be significantly impacted by noise as a result of the extension of the existing runway to the south and potentially North SeaTac Park will be impacted with the addition of a third runway. The impact on these two parks needs to be mitigated. R-7-13

2.9 Noise impacts upon residential areas are identified as the major land use impact. The population affected by noise in the "with project" alternatives is lower in the future time periods (2000, 2010, and 2020) than at present, even with the construction of an additional runway. The difference is attributed primarily to the quieter Stage 3 aircraft engines assumed to be in use by that time. **The entire argument that noise impacts would be less in the future "with project" alternatives hinges on the adequacy of the analysis comparing Stage 2 and Stage 3 aircraft noise levels. The City is requesting a description of a phased-in Stage 2 to Stage 3 noise schedule.** R-6-11

SEA-TAC INTERNATIONAL AIRPORT

MASTER PLAN DEIS

SECTION 1 - NOISE

The DEIS presents this basic premise: ***All of the alternatives would result in noise contours below or within the existing noise contours, primarily due to decisions by the airlines to convert their fleets from Stage 2 to Stage 3 aircraft.***

1.1 Based on that premise, the EIS concludes that it is not necessary for further mitigation beyond existing acquisition and noise insulation programs. The EIS does identify several sites (46+/-) outside of the present Port properties which would be impacted by increased noise. The mitigation for those sites include acquisition by the Port using FAA funds, with five (5) sites not being acquired. The problem is that the conclusions of the DEIS, while on the surface appear to establish baseline mitigation measures, are based on technical assumptions that are difficult to technically analyze and judge as correct or incorrect. Therefore, please clarify these assumptions and provide alternatives to the noise model, proposed mitigation and a better method of explaining the resultant findings. R-6-18 R-6-36

1.2 See Sections 2.8, 2.9, 2.10, 2.11, 8.1 and 8.2 for the potential noise impacts and mitigation relative to other DEIS issues.

SECTION 2 - LAND USE

2.1 **The land use section does not mention the purchase of additional West SeaTac properties that would be necessitated by the "with project" alternatives. The Social Impacts section of Chapter IV does address the relocation impacts on West SeaTac *residents*, but the land use section should acknowledge this *land use* change. It is a change of a whole section of the City from residential to airport use, and cannot be addressed solely in terms of social dislocation alone. Please acknowledge and address this land use change.**

2.2 The land use section talks about the current status of noise remedy and relocation programs, **but does not acknowledge the fact that additional relocation programs and funding would be necessary with all of the "with project" alternatives.** This gives the erroneous impression that no additional acquisition programs would be required. Although the Social Impacts section of Chapter IV addresses the issue of the additional acquisitions, please address programs necessary for the "with project " alternatives in the land use section to better clarify this issue. R-7-2

SECTION 6 - SOCIAL IMPACTS

6.1 A map of the acquisition area with the 5,000 foot runway, the 7,000 foot runway and the 7,500 foot runway is not included. Such a map is needed to compare impacts of the original 5,000, 7,000 and 7,500 foot runway with the 8,500 foot runway. R-4-12

6.2 The EIS seems based on the erroneous assumption that growth in airport activity will be the same regardless of facilities. The EIS states:

> "Aircraft operations are expected to grow 30% while enplaned passengers are expected to grow 100% by the year 2020, regardless of the future facilities available at Sea-Tac Airport. Each of the 'With Project' alternatives would result in the same level of total airport activity as the Do-Nothing." (page IV.8-4)

This assumption is incorrect. An increase in capacity will result in an increase in demand due to market interactions between cost, supply and demand. As supply is squeezed, costs increase, and demand decreases to an equilibrium point. An example that is applicable is that passengers will begin to make alternative mode choices to use trains, autos and other airline routes in other parts of the Country, etc. when capacity is exceeded and they are delayed for long periods. R-3-7

Because of this erroneous assumption in the DEIS, it seems that only the impacts of the new airport facilities, not the associated impacts and the cumulative impacts of growth in the number of flights and amount of traffic, are evaluated in the EIS. The DEIS analysis ignores the fact that increased capacity allows additional opportunities for growth of operations beyond the "do nothing" projections. This apparent shortcoming must be addressed.

6.3 Alternatives 2, 3, and 4 each include different runway options. This takes the focus away from the runway length, which is a major variable for some impacts. The various runway lengths should be closely examined as to their impact on other factors. R-4-12

SECTION 7 - HUMAN HEALTH--These impacts are explored in greater detail in other sections of the DEIS (such as Air Quality and Noise sections).

SECTION 8 - INDUCED SOCIO-ECONOMIC IMPACTS

8.1 While the EIS maps of LDN areas show shrinking noise contours in 2020 as compared to 1994, a comparison of the With Project and No Action alternatives in any given year show that the area affected by airport noise will increase on the western side of the airport (detailed in exhibits IV.1-4 and IV.107.). This will most likely translate into lower property values for those properties remaining within the City. An economic evaluation of the effect of increased noise levels on property values should be part of the socio-economic evaluation to compared the economics of buyout areas. R-16-36

2.10 It would be helpful to report the data on the status of noise remedy and relocation programs in tabular form (Chapter 4, Section 2, p. IV.2-4). The presentation in narrative form (subsection A paragraphs 2, 3, and 4) makes it difficult to see how much mitigation is still yet to be completed. R-7-23

2.11 The plan gives the impression that the Washington State Department of Ecology is the overriding decision making authority in lieu of the City and it's regulations. The City needs to also be acknowledged as a permitting authority. R-18-22

2.12 The entire document needs informational corrections as identified in the following areas:

Chapter 4, Section 2, p. IV.2-8.
The DEIS states that the West SeaTac Subarea Plan and appropriate environmental review is expected to be completed by mid 1995. At the present time, we anticipate that this process would not be completed until late 1995 or early 1996.

Table III-1
FAZ 3705 is used to identify the City of SeaTac in the upper half of the table, and FAZ 3706 is used to identify the City of SeaTac in the lower half of the table. FAZ 3705 is the correct FAZ to approximate the City of SeaTac's population and employment. The population and employment numbers reported in the lower half of the table appear to be those for FAZ 3705, and are therefore correct. The FAZ number should be changed from 3705 to 3706 in the lower half of the table. R-7-1

SECTION 3 - ARCHEOLOGICAL, CULTURAL AND HISTORICAL RESOURCES

3.1 Despite a contingency plan for addressing archeological sites that may be discovered during construction and the notification of proper authorities, the DEIS needs to include a plan or process that the Port would adhere to if artifacts of a historic, cultural or archeological nature are discovered. Also, the plan or process should identify what the process would be following the discovery of such an artifact and how it would the impact the construction schedule. R-7-15

SECTION 4 - DOT SECTION 4(f) LANDS--Does Not Apply

SECTION 5 - PRIME AND UNIQUE FARMLAND--Does Not Apply

In the EIS draft IV.8-7, the Sales Tax that would be lost to the City of SeaTac is $202,892 per year or approximately 4.83% of the total Sales Tax *(Using $4,200,000 as a base therefore, $4,200,000 +$202,892 = $202,892)* base. If the potential 12 "Other" sites are not listed which are identified in the Property Tax listing above, then that figure will be much higher.

Loss per year:

Property Tax:	79.77% of AV	$204,448
	"	32,837
Sales Tax	4.83% of Base	$202,892
TOTAL LOSS TO THE CITY PER YEAR:		$440,177

This loss will occur within the General Fund and equates to 3.38% of General Fund revenues *(operations calculated @ $13 million dollars)*.

In that the proposed buy-out area will still leave the City of SeaTac with service requirements the entire length of the west side of the City, it will not be feasible for the City to make a reduction in the expenditure towards services commensurate with the impact of the revenue loss indicated above. For this reason, there will remain a sizeable net loss in revenues in the City of SeaTac as a result of the proposed Port buy-out for the third runway. This net negative impact on the City of SeaTac is not addressed in the DEIS nor is any mitigation to the City of SeaTac for this impact discussed. Please include a discussion of this negative fiscal impact on the City of SeaTac's annual budget and the form of mitigation that is being proposed to address this matter. R-8-7

SECTION 9 - AIR QUALITY

9.1 The EIS states that aircraft do contribute to air pollution and that construction activity would generate short-term air quality issues. It is a stretch to say that the air quality impacts will be short-term when it will take approximately 2.5 years and 380,000 truck trips to import the fill material for the proposed runway without any consideration for the actual construction. The underlying concern is that the SeaTac area is already considered to be within a non-attainment area as defined by Federal guidelines. Therefore, these identified impacts are not minimal. Acceptable mitigation needs to be provided for the impacts to air quality by construction traffic and the increase in aircraft traffic resulting from the construction and increased capacity created by the development of the third runway and the supporting facilities. R-10-44 R-12-2

9.2 The EIS identifies surface transportation (automobiles/trucks) as impacting air quality, with significant air quality impacts being at the major intersections within the City. The SeaTac area is already considered to be within a non-attainment area as defined by Federal R-10-47

8.2 The frequency of noise experienced by persons (employees and residents) in each given noise *level* contour (not addressed by the Port of Seattle EIS) would increase with all the Project Alternatives. A socio-economic evaluation of the effect of increased noise frequency on employees and residents relative to both job and residential impacts should be part of the socio-economic evaluation. R-8-8

8.3 The plan addresses the regional increases in taxes and jobs resulting from the construction of a third runway. However, the plan does not look at the offsetting impacts on the City of SeaTac and the number of jobs and tax revenue that will be lost as a result of the additional land acquisitions to facilitate the third runway and the traffic delays from construction and road abuse. The plan needs to identify the specific economic impacts to the City with regard to lost vs. new jobs and the relation to tax revenue. R-8-7

8.4 The EIS reports that SeaTac would lose 5% of its annual revenue due to loss of property and sales taxes from acquired residences and businesses. This is termed "insignificant" and so is not mitigated. While lost revenue may or may not be offset in the future by new development, new revenue, if forthcoming, would not likely "kick-in" within the current 6-year CIP as budgeted. The DEIS should identify the short term as well as the long term economic impact relative to present value versus future value to the City related to this issue and provide mitigation for any identifiable revenue losses to the City..

8.5 While it is a reasonable argument that lost revenue may be offset in the future by new development in SeaTac caused by airport growth, if the Port's assumption of equal use of the airport in 2020 with or without facility expansion holds, development in the City of SeaTac associated with 2020 airport use would, likewise, come to SeaTac regardless of airport facility expansion. Thus, the expansion of airport facilities into existing City of SeaTac taxbase on the West side of the airport would only be offset by revenue directly from the use of those acres by the Port. A revenue loss versus gain calculation for the land-use change from single-family and commercial to airport use was not included in the EIS and needs to be included. R-8-6 R-8-23

8.6 Additional mitigation needs to be identified for properties that are outside the buy-out area within the City but are impacted by increased noise or traffic.

The DEIS does not identify what the total loss would be to the City from property tax and the following information was calculated by the City Finance department. The 1995 dollars that the City of SeaTac would lose relative to airport expansion equates to *($256,297.16 X 79.77%)* $204,448 per year from property tax revenues according to our Finance Department. The General Fund property tax loss in 1995 would be 3.68%. The City requests that this be analyzed relative to present versus future value analysis. R-8-7

In addition, the EIS has identified a potential 12 other businesses that may be lost. The total 1995 AV for these other identified properties equals $11,093,700 or an approx. additional loss of $32,837.

guidelines. Therefore, these impacts need to be quantified and acceptable mitigation needs to be provided. R-10-45

9.3 The plan can not properly address air quality from vehicular traffic if the traffic projections for the year 2020 are grossly under estimated in comparison to the 2003 volumes from the City of SeaTac's Comprehensive Transportation Plan. The Master Plan EIS should therefore, be modified to be consistent with the City of SeaTac's Comprehensive Transportation Plan which has more current data. As an alternative the City's is requesting that the DEIS update and verify the data used. R-9-4

9.4 Please clarify the necessary mitigation measures needed relative to the increase in flights projected for the year 2020 and the resulting air pollution of these additional aircraft takeoffs and landings. R-10-44

SECTION 10 - WATER QUALITY AND HYDROLOGY

10.1 The intent of Lake Reba was to provide flood control on Miller Creek for a hundred year event. However, the controls are set at a level to provide storage for a storm of somewhat less than a hundred year event. If the plan chooses to re-look at Lake Reba as a regional facility which provides retention/detention for the third runway expansion, it first must accommodate the hundred year pre-development event before being considered for retention/detention for airport expansion. These facilities need to be designed in accordance with the City's adopted code which references the King County Surface Water Management Design Manual. R-13-8

10.2 Detention facilities need to be designed and sized to include all developed areas that have been constructed without providing any retention/detention since the adoption of surface water regulations in 1977. These facilities need to be designed in accordance with the City's adopted code which references the King County Surface Water Management Design Manual. R-18-22

10.3 This Master Plan EIS needs to address the relocation and mitigation of said relocation of Miller Creek above S. 160th St. or the relocation and mitigation of said relocation of Des Moines Creek above S. 200th St. R-13-32 R-13-21B

10.4 The plan minimizes the short and long-term impacts of fuel and de-icing chemicals discharged to Miller and Des Moines Creeks. With increased projected air traffic, the risks and impacts of fuel and de-icing chemicals discharges to the streams needs to be quantified and acceptable safe guards and mitigation need to be provided. R-13-32

10.5 The plan does not address the impacts the construction of the third runway will have on ground water/springs in the vicinity of and west of the third runway. Springs and ground water have been a problem in the area west of the existing airport. Therefore, supplemental geotechnical exploration needs to be performed to define the hydrology in R-13-21A

this area. Based upon the hydrology report, the impacts to the ground water and its movement need to be defined. In those areas where the ground water or its movement is negatively affected or negatively affects down gradient property acceptable mitigation need to be provided. R-13-21A

10.6 The Master Plan EIS implies that it is looking to the basin plans for Miller and Des Moines Creeks to identify mitigation for impacts to water quality and quantity resulting from the proposed improvements. The plan should also independently address and mitigate the impacts from the proposed improvements to both Des Moines and Miller Creeks independently of the basin plans. R-13-32

10.7 The Master Plan EIS does not identify how the proposed improvements are consistent with the requirements of the Port's National Pollutant Discharge Elimination System Permit for surface water control and discharge. The DEIS needs to address this issue. R-13-11

10.8 The DEIS only states that the Port will provide stormwater runoff mitigation pursuant to the Department of Ecology standards. Surface water runoff requirements also need to be designed in accordance with the City of SeaTac's surface water management ordinance which references the "King County Surface Water Design Manual" standards. R-18-22

10.9 The discussion regarding streams and creeks in SeaTac is found throughout different sections of the DEIS (Water Quality, Wetlands, Floodplain). Because of this, it is difficult to ascertain the full impacts on the streams and creeks. The issue of streams and creeks should be dealt with in it's own sub-section under wetlands so that it would be easier to fully determine the impacts of the 3rd runway on these resources and to insure that proper mitigation are being provided. This will result in the need for an additional review and comment period for this sub-section. R-13-27

SECTION 11 - WETLANDS

11.1 The DEIS does not provide a detailed mitigation plan for wetlands mitigation (Appendix P-A). Only a very conceptual plan has been provided. The DEIS needs to provide a detailed mitigation plan. R-14-13

11.2 There is no assessment of the potential sites where wetland mitigation may be implemented in the same drainage sub-basin (Miller Creek). These potential sites need to be identified in the DEIS. R-14-7

11.3 The DEIS only mentions a general location five (5) miles S.E. in the Green River Valley for wetland mitigation. A specific site location has not been identified for the proposed wetland mitigation in the Green River basin. Since the wetland impacts are occurring in the City the mitigation should also be contained within the City. Also, the City Ordinance requires that mitigation be replaced in the same watershed basin where the loss has incurred. The DEIS needs to address this issue. R-14-13

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SECTION 13 - COASTAL ZONE MANAGEMENT AND COASTAL BARRIERS--Not applicable to SeaTac.

SECTION 14 - WILD AND SCENIC RIVERS--Not applicable to SeaTac.

SECTION 15 - TRANSPORTATION

15.1 The DEIS does not provide a realistic evaluation of what will happen to the transportation network as a result of the third runway. The assumption that the number of airline passengers will increase to approximately 40 million by 2020 with or without a third runway and have no impact on the transportation network is an erroneous assumption because the local road network cannot support this level of growth. R-3-7

15.2 The assumption that the south access to the airport with the third runway can be changed to 28th Avenue South without negative impacts to the transportation network is also an erroneous assumption because S 188th St and International Blvd is at or near level of service F. R-9-12

15.3 While the DEIS does mention Personal Rapid Transit (PRT) as an option to mitigate traffic impacts, the City requests that the DEIS and the Port of Seattle acknowledge the possibility of the PRT system and actively support and participate in the development of a Personal Rapid Transit system as a means of mitigating traffic impacts. R-9-23

15.4 The DEIS does not adequately address the issues of access and exit to the airport from South 188th and avoids the difficult question of South Access/SR509. The South 188th Street intersection is already at LOS F. City Comprehensive Plan policies would be inconsistent with this new entry to the airport and the question of how to accommodate the growth of air passengers representing approximately 40% of airport trips traveling south from the present 21 million to 39 million in the next 20 plus years. Therefore the plan needs to develop a viable access to the airport from the south. Construction of 509 and South Access will divert trips and would reduce impacts on the City Streets and would also reduce the mitigation needed to the City of SeaTac. If no other funding sources are available, the Port should finance the construction of the south access. The transportation mitigation impact fees due the City as a result of the Master Plan improvements would be off set by the funds used to construct the south access. R-9-12

15.5 The DEIS does not mention the very important issue of street vacation and the need to consult the City nor does the document discuss the impacts on the City of taking this necessary action. In order to construct the third runway certain city streets will need to be vacated and/or relocated. R-9-10 R-18-16

15.6 In conjunction with development and expansion of the airport, the City's Transportation R-9-24

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11.4 The DEIS states, "The avoidance and minimization of stream and floodplain habitat impacts will be addressed during future refinement of the fill slope design." Therefore, a supplemental DEIS will be required. Also, impacts and mitigation will need to be addressed. R-14-6

11.5 The plan proposes to provide mitigation outside of the City of SeaTac for the impacts of constructing a third runway. Since the City receives the most significant portion of the impact, the mitigation must be incorporated within the City boundaries.

11.6 The DEIS states that wetlands mitigation within the same drainage basin was not considered because the FAA will not certify an airport where "wildlife attractions" are within 10,000 feet of the runway. Based upon this interpretation of the FAA regulations wetlands are regarded as wildlife attractions. This statement implies that the existing airport is not certified since there are existing wetlands located north and south of the existing runways within 10,000 feet of the runway. Please reconcile your statement that the FAA will not certify airports where wildlife attractions are within 10,000 feet of a runway with the fact that there are existing wetlands within the 10,000 foot limit. Also, in the DEIS it is proposed to expand and maintain several existing wetlands that are within this 10,000 feet zone which is contrary to the FAA regulations. This discrepancy needs to be reconciled. R-14-7

11.7 The DEIS does not identify a Class II wetland located approximately at 1000 S. 158th Pl. South. This wetland should be acknowledged. R-14-2

11.8 The DEIS states that a detailed mitigation plan for wetland and mitigation will be conducted at a later date. A supplemental EIS will be required. R-14-13

11.9 The DEIS does not cover mitigation regarding the removal of fish barriers for the re-establishment of anadromous fish north of S. 160th Street. The DEIS also, does not include detailed mitigation plans for the impacts on Miller or Des Moines Creek. These matters need to be addressed. R-13-32

SECTION 12 - FLOODPLAIN

12.1 A plan for Lake Reba relative to operation and flood control procedures should be developed to the satisfaction of the City. R-13-6

12.2 The DEIS does not provide detailed information regarding the methods in which the Port will maintain the current floodplain capacity where fill is proposed to be placed within the floodplain. Please provide this detailed information. R-13-32

15.14 Many of the 2020 intersections are at a higher performance level than the 2003 timeframe as analyzed within the City's Comprehensive Transportation Plan. The Transportation Analysis in the plan is deficient in that the intersections have improved in level of service with an additional 17 years of growth. The discrepancies need to be reconciled. R-9-4

SECTION 16 - PLANTS AND ANIMALS

16.1 The plan talks about providing habitat, however, the current airport practice is to manage the habitat in the existing airport to minimize wildlife. It would be expected that this management practice would be continued in the future. Therefore, the wildlife in the area of expansion would be reduced and minimized which does create impacts on the City and should be more adequately addressed. R-15-11

16.2 The DEIS does not mention the Bald Eagle sightings around Angle Lake. Please discuss this issue in the DEIS. R-15-1

SECTION 17 - ENDANGERED SPECIES OF FLORA AND FAUNA--Not applicable to SeaTac. None are identified within the City.

SECTION 18 - PUBLIC SERVICES AND UTILITIES

18.1 The impacts on police and fire services do not appear to be addressed. It appears that a lack of continuity of law enforcement exists at the airport relative to vice activity. SeaTac has a history of prostitution and the attendant crimes associated with prostitution. Cleaning up the vice activities in the City of SeaTac was a major driving force for the incorporation of the City. This effort has been successful due in part to a coordinated law enforcement effort involving the police, city prosecutors, and the municipal court. Our concern lies in the fact that the Port of Seattle does not use our police, prosecution or court for any of their law enforcement. While that is certainly within your purview, it none the less creates an environment that would likely allow a greater level of vice activity to occur within our city limits. If the enforcement and adjudication of vice laws are not consistent and coordinated, it is reasonable to expect an increase in these illegal activities and their associated offenses. In order to prevent losing ground in these important areas affecting security and quality of life within the City of SeaTac, we would request that the DEIS discuss some means of mitigating these impacts with the significant level of passenger growth expected within the master plan time frame. R-18-21

18.2 Another related issue also involves the lack of integrated police and criminal justice services delivery. In much the same way that vice activities will mitigate on and off Port and City jurisdictions, we already know that both entities incur similar crime problems in other areas such as larcenies, robberies, etc. Simply put, an airport community draws a certain criminal element because of the unique opportunism associated with the traveling public and transportation industries. The criminal element is most likely not concerned

Mitigation Impact Fees will need to be calculated and paid as a mitigation based upon the increase in P.M. peak trips due to the additional capacity created by the Master Plan Improvements. R-9-24

15.7 The Master Plan EIS indicates that the Air Cargo/South 170th & Airport Expressway intersections will need to be improved and signalized by the year 2010. Based upon the City's Comprehensive Transportation Plan, the Air Cargo/South 170th & Airport Expressway intersections are medium priority and need to be signalized in the 1996/1998 timeframe without consideration of a third runway. R-9-6

15.8 Based upon the City's Comprehensive Transportation Plan, the traffic volumes generated by the increased activity in the area as well as growth at the airport, result in an unacceptable increase in traffic volumes on the local street network. Therefore, it is essential that SR 509/South Access be constructed to provide a relief from traffic going to the airport from the south. If any consideration is to be given to the use of 28th Avenue South and South 188th Street as an interim south access to the airport, a firm schedule and financing that is acceptable to the City needs to be in place for the permanent south access. The permanent south access would need to be in place much sooner than 2020. R-9-12

15.9 The proposed signal at South 160th Street and SR 509 should be a permanent installation not a temporary installation. R-9-24

15.10 The plan does not provide sufficient information to address the specifics of the individual construction projects, therefore individual EIS's will be required for the road projects, the filling and grading activities for the third runway, creek relocation projects and terminal construction. R-12-29

15.11 In the transportation section, the plan recognizes the City's Comprehensive Transportation Plan and the projects it proposes in the immediate future. However, it does not acknowledge the fact that many of these projects are the responsibility of the Port of Seattle to fund and construct. R-9-24

15.12 It appears that from section to section, the assumptions used in the Master Plan EIS are not constant throughout the document. As an example, the City's Comprehensive Transportation Plan (CTP) is acknowledged and recognized as a valid study. However, the Master Plan EIS contradicts the CTP 2003 levels of service. Also, the improvements and mitigation identified in the CTP as being needed by the year 2003 are significantly greater than those in the Master Plan EIS for 2020. The Master Plan EIS should be corrected to be consistent with the City's CTP. R-9-4

15.13 The Transportation Analysis considered International Blvd as a seven lane roadway. However based upon the design for Phase I, it consists of four general purpose lanes with an HOV lane south bound. The analysis should be revised to reflect this change. R-9-5

SECTION 21: HAZARDOUS SUBSTANCES

21.1 The plan minimizes the short and long-term impacts of fuel and de-icing chemicals discharged to Miller and Des Moines Creeks. Some of this is the result of cross-connections between it's storm drainage and IWS systems. Please address this in the DEIS. R-13-12

SECTION 22: ENERGY SUPPLY AND NATURAL RESOURCES--No Comment

SECTION 23: CONSTRUCTION IMPACTS

23.1 No mitigation is proposed for the increased volume of truck traffic using the road network. This high volume of truck traffic will result in the premature demise of the structural integrity of the roadways. The plan should acknowledge and provide for the reconstruction of these roadways resulting from the premature deterioration. The impacts of heavy truck traffic from the borrow pits on port property or from other sources is acknowledged. Therefore, a plan needs to be outlined identifying the physical repairs that are anticipated to be made to the roadways used as haul routes. R-12-15

23.2 The DEIS does not clearly identify the haul routes for the fill from the burrow pits on Port property within the City to the fill site on the Westside. These routes within the City need to be clearly identified and approved by the City with the necessary mitigation.

23.3 The DEIS does not identify any haul routes from borrow pits from outside of the City. These routes need to be clearly identified and approved by the City with the necessary mitigation. R-12-13

23.4 The plan should better identify the social disruptions resulting from construction activities. This was only alluded to in the environmental documents. R-12-19

23.5 Since construction will be taking place over approximately a ten year period, more permanent type mitigation should be implemented. The following examples, which are not all inclusive includes an erosion control pond that is constructed to properly service the project over the duration of the construction period. Another example of a more permanent installation would be a paved construction access in lieu of a rocked entrance. Also, construction signing and traffic control improvements should be permanently installed.

23.6 South 188th Street between I-5 and International Blvd should not be used as a haul route for fill or construction materials. SR 518, SR 509 and appropriate locations along Des Moines Memorial Drive between SR 509 and SR 518 are the roadways of preference for haul routes. R-12-25

with the jurisdictional lines we draw between our political entities, but the more we separate, the less effective we become in providing a high level of public safety to the community at large. We expect that the Port will discuss these issues in the DEIS and work with the City to mitigate the potential for negative impacts to our citizens and commercial interests. R-18-21

SECTION 19 - EARTH

19.1 A planting plan and mitigation plan for the fill slope is not provided. Please include this in the DEIS. R-11-2

19.2 No information is provided regarding the existing and proposed grades for the borrow pits within the City. Further, replanting plans for these pits are not provided. Please provide this in the DEIS. R-12-9

19.3 No mention is made in the DEIS on the potential impacts to adjacent single-family residents (15th Ave.) regarding the borrow pit operations of Area 3. The DEIS must discussed this issue. R-11-4

19.4 How will the aesthetics for the reinforced earth walls be handled? Will vegetation or architectural design be used to soften the impact of the walls? Please discuss this issue in the DEIS. R-11-2

19.5 The detail and scale of the maps provided within the DEIS are not very detailed and are hard to read. This should be more detailed and clearly delineated in the DEIS.

19.6 The environmental and visual impacts and mitigation due to the borrow pits do not appear to be addressed in the DEIS? Please address this issue in the DEIS. R-12-9

19.7 The City has proposed earth berms, ponding of Miller Creek and the development of a linear park on the westside of the City with or without project as illustrated on the concept plan attached hereto. The City requests that the DEIS include this concept to provide a buffer and as a form of mitigation to provide an amenity for recreation uses within that area. R-11-9

SECTION 20: SOLID WASTE

20.1 With regards to solid waste, the plan does not acknowledge any efforts on the part of the Port or its tenants to initiate a recycling program. A recycling program should be addressed in the DEIS as an integral part of the airport expansion program. R-18-6

25: CITY OF SEATAC POSITION ON THIRD RUNWAY--After considerable deliberation the SeaTac City Council on March 5, 1992, adopted a position paper, a copy of which is attached hereto. By its inclusion in our response to the DEIS the SeaTac City Council hereby reaffirms and resubmits that position paper. Since the adoption of that position paper, the FAA has proceeded with the development of this DEIS document and is considering runway lengths far in excess of the position taken by our City Council. Although the Council realizes information that is being developed as part of this process may impact how we view our original approach as to the issue of runway length, it is imperative that we strongly indicate to the Port of Seattle our clear and unanimous opposition to any runway length in excess of 7,000 linear feet. It should be noted that a 7,000 foot runway length will handle 85% of the aircraft landing at SeaTac Airport. In essence, while we definitively restate our original position on the runway including the issue of runway length, we recognize that the data developed during this process may be presented which could modify that initial position to better accommodate the overall needs of the regions' air transportation system. However, to the extent that those needs should be balanced with the impact on the City of SeaTac, our stated opposition to a runway length in excess of 7,000 feet is in furtherance of our original position, and better attains the delicate balance between our community and the regional system needs. R-4-12

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23.7 The construction impacts only talk about the impacts caused by the hauling of fill materials for the third runway. The traffic generated by workers and the importing of construction materials and equipment needs to be more adequately discussed and mitigated as they are significant impacts. R-12-21

SECTION 24: AESTHETICS AND URBAN DESIGN

24.1 The design of the transit center along International Blvd is not discussed, nor are there any images, drawings or schematics to illustrate this project and its impacts on the built environment. Please discuss this issue for consistency with City plans. R-18-25

24.2 There is no discussion in any of the alternatives, nor presentation of images, drawings or schematics, that illustrate pedestrian links or orientations between the terminal and the east side of International Blvd. So. Please discuss this issue.

24.3 All of the alternatives presented ignore the aesthetic/design considerations along the Westside of the airport, namely for automobile travel along SR 509 and Des Moines Memorial Drive; pedestrians and/or local residents. Some examples include the screening of impacts, landscaping at or near predominate features of the airport, or, any consideration in incorporating the Westside of the airport with the existing built environment west of Des Moines Memorial Drive within the City. R-11-2

24.4 None of the alternatives adequately addresses the height, bulk and scale of proposed buildings that would be visible from street level along International Blvd. So. or So. 188th. The only aspect of this issue that is addressed is that vegetation would mitigate the appearance of buildings along the street frontage. Please further address this issue.

24.5 Under Alternative 4, the land uses and designs that are envisioned for the property Northwest of the intersection at International Blvd So./So. 188th, are inappropriate for the area, given the existing and anticipated built environment. As represented in the photograph of the site from Appendix N (Ex.IV.24-14), modified to show potential visual impacts, there is no consideration for massing of the proposed development along International Blvd., no accompanying discussion to address elements such as mixed commercial or retail uses that would better incorporate the proposed building into the pattern of existing land uses, or, any discussion in general of how this structure will complement the built environment along this corridor. This type of development, without any of the above considerations, would be inappropriate and out of scale for the surrounding environment. Please address this issue. R-18-25

24.5 The plan calls for the development of the Port's property east of 24th Avenue South and south of South 148th Street as an airport maintenance facility. Currently, the zoning for that property would not support that type of activity. Please address this issue. R-7-3

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5. It does not make sense at all to cram the increased air capacity into one of the smallest urban airports in the country, namely Sea-Tac International Airport. A more realistic approach would be to decentralize the anticipated air capacity increases in the region by taking advantage of such underutilized airports as Paine Field, Bellingham, Renton, Auburn, Boeing Field, Bremerton, Olympia, Moses Lake and Spokane. In addition, every effort must be made to use McChord Air Force Base and /or Ft. Lewis' airport for dual civilian/military use as a long-term solution. Finally, it is in the best interest of the State of Washington to acquire land for a major supplemental airport now, either along the I-5 or I-90 corridor, so that we do not loose a precious opportunity of preparing to compete aggressively in the 21st century global economy. The proposed 3rd runway at SeaTac is an exorbitant $1.5 billion "Band-Aid" solution to a problem that will not go away. R-4-4

Our main concern, of course, is the enhancement of the quality of education of the students at John F. Kennedy Memorial High School in Burien. We cannot accept the Port of Seattle's plan to build a third runway. It infringes upon the legitimate rights of our children to thrive in their preparations to become tomorrow's leaders through education, training, and professional development.

The quality of life of our residents and families must remain the cornerstone of the vision of this community. No entity, whether the Port of Seattle/Sea-Tac Airport or the FAA has the right to negatively impact our educational infrastructure. We will aggressively continue to oppose any plan to expand the current two-runway airport at Sea-Tac. The Port of Seattle and the FAA, as joint agencies of the proposed DEIS, must prepare a detailed cost/benefit analysis of the potentially adverse impacts of the proposed third runway on the educational quality of our region in the Final EIS, to be released later this year. This important element can not be overlooked by our regional decision-makers.

Sincerely,

John C. Schuster

John C. Schuster
Principal

JCS:vj

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John F. Kennedy ***MEMORIAL HIGH SCHOOL***
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August 1, 1995

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ANM-610

Mr. Dennis Ossenkop
Environmental Protection Specialist
Federal Aviation Administration (FAA); ANM-611
Northwest Mountain Region; Airports Division
1601 Lind Avenue S.W.
Renton, WA 98055-4056

Dear Mr. Ossenkop:

Subject: Draft Environmental Impact Statement (DEIS); Seattle-Tacoma International Airport Master Plan Update

John F. Kennedy Memorial High School is pleased to submit the following review comments on the subject DEIS:

1. Our Archdiocesan Catholic high school has been a premier educational institution in the city of Burien for over 25 years, located between SR 509 and First Avenue South at 140th Street.
2. Nearly 1000 high school students, teachers, staff and volunteers have been constantly bombarded with aircraft/airport noise, both inside the classrooms as well as outside on the playfields. It has taken a toll on our educational facility due to the ever-increasing flight operations at Sea-Tac Airport since the second runway was built in the 1970's. Currently teachers have to stop and wait when planes take off to the North.
3. It is not right to even consider the proposed $1.5 billion third runway at Sea-Tac International Airport when the mitigation from the adverse environmental impacts of the second runway is yet to be completed by the Port of Seattle.
4. Some of the detrimental health effects on our students include increased noise, air pollution, and vehical exhaust emissions. R-5-4

with open doors and windows. Under all alternatives, other noise abatement and mitigation planning efforts must be agressively and continuously implemented to reduce noise heard outside homes. This mitigation should include installing noise barriers and berms where applicable and extensive planting of trees throughout the affected communities and the airport. R-6-31B

Chapter IV, Section 2, Land Use

The EIS is selective about which relevant portions of local and regional land use plans to examine for compatibility with the Master Plan Update alternatives. All mandatory comprehensive plan elements of RCW 36.70A.070 have provisions which apply to the proposal. For example, how is the Master Plan Update Development Actions compatible with housing affordability given the loss of up to 649 homes, many (if not all) of which qualify as affordable? How does their displacement impact affordable housing targets established by the King County Countywide Planning Policies and City and County comprehensive plans? What does the displacement of 649 homes and 105 businesses do to the growth targets for households and employment established by the Countywide Planning Policies? R-7-27 R-8-20

Another example of analysis and impacts overlooked is the critical area and resource lands designations and regulations required by RCW 36.70A.170 and .060. All of the local comprehensive plans cited by the EIS have (or will have) designated critical areas and, if applicable, resource lands (including designated mineral resource sites). These jurisdictions also have (will have) regulations for critical area and resource lands protection. The EIS should identify these critical area and resource lands designations and discuss how the regulations will be used to mitigate impacts caused by the Master Plan Update alternatives.

The EIS does not show that the Master Plan Update Development Actions are compatible with the essential public facility policies of the King County Comprehensive Plan. Namely, it cannot pass the test of F-220 which states in part, "...No single community should absorb an inequitable share of the facilities and their impacts...". Indeed, by the EIS's own description of the affected environment it is clear that the airport communities already have absorbed an inequitable share of this facility and its impacts! Additional airport development actions will only skew equity further as evidenced by the numerous unavoidable and unmitigatable adverse imacts proclaimed by the EIS. The Update Development Actions are inconsistent with policy F-220 which means the EIS has failed to satisfy F-222. This policy requires siting of essential public facilities to consist, among other requirements, of "an analysis of the proposal's consistency with policies F-217 through F-221". R-7-11

Chapter IV, Section 5, Prime and Unique Farmland

While the Vacca Farm may not qualify for protection under FPPA criteria, it is nonetheless an outstanding and unique asset to the airport communities, if not the region. The farm is obviously economically viable to its owners if it hasn't been converted into apartment houses as it is zoned. The row crops produced by the farm provide food to local markets, and pumpkins and Christmas trees are provided directly to residents seasonally. It is a joy to have this farm as part of our communities. To proclaim that no mitigation is necessary by its acquisition is an outrage! Losing this farm should be addressed under the social impacts of Chapter IV, Section 6. Mitigation under all alternatives should include keeping the farm and R-7-19

19635 Marine View Drive SW
Normandy Park, WA 98166

REC'D ANM-610
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AUG - 3 1995
ANM-610

August 3, 1995

Mr. Dennis Ossenkop
ANM-611, Federal Aviation Administration
Northwest Region, Room 540
1601 Lind Avenue SW
Renton, WA 98055-4056

Dear Mr. Ossenkop:

We have reviewed the Draft Environmental Impact Statement for Proposed Master Plan Update Development Actions at Seattle-Tacoma International Airport. In general, this document clearly shows that the airport communities will continue to be assaulted by the unavoidable and unmitigatable environmental and social impacts of SeaTac Airport as it exists today and as it is proposed to be expanded. The EIS's numerous unsubstantiated pronouncements and narrow-minded analyses show that there is a lack of understanding about how people live, work and play within the airport communities. R-5-4

Do the authors think that all people do here is seek refuge from the incessant aircraft noise by holing up in our homes and never going outside or opening windows and doors? Do they think that we don't care about displacement of up to 649 neighbors and 105 businesses? Do they think that because a very unique farm nestled in a sea of asphalt doesn't bring joy to our hearts when we annually purchase pumpkins and Christmas trees, or even when we simply walk/drive by? Our comments center on the added undue and unfair burden that the Proposed Master Plan Update Develoment Actions will place on the people of the airport communities who are already significantly impacted by the airport.

Chapter IV, Section 1, Noise Impacts

We live in Normandy Park which is almost entirely excluded from the General Study Area (Exhibit III-2). Therefore, except for some general statements that residents who are disturbed by noise less than DNL 65 could continue to be impacted, it is impossible to ascertain the noise impacts that would be incurred by most Normandy Park residences. We are currently significantly impacted by aircraft noise. Indeed, as we write these sentences in our basement we are disturbed by aircraft noise every two to three minutes. And yet, no homes in Normandy Park qualify for the touted Noise Remedy Program. At a minimum, under all alternatives, including Alternative 1 (Do Nothing), the Noise Remedy Program should be expanded to include homes in Normandy Park and other neighborhoods which are subject to similar aircraft noise levels. We disagree that no additional mitigation would be needed. R-5-2 R-7-38

Moreover, even though the Noise Remedy Program helps to reduce noise levels in homes, it does absolutely nothing to reduce noise outside homes and within homes R-6-31B

<u>Chapter IV, Section 19, Earth and Section 23, Construction Impacts</u>

The EIS significantly overlooks the impacts of excavating and transporting fill from the 16 potential off-site borrow sources. Indeed, Section 19 conflicts with Section 23. In Section 19, the EIS pronounces that off-site borrow sources are not addressed. However, 16 sites are listed in Section 23. The location of off-site borrow sources must be identified. The EIS admits that there would be from 379,400 to 571,200 trips to /from the off-site borrow locations. The EIS must specifically show how and where the fill from off-site sources will be transported. Anything less than full disclosure renders the EIS inadequate. R-12-15

923,000 truck loads of fill is simply staggering! This construction activity, occurring for 2.5 years, 16 hours per day, six days per week, 50 weeks per year, will cause great disruption, pollution and depletion of mineral resources that could be used for other development, contrary to the EIS's unsubstantiated pronouncement that "no significant impacts would result".

What will be the impact to our roads and streets caused by this amount of truck traffic? The Port of Seattle should be responsible for all resurfacing costs.

<u>Chapter V, Unavoidable Adverse Impacts and Mitigation</u>

In conclusion, the EIS clearly shows that impacts to the full range of issues analyzed cannot be adequately mitigated. Therefore, "with project" alternatives should be denied. The EIS sponsors should choose Alternative 1, Do Nothing, and continue to agressively mitigate the existing unmitigated impacts on the airport communities of its current facility. These communities, as well documented in the EIS, have been and continue to be severely and negatively impacted by Seattle-Tacoma International Airport.

In the event that any of the "with project" alternatives are chosen and eventually allowed, an absolute imperative mitigation measure is to significantly compensate the airport communities with money. All users of the airport should be assessed a fee which is turned over to the airport communities. The communities could use the money to help build schools, parks, streets, etc, or to do other community enhancement projects, such as stream restoration or street tree plantings. This funding needs to continue throughout the life of SeaTac Airport. This compensation only seems reasonable in light of the EIS's proclamation that the airport is for the socio-economic good of the region and State. If this outweighs the drastic impacts to the airport communities, then the Port of Seattle, region, and State must pay us lucratively over the life of the airport. R-18-8

Thank you for the opportunity to comment on the EIS.

Sincerely,

Doug, Julie and Mitchell Osterman

Doug, Julie and Mitchell Osterman

its operation intact into perpetuity; a demonstration farm funded and maintained by the Port of Seattle.

<u>Chapter IV, Section 6, Social Impacts</u>

Please understand that acquiring homes to mitigate adverse noise impacts may mitigate such impacts at the individual home owner level, but it permanently degrades the airport communities. Displaced [illegible] barren wastelands [illegible] by leaving chain-link fences while they are "held in reserve for future compatible uses". Displacement significantly changes community character. Residents, visitors, potential home buyers, etc. are [illegible] negatively influenced by this dramatic [illegible] of homes and entire neighborhoods. Moreover, the "future compatible uses" are hardly compatible to residential land use, such as the proposed Des Moines Creek Technology Campus. In the case of the North SeaTac Park, no jurisdiction can afford to develop, operate and maintain it, so it is a [illegible] on everyone's back. The displacement of the West SeaTac neighborhood will be no exception. There is no possible way that the loss of this wonderful neighborhood can be mitigated, particularly if the West SeaTac Subarea Plan [illegible] may lead use other than open space. Mitigation under all alternatives should include keeping displacement areas in safe, clean, well maintained, public accessible open spaces which are fully funded into perpetuity by the Port of Seattle. R-8-1

<u>Chapter IV, Section 11, Wetlands</u>

If weland compensatory mitigation for the "worst-case scenario" or otherwise cannot be achieved within the same watershed as the impacted wetlands, then by no means should alternatives 2, 3 or 4 be allowed. Wetland mitigation outside the watersheds is simply and clearly unacceptable given existing environmental problems in these watersheds, let alone the added impacts due to any of the "with project" alternatives. It is absolutely shameful to even suggest "opportunities in the lower Green River Valley". To do so is a slap in the face to us who live in the airport communities and deal with these environmental problems every day. Perhaps the lower Green should be considered as a site for a major supplemental airport if such opportunities exist. In the event in-basin wetland compensatory mitigation is pursued under all alternatives, it should be carried out, monitored, and proven successful in advance of any construction. R-14-7

<u>Chapter IV, Section 16, Plants and Animals</u>

Again, this section shows continued degradation of the natural environment of the airport communities. Its astounding and inadequate that the EIS only offers mitigation as a series of "coulds". Indeed, if in fact the impacts as outlined in this section cannot be fully mitigated, then no "with project" alternatives should be considered. Our communities do not need more starlings, house sparrows, raccoons, opposums and deer mice.

Please note that we often observe red-tailed hawks in the vicinity of SR-509 and South 176th Street (wetland #43). The red-tailed hawk is a raptor of local importance in the King County Comprehensive Plan and a State listed Priority Species and Habitats of King County. How will all alternatives impact this species and its habitat? How will impacts be mitigated? R-15-1

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August 3, 1995

REC'D ANM-610
PLAN, PGM, & CAP BR
AUG - 3 1995
ANM-610

Mr. Dennis Ossenkop, ANM-611
Federal Aviation Administration
Northwest Mountain Region
1601 Lind Avenue SW
Renton, WA 98055-4056

Dear Mr. Ossenkop:

Enclosed please find the Regional Commission on Airport Affairs' comments of the *Draft Environmental Impact Statement for the proposed Master Plan Update Development Actions at Seattle-Tacoma International Airport (Volumes I-III)*. This submittal supercedes all previous RCAA submissions to the FAA regarding the Draft Environmental Impact Statement.

Our organization looks forward to the responses. We would appreciate receiving a complete copy of the Final Environmental Impact Statement including all responses to all submitted comments.

Sincerely,

Stuart J. Creighton
President

Preface to Comments

Regional Commission on Airport Affairs (RCAA), a Washington not-for-profit corporation, is a non-governmental, citizens' organization, whose mission is to achieve a long-term integrated plan for air and surface transportation to meet the competitive needs of Washington state, and to achieve immediate and permanent reduction in noise and other adverse environmental impacts from commercial aircraft in the Puget Sound Region.

RCAA is governed by its Board of Directors, with input from numerous volunteers and from endorsing and supporting organizations in Pierce and King Counties. Its work is primarily performed by its volunteers. RCAA was created to be, and it is, the co-ordinating and 'umbrella' organization for citizen groups, institutions, organizations public and private, and individuals who support its mission statement.

Since its founding, the organization has closely followed and actively participated, to the extent permitted, in such processes as the Port-PSRC study, the work of the State Air Transportation Commission, the work of the State High-Speed Rail Commission, the Expert Arbitration Panel review ordered by PSRC, and the present environmental review for the site-specific portion of the third-runway project. Representatives of the organization have spoken and testified at numerous public hearings, have submitted their own studies and critiques, have encouraged others in similar activities. RCAA has commissioned expert studies of particular issues and has submitted those studies to appropriate official bodies involved in airport and transportation issues.

RCAA submitted extensive scoping comments at the start of the present environmental review and participated in the two occasions afforded for public input during the scoping process. RCAA's preparation and submission of the following comments on the Draft Environmental Impact Statement for the so-called Sea-Tac International Airport Master Plan Update is part of its ongoing concern with transportation issues and the adverse impacts of commercial air activities.

***

Introduction to comments of RCAA on Master Plan Update DEIS

A note on method: The abbreviations used in these comments are the same as those used in the Draft Environmental Impact Statement. These Comments are numbered for ease of reference. Most Comments are directed at materials appearing in the numbered chapters in volume one of the DEIS. The initial Roman number refers to the Chapter. The comments on each chapter are serially numbered, e.g., II-27. Subcomments are designated with letters in parentheses, (a), (b), &c.

In our text, "DEIS" followed by numbers refers to volume one of the DEIS. The few references to the second or third (appendices) volumes designate the volume number with a preceding Roman numeral: II DEIS.

In most instances, we accept & use the definitions of terms found in the DEIS' Glossary. Note the two major exceptions: (1) normally, when we use "region", we wish to be understood as referring to the entire State of Washington, adjacent parts of British Columbia, the entire State of Oregon, & those parts of Idaho primarily relying on Sea-Tac for their major airport. (2) We use "air carrier" in a broader sense than does the EIS, to encompass all commercial common-carrier air travel & cargo activity.

General Comments: Our review of, & our following comments on, the Draft Environmental Impact Statement lead us to the conclusion that the proposed third runway at Seattle-Tacoma International Airport is the most-expensive, most-damaging, & least-effective method yet proposed for meeting long-term air & ground travel needs in the immediate area, in the State, in the Region. It is in no way integrated with other transportation modes. If constructed, it will not make any significant contribution to the needs of our State, &, in addition to direct environmental & economic harm will damage the State by diverting enormous sums of money & effort from more fruitful efforts.□

Our review also reveals that the environmental consequences are grossly understated -- many are ignored entirely -- & that mitigation measures are utterly inadequate. The graver the consequences, the more cursory the study, in fact.

On almost every topic examined, the DEIS does not meet minimum standards for accuracy, completeness, or technical competence. Scientific, engineering, economic, & other technical studies, published in learned journals & subject to peer review, are passed over in favor of unscientific bureaucratic self-serving declarations. Major conclusions are stated as bald matters of fact, without citation to authorities. Repeatedly, technical & scientific conclusions are based, it seems, on conversations between staff of the co-lead agencies and/or other preparers, or similar conversations with other bureaucratic colleagues, instead of examination of scientific literature and consultation with recognized & independent experts.

* * *

CHAPTER I
PROJECT BACKGROUND

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Chapter I: Project background

Comment I-1 -- Background --. The DEIS errs in asserting that Seattle-Tacoma International Airport is the eighth largest international gateway to Europe and Asia. Actually, the airport is constricted on about 2500 acres, one of the very smallest U.S. airports serving international air-cargo needs. The FEIS should provide more accurate information on size. In fact, it would be relevant for the FEIS to provide a table of U.S. international airports ranked by size & also ranked by volume of various sorts of service (general aviation, scheduled passenger travel, all-cargo flights, &c.). R-2-13

Comment I-2 -- Background -- Airport Management (p. I-1, col. 1). The Port of Seattle is a limited-purpose government, not a municipal government in the ordinary sense of the term. Until recently, there were two limited-purpose municipal governments in King County with boundaries co-terminous with the County itself. One of those limited-purpose organizations has now been merged with the County.

Comment I-3 -- Background -- Airport Management -- Taxation by Port (p. I-1, col. 2). The Port of Seattle levies & collects a multi-million dollar real-property tax every year. The statement that revenues from that taxation have not been used at the airport in over 20 years is at best a statement of internal accounting conventions. Overall, is it not true that the Port operates in the red? The taxpayers pick up the difference. Who can say whether the airport side is paying its way? To the taxpayer, it appears that taxes subsidize the Port's operations, including the airport. R-2-6

Comment I-4 -- Background -- Airport management -- alleged mandate of Port. It is averred, p. I-1, col. 2, that when King County citizens voted to organize the Port (which certainly was not one of the "country's first public ports") they "mandated that the Port of Seattle keep the Region strong in its competiton for West Coast world trade". We suggest that if this is important, and true, the FEIS reprint the title of the ballot proposition. We suggest that what the citizens were asked was whether a county-wide Port district should be created, as allowed by the Constitution & enabling statutes, period. No mandate. We comment below, Comment II-21, on the inappropriateness of the F.A.A. picking & choosing certain ports to favor in the contest for supremacy, & that comment applies to the quoted material as well.

Comment I-5 -- Background -- Airport management -- alleged

responsibilities of Port. The last paragraph of p. I-1 errs in using the word "responsible". Regulation of interstate & foreign commerce (to say nothing of commerce with the Indian tribes) is in the first instance a responsibility of the U.S. Congress; subject to Congressional action or inaction, the Legislature acts for the State of Washington. In the absence of action by the Legislature, or with its consent, the political subdivisions of the State (the counties) exercise the State's power. The responsibilities of the Port are much less grandiose than the DEIS states. It would be more accurate to say that the Port has two key operating divisions, & continue from there as is. R-24

Comment I-6 -- Background -- Airport history -- Seattle's bid for dominance (p. I-3). See Comment I-4, supra, and Comment II-21, infra. Contrary to what this DEIS inferentially suggests, it is not the role of the F.A.A. to make "Seattle" (i.e., the Port district), the dominant port of this State or of the the Pacific Northwest. The goals of the Port Commissioners in this respect may be here accurately stated but policy requires a more-dispassionate approach from the F.A.A.

Comment I-7 -- Background -- Airport history --Sea-Tac Communities Plan (p. I-3). How many runways at Sea-Tac are permitted under the Sea-Tac Communities Plan? How does that Plan relate to the present proposal? How does that Plan relate to plans adopted by recently-formed municipalities in the area covered by the Plan? Or to the County's comprehensive & growthmanagement plans? R-18-20

Comment I-8 -- Background -- Regional airport planning (pp. I-14/5). We note that the transportation plan suggested by the Port & PSRC in 'Flight Plan', approved by the Port in Resolution 3125, & addressed by an EIS, is not the transportation plan presented in this DEIS, which lacks critical elements previously made an integral part of the plan. R-3-9

Comment I-9 -- Aviation demand forecasts -- population & employment.

a.) It is astonishing that the DEIS presents here & elsewhere pupulation forecasts without ranges, without estimates of degree of reliability, & unconditioned in any way on the possibility that the suggested scenario of population growth may not be the one that actually plays out.

b.) We repeat our request from our Scoping Comments (p.4, first bullet point) that forecasts & projections should include assumptions &

high-low estimates.

c.) The population forecasts are less certain than the DEIS suggests. They seem to rest on the usual two assumptions, both dubious: (1) that population can be forecast by extension of prior growth rates into the future; (2) that the economy of the study area will continue to enjoy extraordinary growth. To state assumption (1) is to refute it. The second assumption ignores the long-term decline of the Boeing work force & the steady ero⅓sio of the State's prior high standing as a high-earnings, highstandard-of-living part of the continent. Do the EIS preparers disagree with this analysis? Is it not true that hourly wages are declining, on average, both in real terms & in comparison to other places, especially at the lower end of employment? Is it not also the case that non-wage compensation -- vacation & holiday provisions, medical benefits, retirement programs, & so on -- are likewise decaying, especially as part-time employment increasingly becomes the nomrin the lower ranges. The place is not as attractive to wage & salary earning people as it once was.

d.) The DEIS also fails to analyze demographic shifts in population growth. It is well known, but not recognized in the DEIS, that the area is receiving an ever-increasing proportion of economically less-advantaged in-migrants: non-English-speaking, uneducated people from all over the world, usually without skills or capital & candidates; noteworthily, an increasing proportion of Hispanic arrivals; an increasing proportion of arrivals from black ghettos in the East, Mid-West, & Southern California, & from disadvantaged areas in the South. The number of homeless is ever-rising. The number of adults receiving food stamps, children receiving special school lunches, individuals & families seeking public (subsidized) housing, all are on the increase. Do the EIS preparers have a different view, & if so, where are the data to support it. Our conclusion is that these are not indices of the kind of growth that will continue to attract people here in large numbers.

e.) Is it not true that Washington's basic industries, using that word in its broad economic sense, is being hammered: plutonium production ended; nuclear energy industry closed down; salmon fishing in decay; logging almost completely closed down; Columbia River barge transportation threatened; hydroelectric energy R-3-11

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threatened with huge cut-backs; domestic water in short supply on the wet side of the mountains; irrigation water harder & harder to find on the dry side; farming & ranching under continuing environmental constraints?

We conclude that jobs for the projected newcomers will be hard to find. Not everyone will just hop in the old jalopy & drive out here from wherever, trusting that Providence will provide. Rather, people will weigh their options. What will that do to these forecasts?

f.) The projections for air travel do not take into account the long-term downward economic trends here, but they should.□

R-3-11

CHAPTER II
PURPOSE AND NEED AND ALTERNATIVES TO SATISFYING THE NEEDS

Chapter II: Purpose & need; Alternatives to satisfying the needs

Introduction to Comments on Chapter II. Our comments on this Chapter are in two groups. In the first group, Comments II-A through II-E, we include five studies of certain issues included within the scope of the Chapter; these studies present materials, data, findings, & analyses not included in the DEIS, which should be addressed in the FEIS. In the second group, Comments II-1 through II-64, are our comments on particular points raised in the DEIS or suggested by it.

Listing of items included as Comments II-A - II-E:

Comment II-A: "An Evaluation of a third runway at Sea-Tac International Airport: Delays, airport capacities, airport life times, & passenger volumes", RCAA White Paper Book No. 2, John Sandelius (1992).

Comment II-B: "Seattle-Tacoma International Airport third runway project: air capacity", RCAA White Paper Book No. 1 Gerry H. Bogan (1993)

Comment II-C: "Prepared testimony on the passenger ridership diversion potential for the railroad passenger service alternative to the Sea-Tac Airport runway capacity expansion," Hal B.H. Cooper (1995)

Comment II-D: "Implementation of an LDA/DME Approach to Runway 16R in lieu of a third runway at Sea-Tac", Gerry H. Bogan (1995)

Comment II-E: "Final Phase I Order on Demand/System Management Issues", Puget Sound Regional Council Expert Arbitration Panel (July 27, 1995)

Comment II-1: -- Purpose & Need --Objective

(a) The FEIS should clearly state the authority for the statement of "overall objective" found at DEIS II-1. It is not compatible, on its face, with the statements of objective found in Chapter I.

(b) From all that appears in Chapter II of the DEIS, this objective emanates, not from any responsible public body or official, but from a technical report, Technical Report No. 3, Port of Seattle, May 1994. (DEIS, II.1, n. 1.) This is a strange way to define the work to be done in the latter

stages of environmental studies for a project estimated to cost $1500 million.

(c) The actual documents authorizing this present EIS process and the involvement of the two co-lead agencies should be specifically cited, & set out in full in the FEIS, so that the authority given & objectives defined may conveniently be compared to the work reported in the DEIS & FEIS, & so that readers can judge how well the objectives have been met.

(d) Readers generally will not understand from either Chapter 1 or Chapter 2 of the DEIS what the relationships are between the Port Commissioners' resolution of 3 November 1992, the various resolutions of the PSCOG & PSRC, any Federal authorizations, other actions (if any) of other public bodies or officials, & this process. Those relationships should be fully explained in the FEIS. This is especially important given that the careful reader of the DEIS will observe that it does NOT comport with the directions given by the General Assembly of the PSRC & thus does not comport with the amended "Regional Airport System Plan" (RASP) of the PSRC approved by the PSRC. Or, the FEIS must to explain how the Executive Board of the PSRC overruled the General Assembly & arbitrarily amended the RASP to exclude one of the necessary conditions of the prior inclusion of the third runway in the RASP, as well as consideration of Paine

(e) If the process was actually begun in whole or part by some ruling or order within the U.S. Department of Transportation, that ruling or order should be set forth in full, & the legal authority for its issuance should be provided. As things now stand, this DEIS appears to have been prepared & issued on the bare authority of a minor F.A.A. functionary, one Dennis Ossenkop, & a couple of minor Port employees. This exact issue of authority to initiate the process was raised in our scoping comments, Part III, nos. 4, 5, 6, 7 & 8.

f.) The FEIS should explain with crystal clarity how the F.A.A. has become involved as a co-lead agency in a project that until now has been that of its other co-lead agency (Port of Seattle) and the PSRC.

Comment II-2: -- Purpose & Need--Objectives. Mr Ossenkop & his Port colleagues inform us (through quotation of the Technical Report cited supra., that the process has the following objectives:

"Prepare a comprehensive Airport Master Plan (Update) for the

airside, terminal & landside needed at Sea-Tac to meet air travel demand to the year 2020 & beyond."

It is further stated at DEIS II.1 that an undated resolution of the Port of Seattle, no. 3125, (which we know, but not from the DEIS, to have been passed on 3 November 1992) requires that the master plan update study fulfill these additional objectives (which we refer to hereafter as the "Resolution 3125 objectives"):

"Design a mechanism and process to promote (land use and community) compatibility through improved coordination, communication & involvement" [the purpose of the parentheses in the foregoing material is not understood]

"...third runway studies ..."

"reconsideration of a fast rail system together with diversion of all cargo carriers" [emphasis supplied]

Full exploration of *"the impacts of peak period pricing"*

Full exploration of *"other demand management techniques"*

Exploration of *"land acquisition and redevelopment to compatible uses"*

Attenuation of *"airport noise through the use of barriers"*

Promotion of *"aggressive on-airport emissions reductions"* [presumably referring to air pollution]

Promotion of *"regional transit & reduction in use of automobiles"*

Improvement of the *"aesthetic appearance of the airport boundary"*

Development of *"a comprehensive stormwater management plan"*

It would be better to quote fully, or even better, to set out in full in facsimile in the main text (or an Appendix), the source documents for the objectives as stated at DEIS II.1. R-4-2

Comment II-3:-- Objectives; "planning horizon". At various places in the DEIS (& appendices: e.g., Appx B, p. 19), it is asserted that

the "planning horizon" for the Master Plan Update & the EIS is the year 2020. I

(a) The first objective quoted in Comment II-2 shows that the planning horizon is NOT cut off at 2020 but extends into the indefinite future. Wherever the DEIS considers alternatives, adverse impacts, or mitigation however, the planning horizon is cut off as of 2020. The FEIS should determine that a truly appropriate planning horizon extends beyond the year 2020 & should provide the necessary detail to extend the relevant discussion out beyond 2020 to at least the year 2050. This especially applies to the discussion of the high-speed (TGV) rail alternative. See Comment II-C supra. In general, we would suggest a planning horizon in the range of 2050 to 2070.I

(b) he study reproduced as our Comment II-A, the Sandelius paper, shows that in the year 2020 Sea-Tac with the third, dependent runway proposed in the DEIS, will no longer be able to meet the projected travel demand posited by the planners of the Port & PSRC. The 1993 Bogan report, our Comment II-B, reports the same thing. Unless the co-lead agencies are now changing radically downward their projections of travel demands in the period 2020-2030, it is important that the FEIS reveal (i) how the third runway & other construction advocated in the DEIS will meet "air travel demand ... beyond [2020]. R-3-36

(c) If, as now seems evident, demand will once again exceed demand at or about the year 2020, on the current projections, the FEIS should tell the reader what the plan is for meeting that demand.

Comment II-4: Objectives; air travel study. We assume that there is no question whether the first of the objectives stated at DEIS II.1 permits consideration of the possibility that travel demands "to the year 2020 & beyond" may be met by modalities other than air travel. A more restrictive interpretation would forbid fair consideration of alternatives to the existing air-travel system. The FEIS should discuss this question. We urge that the FEIS will be fatally flawed unless it fully considers non-air alternatives to meeting anticipated future air travel demand. R-4-7

Comment II-5: Objectives; high-speed rail & air-cargo diversion. One of the Resolution 3125 objectives is stated as "reconsideration of a fast rail system together with diversion of all cargo R-4-10 carriers", a curious limitation. The DEIS, perhaps for good reason, discusses fast rail without the limitation seemingly imposed by the Resolution.

(a) The FEIS should explain why the study of a rail alternative should be limited to consideration only in the context of diversion of all carriers of air cargo, for cargo diversion seems to be an alternative that merits independent study, just as the TGV (high speed) rail alternative (which is primarily a passenger alternative) merits independent study. R-4-10

(b). The limitation appears unreasonable. It seems more reasonable that the FEIS should look at diversion of some air cargo, and also at diversion of all air cargo, away from Sea-Tac to other sites, as alternatives meriting consideration independent of, as well as in conjunction with, the high-speed rail alternative.

(c) The FEIS should examine all rail alterntiave, not just high-speed.

Comments II- 6 - 15: Objectives; other objectives not addressed. The other nine Resolution 3125 objectives each should be separately addressed in the FEIS. R-3-2

Comment II-16: Purpose & need; definition of 'region'. The FEIS needs to adopt, & to plainly state, one & only one definition of the term 'region'. At some places, the FEIS refers to region as if it mean King County, or King, Pierce & Snohomish Counties, or those three & Kitsap County. At other places, the context suggests that the region of interest is the States of Idaho & Washington, or other areas much larger than the three or four counties of the Central Puget Sound sub-region. We note that in our Scoping Comments, p. 3, fourth unnumbered bullet point we specifically asked for a definition of 'region' in the DEIS & for consistency in its use. We urge that the term be used exclusively to cover the States of Washington & Oregon, plus those parts of the State of Idaho that "rely on air service at Sea-Tac as an important transportation link" (DEIS, II-1), plus these parts of British Columbia: Vancouver Island, the Lower Mainland, & the Okanogan. An airport designed to meet only the needs of King County, or King & its bordering counties West of the Cascades, is no airport for the region in the next century. R-3-6

Comment II-17: Purpose & need; definition of 'Master Plan

Update'. At some places (as in the Technical Report quoted on p. II-1, first paragraph), the Master Plan Update is referred to as a document, & at other places as, second paragraph of Section 1, p. II-1; p. II-19; p. III-3, second unnumbered paragraph), as a process. It can scarcely be both. Let the FEIS settle on one stated definition, preferably the Update as a single document; the associated studies are best referred to individually, as studies. R-3-6

Comment II-18: Purpose & need; expectation of ever-increasing 'airport activity'. At p. II-2, it is assumed & stated that 'airport activity' will increase with or without airport development.

(a) Does 'airport activity' basically mean 'operations' as that term is used through the FEIS (landings/takeoffs)? If not, what?

(b.) Also explain how 'airport activity' will increase without airport development. R-3-7

Comment II-19: Purpose & need; expectation of ever-increasing 'airport activity' (p. II-2). This 'expectation", stated at p. II-2, assumes the thing to be studied in the later parts of the document, which is the need for the proposed project. It must surely be evident that if the preparers of the FEIS assume that oparations will mount in number no matter what, & if the decision-makers accept this artfully insinuated assumption, then all the study of alternatives to runway construction are negated before the study begins.

Comment II-20: Purpose & need; expectation of ever-increasing 'airport activity' (p.II-2). It is assumed here, also, that the posited increase in operations will necessarily result in inefficiencies of operation, an assumption that predetermines the study of various alternatives, including alternatives of improvement in groundside management techniques. We agree that most qualified investigators believe, & experience shows, that large delays occur before the arithmetical capacity of the airport is reached. See our Comment II-A (the Sandelius paper) at p.2, for example. However, one must also take into account the high likelihood of additional technological progress, improvements in management of the traffic system airside, & various groundside measures that may increase efficiency. The FEIS must examine whether greater levels of operations provide greater revenues that will then be available to finance useful improvements other than more runways. Again, if the FEIS insinuates an unproven assumption R-4-9

State: (Seattle, the state's largest city, population 516,239--every neighborhood is affected by Sea-Tac traffic): Tacoma (3rd most populous, Tacoma: many neighborhoods are affected); Bellevue, (4th most populous; some neighborhoods are affected) & many other incorporated cities & towns, including Mercer Island, Clyde Hill, Beaux Arts, Hunts Point, Yarrow Point, Medina, Kirkland, Renton, Federal Way (6th most populous city of the State), Auburn, Kent, Tukwila, SeaTac, Des Moines, Burien, Normandy Park, Ruston, Gig Harbor, & others, as well as densely settled unincorporated areas, such as Maple Valley, Mirrormount, & Skyway. Many of these areas did not receive Sea-Tac associated overflights until the heavy increase in Sea-Tac operations in the 1980s led the F.A.A. to relocate flight paths in such a manner as to blanket western King County & adjacent parts of Pierce County. R-5-2

Many of these areas also receive aircraft noise, air pollution, & fuel dumping from flights associated with other airfields: Boeing Field International (King County Air Port), Renton Municipal Airport, Paine Field, McChord Air Force Base, the aviation facilities at Fort Lewis, the float plane base on Lake Union in Seattle, float plane activities on Lake Washington, & the airfield in Kitsap County, as well as private strips scattered around the Central Puget Sound, together with noise & pollution from operation of rotary-wing aircraft from all sorts of sites. R-5-4

The FEIS should more candidly recognize (1) the heavy impact of Sea-Tac arising from the inevitable North - South orientation of its flight tracks & (2) the central location of the facility within the metropolitan area, concurrently recognizing that this airport has the greatest environmental impact on activities on the ground of any airport in the Central Puget Sound area, the State, or the Region and the whole vast territory north of San Francisco or West of Minneapolis.

Comment II-25: Purpose & need: Poor weather (pp. II-2/3). Is it not an error to lump together as one category the four different poor-weather, low-visibility conditions designated IFR1, IFR2, IFR3, & IFR4, together with the not-good, but not-quite poor condition designated as VFR2? See table II.1-1, p. II.3, & associated discussion. The FEIS should indicate what arrival capabilities are associated with each of the six different defined weather conditions: it is well-known that an additional runway will do nothing to increase operations capacity under those weather conditions that lead to complete closure of the airport. But the discussion R-3-20

does not seem to differentiate between weather that restricts flights & weather that prohibits them. R-3-20

Comment II-26: Purpose & Need: Poor Weather (p. II-3). The DEIS states "... *during poor weather (IFR and VFR2), Sea-Tac is limited to a single arrival stream. Based on the 10 year weather analysis performed by the Master Plan Update, poor weather (with the associated single arrival stream at Sea-Tac), occurs about 44 percent of the time.*" The DEIS however fails to substantiate the basis for the results of its purported "10 year" weather analysis or provide any data or statistical analysis to substantiate this claim. F.A.A. officials, recently questioned during the Expert Panel hearings, were unable to provide any substantive basis for the 10-year weather analysis. In fact, F.A.A. official Sarah Dalton, disclosed during the recent Expert Panel hearings that the delay calculations for the third runway in the DEIS are based on a computer simulation model (SIMMOD) which had not correlated the relationship between the airport's demand profile and weather variations when calculating the delay figures published in the DEIS. (See Transcript of Expert Arbitration Panel Hearing, May 4, p. 68, l. 14.) This observation was recently recapitulated in a recent finding by members of the Expert Panel who wrote: *"Neither the POS nor the WSDOT has offered a fully developed analysis that shows, for example, how much of the delay at Sea-Tac (either experienced in the past or forecast in the future) is attributable to the coincidence of peak demand and poor visibility, and how sensitive the resulting delays are to relatively small changes in the level of peak operations."* (Comment II-E, p. 4, supra.) R-3-19

Comment II-27: Purpose & Need: Poor Weather (p. II-3). A recent study has also challenged the 44 per cent. "bad weather" (VFR 1) figure cited in the DEIS. See Comment II-D, supra. Implementation of an LDA/DME Approach to Runway 16R in Lieu of a Third Runway at SeaTac Airport, G. Bogan & Associates Inc. (1995). This study includes a detailed analysis of hour-by-hour weather observations reported by the U.S. Weather Bureau for the years 1993 and 1994. This study reviewed nearly 17,000 discrete hourly weather observations taken at Sea-Tac and reported to the U.S. Weather bureau.

Based on U.S. weather bureau records over a two-year period, the Bogan study found the 44 per cent. "bad weather" figure in the DEIS grossly overstated and The DEIS fails to provide any substantiation justifying its 44 per cent. "bad weather" figure. The DEIS 44 per cent. bad weather figure must be rejected. In order to meet its burden of proof for that "bad weather" figure, the FEIS must provide a statistically sound response, based on certified U.S. Weather Bureau data. R-3-19

Comment II-28: Purpose & need: **Poor weather** (p. II-3). A reference is made to a '1991 Capacity Enhancement Study'. While some readers may be familiar with this work, most will not be. The study is not reproduced in any appendix to the DEIS; its author(s) & publishers are not named. It is very bad practice to rely on documents & studies that are not properly identified in an EIS. See our Scoping Comment, second bullet point, p.3. This error might have been corrected had the preparers provided an Authorities section. R-1-6

Comment II-29: Purpose & need: **Delay** (p. II-3). The DEIS explanation of Exhibit II.1-1 should be made clearer. The Exhibit bears the caption 'Hourly Arrival Distribution' but the text, p. II-3, col. 1, seems to suggest that it shows 'operating delay'. The Exhibit shows something, not delay, but what it shows is unclear. R-3-17

Comment II-30: Purpose & need: **Delay**; definitional problems (p. II-3). In discussing the '1991 Capacity Enhancement Study', the DEIS rathar confusingly defines 'delay': "delay ... is not related to flight schedule delay". Yet we read later, p. II-5, that a certain 'average delay level' "was determined desirable to minimize ... passenger inconveniences". Surely in that discussion, delay refers to flight schedule delay, not 'aircraft operating delay'; surely it is no inconvenience for the passenger to have his or her aircraft operate for a longer period of time than expected, so long as he or she arrives as expected. The term is used so confusingly in Ch. 4, that readers cannot be sure what sort of 'delay' is being referred to at any particular point; the result is that no rational justification for the project is provided.

Given that this whole project supposedly is advanced to reduce 'delay', it would be desirable for the FEIS to provide a comprehensible definition of 'delay' & stick with it throughout. We warned in our scoping comments, Part IIA, first bullet point, sub-item 7, that the DEIS & FEIS should provide complete definition & consistency of all terms of art.

If 'delay' is used at any point in the DEIS or FEIS to refer to expectations of travelers & cargo shippers, the FEIS should clearly point out such usage. If any part of the rationale for a third runway in the DEIS

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depends on conclusions as to delay, as perceived by travelers & cargo shippers, that discussion needs to be much more explicit in the FEIS, & the reasonableness of such perceptions needs further discussion.

This concern about the definition of delay was recently re-echoed in the July 27, 1995 ruling issued by the Puget sound Regional Council Expert Panel, who also questioned the purported delays described in the DEIS. In their procedural order the Panel wrote: "We have not found in the evidence presented to us e succinct, well-documented statement of the delay and capacity problems that have led the POS to seek approval of the third runway." (See Comment II-E, supra , p. 4.) R-3-17

Comment II-31: Purpose & need: **Recent reductions in delay** (p. II-3). It is said, in numbered subparagraph 5, that (since 1989), "[t]he aircraft fleet is more homogenous, meaning that there are fewer larger and smaller aircraft using the Airport." The common understanding is that more & more larger aircraft are using the aircraft. If larger aircraft indeed are being phased out (which types?), what impact will that have on the average numbers of passengers per flight? Should we look forward to a Sea-Tac with few or no Boeing 747s? What are the implications for landside services? The FEIS should reconcile the above-quoted statement that fewer larger planes are using Sea-Tac with the statement at DEIS I-9, col. 2, that there is an "increased use of larger aircraft" at the facility.

Comment II-32: Purpose & need: **Delay: costs of** (p. II-4). In col. 2, second unnumbered paragraph, the DEIS presents a figure for present costs of delay at Sea-Tac to airlines & a figure for a higher volume of traffic. What is the source of these numbers? Sources should always be provided. R-3-21B

Comment II-33: Purpose & need: **Delay; acceptable level** (p. II-5). What is the source for the statement as to the maximum tolerable level of total all-weather delay? Sources should always be provided for such assertions.

Comment II-34: Purpose & need: **Delay; measurement** (p. II-5). We question the use of the 10-minute average all-weather delay measurement (calculation) as the criterion for determining an "unacceptable" amount of delay. It is the premise of this exercise that poor-weather delays are the whole problem? If that be so, then the analysis R-3-22

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should focus on -- poor-weather delays. Such delays should be measured or calculated directly, not inferred from some other measurement. The FEIS should make the necessary corrections. R-3-32

Comment II-35: Purpose & need: Delay (pp. II-4 - II-6).

(a) The DEIS proceeds on the assumption that commercial airlines will increase their number of flights into & out of Sea-Tac ('operations') without regard to operating efficiency. The FEIS should explain the reasoning behind this assumption, or, more realistically, abandon it.

(b) If the commercial air carriers decide, as the DEIS assumes, to continue to add flights -- unnecessary flights, as we show in Comment II-36, infra -- & if major increases in delay do occur, then the air carriers, travelers, & cargo shippers can decide how bad the added delays truly are; if the operating costs are too high for the air carriers, they can & will make rational economic decisions in accommodation of their own self-interest. They can & will cut back their schedules, just as they already do from time to time in many major air travel markets. They can & will re-adjust schedules so as to make better use of non-peak hours. They may find themselves able to use other, near-by airports for cargo operations. The FEIS should address the question of whether market forces will lead to modification of the behavior of airport users. R-3-7

(NOTE: The DEIS refers to corporations using planes with a capacity of 60 seats & more as air carriers, & those using planes with capacity less than 60 seats as commuter operations. See, e.g., p. I-9, col. 2. For ease of reference, we do not observe that distinction, instead using the term 'air carrier' to include all firms flying passenger or cargo aircraft into the Airport as common carriers.)

Comment II-36: Purpose & need: Delay (pp. II-4 - II-6). The DEIS errs in assuming that 90,000 more flights will come to Sea-Tac by 2020 (DEIS I-9, col. 2) as a result of population growth: the assumption is speculative at best. We comment elsewhere (Comment I-7) about the problematic character of the DEIS' population predictions. But even if the CPS area receives the projected huge increases in people, comparable increases in flights do not automatically follow. Master Plan projected boarding increases by 2020 could be accommodated through a combination of higher load factors, a modest increase in flights using the existing two-runway configuration, high-speed rail travel, technical

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advances, etc. as previously mentioned.

Currently, load factors for all domestic flight operations at Sea-Tac are 57 per cent. for the larger (more than 60 seat) planes and 44.5 per cent. for the smaller (less than 60 seat) planes, according to the most-recent year-available 1993 figures in the Port of Seattle's Master Plan Update. The Master Plan Update assumes that in the year 2020, the larger planes will be only 60 per cent. full on average, & the smaller planes, 55 per cent. full. Thus, load factors on the larger class are projected to increase 4 per cent. over 27 years, & for the smaller, 10 per cent.

The Port's Year 2020 forecast of 19.1 million enplaning passengers (Table I-3, p. I-10) could be met, without a third runway, with a small increase of 20,000 more flights per annum, each with the Port's official average seating capacity of 204 passengers per plane. None of the added flights need be the smaller air taxi & commuter planes, because their 2020 load factor is projected by the Update to be a still-weak 55 per cent., so great increases in passengers on those flights could easily occur with no schedule additions whatsoever. R-4-7

These additional 4.08 million departing seats (from 20,000 additional flights with an average per flight seating capacity of 204), added to the existing 1993 departing seats of 15.9 million, provides a total of 20.7 million departing seats, or nearly twice as many as Sea-Tac recorded in 1994 (10.4 million). Any increase in average load factor would result in higher totals of departing seats or lesser numbers of required flights or some combination of both. As our Comment II-35, supra, suggests, normal market forces would, in the present two-runway solution along the lines just suggested, rather than to the artificial 90,000-plus additional flights projected by the DEIS. R-3-7

Comment II-37: Purpose & need; improving poor-weather capabilities; a larger perspective. As the DEIS partially recognizes, p. II-1, p. II-4, Sea-Tac is part of a network or system of airports, which extends not just throughout the U.S.A. but world-wide. It is sometimes argued that poor-weather delays at Sea-Tac have far-reaching adverse impacts on operations elsewhere. See National Plan of Integrated Airport Systems (NPIAS) 1990-1999, F.A.A. (March 1991), cited at n. 3, DEIS II-1, inter alia. The system is supposed to be so stressed, so tightly geared-up, so lacking in tolerance, slack, that any delay anywhere has a cascading effect. It is asserted, and we have no reason to disagree, that this *"situation will* R-3-4 *worsen as traffic increases*". DEIS II-1.

The DEIS gives us this warning, threatens us with enormous costs to already troubled air carriers using Sea-Tac ($176 million per annum in the year 2020, DEIS, II-4), but fails to carry the argument further. This problem of system slow-down or gridlock is NOT a problem peculiar to Sea-Tac. It is an inherent difficulty of the deregulated network in a time of increasing numbers of flight operations.

(a) What the DEIS does not tell the reader, but what the FEIS should, is the fiscal consequence of continuing with a program of ever-increasing public expenditures that provide what economists would call a 'free good' to the air operators (especially the commuter airlines). At Sea-Tac, $1500 million, this time. How much at the many other airports in the U.S.A., where similar expansion projects are pending, where DEIS's like this one are being prepared? Is the Sea-Tac projected expense typical? Should one assume that the 30 busiest airports in the U.S.A. will each need another $1500 million in the next decade?

The FEIS must disclose the total fiscal consequences of acceptance of the F.A.A.'s 'build it, so that they will come' philosophy, listing the airports needing similar improvements, current cost estimates for those improvements, likely completion dates thereof, &c. This EIS process is a part of the larger process of re-vamping the entire system of major airports in the U.S.A. The law requires, & good practice suggests, that the full picture be disclosed each step of the way.

If this area accepts the idea that there is a duty to expand Sea-Tac to reduce system delay, then the next area in line will be told that they too have a duty to accept expansion of their major airport (to match the improvements made at Sea-Tac), & so on, for surely reduction of delay at this one airport cannot cure the system-wide problems that the F.A.A. predicts.

R-3-4

(b) What happens when all these expansions are completed? Will commercial air travel & air cargo operations level off? How long till the Port of Seattle & its competitor/colleagues around the world, together with the F.A.A. or equivalent civil aviation authorities abroad, are back, drumming up support for a fourth (or whatever number) runway, further site expansion, more terminals, more ground connections?

R-3-35

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The communities were assured that the second runway was all that would be required, & grudgingly gave their assent to that expansion on that basis.

RCAA has discovered, & reported, the Port's plans for a fourth runway, plans that have been disavowed as a "typographical error" in the 1993 Aviation System Capacity Plan. (F.A.A. Report no. DOT/FAA/ASC-93-1, Appendix D, p. 58.) The FEIS needs to tell the people when this process of expansion will end, how much the public of the U.S.A. is expected to pay, & how, if at all, the F.A.A. & the airport operators will CAP this runaway (runway) program.

R-3-35

Comment II-38: Purpose & need: Is it capacity, is it delay, or what? "Flight Plan" proposed the third runway in order to reduce delays in the future due to a shortage of air capacity. However, it turns out that because of its dependent operation the third runway is a low-capacity runway with only 100,000 operations at best per annum and for practical purposes it is a no-new-capacity runway when measures to prevent incursions of aircraft using the third runway onto the existing two runways and increased separations & staggering of so-called side-by-side flight patterns are instituted for safety reasons. See our Comment II-B, the 1993 Bogan report, pp. 4-5. Then the Port's argument shifted to saying that the third runway was needed to reduce delays during peak-period bad weather. DEIS, II-2 - 6, DEIS, II-17. However, when other less-expensive, less-environmentally destructive measures such as LDA are suggested to deal with the weather problem, these are rejected for not solving the delay problems, forgetting that the third runway itself does not solve that problem.

R-3-4

Comment II-39: Purpose & need; measuring delay. It is entirely unclear from Chapter II of the DEIS which techniques were used to measure or to assess delay at Sea-Tac in the various studies mentioned. We are aware of three different techniques, known as ATOMS, ASQP, & SIMMOD, & that they yield very different results as to delay. But the details of each are unclear to us, & the average lay reader of the DEIS would not have a clue that there are competing measurement or assessment methods, or that different studies have produced different results. What is measured? Who does the measuring? Are various causal factors considered? reported? Who decides whether a delay is caused by weather, by aircrew problems, by groundside problems? What happens if

R-3-18

one delay has multiple causes? What happens if no-one is sure what the cause was? At a minimum, the FEIS should pull up from the studies on which the lead agencies rely sufficient detail to enable the intelligent lay reader to know what was done, why, & how, to measure delay, & to understand what the controversy is about the results reported in the DEIS, & why the DEIS & FEIS accept a particular set of figures.

Comment II-40: Purpose & need; measuring delay. The reader gathers from DEIS, II-5, that "simulation analysis" was used to derive critical delay figures and that "simulation analysis" means the employment of a mathematical model on some data (what?) to predict, on the basis of assumptions (what?), present & future delay. In the absence of any description of the methods employed, a rational reader is left to take the results on pure faith, which is not a satisfactory method of choosing alternatives. The FEIS should much more fully disclose the interplay between actual, observed delay (after disclosure of the measurement techniques, see our Comment II-39, supra) & mathematical models (describing them & their assumptions), so that readers can follow the reasoning & calculations processes, & in some instances no doubt, compare the reported results with their own.

This problem of the use of undescribed mathematical models that manipulate unreported date on the basis of unstated assumptions is replete throughout this DEIS. An accompanying problem is the technique of referring to unreproduced & obscure reports (sometimes uncited) as the source of the results of these mathematical processes. We suggest that this technique does not comport with the requirements of the EIS process. The problem is exacerbated when this obscurity involves the central rationale for the entire $1500 million project. The reader, the decision maker, is left with no independent basis for decision making, & the interested outsider, no basis for intelligent comment. Why bother with an EIS at all? R-3-18

Comment II-41: Extension of easterly runway. Quite apart from the original charge to study a third runway, the DEIS proposes an extension of the more easterly of the two existing runways (Runway 16L/34R), to accommodate larger aircraft flying to East Asia. This extension consists of two elements. The first is lengthening the actual runway by 600 feet, to 12,500 feet. DEIS II-6. The second element is the expansion of the R-3-28

associated runway safety area (RSA). DEIS II-7. It appears to be proposed to clear & grade an area 500 feet wide by 1600 feet long at the South end of the easterly runway. DEIS II-26.

It would be helpful if the FEIS would give a much clearer description of the preferred alternative for extension of the easterly runway & associated RSA, including maps, to scale, showing North, & showing the construction area(s) as is & as proposed. Until there is a comprehensible description of the proposed projects, it is difficult to comment on the possible impacts. If the maps denominated Ex. II.3-3 and 3-4 are the ones intended to show the proposal, then the text should make an intelligible reference to them for the sake of the busy reader.

Comment II-42: Extension of easterly runway. This project -- the actual extension of pavement & the other, lesser RSA improvements -- will require, according to DEIS IV.19-7 & III DEIS Appx J, p. 4, a total of 3,380,000 cubic yards of fill. We mention these figures to give an idea of the scale of the project: it will require almost a fifth of the fill required for the entire brand-new third runway. The extension itself, then, is a major undertaking. Yet, in terms of construction difficulties & costs, it would certainly be a lot easier to meet the projected need at a 'green grass' site on flat terrain. The FEIS should consider that alternative, particularly in light of the requirement to consider diversion of all-cargo carriers. Also the FEIS should consider the noise & pollution impacts from unregulated foreign aircraft operating all-cargo and nighttime flights from places where noise & pollution controls are of no consequence, like the Port's hoped-for big new freight markets: China & Russia. R-3-28 R-4-12

Comment II-43: Extension of easterly runway. Is the proposed extension enough to meet needs to the year 2020 & beyond? The DEIS only mentions one aircraft type as requiring the extension to operate at maximum load. The FEIS should tell the reader about other large aircraft, including those not yet operational but in advanced planning stages. Perhaps an even greater extension is really needed, making the need to look at 'green-grass' sites all the greater. R-3-28

The next group of comments relates to the discussion of alternatives in the DEIS:

Comment II-44: Reconsideration of a fast rail system -- rail generally.

(a) The present study was mandated by the Port of Seattle to reconsider the alternative of a fast rail system. DEIS II-1. This study does not reconsider fast rail. What it does is report on "discussions" between someone (one or more anonymous contributors to the DEIS, most likely) & unidentified personnel in the Department of Transportation (WSDOT). DEIS II-10. The use of undocumented conversations between unnamed persons as the source for EIS conclusions is not satisfactory.

In an Appendix (B III), there is a perfunctory discussion of WSDOT reports that predate the POS mandate here discussed & discussion (without citations of authority) of two rail programs now in operation in the State, neither of which is a fast rail system, as we understand the term. In truth, the FEIS defies the mandate of the Port on this matter. There is no reconsideration, just a re-hash of what was not satisfactory the first time around. R-1-5

(b) A full reconsideration would at the very least discuss existing fast rail systems. If one accepted the DEIS as a complete source of information on this subject, one would have to conclude that there are no such systems, except the Talgo 2000, with a top speed of 125 m.p.h. As most informed people know, & as our comment II-C (the Cooper report),] supra details, there is a high-speed passenger train running on conventional trackage in Japan, the 'bullet train', and a more extensive system of high-speed passenger service operating routinely in France, the 'Tres Grande Vitesse' (very great speed, or TGV) trains. In addition, there are high-speed lines in Germany of a conventional character, & a German firm is successfully operating in western Germany a very high speed magnetic-levitation demonstration system (which runs on its own elevated, grade-separated, trackage). These are four operational very-high-speed rail systems, totally ignored by the DEIS. We also note the entire absence of any information relating to the activities of the States of Florida and Texas in this regard, which at least should be mentioned & really should be explained in depth. We are aware Floride is spending $50 million per year on high speed rail. (See, Exhibit 2-3 , Railway Age. September 1994.) R-4-10

(c) The abbreviated discussion in the DEIS (p. II-10) seems to hint at grave technical difficulties in operating higher-speed trains. (i) These difficulties cannot be severe, when one considers that conventional coal-powered steam locomotives achieved speeds in excess of 100 m.p.h. on then-conventional trackage a century ago. (ii) Nor can they be severe when

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one considers that the French, Japanese, & Germans are all operating such systems routinely, as important contributors to their regional transportation needs, & that Amtrāk is operating moderately fast trains in other transportation corridors in the U.S. (see discussion in the Cooper report, our Comment II-C, especially at p. 28, for U.S. experience) The FEIS should spell out the supposed technical difficulties & indicate why they cannot be dealt with satisfactorily in light of the actual experience of operators of such system elsewhere.

(d) A full reconsideration would at the very least be based on information from successful operators of high-speed rail systems, not from an agency that is devoted to highway construction & which has exactly no, zero, experienced in designing, purchasing, or operating TGV rail (WSDOT). One observer has suggested that the authors of this part of the DEIS should have started with a telephone call to the commercial attache' in the French Embassy. It is not too late to make the call. The FEIS needs to include relevant information from successful operators elsewhere. R-4-10

(e) The full reconsideration should not be limited by the erroneous notion that the year 2020 is the 'planning horizon' for this study. See our Comment II-3 (a) supra R-3-36

(f) In a full reconsideration, attention should be directed to a more expeditious timetable than is presently contemplated. It seems absurd that a high-speed link from the CPS to Portland cannot be built in less than 25 years. Our Comment II-C provides summary information on planning & construction times for existing high-speed systems, built much more expeditiously than 25 years (pp. 34-5). Many, many examples of major engineering projects could be cited, which though of comparable scope were constructed far more swiftly, often with no prior experience, or in unsurveyed territory, or under extreme conditions. One finds it very hard to believe that a TGV system cannot be emplaced in a time frame more like six to 10 years; the rights-of-way exist, after all, as do several proven, commercially-available technologies.

(g) The DEIS discussion of TGV rail is marred by its failure to consider the past, present & probable future mix of operations at Sea-Tac in the absence of demand menagement. As has been noted in prior comments, 40% (+2%) of operations are devoted to but 7% of passengers, the commuters. Diversion of one-seventh of these passengers to rail would free up nearly 6% of operations capacity.

(h) It is important to recognize that in good weather or bad the airport does not & cannot operate without delays at the nominal top capacity. The DEIS reports, & all investigators agree, that as the number of operations approaches the nominal capacity, more & more delay is experienced, the delay time increasing exponentially. See our Comment II-A, the Sandelius study, for a summary explanation of causes of such delay. (This is not a phenomenon restricted to this airport or to airports generally; rather, it is a characteristic of systems involving numerous movements of numerous things in constrained patterns. It is true of motor-vehicle traffic on grid-pattern streets & on freeways. It is true of movement of air under many circumstances and of movement of liquids through tubes & orifices (where the delay is called turbulence). It is true of many manufacturing processes, such as printing, assembly-line operations, in-line chemical processes.) R-3-19

Therefore, any reduction in the number of operations confers a disproportionate savings in delay when the airport is operating at the "edge", at the point where a slight increase in operations results in much-increased delay. Moving several hundred people a day by rail instead of by commuter aircraft may not do much to reduce delay at traffic levels of 1990 or 1995 but it becomes an enormous relief, far out of proportion to the numbers involved, at projected future levels of operations, when delay begins to rise very rapidly.

In fair weather, at this airport as now configured & with the present mix of traffic, it appears that delay begins to rise very sharply when operations approach 80 per cent. of nominal capacity, & at about 50-60 per cent. during poor weather. The FEIS needs to discuss this matter in full detail, & to keep the idea in mind when considering various alternatives that seem to reduce travel at the airport only slightly.

(i) The FEIS should investigate all rail options. In addition to the high-speed and very high speed alternatives mentioned above, the FEIS should investigate less costly rail options that might come into operation sooner than other options. The FEIS should take into account the conclusion of the Expert Arbitration Panel, 27 July, 1995, with respect to the possibilities of diversion of air passengers to rail, even rail operating less than high speed velocities. At the very least, the FEIS should consider issues which the Expert panel is also studying. R-4-10

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At the request of the Expert Panel, WSDOT provided its views as to the ability of improved rial service to alleviate the need for Sea-Tac runway capacity expansion. That response closely parallels the capacity given by the WSDOT to the E.I.S. preparers on the same topic. The WSDOT reponses are deficient. WSDOT greatly underestimates the market-penetration potential of impvoved rail service to capture (divert) passenger trips otherwise taken by rail. WSDOT failed , among other things, to consider the effect of highway congestion on demand for rail. R-4-10

The DEIS is far too pessimistic about the possibilities of rail. The FEIS should take a more realistic view. Rail works to direct passengers in Japan, Britain, France, Germany, the N.Y. to Washington & Boston to NY corridors of the U.S. Why not here?

Comment II-45: Air cargo diversion. The third Resolution 3125 objective (DEIS II.1) is stated as "reconsideration of a fast rail system together with diversion of all cargo carriers" [emphasis supplied]. The DEIS treats fast rail as a separate subject, as it should. Table II.2-1 (at pp. II.-9A & B) is silent on the subject of cargo diversion. Chapter 2 devotes one paragraph to the topic (p. II-17), & that considers only the question of developing a cargo-only airport, rather than the question of diversion of all-cargo operations away from Sea-Tac. Nothing in Resolution 3125 speaks of an all-cargo airport, & obviously cargo can be received at a mixed-use airport, so the DEIS misses the point.

The single, unresponsive DEIS paragraph needs considerable expansion in the FEIS. The DEIS reports that nearly half the cargo now arriving at Sea-Tac comes in passenger craft, while all-cargo flights constitute 6 per cent. of total operations. The DEIS is silent on the anticipated future mix, though it projects an increase of 131 per cent. in cargo tonnage as of 2020. It is well known that the Port has a long-term program to encourage much more cargo business, primarily from East Asia (& on aircraft not subject to any Federal or local noise or pollution controls). An increase in the percentage of cargo operations may be likely. The FEIS needs to project the cargo mix at representative dates from the present to & past 2020. The FEIS needs to present a complete analysis of the consequences of diverting all-cargo flights elsewhere, airport by airport. Here, as elsewhere in the FEIS, the airports to be considered should include the two major candidates for development as 'green grass' facilities, i.e., the existing & operational Grant County International Airport & the proposed site in the Toledo-Winlock area R-4

(Napavine Prairie), in Lewis County. The FEIS should explain the reasoning behind the DEIS statement that if air cargo does not all come to Sea-Tac, "some cargo would be required to arrive in the Region and be transported to Sea-Tac" (p. II-17, col. 2): one would have thought that cargo once on the ground would then go by the usual ground-transportation systems to its many local destinations. The FEIS should abandon the idea that one of the purposes of this planning is to give the Port of Seattle an advantage over its competitors. See our Comment II-21, supra. R-4-4

The gain to be realized from diversion of all-cargo operations must be considered together with gains realizable from other measures. The DEIS makes the methodological error of treating each measure separately, finding that no one by itself does enough to relieve the strain on the airport, & then dismisses all the measures as inadequate without considering the potential cumulative benefits.

Comment II-46: Improved telecommunications. This subject is addressed at DEIS II-11 & -12. The DEIS dismisses any benefit of the potential incremental reduction in Sea-Tac operations of 4 - 9 per cent. from increased use of telecommunications. Here we have another example of the deep-seated resistance on the part of the project sponsors to considering the incremental beneficial effects on the Sea-Tac problem from a combination of possible factors. The FEIS should overcome this bias & present as a full alternative the results of reductions in operations that might reasonably be expected to follow from high-speed rail, improved telecommunications, peak-period pricing & other demand-management techniques especially aimed at commuter operations, cargo diversions, & other no-build remedies. R-4-10

Comment II-47: Use of other airports. See DEIS II-12. The discussion here essentially overrules the prior planning decision to locate or develop a supplemental airport. Flight Plan Study; PSRC General Assembly Resolution A-93-03. Apparently the Port & the F.A.A. have concluded that the Port & PSRC were wrong in their analysis of the Sea-Tac problem in Flight Plan: "a supplemental airport would not satisfy the needs addressed by this Environmental Impact Statement" (p. II-12, col. 2). What a colossal waste of time & money Flight Plan was, then! Perhaps the FEIS for Flight Plan is also wrong? Perhaps we need to go back & re-do the RASP in light of these new conclusions, which hold that the existing RASP is incorrect. R-4-4

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Comment II-48: Use of other airports. We note that the two identified potential 'green grass' sites for additional airport capacity, Moses Lake & Napavine Prairie, are once again systematically excluded from serious study. The studies to date of existing airports & potential airport sites in the Central Puget Sound sub-region have amply demonstrated that each & every one of them, including Sea-Tac, is unsuited for expansion: the solution for the regional air-travel problem, as distinguished from the desires of the Port of Seattle to dominate air travel, plainly do not lie in the CPS sub-region. Other, more suitable sites must be studied. The FEIS would be a good place to begin. If the preparers of this present DEIS can ignore the adopted Flight Plan with respect to a CPS supplemental airport, then they can surely likewise ignore the restrictions against looking at reasonable alternatives for new airport space. R-4-4

Comment II-49: Peak period pricing. The present study was mandated by the Port of Seattle, Resolution 3125, to examine the alternative of peak period pricing. DEIS II-1. We find no examination of this alternative & it is not referred to in Table II.2-1, pp. II-9A & B, the summary of alternatives considered. (If one considers pricing to be a form of demand management, as indeed it is, then it has been dismissed together with all other forms of demand management, in the cited table, by this assertion: "Not considered further, as these actions will not eliminate the poor weather operating need." A short paragraph, p. II-17, asserts, without reference to authorities, that airport operators in the past have not been successful in changing the operating behavior of major airlines through pricing policies, seemingly because operating fees are, on average, only 3 to 6 per cent. of operating costs. Even a single percentage point would seem to this commenter to be, under some circumstances, the difference between solvency & bankruptcy. The subject is worth more intense examination in the FEIS. R-4-7

Comment II-50: Peak period pricing. The DEIS worries that effective peak-period pricing would be "highly questionable" (in the legal sense. Our comments II-51(c) & (d)]]]BU infra]]] EU addresses this concern in the over-all context of demand management, & is equally applicable to this particular aspect of demand management.

Comment II-51: Demand management, generally. The present study was mandated by the Port of Seattle to examine the alternative of demand management techniques beyond peak period pricing. DEIS II-1.

(a) The discussion of this point is found at DEIS II-16/17. It is entirely unsatisfactory & should be replaced in the FEIS with a more thoughtful, & more thorough, analysis.

(b) The discussion of commuter operations may serve as an example: The DEIS reports what is well known, that the commuter traffic, 7% of passengers, takes up 40% (+2%)]]] plus / minus symbol needed here]]] passenger operations. It is also well known that commuter operations run with very great frequency to & from the two major target cities (Spokane & Portland) & are under-utilized, at a load factor of about 45% on average over-all. See Comment II-36, supra, 2nd unnumbered paragraph. See also the Cooper study, our Comment II-C, supra. A more careful examination of demand management would report on the load factors specifically for each of the two major target cities, & any other important destinations that careful study would reveal. (We assume that the flights to Portland & Spokane fly with load factors considerably less than 45%.) Obviously, half-empty flights every half hour to Portland & every hour to Spokane in poor weather are a luxury when the airport is suffering from a lack of capacity for larger aircraft carrying more passengers. The FEIS should report how much money it will cost per commuter passenger flight when the cost of money is taken into account. It should not encourage a mis-use of what we are told is a scarce resource. R-42

(c) The DEIS seems to suggest, p. II-16, col. 2, that administrative measures, perhaps including selective pricing, to discourage over-use of 'slots' by commuter operations would violate a principle that "access be permitted to the Airport on fair & reasonable terms, without unjust discrimination". Would it truly be unfair, unreasonable, unjust to favor in some way or another those operations that directly serve the greater number of travelers? If so, then an obvious alternative that should have been examined is a minor change in the applicable Federal statute or regulation to permit a more rational allocation of the resource among users. R-47

(d) It is unsatisfactory for the principal Federal agency regulating aviation to suggest that some types of demand management (without identifying them) might violate the principle just mentioned in part (c) of this Comment. Surely by now the Federal co-lead agency has sufficient expertise in its own regulatory area to know what will pass statutory & regulatory muster? The FEIS should spell out what is acceptable, what is not. If, as we do not believe, there still are 'grey' areas in what is or is not permitted in the way of demand management, then the FEIS should spell

out those too.

Comment II-52: Demand management, generally. The do-nothing alternative as to third-runway construction itself is a form of demand management, as our Comments II-35 & 36 make clear, & it should have been so considered in the DEIS. The FEIS should take a harder look at 'do-nothing' as an effective way of letting market forces do the managing that the DEIS fears cannot be done directly (p. II-16, p. II-17).

Comment II-53: Demand management, generally. It appears to be the premise of the DEIS that Sea-Tac is at present generally adequate to meet air travel demand to the year 2020 & beyond, except for the poor-weather constraints discussed at DEIS II-1 to -6. See the comment in Table II.2-1, & see our Comment II-34, supra. Is this a correct understanding of the position of the preparers? If so, just how much of a diversion or limitation of poor-weather operations would be required to prevent Sea-Tac from being unable to meet the projected demands?

Comment II-54: Demand management, generally. The DEIS dismisses demand management as not being a substitute for increasing capacity, relying on the document, The Flight Plan Project, Draft Final Report and Technical Appendices, PSRC & POS (January 1992). DEIS II-17. Yet the Port of Seattle resolution previously referred to (no. 3125, cited at DEIS II-1) mandated that this present study fully explore demand management. It is evident that the Port Commissioners were not satisfied with the discussion in the January 1992 document, & the DEIS should not have relied on it as the ground for dismissing this alternative. The FEIS should examine the matter as mandated: fully. R-47

Comment II-55: Demand management, generally. The DEIS sums up its objections to all forms of demand management in Table II.2-1, first page (DEIS, II-9A), as follows: "Not considered further, as these actions will not eliminate the poor weather operating need". This conclusion rests on conclusions reached in The Flight Plan Project, Draft Final Report and Technical Appendices, PSRC & POS (January 1992), according to text & footnote at p. II-17.

(a) This is another instance where the DEIS preparers have blatantly ignored the Port's request, in a later action (Resolution 3215), for re-examination of the prior third +runway work. It is unsound, & unresponsive, to quote prior materials as a substitute for a re-examination of the subject dealt with in those prior materials. The public still needs that re-examina+tion.

(b) We further suggest that the ultimate conclusion on this point is wrong in two separate ways: (1) Any diminution in the number of operations at SeaTac reduces the possibility that the airport will reach what we have referred to as "edge" conditions, that point when the large number of operations results in suddenly-greater delays. See our Comment II-A, supra , esp. p.2, & our Comment II-44(h), supra. This applies both to good & bad weather, but the projected need is for relief at lower levels of operations: bad weather. ANY reduction in operations is particularly important for relieving the very conditions that are said to drive this FEIS. A combination of diverse measures that reduce operations may put off into the far future that feared time of very great delays: this DEIS certainly does not show the contrary (in part because the DEIS scrupulously avoids consideration of cumu+lative benefits of various measures). It is worth noting in this regard that the Port & the F.A.A. have been sedulous in taking many small-scale measures to keep growth in numbers of operations from causing 'unacceptable' delay: see listing, e.g., at DEIS II-3, col. 2.

(2) It would appear from this DEIS that the bad-weather delays will be right back with us at about the year 2020, if the projections of levels of future operations hold true. See Exhibits II.1-1 & -2, p. II-3A. Compare Fig. 3, p. 4, our Comment II-A, which reaches a similar conclusion on the basis of figures from the Draft Final Report, Puget Sound Air Transportation Committee (1992).

Comment II-56: Demand management, generally; another viewpoint. It is suggested that the FEIS consider demand management as a form of conservation, as wiser use of scarce & expensive resources. Our society has gradually come to appreciate that in many instances it is less costly to conserve than to build anew. This has long been apparent with respect to domestic & industrial water (hence, in part, sewage-treatment plants), & has recently become evident in the areas of electric power generation, paper manufacture, metals extraction & refining, & others. If one thinks of demand management as a way of getting greater use, greater value, from the existing runways & support facilities, demand management becomes a good thing, standing by itself.

Comment II-57: Technology alternatives: LDA (p. II-21). It is stated at DEIS II-21 that about 70 per cent of arriving flights (South flow) align their approach over the Duwamish corridor. The suggestion is that flights are so directed, for noise avoidance purposes. The DEIS states, p. II-21, col. 1, that were the Localizer Directional Aid (LDA) technology employed at Sea-Tac, South-flow arrivals would fly over more-populated areas, such as West Seattle & Beacon Hill, with a substantial increase in noise.

(a) Would such noise exceed the 65-dBA Ldn level?

(b) Seattle residents & citizen groups that are in communication with this commenter report that arrival flights are all over the skies of Seattle, especially over Beacon Hill & Rainier Valley, so that the statement as to the location of South-flow arriving traffic is inaccurate.

(c) The FEIS should cite some published authority to which readers can refer (best in an Appendix) for further discussion of this landing-enhancement technique, to permit independent evaluation of its potential benefits & detriments.

Comment II-58: Technology alternatives: GPS (p. II-21). The DEIS dismisses the usefulness of the Global Positioning System (GPS). This system, which uses low-orbit earth satellites to provide locational information of pin+point accuracy, would, we are led to believe, permit safe operation of commercial aircraft under the worst-visibility conditions, as if visual flight rules were in effect. Is this a correct understanding? The DEIS does not provide a satisfactory, quantified explanation of the enhancements that GPS will permit, but the FEIS should.

Comment II-59: Technology alternatives: Wake vortex avoidance (p. II-20/1). (a) The DEIS states, p. II-21/2, that GPS will not enable dual approaches to the existing runways, owing to wake-vortex issues described elsewhere in the DEIS (at p. II-20/1). The wake-vortex discussion says that wake-vortex avoidance/advisory systems are not expected "to enable parallel approaches on runways with a separation of less than 2,500 feet, so it would not enable dual independent approaches during poor weather conditions" ibid.. But surely wake-vortex problems are the same in good visibility and in poor? If the problems are the same regardless of visibility, then it seems to follow that Sea-Tac cannot operate parallel approaches on existing runways at the present time. And if that be so, then the real issue here is not a fog problem but a wake-vortex problem. It would be well if the FEIS could clear up this point.

(b) DEIS II-20, col. 2, discussing the Precision Runway Monitor system, seems to state that the required minimum separation between parallel approaches to avoid wake vortex problems is 3000 feet, not the 2500 feet stated in the Wake Avoidance section. Why the discrepancy?

Comment II-60: The potential utilization of a third runway hinges upon the ability of the Port of Seattle (POS) to install an instrument landing system (ILS) on Runway 16L (the more easterly existing runway). An ILS system is currently installed on Runway 16R, the shorter, more westerly existing runway. Before a third runway can be approved, the F.A.A. must perform a full feasibility and engineering study prior to issuance of a final EIS to validate that an ILS can indeed be placed on Runway 16L. If this cannot be done because of technical reasons, such as topography, then a third runway would have to be placed much further westward. The FEIS must respond and verify feasible locations of additional ILS systems at Sea-Tac including the proposed alternative runways discussed. R-4-9

Comment II-61: Technology alternatives, generally.

(a) The DEIS spells out numerous technological advances of the past, which are given credit for significant improvement in operation of the airport, but seems to assume that just at this point in time technology has ceased to advance. We would suggest that before the FEIS comes out, the person or people charged in this process with examining technology should conduct a thorough up-dating review, perhaps with a less pessimistic mindset. The DEIS does not quite co-ordinate its conclusions about the various measures discussed. The preparers seem to be fixated on independent parallel operations as the only way to go. R-3-21B

(b) In particular, the DEIS seems remarkably pessimistic about measures for dealing with wake vortices. If wake vortices are as great a safety issue as the public has been led to believe, then it would seem that the avoidance measures described at p. II-20 should be used routinely.

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Comment II-62: The DEIS states "because the new dependent parallel runway is proposed to reduce poor weather delay, which is predominantly arrival related, the runway would be expected to be used primarily for arrivals." Recently however, F.A.A. officials have disclosed that the delay calculations for the third runway in the DEIS are based on a computer simulation model (SIMMOD) which has not correlated the relationship between the airport's demand profile and weather variations when calculating the delay figures published in the DEIS. (Transcript, Expert Arbitration Panel, p. 68, l. 14). Additionally, a recent study has challenged the 44 per cent. "bad weather" figure cited in the DEIS, 1995 Bogan report, our Comment II-D, supra. That study proposes the addition of existing navigation technology in the form of a Localizer Directional Aid (LDA) aircraft navigational system to allow parallel dual stream arrivals under weather conditions with ceilings as low as 2200 feet, a system which obviates the need for a third runway. (For a detailed exposition of LDA see Chapter II, Purpose and Need, p. II-21; for discussion & rebuttal of the alleged noise difficulties that LDA might cause, see our comments on the noise section of Chapter IV.) The F.A.A.'s 1993 Aviation System Capacity Plan recommended LDA as an improvement to Sea-Tac's existing airfield, including provision of an LDA approach to Runway 16L/34R. 1993 Aviation System Capacity Plan, Report DOT/FAA/ASC-93-1, Appendix C-53. R-3-19 R-4-4

Other sources substantiate that weather conditions compelling single-stream arrivals at Sea-Tac occur only 17 per cent. of the time, as opposed to the 44 per cent. figure stated in the DEIS. According to a 1988 study by P&D Aviation (a consultant to the Port for the current Master Plan Update!) "[t]he yearly frequency of occurrence of south flow conditions, with ceilings below 2,000 feet is approximately 17 percent." Airspace Study Working Paper 1, P&D Technologies, pp.2-12 (March 1988).

The DEIS points out that under north flow conditions Sea-Tac experiences predominantly VFR1 weather. A March 26, 1989 newspaper article also states that visibility conditions prohi+biting dual stream arrivals exist only 17 per cent. of the time. Seattle Times, 26 March 1989, p. E1.

The Localizer Directional Aid (LDA) aircraft navigational system allowing parallel dual stream arrivals under weather conditions with ceilings as low as 2200 feet, must be studied as an alternative which may obviate the need for a third runway. The Expert Panel wrote "The Bogan report .. deserves scrutiny by, and a response from, both the POS and the FAA." (PSRC

Expert Arbitration Panel, Final Phase I Order on Demand/Systems Management Issues, July 27, 1995, p. 8.)

Comment II-63: Technology alternatives, generally. The DEIS speaks of independent operation of the new, westerly runway & the existing easterly. Does not the DEIS actually recommend a dependent, rather than an independent, runway, seeing that all four options recommended for further study (p. II-37, col. 2) would have a 2500-foot separation from the easterly runway? R-4-16 R-4-12

The minimum separation requirement for simultaneous takeoffs from parallel runways (under radar control) is 2500'. The DEIS states the purpose of the new runway as "arrivals only." In lieu of an interlocal agreement between the Port of Seattle and the adjacent cities, the FEIS must consider use of the runway for departures as well. R-4-13

Comment II-64: The recent finding by the Expert Panel re-echoes the main concern on the subject of Purpose and Need which remains to be addressed in the FEIS: "Sea-Tac is not currently a highly congested airport. According to the most recent ASPQ data available from the USDOT (for May 1995), Sea-Tac ranks #1 in on-time departures (90.0%) and #6 in on-time arrivals. (84.6%) In recent years, the total annual hours of delay (as defined in the 1995 FAA Capacity Enhancement Update) have dropped from 48,000 (in 1988) to only 26,000. Reported delays as compiled in the FAA's ATOMS data series show a similar decline, from 30 delays per thousand operations in 1990 to 6 delays per thousand operations in 1994." (PSRC Expert Arbitration Panel, Final Phase I Order on Demand / Systems Management Issues July 27, 1995, p. 6. R-4

Recently, a television advertisement immortalized the line: "Where's the beef?" The authors of the DEIS, must clearly, articulately and persuasively convince the readers through their FEIS, that they must spend $1.5 billion dollars to expand an uncongested airport when far less costly alternatives are alternives.

A

Regional Commission on Airport Affairs

White Paper #2

November, 1992

An Evaluation of a Third Runway at Sea-Tac International Airport: Delays, Airport Capacities, Airport Life Times, & Passenger Volumes

Prepared by John Sandelius, BSc

INTRODUCTION

It is clear that sometime early in the 21st century, the five-state northwest region will need a state-of-art airport capable of handling very large long-haul passenger and freight planes if the region wishes to be plugged into the global economy. Ideally, such an airport would have the following attributes:

* long, multidirectional runways, including east-west runways because of our location in the northwest corner of the country;
* a location as little subject to weather delays as possible;
* room to expand for possible hypersonic and other advanced design aircraft;
* good connections to the other states in the region;
* careful planning to avoid environmental and legal liabilities of flying jet traffic over human populations.

The National Research Council Transportation Research Board recommends that the United States build ten such global trunkline "wayports" around the country in order to handle growth in air traffic, larger aircraft, and to reduce system delays (N.R.C., 1990.) Indeed, one northwest state has already designated a site for a long-haul wayport. Washington State has not yet done so.

In the meantime, the Puget Sound Air Transportation Citizen's Advisory Committee (PSATC) has recommended that the local western Washington region be served by a "multiple airport system," specifically recommending the following:

* adding a third dependent air carrier runway at Sea-Tac International Airport before the year 2000;
* introducing limited air carrier service at Paine Field before the year 2000 (North Local Service[1]);
* identifying a two-runway local service airport site in Pierce or Thurston county (South Local Service).

Obviously, none of these sites can qualify as a long-haul

1 Reference to the "North Local Service Airport" in this paper does not refer to Paine Field, although PSATC recommended the Paine Field site. Paine Field, however, is a poor site that suffers all the deficiencies of Sea-Tac and should be rejected. For purposes of this study, any commercial local service airport in the north Puget Sound region would produce similar results. Arlington would be a better choice. Any choice of sites for a multiple airport plan should meet a much more stringent list of operational and environmental criteria and local participation in the selection than has been done to date.

trunkline wayport of the 21st century. It is unlikely that any can handle the large 600-800 passenger planes expected on line in the next century (Tibbet, 1992). Weather delays at Sea-Tac are well known. The airfield is extremely small--just 2900 acres--without room for multidirectional runways. Efficient east-west runways cannot be built. Further expansion with a fourth parallel runway is not practical. Adding room for terminal improvements and ground access to process a larger passenger volume is likely to be difficult and expensive. In addition, its runways direct low-flying jet aircraft down the most densely populated corridor of the state[2], testing public patience with the noise and pollution impacts of increasing traffic and causing economic dislocations as people try to avoid the noise. The dense residential neighborhoods surrounding the airport raise serious questions about the health impacts of noise, air pollution and jet fuel residues on ground populations (R.C.A.A.; Hansen, Sanders, et al. 1992). Finally, the extremely high land costs of a dense, urban location are likely to drive expansion costs to non-competitive levels (U.S. G.A.O., 1991.) The north and south local service airports suggested by PSATC suffer similar deficiencies as long-haul facilities.

The risk of adopting the "quick-fix" plan proposed by PSATC is that the State will effectively put itself out of the running as the site for the real airport of the future, the wayport.[3]

This paper finds that the third parallel runway at Sea-Tac is largely a wasted investment. It has very high costs but adds very small additional capacity (10 million passengers/year) to Sea-Tac and has a short life-span--just 21 years--before demand exceeds capacity and the State will be forced to turn to the north and south local service airports (See Figure 3.) By contrast, the North local service airport alone can handle twice the traffic (16 million passengers) and has a lifespan of 29 years (See Figure 4).

Current delays are weather & system[4] related. Delays due to capacity shortages are not projected until 85% of the projected growth

2 See Appendix A, Flight Track Map.

3 PSATC briefly reviewed one wayport option. There are a number of different kinds of "wayports" ranging from a hub transfer/international/freight wayport connected to population centers by quiet turboprops to full scale wayports connected by high speed rail. There are also several sites each with its advantages and disadvantages.

4 Under the computerized delay recording system, a plane delayed leaving another airport and arriving late at Sea-Tac is recorded as a "Sea-Tac" delay. Because, the delay was caused elsewhere in the system, it should be distinguished from capacity delays at Sea-Tac. Weather delays should also be treated separately.

in demand occurs (See Figures 1 & 2). The relatively small 16-20% additional demand can be handled through the use of any one of a variety of demand management techniques or through the North local service airport without a major public investment in a dying airport.

Given that none of the multiple airports can meet the technological demands of the global air transport system of the next century, the state should focus planning and investment on the wayport before considering any of the components of the multiple airport system. It is not clear that expansion of local commuter service will be needed or that the multiple airport system is the best option. If, however, the multiple airports option is chosen, the State would be better off to skip the intermediate step of the expensive third runway at Sea-Tac and use demand management or other less expensive techniques to handle the final 16% increment of demand that is projected to cause most of the delays. If a multiple airports plan is later needed, a second Local Service airport should be appropriately sited and opened before any consideration is given to Sea-Tac expansion.

ANALYSIS OF THE QUESTION OF A THIRD RUNWAY AT SEA-TAC

Key Findings

1. Delays due to capacity shortages will not occur until the last 15% increment of growth occurs. (Current delays are due to weather and other systems delays.) (See Figures 1 & 2.) Dramatic reductions in estimated delay costs--from $232 to $40.5 million--would occur with modest 16-22% reductions in future demand.

2. The third runway adds limited capacity at SeaTac: 10 million passengers per year giving a poor return on investment. (See Figure 3.)

3. The lifetime of the proposed third runway is short: 21 years. (See Figure 3.)

4. The North Local Service airport is scheduled for construction in the same time frame as the third runway: by the year 2000.

5. The North Local Service airport can handle nearly twice the traffic of the 3rd runway: 16 million passengers. (See Figure 4)

6. The lifetime of the North Local service airport is longer than the 3rd runway: 29 years. (See Figure 4.)

7. Passengers studies show that, if the North Local Service Airport is opened simultaneously with the third runway, 16-22% of the demand will siphon to the North Local Airport, eliminating projected increased delays at SeaTac. (See page 6.) Dramatic reductions in delay costs--from $232 to $40.5 million--would occur with siphoning.

This paper recommends the following:

1) Designate the potential long haul, trunkline airport at a "green grass" location suitable to the criteria for such an airport.

2) It is not clear that additional local service will be needed or that the "multiple airport system" is the best alternative for providing it. If the State decides to proceed with a multiple airport system nonetheless, it should skip the wasteful intermediate step of building the third runway at SeaTac. First, use demand management and other less expensive options. Second, consider options for making the large volume of local commuter flights more efficient and/or transferring it to other modes. Third, open longer-lived, higher capacity second airport at either a North or a South Local Service site, only if needed. Designate a second Local Service airport last.

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AIRPORT DELAY TIMES & COSTS

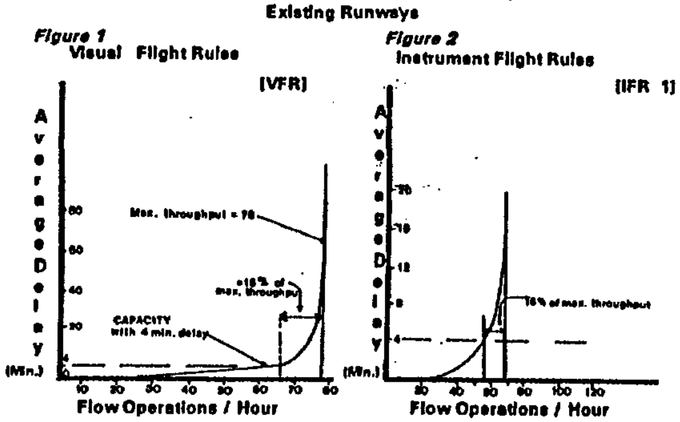
Figures 3 & 4 below show that delays due to capacity shortages would not exceed 4 minutes and would not significantly increase with growth until the last 15-16% of growth was attained.

This 15%-16 is a small increment of demand that could easily be handled by a variety of means: demand mangement techniques alone would likely do it. Given the large number of Sea-Tac commuter flights (40%) going to local destinations, such as Portland, Spokane, and Vancouver, even modest improvements in ground transportation would reduce demand this small amount. If the North Local Service airport is opened simultaneously with the third runway, as planned, siphoning of demand to that airport alone would achieve the reduction in any case (See "Air Traffic at Supplemental Airports" below).

Reducing future demands on SeaTac by a modest 15% could reduce delay costs from $232 million per year to $40.5 million per year (USDOT et al, Airport Capacity Enhancement Plan June 1991.)[5]

Flow Rate vs. Average Delay*

Existing Runways



*Source: U.S.D.O.T., F.A.A., Port of Seattle, et al. *Seattle Tacoma International Airport: Airport Capacity Enhancement Study, 1991.*

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[5] PSATC & FAA delay costs estimates may need to be re-evaluated in light of a recent report by the Dye group to the WSATC that caps and delays to not appear to effect local economies.

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AIRPORT LIFETIMES

As Professor Richard de Neufville of M.I.T. pointed out to the Washington State Air Transportion Commission, predictions of air traffic demand have historically been unsuccessful, particularly for long-term predictions (WSATC, de Neufville, Aug. 1992.) For that reason the air traffic forecasts in Figures 1 & 2 are included primarily to show relationships to the multiple airports planned for the Puget Sound Region. Both Port of Seattle and the longer-term C.A.S.E.[6] projections are included. Airport capacities were taken from the Puget Sound Air Transportation Committee report (PSATC, Draft Final Report & WP #7, Jan 1992.)

Figures 3 & 4 show key airport milestones, projected air traffic growth, airport capacities and airport lifetimes. Airport lifetimes are defined as the elapsed time from the beginning of operation until demand traffic equals capacity.

Figure 3 gives the life of Sea Tac with a third runway. It also shows the life of Sea-Tac "as-is" with the addition of the North and South local airports. Figure 4 shows the third runway at Sea-Tac replaced with the North Local Service airport and the South Local Service airport added later.

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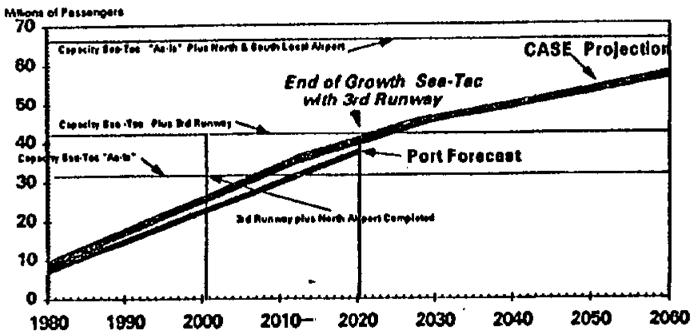
[6] Citizens for Alternatives to Sea-Tac Expansion.

FIG. 3

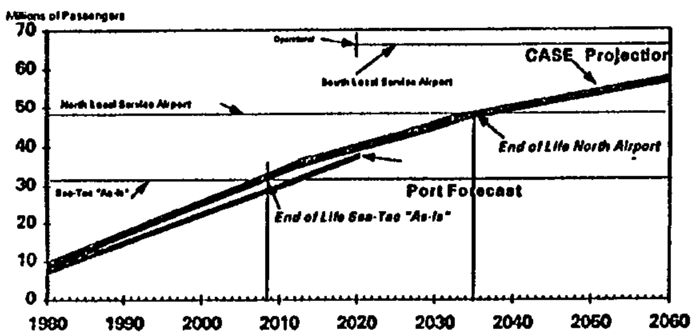
Regional Airport Development with Third Runway



* Source: Puget Sound Air Transportation Committee, *Draft Final Report 1992.*

FIG. 4.

Regional Airport Development without a Third Runway



* Source: Puget Sound Air Transportation Committee, *Draft Final Report 1992.*

Figures 3 & 4 demonstrate the following points:

1) the third runway adds little additional capacity, just 10 million passengers;

2) the third runway has a short lifetime for such a large public investment. If demand is slightly lower than the Port forecast, the third runway would not be needed until the year 2020;

3) both supplemental airports combined with the current SeaTac "as is" have airport lives until 2050 and have a combined capacity of 66 million passengers per year;

4) the North Local Service airport alone would add a 16 million passenger capacity over a 29-year life.

Even if one looks only at the multiple airports plan, by this analysis the third runway is the most expensive but least efficient component of that plan. A better multiple airports model would be to skip the third runway and go directly to the North & South airports which offer higher capacities and a longer lifetime.

AIR TRAFFIC AT NORTH/SOUTH LOCAL SERVICE AIRPORTS

Under the multiple airports plan, even if a third runway at SeaTac were to be built, the overflow traffic capacity in the Puget Sound Region will be at the North and South local service airports. The extent of this surplus traffic indicates that when the North Local Airport is operational, originating and terminating business and local passengers from Snohomish Country will prefer to emplane there rather than face a long drive through Seattle and the gridlock problems near the airport in order to reach SeaTac. The majority of East Side business and local transportation users would find it easier to access the North Local Airport as well.

A survey of departing passengers done by Evans McDonough from November 4 to 11, 1991 (Evans, 1991) showed the following:

* 11% of the departing passengers were from Pierce and Thurston Counties;
* 8% were from Snohomish County, and
* 69% were from King County.

Arriving and connecting passengers were not included in the Evans survey.

Assuming that arriving and connecting passengers were at least equal in number to those departing, passengers from Pierce and Thurston Counties would therefore be 22% of the total; passengers from Snohomish County, 16%. Based on the annual traffic at SeaTac, demand traffic at the North and South local airports would be as follows:

AREA	PASS./YR.
Pierce, Thurston Co.	5,500,000
Snohomish	4,000,000

The four million passengers per year shown above for the North Local Airport warrants additional discussion. The number is based on a passenger survey taken at SeaTac without a North Local service airport in place. This traffic is likely to be higher because of the attraction of traffic to the airport as well as by growth of business and population in Snohomish County by the year 2000 when the North Local Service Airport is proposed to become operational. Ground gridlock in and around downtown Seattle and the area around Sea-Tac would make the North site more convenient to large numbers of people north of downtown and on the eastside of Lake Washington in addition to those in Snohomish and Whatcom Counties. The South Local Airport would have a similar attraction for those South the the City of Tacoma.

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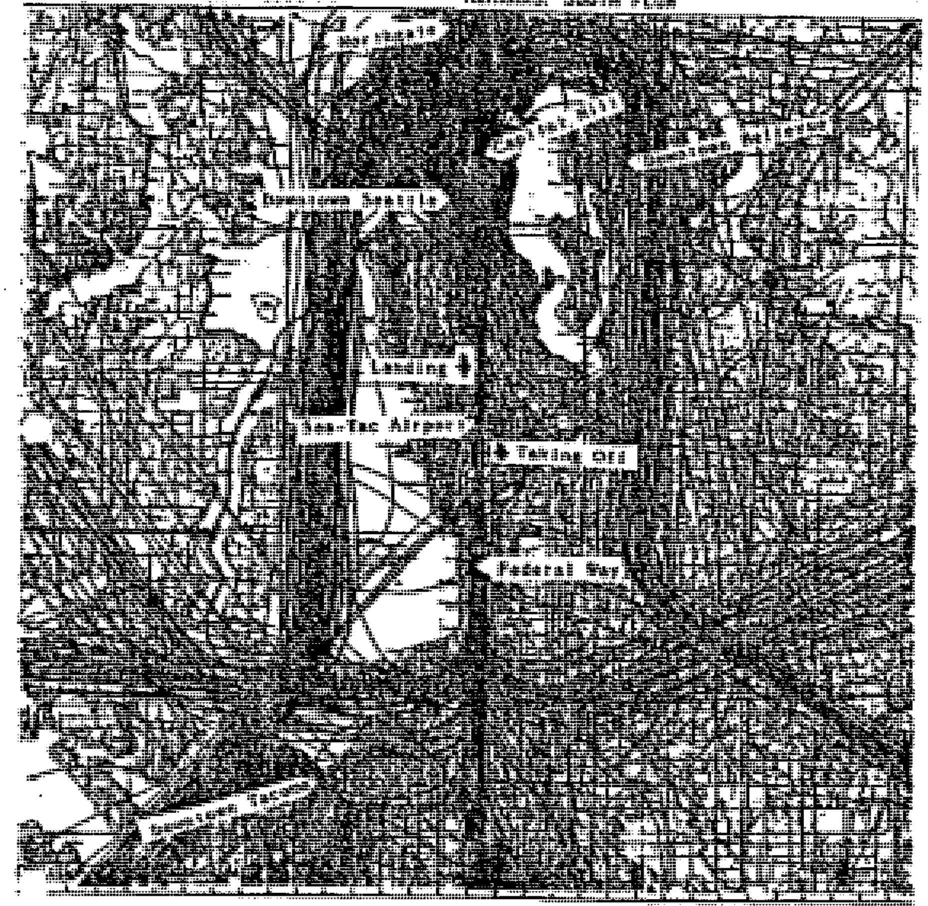
Where do the Sea-Tac jets fly? (South Flow)

PORT OF SEATTLE FLIGHT TRACK SAMPLE

AIRPORT: SEA 08/26/91 11:00 - 22:00 ARRIVALS /DEPARTURES
ID: ALL FLIGHTS
C: JETS
SCALE: 0.25125 IN = 5000 FT REMARKS: SOUTH FLOW



APPENDIX A

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SEATTLE TACOMA INTERNATIONAL AIRPORT
THIRD RUNWAY PROJECT
AIR CAPACITY

I INTRODUCTION

Seattle Tacoma International airport (Sea-Tac) is the major air carrier airport in the state of Washington. Most communities in the state are reached via connecting flights through Sea-Tac.

Currently air service at Sea-Tac is limited to two parallel dependent runways oriented north and south. The centerline of the runways are separated by 800 feet. Paraphrasing the Federal Aviation Administration (FAA) definition of dependent runways, they are runways separated by less than 4,300 feet and therefore, unable to accommodate instrument arrival and departure operations without considering the arrival and departure activities of the adjacent runway. Aircraft utilizing flight paths associated with dependent runways must be integrated which results in less hourly capacity than similar runways that are farther apart.

Weather conditions also impact the hourly capacity of a runway. When weather conditions are clear and visibility unrestricted, arriving and departing aircraft can utilize a separation,"visual separation", which is less than that required during restricted weather conditions. In general terms, during visual weather, inflight separation is reduced to see and be seen and one runway activity at a time. As weather deteriorates, pilots are unable to operate at the minimum separation criteria for visual operations. Air traffic controllers must provide increased separation between aircraft in poor weather. This results in fewer hourly operations and a reduced airport capacity.

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If such weather exists during peak demand periods the end result is delay to arriving and departing aircraft. When delays become unacceptable, operational and/or airport configuration changes must be made. Weather and its impact on the proposed third runway at Sea-Tac will be discussed in more detail in section III of this report.

II OPERATIONAL BENEFITS/LIMITATIONS OF THIRD RUNWAY

The proposed third runway at Sea-Tac is to be constructed west of the existing parallel runways. It is planned to be 7,000 feet in length and located 2,500 feet west and parallel to runway 16L/34R (the eastern most runway). In order to attain the optimum criteria for such a runway configuration special radar equipment must be installed and special FAA operational procedures implemented.

Basic separation between arriving aircraft during instrument flight is three miles or approximately 36 arrivals per hour. This in-trail separation can be reduced to two and one half miles with the use of special radar and corresponding air traffic control procedures. When parallel runways are between 2,500 feet and 4,299 feet from each other, aircraft must also be horizontally separated by a minimum of two miles staggered separation. Again, with the use of special radar equipment and procedures the staggered separation could be reduced to one and one half miles. The diagonal separation requirement places speed and in-trail restrictions on aircraft which reduce the arrival rate and operational flexibility of dependent parallel approaches. This limits the capacity increase normally associated with two arrival streams. Therefore; a third runway at Sea-Tac, if dependent, will not provide a <u>full runway hourly capacity increase</u> as could be expected from an independent runway. At Sea-Tac air traffic controllers will be required to separate

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successive arrivals for the same runway, insure staggered separation between adjacent runways, and then also provide spacing intervals between arrivals to allow for departures. It quickly becomes obvious that runways constructed less than 4,300 feet apart (dependent), do not provide the hourly capacity of independent runways. To maximize the hourly runway capacity, Sea-Tac will require additional equipment and implementation of procedures designed for dependent runway operations. The Sea-Tac runway configuration planned, i.e., all runways dependent, will not handle the number of operations forecast in future years.

The use of special equipment and procedures are not the only considerations when determining true runway capacity. An airport's actual runway capacity is dependent on weather, runway length and interaction with other runways, taxiway to runway intersecting points, separation between runways at the holding locations, fleet mix, electronic landing aids, in addition to pilot/controller skills.

At Sea-Tac, pilot and controller skills are not in question. Therefore to understand the potential runway capacity of the proposed third runway the other influencing conditions must be analyzed.

The year 2000 forecast fleet mix in the "Airfield Capacity Review Working Group Study", concludes that 95.1 % of the fleet will be able to use the planned runway for landings and 72.5 % for takeoff. The high percentage of forecast fleet mix that will be able to use the runway is misleading. True, the runway will accommodate the aircraft size that justify the high percentages identified in the study. However, to determine total airport capacity, one must consider the real operational use of the

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new runway during peak hour periods. It is simple to land or depart a single aircraft without consideration of other air operations. However, air traffic control consists of many simultaneous actions. The total airport configuration must be considered when allocating fleet mix to runway usage in an attempt to determine hourly capacity of an airport.

Landing aircraft must clear the runway before the next aircraft can land or depart. If the current runway 16R/34L is being used for arrivals or departures, aircraft that land on the new runway will have to hold between runways until the other traffic is clear. During rush periods there would soon be no holding area between the runways and either the new runway or the center runway will lose its desired hourly capacity.

A ground taxi problem will exist when runway 16R is used for departures. There is not enough room between the runways to hold aircraft awaiting departure. Therefore aircraft would have to hold either in the gate area or on the ramp/taxiway east of the runway complex. This type of problem will complicate and congest the use of all the runways during rush periods. Maximum runway usage can not be attained under these conditions.

Practical air traffic control logic would conclude that during peak hour periods the new runway would be best used by limiting it to the smaller aircraft. They are easier to hold between runways and can quickly cross adjacent runways between other operations. While this fleet segregation can help to attain maximum runway usage, it does depend on the availability of such type aircraft during the peak periods, and the ability to efficiently assign them to that runway. Forecasts indicate a significant reduction in the smaller commuter type aircraft.

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This will compound the problem of trying to segregate runway usage by aircraft size. Any time "special" actions are required air traffic control becomes more complex resulting in reduced operations, thus, less hourly capacity than expected.

Sea-Tac currently experiences delays caused by the lack of holding area between the two runways. Adding another runway without sufficient holding area will compound the delay problem.

The following is an example of the height and length of the larger aircraft that could use the proposed runway.

Boeing 737-200, 300, 400.	height	36' 6"	length	119' 6"
Boeing 767	height	52' 9"	length	180' 3"
Airbus 300, 310, 320.	height	55' 6"	length	175' 6"

During poor weather conditions all holding between runways will probably be prohibited. FAA has very strict criteria regarding holding areas that can interrupt navigational aids. Electronic navigational aids can easily become unusable if the electronic signal is subjected to reflection interference.

As stated above, it is highly unlikely that aircraft of this size could hold between the runways. Additionally, a metal surface the size of the above aircraft would certainly cause interference with electronic landing aids. An aircraft holding between runways as close as those at Sea-Tac can easily cause such signal interference. This further degrades the use of the proposed runway.

The Flight Plan Study Forecast for the year 2000 is 411,000 operations, with an average day peak month of 1243 operations. The fleet mix for that daily average is:

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Aircraft class	Arr.	percent	dept.	percent	total	percent
Heavy	104	17%	105	17%	209	17%
narrow body	279	45%	279	45%	558	45%
commuter	192	31%	192	31%	384	31%
small prop.	46	3%	46	3%	92	3%
total	621	100%	622	100%	1243	100%

The Airfield Capacity Study runway utilization plan allocates the percentage of arrival and departure traffic by runway and hour as follows:

DAILY PERCENT OF ARRIVALS/DEPARTURES BY RUNWAY

VFR (visual) weather conditions south flow

Runway	Arrivals	Departures
New runway (16W)	40 %	0 %
Runway 16R	50-55 %	10-15 %
Runway 16L	5-10 %	85-90 %

IFR weather conditions south flow

16W	40 %	0 %
16R	0 %	95 %
16L	60 %	5 %

VFR (visual) weather conditions north flow

34W	40 %	0 %
34L	50-55 %	10-15 %
34R	5-10 %	85-90 %

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IFR weather conditions north flow

Runway	Arrivals	Departures
34W	40 %	0 %
34L	0 %	95 %
34R	60 %	5 %

North flow has the same runway use by percentage, fleet mix, and daily/hourly operations as south flow for both VFR and IFR operations. North flow will have the same airside and landside problems that are encountered in the south flow scenarios. Therefore, for brevity this report will be primarily directed to south flow analysis.

DAILY ARRIVALS/DEPARTURES BY RUNWAY AND AIRCRAFT TYPE

VFR (visual) weather conditions south flow

Runway Used	Aircraft Operations Arrivals	Departures
16W (heavy jet)	41	0
(jet)	111	0
(commuter)	76	0
(prop)	18	0
16R (heavy jet)	52- 57	10-115
(jet)	139-153	27-441
(commuter)	96-105	19-228
(prop)	23-25	4-7

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Runway Used	Aircraft Operations Arrivals	Departures
16L (heavy jet)	5-10	89-94
(jet)	14-28	237-251
(commuter)	10-19	163-173
(prop)	2-5	39-42
total operations (rounded)	621	622

IFR weather conditions south flow

Runway Used	Aircraft Operations Arrivals	Departures
16W (heavy jet)	42	0
(jet)	112	0
(commuter)	77	0
(prop)	5	0
16R (heavy jet)	0	98
(jet)	0	265
(commuter)	0	182
(prop)	0	44
16L (heavy jet)	62	5
(jet)	167	14
(commuter)	115	10
(prop)	28	2
total operations (rounded)	621	622

The hourly runway use breakdown that follows is a sample of two hours using the year 2000 forecast. The first sample hour

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is an hour at or near the airport capacity, 58 operations per hour. The second sample hour is the peak hour reported in the subject forecast.

VFR (visual) weather conditions south flow (58 operations/hr)

		air carrier hvy jet	jet	commercial	prop	total
16W	arr.	1	3	4	1	9
	dep.	0	0	0	0	0
16R	arr.	1	4	5	1	11
	dep.	1	1	1	0	3
16L	arr.	0	1	1	0	2
	dep.	5	14	10	2	31

IFR weather conditions south flow (58 operations/hr)

16W	arr.	1	3	5	1	10
	dep.	0	0	0	0	0
16R	arr.	0	0	0	0	0
	dep.	5	15	10	2	32
16L	arr.	2	4	6	1	13
	dep.	1	1	1	0	3

VFR (visual) weather conditions south flow (95 operations/hr)

16W	arr.	5	10	7	1	23
	dep.	0	0	0	0	0

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		air carrier hvy jet	jet	commercial	prop	total
16R	arr.	6	12	8	1	27
	dep.	1	2	1	0	4
16L	arr.	1	2	2	0	5
	dep.	9	17	9	1	36

IFR weather conditions south flow (95 operations/hr)

		air carrier hvy jet	jet	commercial	prop	total
16W	arr.	5	10	7	1	23
	dep.	0	0	0	0	0
16R	arr.	0	0	0	0	0
	dep.	9	18	10	1	38
16L	arr.	7	15	10	1	33
	dep.	1	1	1	0	3

The above tables identify the anticipated fleet mix, daily percent of arrivals and departures by runway, daily arrival and departure fleet mix by runway, and two sample hours of distribution of that data in both VFR and IFR conditions.

The 58 operations per hour breakdown was analyzed using prescribed arrival and departure separation standards. However, the current two runway configuration with improved electronic systems such as LDA, MLS, and state-of-the-art radar, will also satisfy the forecast demand.

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The 95 operations per hour breakdown was analyzed in the same manner as the 58 operations per hour. At peak hours and IFR weather conditions, if the 95 operations per hour forecast and proposed runway assignments are correct, a two or even three dependent runway configuration at Sea-Tac would be hard pressed to accommodate the demand without encountering excessive delays.

However, to fully understand the third runway cost v benefits equation, a comparison of peak hour demand to weather must be explored. If a portion of the restrictive weather conditions (IFR), occur during non-peak demand periods then the need for a third dependent runway to temporarily resolve capacity demand may be overstated. Under such circumstances electronic and procedural enhancements of Sea-Tac (with the current two runway configuration) could very well be the prudent answer until a complete solution to the air capacity demand problem is accomplished.

Virtually every current study that has been conducted regarding future demand at Sea-Tac has concluded that a third runway is only a stop gap improvement. The ultimate solution to the forecast passenger demand is the expanded use of existing airports or the development of a totally new regional airport site.

Boeing Field is a prime candidate for use as a commuter airport for those short haul passengers who originate or terminate their travel in the Seattle area. The Port of Seattle 1991 Airport Activity Report states that flights of 150 miles or less accounted for 38 % of all 1991 aircraft operations. A significant reduction in annual operations at Sea-Tac could be realized by increased use of Boeing Field for commuter operations.

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Arrival/missed approach conflicts between Sea-Tac and Boeing can be resolved by the use of state-of-the-art navigational equipment, radar, and corresponding air traffic control procedures.

If these assumptions are correct then the installation such equipment and enhanced air traffic control procedures is a prudent near term solution to capacity problems. A third runway that only temporarily solves the problem is not a reasonable alternative. Instead the time and money spent on a dependent runway could be better used finding a permanent solution to the problem.

The 1991 Sea-Tac airport capacity enhancement plan identifies the savings in hours and dollars that can be realized in several scenarios including an "improvements to existing airfield" scenario. The Plan concluded that improving runway exits and taxiways, reducing in-trail spacing, installing enhanced landing aids and radar, providing a wake vortex advisory system, and refining the noise abatement effects on departures saves over 148,000 hours or $ 213 million dollars at the Future 2 forecast period.

III WEATHER CONDITIONS AS JUSTIFICATION FOR A 3RD RUNWAY

Section II detailed the fleet mix and runway use forecasts that are being offered as justification for the construction of a third dependent runway at Sea-Tac. To better understand the value of such a plan, an analysis of weather conditions is necessary.

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Weather as it affects Sea-Tac air operations falls into two categories, airport weather, and weather conditions beyond the immediate airport area. Airport weather is the weather that effects the immediate airport environs. Surrounding weather affects arrival and departure operations outside the immediate vicinity of the airport. This weather determines departure flow and the arrival rate and spacing required to separate aircraft.

Air traffic controllers must provide separation between arrivals until the pilot is clear of all clouds, sees other arrival traffic and the airport, then a "visual approach" can be conducted. When weather conditions permit, visual approach operations maximize a runways acceptance rate.

Airport weather is determined by observations from a specific airport location. The ceiling and visibility determines whether visual or instrument flight rule conditions exist. Instrument weather conditions means that air traffic control is responsible for the separation of all air operations. IFR separation requirements mandated by Federal Air Regulations result in lower hourly capacity than the separation criteria used in visual flight operations.

The proposed third runway will be less than 4,300 feet from the existing runways. Prevailing weather will have a direct bearing on its use and the ultimate hourly capacity increase it will provide over the current two runway configuration.

Section II identified taxi and holding constraints that will be encountered during IFR weather conditions. The Sea-Tac taxi-way/ramp congestion and potential electronic interference when holding between runways will result in less capacity potential than claimed in prior studies.

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An analysis of available weather data indicates that about 25 % of the year IFR or marginal VFR meteorological conditions exist, with one third occurring during low traffic demand periods. Approximately 75 % of the year weather is good enough to allow visual approaches to the existing runways. During high demand periods if aircraft are guided through the clouds using an electronic system such as an LDA, dual arrival streams can be conducted which will increase airport capacity without having to build a third runway. During non-visual weather conditions, building an additional dependent runway, will provide little relief to the delays anticipated at Sea-Tac.

During IFR or marginal VFR weather conditions dependent runways are least productive. As previously stated, a third runway at Sea-Tac that is dependent will not provide the needed capacity during peak demand periods. Electronic equipment and ATC procedural improvements to the existing two runways will improve capacity to an acceptable level until a permanent solution is found.

Multiple consultant studies refer to the weather as VFR 1, VFR 2, IFR 1, IFR 2, and IFR 3. Federal Air Regulations identify weather in only two categories VFR and IFR. VFR weather is defined as three miles visibility or greater and a cloud ceiling of one thousand feet or higher above the ground. IFR is when the visibility and or ceiling is less than that of VFR weather conditions. The type of air traffic control separation applied is based on the FAA definition of IFR and VFR weather.

An analysis of the Seattle weather pattern suggests that peak hour periods can be exposed to ceilings that will require air traffic IFR separation during descent to the airport.

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When pilots encounter clouds during descent to Sea-Tac, controllers are required to provide standard IFR separation even though the airport weather is reported as VFR. To conduct visual approaches the cloud base in the arrival area (5 to 20 miles from the airport) should be 3,500 feet above the ground with visibility 4 miles or better. If the weather is less than what is required for visual approaches, a single arrival stream is required. When a single stream is necessary, by the time aircraft are clear of clouds arrival delays have already been encountered. A third runway will not prevent that delay.

IV ALTERNATIVES TO INCREASE CAPACITY WITHOUT A 3RD RUNWAY

Section II and III conclude that an additional dependent runway at Sea-Tac will not provide enough capacity to handle the future passenger and air operations demand forecasts of the airport. The consensus of virtually all recent studies of Sea-Tac capacity agree that an additional runway is an interim fix. Expansion of other existing airports and or the development of a new regional airport must be considered if forecast demands are to be satisfied.

A. Airport and electronic aid improvements

Near term delays can be mitigated by the installation of state-of-the-art equipment at Sea-Tac using the existing two runway configuration. Following is a summary of equipment that can be used to improve efficiency and reduce delays.

1. Microwave Landing System. An MLS would improve efficiency at Sea-Tac. It could provide multiple arrival and departure tracks which would maximize the use of available airspace. Potential flight path conflicts between Sea-Tac and Boeing Field (BFI) would be reduced.

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2. Equip each runway end with full all weather lighting and electronic landing aids. This would allow air traffic controllers more flexibility in runway use. It allows arrivals and departures access to both runways during minimum acceptable weather conditions. All weather runway lighting will assist pilots in entering and exiting runways more quickly, thus reducing runway use time by each aircraft.

3. Install a Localizer Directional Aid (LDA) for runway 16R/34L to be used during visual approach weather conditions. This system provides the capability of two simultaneous arrival streams through the clouds.

4. Install state-of-the-art radar systems that will allow reduced in-trail separation for arrivals, and provide the coverage required for simultaneous arrival streams between runways separated by less than 4,300 feet.

5. Install wind sheer and wake vortex systems. This would provide safety information data when minimum separation standards are being used both for arrivals and departures.

6. Minimize runway occupancy time by improving the exit taxiway system to include high speed turnoff capability plus additional mid-field turnoff locations.

7. Temporarily use Boeing Field as a commuter airport for short haul passengers originating/terminating in the Seattle area.

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C. Overview of the 1991 Sea-Tac Enhancement Plan

The Enhancement Plan analyzes delay situations in detail. The two runway airport capacity analysis assumes a 50%/50% of arrivals and departures. The Airfield Capacity Review Study does not support this assumption. In that Study, the year 2000 forecast busy hours are not balanced. Virtually every hour that exceeds 57 operations per hour favors either arrivals or departures. Example; the 58 operations per hour is, 23 arrivals and 35 departures. The 95 operations per hour is, 55 arrivals and 40 departures. The Enhancement Plan delay conclusions may be overstated in comparison to actual delays encountered.

The Study concludes that visual approach weather prevails approximately 75 % of the year. The cloud base is 5,000 feet or higher 56 % of the year. The cloud base is between 2,500 and 4,999 feet 19 % of the year. To fully capitalize on the 19 % visual approach weather, electronic landing aids must be added. If the Capacity Review Study forecasts are reasonable and hourly arrival and departure activities are seldom balanced, two runways will accommodate the near-term forecasts. The addition of a third dependent runway would not appreciably increase capacity.

The Capacity Enhancement Study identifies numerous improvements that would reduce anticipated delays. Each improvement listed has a number of hours saved and the dollar value to that saving. The Study compares delays using 1989 (Baseline) figures. In 1989 more than 15 million passengers flew in and out of Sea-Tac and the airport recorded almost 355,000 operations. The study claims the delay experienced was 48,000 hours which represents a cost of about $ 69 million dollars.

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The study forecasts that when annual operations reach approximately 425,000, without airfield improvements, delays will be approximately 241,000 hours with an associated cost of $ 347 million dollars. It estimates a delay savings of almost 96,000 hours and more than $ 137 million dollars even without providing for a dual stream of arrivals using a system such as an LDA.

The Study forecasts additional savings of more than 51,000 hours representing $ 74 million dollars can be anticipated if an ILS and LDA system were installed.

It would seem that by improving the airfield taxiway system, add electronic landing aids, vortex equipment, state-of-the-art radar, and associated improved operating techniques, Sea-Tac can function with minimal delay until a permanent solution can be developed. The cost of a third runway with all its flaws and limited usefulness does not seem to be an appropriate plan. The other recommended improvements should be the first priority for Sea-Tac capacity enhancement, followed by a concerted effort to find and implement a permanent solution to future capacity problems.

D. Overview of the next generation electronic aids

Research and development of electronic aids that will improve airport capacity, increase safety, and provide more precise navigation capabilities is an on-going project.

FAA and the aviation industry are testing equipment and procedures that will allow landings and departures in zero visibility weather which means airports will be operational almost all the time regardless of weather.

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At the present time independent runways must be laterally separated by a minimum of 4,300 feet. Tests are in progress to determine if independent operations can be conducted with runways separated by 3,500 feet and less.

The global satellite system is expected to provide precise flight track and landing guidance data that will reduce airspace congestion and reduce airborne separation standards.

High resolution rapid update radar systems are being tested to determine the minimum safe separation spacing between aircraft.

All of the above tests are expected to help reduce airspace congestion, reduce separation between aircraft, improve bad weather operations with the end result of more airport capacity with basically the same airport layout.

Sea-Tac like most other air carrier airports throughout the country have limited expansion capability. The present FAA Airport Capacity Planning Document suggests that a two dependent runway layout can accommodate approximately 275,00 to 365,000 annual operations. If the new equipment and procedures being evaluated are successful, annual operations for two dependent runways could be increased considerably.

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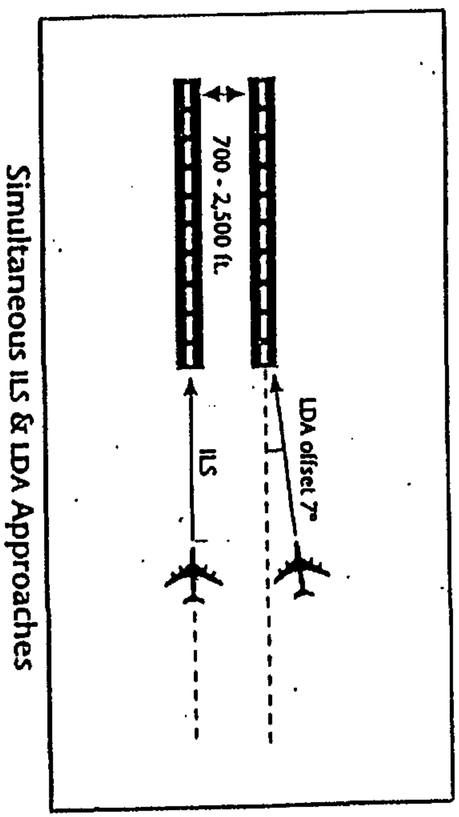
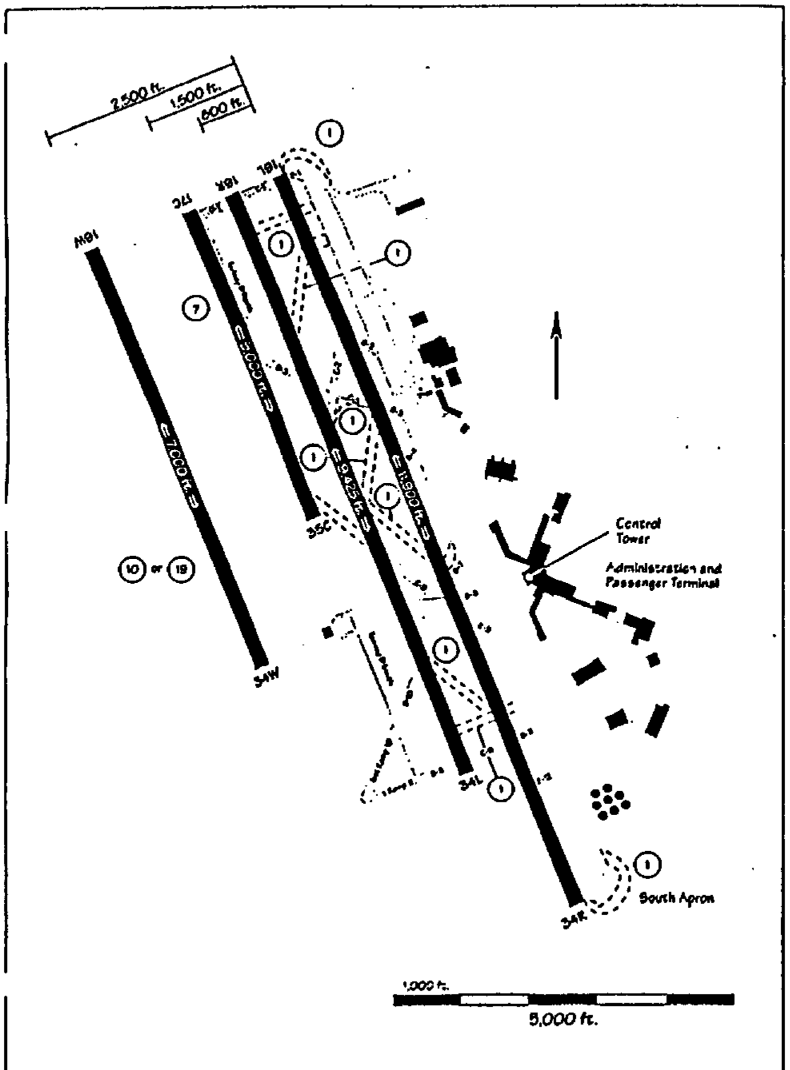


Simultaneous ILS & LDA Approaches



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RCAA ENDORSING ORGANIZATIONS
Airport Noise Action Council
Aircraft Noise Coalition
Aircraft Noise Group
Beverly Park Community Club
Brown's Point Improvement Club
Citizen's Ad-Hoc Committee
Citizens to Save Puget Sound
Citizens Alternatives to Sea-Tac Expansion
City of Burien
City of Des Moines
City of Normandy Park
City of Tukwila
Communities Against Noise - Beacon Hill
Friends of Lincoln Park Community Council
Greater Des Moines Chamber of Commerce
Haller Lake Community Club
The Highline Community Council
Highline Hospital District
Highline School District
Highline Community College
Hurstwood Community Club
Lakewood/Seward Park Community Club
Montlake Community Club
Mt. Baker Community Club
North Hill Community Club
Ocean View Community Beach Club
Portage Bay /Roanoke Park Community Council
Ravenna-Bryant Community Association
Redondo Community Club
Salmon Creek Community Council
Seahurst Community Club
Seattle Citizens For Quality Living
Shorewood Community Council
Southeast Area Action Council
WAAR
Wesley Terrace Center
White Center Chamber of Commerce
White Center Ad Hoc Committee
White Center Youth Task Force

Gerry H. Bogan, president of G. Bogan & Associates, Inc., specializes in airport planning and air traffic control. Mr. Bogan is an internationally recognized expert on aviation matters bringing 38 years of experience in the field of air traffic control to bear upon a project.

During his career with the FAA, Bogan's responsibilities included planing and budgeting the national airspace system for the Western Region; managing the enroute air traffic control facility for Southern California; and developing the noise abatement section for the Western Region.

In recent years Bogan has been involved in numerous aviation projects including:

- Feasibility study for a new airport in China
- Air traffic control needs at Jeddah Airport, Saudi Arabia
- Improvement of air traffic control aids, Republic of Indonesia
- Impact of hypersonic aircraft on air traffic control system, NASA
- Study of capacity limits of air carrier airports and airspace review for possible sites for new air carrier airport, California Department of Transportation
- Advice on expansion and noise matters, Suburban O'Hare Commission
- Part 150 Noise Compatibility Study, City of Tempe, Arizona

Mr. Bogan's aviation consulting firm is based in La Quinta, California.

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May 20, 1995

Mr. Scott Lewis, Chairman
Expert Arbitration Panel
Puget Sound Regional Council
500 One Waterfront Place
1011 Western Avenue
Seattle, Washington 98104

Dear Mr. Lewis:

Reference is made to my previous testimony to the Expert Arbitration Panel of the Puget Sound Regional Council on the matter of the proposed expansion of the runway capacity at the Seattle-Tacoma Internationla Airport on May 3, 1995.

Enclosed is an Executive Summary of the Prepared Testimony on the Passenger Ridership Diversion Potential for the Railroad Passenger Service Alternative to the Sea-Tac Airport Runway Capacity Expansion for your review and consideration. The Executive Summary presents the major findings of the report document plus of my verbal testimony to the Expert Arbitration Panel.

Please let me know if you or any of the other members of the Expert Arbitration Panel have any questions with regard to any of the materials contained in the Executive Summary or in any of the other documents which I have prepared for your consideration.

Respectfully submitted;

HBHC

Hal B. H. Cooper, Jr.
Consulting Engineer

EXECUTIVE SUMMARY

of the

PREPARED TESTIMONY DOCUMENTS

on the

PASSENGER RIDERSHIP DIVERSION POTENTIAL

for the

RAILROAD PASSENGER SERVICE ALTERNATIVE

to the

SEA-TAC AIRPORT RUNWAY CAPACITY EXPANSION

Presented to

Mr. Scott Lewis, Chairman
Expert Arbitration Panel of the
Puget Sound Regional Council
500 One Waterfront Place
1011 Western Avenue
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Prepared by

Hal B. H. Cooper, Jr.
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11715 N.E. 145th Street
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May 15, 1995

Prepared on behalf of the Regional Coalition for Airport Affairs, Normandy Park, Washington, 1995.

CONCLUSIONS

1. An analysis has been prepared of the rail passenger service alternative to the proposed expansion of the existing runway capacity of the Seattle-Tacoma International Airport(Sea-Tac) for the Expert Arbitration Panel of the Puget Sound Regional Council, as contained in the enclosed document herein.

2. The implementation of the recommended rail passenger system improvements in the Western Washington intercity corridor in the near term can alleviate the immediate runway capacity constraints at Sea-Tac Airport by the diversion of passengers from air to rail from short distance commuter flights at a lower cost and in a shorter time frame than would otherwise be possible by the mere construction of a third runway.

3. The implementation of improved rail passenger service in the Western Washington intercity corridor can also alleviate the long term runway capacity constraints at Sea-Tac Airport by a diversion of the large number of air commuter flight passengers to rail with fewer adverse environmental, social and economic consequences than the construction of a third runway.

4. The rail passenger service alternative is particularly suitable for diversion of air passenger traffic at Sea-Tac Airport for the short distance commuter flights which make up 40 percent of the total flight operations but carry only 11 percent of the total passengers at Sea-Tac Airport.

5. An estimated expenditure of $250 to 300 million between 1995 and 2000 for rail passenger service improvements in the Western Washington intercity corridor from Portland to Seattle to Vancouver would be able to reduce the short term runway capacity constraints at the Sea-Tac Airport through a combination of increased train frequencies, nonstop through train service, a Tukwila rail station with connecting bus service for Sea-Tac Airport, a Bellevue-to Tukwila rail shuttle service, modest railroad right-of-way improvements and the purchase of four new trainsets by diverting up to 70 flights per day to rail.

6. An estimated expenditure of $1,250 to 1,500 million by the year 2005(including the $250 to 300 million by the year 2000) could achieve passenger traffic diversions from air commuter flights from air to rail of between 100 and 140 flights daily, and between 140 and 240 flights per day if based on a governmental policy mandate of conversion of short distance air to rail after 2010 in the Western Washington intercity corridor as train speeds were progressively increased in the future.

7. The planned rail passenger service improvements to be implemented in the Western washington intercity corridor will reduce the problem of weather-related delays at Sea-Tac Airport by the diversion of the short distance air commuter flights to rail could be initiated as early as 1998 so as to reduce the present runway capacity constraints at Sea-Tac Airport during the 44 percent of the time when adverse weather conditions limit aircraft takeoffs and landings . .

TESTIMONY SUMMARY
(May 3, 1995)

1. **Train Service Improvements- House Bill 1617**

The response of the Washington State Department of Transportation(WSDOT)states that train travel times from Seattle to Portland can be reduced from the present 3.9 hours to 3.4 hours with an expenditure of $266 million. It is possible that the travel times between Seattle and Portland can be reduced to 3.0 hours with an expenditure of only $150 million in this corridor especially if nonstop train service is implemented before 2000.

The WSDOT response states that the current rail ridership in the Seattle-Portland corridor could be increased from the present 425,000 per year to 1,050,000 passengers per year by 2000. In actuality, the rail ridership by the year 2000 could range from as little as 1.0 million per year to as much as 2.0 million per year, depending upon the type and extent of rail passenger service improvements implemented. Increased train frequency is likely to be the most important single measure which could be taken during this period to increase rail ridership as well as to alleviate commuter flight induced runway congestion at the Seattle-Tacoma International Airport.

There is no mention in the WSDOT response or in the prior legislation of the need for and importance of improved coordination of air and rail passenger service within Washington State.

2. **Passenger Traffic Diversion from Air to Rail**

The response by the WSDOT understates the potential for airline flight diversion by a factor of 2.0, and of the passenger traffic diversion by a factor of 2.5. The WSDOT response states that at the 40 percent commuter flight diversion level that there will be only 158,000 passengers per year diverted to rail which will result in a net reduction of 6,466 flights per year, or 1.7 percent of total airport operations. In actuality, there will be 361,350 passengers per year diverted from air to rail which will result in a reduction of 20,075 flights per year or 5.3 percent of total flight operations at SeaTac Airport.

The baseline projections for passenger ridership with the Wilbur Smith model are much lower than with the Parsons Brinckerhoff mode split model by a factor of 250 to 300 percent. The projections of increased passenger ridership with the Wilbur Smith mode split model are lower than what has actually happened in the real world intercity corridors by a factor of 400 to 500 percent. The intercity corridors from New York to Washington, New York to Boston, and Los Angeles to San Diego all show rail market penetration levels far greater than predicted by the Wilbur Smith mode split model used in the present WSDOT response.

3. **Comparison of Travel Times by Rail, Air and Auto**

The WSDOT response ignores the effects of increasing highway and airport congestions on passenger diversion to rail. Rail will be more time competitive than auto after the year 2000, and will be more time-competitive than air after 2010 with the improvements.

4. **Comparative Travel Costs for Air, Auto and Rail Trips**

The rail travel mode is less expensive than either the air or auto modes when all direct and indirect expenses are included at the present time. It is expected that the costs of rail trips will continue to be less than for auto and air trips in the foreseeable future. These relative differences in cost are expected to become even more favorable to rail in the future with the expected impacts of increased airport and roadway congestion.

5. **Gina Marie Lindsey Letter of November 17, 1994**

No response is necessary by the author to this letter.

6. **Assumption of 100 Percent Air Traffic Diversion to Rail**

The WSDOT response states that there would be only 500,000 passengers per year diverted from air to rail with a 100 percent diversion of commuter flights of 19,735 flights annually. These numbers are equivalent to 1,370 passengers per day or 54 flights per day, upon which the WSDOT response states that these operations are only 2.1 percent of the total passengers on 5.2 percent of the total daily flights at Sea-Tac Airport.

The actual flight operations with a 100 percent diversion of the commuter traffic extracted from the Official Airline Guide April 1995 edition presents a much different picture. There are actually 240 commuter flights per day in the Western Washington corridor to and from Sea-Tac Airport out of a total of 299 flights. These 240 commuter flights carry 50 percent of the total seating capacity of approximately 18,000 seats per day with an average seating capacity of 35 for the commuter flights and 62 for all flights in the Western Washington corridor.

The Western Washington corridor commuter flights have 8,400 seats capacity on the 240 flights. The Eastern Washington flights have an even higher proportion of commuter flights with a total of 138 per day as compared to a total of 154 per day. The total number of commuter flights in both the Eastern and Western Washington corridors is 378 per day, which is 40.4 percent of the total 935 daily flight operations at Sea-Tac Airport. These 378 commuter flights have a total seating capacity of 12,432 per day out of a Sea-Tac Airport total of 97,750 per day, or 12.7 percent of the total for all of the airport daily operations.

7. **Northeast Corridor Cross Modal Air Rail Passenger Diversion**

The WSDOT response presented some available information on the potential for air traffic diversion to rail based on the data provided for the New York to Boston corridor. The WSDOT response stated that the rail traffic will increase from 1.0 million trips in 1993 to 3.4 million trips in 2010, which represents an increase in modal share from 6 to 17 percent. At the same time, the air trips are expected to be reduced from 3.5 million in 1993 to 2.2 million in 2010, which represents a decrease in modal share from 19 to 11 percent during this 17 year period as service frequencies and train speeds are simultaneously increased.

In the New York to Washington corridor, the proportion of rail ridership has steadily increased from the 30 to 35 percent of the total air-rail market before 1980 to 53 percent at the present time as service frequencies and train speeds have been increased. It is expected that by the year 2000 that the rail portion of the total air-rail ridership will increase to over 60 percent of the total as the train speeds are further increased with the initiation of the new high speed trainsets. This corridor is not mentioned in the WSDOT response for Northeast Corridor data.

The WSDOT response does not mention at all the Los Angeles to San Diego intercity corridor. The rail ridership in this corridor has steadily increased from less than 0.4 million in 1973 to 1.0 million in 1980 to 1.5 million in 1985 and 1.8 million in 1993. The total rail ridership is expected to increase to 3.9 million by the year 2000 as additional improvements are made as train speeds and frequencies are increased. The air traffic is then expected to decrease slightly from 3.1 million in 1993 to 2.8 million trips in 2000 as the rail services are improved. In addition, there has been a decrease in total daily average flights in the Los Angeles to San Diego corridor from 142 in 1988 to 118 in 1995. There is no way to ascertain if improved rail passenger service in any way contributed to this decrease in flight frequencies.

The WSDOT response did address the New York to Boston corridor to some extent, but did not address the other corridors. In addition, there was no information presented on ridership trends in foreign countries or how any of that material might have a bearing on the Western Washington intercity corridor.

8. **Talgo Train Impacts on Cascadia Corridor Rail Ridership**

The WSDOT resonse did acknowledge that there were 58,000 new riders on the Talgo train in a six month period which actually led to significant increases in overall corridor ridership between Portland and Seattle in 1994. This trend indicates a substantial potential for discretionary induced ridership in the corridor which is amenable to increased train frequency, speed and service levels. The model used by the WSDOT based on the Wilbur Smith data does not appear to be able to indicate such increases in the actual corridor ridership. It is suggested that there be more consideration given to those experiences in foreign countries in that actual ridership data is utilized for the respective modes.

9. **High Speed Rail Implementation Time Frame**

The WSDOT response states that the implementation time frame for improved rail passenger service could be accelerated significantly if additional funding were available. This statement is true to the extent that it is applicable. However, what is probably even more important than increased funding is increased will to get on with the job of improving the rail system for all types of passenger and freight movements. The incremental steps which have been suggested indicate that some improved rail passenger service could be implemented in as little as one to three years. The mere increase in train service frequency could have a significant impact upon increasing rail passenger ridership in the West-Washington corridor.

The experiences in foreign countries indicate that there can be significant improvements made in rail passenger service in much less than 25 to 30 years. The first TGV high speed rail line was implemented in France in 12 years from start to finish. The Japanese high speed rail lines have all been completed in much less than 20 years in terrain more difficult than in the Northwest.

10. **Impacts of Congestion on Rail Passenger Ridership**

The WSDOT response assumed that a 76 percent increase in the overall corridor travel would have no measurable impact upon air or auto travel times and no observable impact upon rail ridership. The fact for air travel is that a 10 to 20 minute delay would result in a 5 to 6 percent increase in rail passenger ridership. A 30 to 40 minute delay average would result in a 10 to 12 percent increase in rail passenger ridership. Increased air traffic congestion would be expected to result in a significant diversion to rail travel if the alternative were to be available.

For auto travel, a reduction in average speed from 55 to 45 miles per hour would result in an increased driving time from 3.2 to 4.0 hours and result in a 6 to 8 percent increase in rail ridership. A further reduction in auto speed average from 55 to 35 miles per hour would result in an increased auto trip time from 3.2 to 5.0 hours, and result in increased rail ridership of 12 to 15 percent. Increased auto traffic congestion in urban and non-urban areas is a strong argument for increased rail passenger service.

The cost of building a third runway and other facilities at the Sea-Tac Airport is estimated as $1.2 billion by the Federal Aviation Administration, which will be higher because of the delays to occur. The cost of building a new freeway in Western Washington is $20 to 30 billion if it could be built at all. The rail service alternative provides a much more cost-effective means of providing freight and passenger transportation capacity than either airports or freeways.

11. **Effect of Increased Auto Travel Time on Rail Ridership**

The previous WSDOT high speed rail study indicated that a 20 percent increase in auto travel time would result in a 17 percent increase in rail ridership. A 50 percent increase in auto operating cost would result in a 23 percent increase in rail passenger ridership and that the effects would be cumulative. There is a need for further clarification of this matter but their estimate of percentage increases in rail ridership resulting from these combined effects of up to 39 percent is greater than that of the author of this document.

12. **Impacts of Increased Train Speeds on Rail Ridership**

The WSDOT response does not address the question of eliminating the intermediate stops on some trains as a means of being able to increase average train speeds to reduce overall trip times. Increasing the average train speed reduces the ratio of the maximum to average speed while reducing the intermediate stops also reduces the the ratio of maximum to average speed. Average speeds are the primary factor influencing the overall trip times. The trip times can be reduced between Seattle and Portland from 4.0 hours at 45 miles per hour to 3.0 hours at 60 miles per hour to 2.5 hours at 70 miles per hours to 2.0 hours at 90 miles per hour to 1.5 hours at 120 miles per hour and to 1.0 hour at 180 miles per hour.

13. Seattle-Portland Corridor Passenger Traffic Projections

The WSDOT response indicates that the total passenger ridership traffic volumes between Seattle and Portland will increase from 34.0 million trips in 1992 to 62.5 million trips in 2020. If a high speed rail system were to be built, the total corridor traffic would increase from 62.5 million trips in 2020 to 74.5 million trips, but that almost all of the increased travel would be by automobile. This response is erroneous because it creates induced ridership for the train and not the car except to drive to the station. The rail mode would be able to take significant levels off of the both the air travel mode(40 to 45 percent by the year 2020), and also from the auto travel mode(10 to 15 percent by 2020) with total rail ridership levels of 6 to 10 million trips per year by 2020.

14. Weather Delay Impacts upon Rail Passenger Ridership

The WSDOT response is that air travel delays from adverse weather would have only a minimal effect upon rail passenger ridership of less than a one percent increase. A 20 minute delay could result in a 5 to 8 percent increase in the average rail ridership while a 40 minute delay would result in a 10 to 12 percent increase in rail passenger ridership. With a 44 percent adverse weather factor at Sea-Tac Airport, an annual passenger diversion would be 2 to 3 percent for a 20 minute delay and a 4 to 5 percent diversion for a 40 minute delay.

15. Effects of Induced Ridership on Rail Passenger Traffic

The WSDOT response states that increased rail passenger ridership would be only to 1.2 million trips per year by 2020 as compared to 5.1 million trips per year from the high speed rail study. The WSDOT response is based on the results from the Wilbur Smith study and does not consider the effects of induced discretionary ridership. In France, the introduction of the TGV high speed train has resulted in a 17 to 35 percent increase in trips which would not otherwise be taken if this train were not in service. The recent experience with the Talgo train in the Portland-Seattle corridor points to a substantial induced ridership market for the improved rail passenger service in the Pacific Northwest.

MAJOR IMPEDIMENTS

A number of factors have been identified which could inhibit the ability to develop and implement improved rail passenger service in the Pacific Northwest in general and the State of Washington in particular. These potential impediments are summarized in the following paragraphs of this section in order of importance.

1. Institutional Factors

Resistance from the existing predominant oil, aviation and automobile interests to change is the greatest single factor which will limit the development of improved rail passenger service in the State of Washington and throughout the United States.

2. Financial Factors

The need to raise large amounts of money for improved rail passenger service in a constrained funding environment is the second greatest impediment to the development of improved rail passenger service in the State of Washington and the United States.

3. Political Factors

Large scale public support is needed in order to implement improved rail passenger service so as to be able to overcome the resistance from the existing air, auto and oil lobbies. There is then the need for all sectors and all areas to benefit from any rail passenger improvement project for it to be successful.

4. Legal Factors

The need to have some type of dedicated funding source for rail passenger service may place it in conflict with the 18th Amendment of the State Constitution, which may require some type of alteration or modification in order to be implemented.

5. Environmental Factors

There are some specific environmental concerns with wetlands for improved rail passenger service, but in general environmental concerns with rail are positive in comparison with auto or air.

6. Safety Concerns

There is a definite need to construct as many rail-highway grade separations as possible to minimize the potential for accidents as well as to alleviate community concerns. There is also a need to isolate railroad rights-of-way by means of fencing so as to minimize human and animal access to railroad lines as well.

IMPLEMENTATION PLAN

An implementation plan is being prepared which proposes a series of incremental improvements on a phased timewise basis in the Western Washington intercity corridor from Portland to Seattle to Vancouver to alleviate the upcoming runway capacity constraint at the Seattle-Tacoma International Airport. These railroad line improvements are proposed to be completed in four separate periods of five years each as follows: 1) 1995-2000; 2) 2000-2005; 3) 2005-2010; 4) 2010-2020. These railroad system improvements will be implemented so as to alleviate future runway capacity constraints in the near term, intermediate term and long term time frames. A list of the proposed rail system is presented on the enclosed page, and will be discussed in more detail in a subsequent document.

SUMMARY FEATURES OF THE STEPWISE PHASED IMPLEMENTATION PLAN FOR THE INCREMENTAL IMPROVEMENTS IN THE WESTERN WASHINGTON INTERCITY CORRIDOR FROM PORTLAND TO SEATTLE TO VANCOUVER, B.C. TO ALLEVIATE THE RUNWAY CAPACITY CONSTRAINTS AT THE SEATTLE-TACOMA INTERNATIONAL AIRPORT.

Time Frame	Plan Element Description	Capital Cost Million $	Time Saving Minutes	Passenger Diversion Pass/Day	Passenger Diversion Percent	Flight Diversions Flight/Day	Flight Diversions Percent
1995-2000	Buy 4 New Trainsets for Service Build Tukwila Airport Station Construct Prairie Line Bypass Start Bellevue-Tukwila Service Upgrade Bellevue-Tukwila Line Make Signal & Track Improvements Start Nonstop Train Service from Seattle to Portland via Tukwila Start Bellevue-Portland Servive	250-300	30-50	500-1,200	5-12	25-70	3-7
2000-2005	Buy 4 Additional Trainsets Upgrade Bellevue-Tukwila Line Construct Olympia Connector Line Make Signal & Track Improvements Start Upgrade Bellevue-Snohomish Line for Vancouver Service Start Third Main Track on Seattle to Portland Corridor Line Start Double Tracking of Seattle to Vancouver Corridor Line Start Bellevue Main Terminal Nonstop Seattle-Vancouver Service	700-750	60-90	1,200-1,800	12-18	70-100	7-11
2005-2010	Buy 4 Additional Trainsets Construct Lake Samish Bypass Line Rebuild Eastside Rail Line Start Sea-Tac Airport Connector Complete Third Main Track from Seattle to Portland Corridor Complete Double Tracking of the Seattle to Vancouver Corridor Expand Track and Signal Upgrading Expand Nonstop Train Services Start Eastside Railroad Tunnel	1,200-1,500	90-110	1,800-2,200	18-22	100-140	11-15
2010-2020	Full High Speed Rail Operation	2,500-6,500	115-145	2,500-4,500	25-45	140-240	15-26

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IMPLEMENTATION PLAN
(May 15, 1995)

1995 - 2000 Time Frame

A series of improvements are proposed in the Western Washington intercity corridor for upgrading the rail passenger system so that it help to alleviate the upcoming runway capacity limitation at the Seattle-Tacoma International Airport(Sea-Tac). These proposed rail passenger service improvements will include the purchase of four additional trainsets plus the upgrading of the existing railroad lines. Initial emphasis during this period will be on improvements in the corridor from Seattle to the Portland area with the Seattle to Vancouver, B.C. corridor to follow during the second five year interval.

The initial step will be to construct a new train station at Tukwila with a connecting shuttle bus service to Sea-Tac Airport. The existing rail line from Bellevue to Renton to Tukwila will be upgraded so that a rail commuter service to connect with the intercity trains and the airport shuttle bus service to the Sea-Tac Airport. A new temporary train station will be built at Bellevue in order to facilitate the new train service to Tukwila. The existing so-called "Prairie Line" across Fort Lewis between Tacoma and Nisqually will be upgraded and placed into service so that passenger trains will be able to bypass the time-consuming Point Defiance line prior to the year 2000.

The goal of this program is to be able to increase the average train speeds for travel from the present 45 miles per hour to 60 miles per hour. The initial objective is to reduce the travel times by train from the present 3.9 hours in the Seattle -Portland corridor to between 3.1 and 3.5 hours by the year 2000. It is also the objective of this program to be able to reduce train travel times from an initial 4.0 to 4.5 hours in the Seattle-Vancouver corridor to between 3.7 and 4.0 hours by the year 2000, and to a shorter travel time thereafter. Another important goal of this rail passenger service improvement program will be to increase the frequencies of travel from 4 to 8 round trips per day by the year 2000, and to 8 round trips per day thereafter or more.

There will also be an effort to increase the planned railroad passenger service in the Seattle-Vancouver corridor from one to at least two round trips per day by the year 2000. One possible means for implementing this increase train service frequency is to have the present Coast Starlight train extended from Seattle to Vancouver in the near future. There will be nonstop passenger train service initiated between Seattle and Portland so as to offer reduced travel times so as to be more time-competitive with air travel so as to reduce flight frequencies at Sea-Tac Airport which will later be extended to the Seattle-Vancouver corridor. Direct train service is also planned to be initiated between Bellevue and Portland by way of Tukwila prior to the year 2000.

These rail passenger service improvements to be completed by the year 2000 are expected to cost between $250 and 300 million as they will incorporate more track improvements than previously described. Train travel time are expected to be reduced by 30 to 50 minutes with the greater time savings for the nonstop trains. These improvements are expected to result in the diversion of between 500 and 1,200 passengers per day, or between 5 and 12 percent of the present total air travel level of approximately 10,000 passengers per day in the Western Washington intercity corridor. The total number of flights which could be diverted from Sea-Tac Airport as the result of alternative rail travel instead of air would be between 25 and 70 flights per day, or between 3 and 7 percent of the present 935 total daily airport operations.

2000 - 2005 Time Frame

A second more extensive series of rail passenger service improvements are proposed to be made in the Western Washington intercity corridor between 2000 and 2005 to further increase the capacity of the rail system to be able to divert air passenger traffic away from Sea-Tac Airport for the short distance commuter flights. These improvements will include a series of right-of-way improvements so as to increase train speeds and line capacities as well as to increase train service frequencies. The goal of the rail system improvements to be made during this period will be to allow increases in average train speeds from 60 to 70 miles per hour so as to reduce train travel times between Seattle and Portland to 2.5 to 3.0 hours from an initial 3.9 hours, and to between 3.0 and 3.5 hours in the Seattle-Vancouver intercity corridor.

A number of improvements will need to be made in the signalling and communications systems so as to be able to further increase the maximum and average train speeds in both the Seattle-Portland and in the Seattle-Vancouver intercity corridors. There will need to be a number of trackage and curvature improvements in these lines so as to be able to raise maximum train speeds along the route. There will be the beginning efforts to lay a third main track between Seattle and Portland along with a second main track in the Everett to Vancouver intercity corridor. The upgrading of the Bellevue to Tukwila rail line across the Eastside will be completed and the upgrading of the Bellevue to Snohomish line will be initiated. The rail connecting line from Lacey to downtown Olympia will be upgraded so as to be able to provide direct rail passenger service from the largest city to the State Capital without requiring an automobile.

An additional four trainsets will need to be purchased as a means of increasing rail passenger service frequencies to as many as 8 round trips per day in both the Seattle-Portland and Seattle-Vancouver intercity corridors. Additional passenger train service will be added from Centralia to Olympia to Seattle and from Bellingham to Everett to Seattle to facilitate improved access from these outlying areas to Sea-Tac Airport. The rail passenger service between Bellevue and Portland will be expanded during the period from 2000 to 2005. The direct rail passenger service from Bellevue to Vancouver, B.C. by way of Snohomish will be initiated following the completion of the line upgrading so as to be able to improve rail travel times between the Eastside and Northwest Washington as well as the Lower Mainland of British Columbia. Improved rail passenger commuter services will be initiated and improved during this period from 2000 to 2005 in these rail passenger corridors.

IMPLEMENTATION PLAN
(May 15, 1995)

1995 - 2000 Time Frame

A series of improvements are proposed in the Western Washington intercity corridor for upgrading the rail passenger system so that it help to alleviate the upcoming runway capacity limitation at the Seattle-Tacoma International Airport(Sea-Tac). These proposed rail passenger service improvements will include the purchase of four additional trainsets plus the upgrading of the existing railroad lines. Initial emphasis during this period will be on improvements in the corridor from Seattle to the Portland area with the Seattle to Vancouver, B.C. corridor to follow during the second five year interval.

The initial step will be to construct a new train station at Tukwila with a connecting shuttle bus service to Sea-Tac Airport. The existing rail line from Bellevue to Renton to Tukwila will be upgraded so that a rail commuter service to connect with the intercity trains and the airport shuttle bus service to the Sea-Tac Airport. A new temporary train station will be built at Bellevue in order to facilitate the new train service to Tukwila. The existing so-called "Prairie Line" across Fort Lewis between Tacoma and Nisqually will be upgraded and placed into service so that passenger trains will be able to bypass the time-consuming Point Defiance line prior to the year 2000.

The goal of this program is to be able to increase the average train speeds for travel from the present 45 miles per hour to 60 miles per hour. The initial objective is to reduce the travel times by train from the present 3.9 hours in the Seattle -Portland corridor to between 3.1 and 3.5 hours by the year 2000. It is also the objective of this program to be able to reduce train travel times from an initial 4.0 to 4.5 hours in the Seattle-Vancouver corridor to between 3.7 and 4.0 hours by the year 2000, and to a shorter travel time thereafter. Another important goal of this rail passenger service improvement program will be to increase the frequencies of travel from 4 to 8 round trips per day by the year 2000, and to 8 round trips per day thereafter or more.

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These rail passenger service improvements to be completed by ear 2000 are expected to cost between $250 and 300 million as , will incorporate more track improvements than previously desed. Train travel time are expected to be reduced by 10 ... tes with the greater time savings for the enger service is expected to result in the diversion of between 100 and 140 flights per day to rail, which is between 11 and 15 percent of the present total of 935 operations per day at Sea-Tac.

2010 - 2020 Time Frame

It is planned to further upgrade the railroad lines in the Western Washington intercity corridor to a full high speed rail operation. The plan is to first raise the train speeds from the maximum limit of 110 miles per hour to 125 miles per hour and then to 150 miles per hour in stages. The average train speeds would be raised from 90 miles per hour to 110 miles per hour and then to 125 miles per hour coincident with the maximum train speed increases. These train speed increases will gradually reduce the travel times from Seattle to either Portland or Vancouver from the present 3.9 to 4.5 hours to between 1.5 and 2.0 hours. The train service frequencies would be progressively increased from the 12 daily round trips planned in 2010 to between 16 and 18 round trips per day by 2020 in both the Seattle to Portland and Seattle-Vancouver intercity with significant services to Bellevue as a part thereof.

The achievement of full high speed rail operation with maximum train speeds of 150 miles per hour with average speeds of 125 miles per hour can still meet the Association of American Railroads criteria for simultaneous operation of passenger trains and fast freight trains on the same rights-of-way. It will probably be necessary to operate the high speed passenger trains and the fast intermodal freight trains on one set of tracks while the slower freight trains will move on a separate set of tracks. It will probably be necessary to construct a fourth main track in the Portland-Seattle corridor as well as a possible third main track in at least portions of the Seattle-Vancouver intercity corridor. There will also need to be major railroad infrastructure improvements made in the Eastside rail corridor with the completion of a proposed railroad tunnel between Bellevue and Redmond under Cherry Crest Hill, plus SeaTac Airport.

The operation of full high speed rail passenger service in the Western Washington intercity corridor from Portland to Seattle to Vancouver will achieve the diversion of as many as 2,500 to 4,500 passengers who would otherwise travel by air. These travelers constitute between 25 and 45 percent of the present air travel market in the Western Washington corridor of approximately 10,000 passengers per day. The diversion of these passengers from air to rail would result in the diversion of between 140 and 240 commuter flights per day away from the Sea-Tac Airport, which comprises from 15 to 26 percent of the present total of 935 daily flight operations at the Sea-Tac Airport. The attainment of these maximum train speeds of as much as 150 miles per hour would necessitate an additional capital expenditure of $1.0 to 5.0 billion for a total estimated cost of rail service improvements in the 25 year period from 1995 to 2020 of $2.5 to 6.5 billion, including a new SeaTac Airport rail tunnel.

It is even possible that additional improvements could be made to the rail passenger system after the year 2020 to increase the maximum train speeds to 185 miles per hour in the Western Washington intercity corridor. There would need to be a separate right-of-way constructed for freight and passenger trains and the incremental increases in ridership may not offset the increased costs.

PREPARED TESTIMONY

on the

PASSENGER RIDERSHIP DIVERSION POTENTIAL

for the

RAILROAD PASSENGER SERVICE ALTERNATIVE

to the

SEA-TAC AIRPORT RUNWAY CAPACITY EXPANSION

Presented to:

Mr. Scott Lewis, Chairman
Expert Arbitration Panel of the
Puget Sound Regional Council
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May 3, 1995

Prepared on behalf of the Regional Coalition for Airport Affairs, Normandy Park, Washington.

SUMMARY

The enclosed document presents an analysis of the potential for intermodal diversion of passenger traffic at the Seattle-Tacoma International Airport (Sea-Tac) from air to rail. The purpose of this analysis is to determine the potential of improved rail passenger service in Western Washington to alleviate the need for construction of a third runway at Sea-Tac Airport. Findings of this analysis are presented in the following sections of this document along with recommendations made for implementation of rail passenger system improvements to alleviate present and future airport congestion. This document will emphasize those rail passenger system improvements in the Western Washington intercity corridor for Portland to Seattle to Vancouver (the so-called Cascadia Corridor) which can reduce airline flight frequencies at Sea-Tac Airport, especially by diversion of commuter flight air traffic to rail by market competition or government policy mandates.

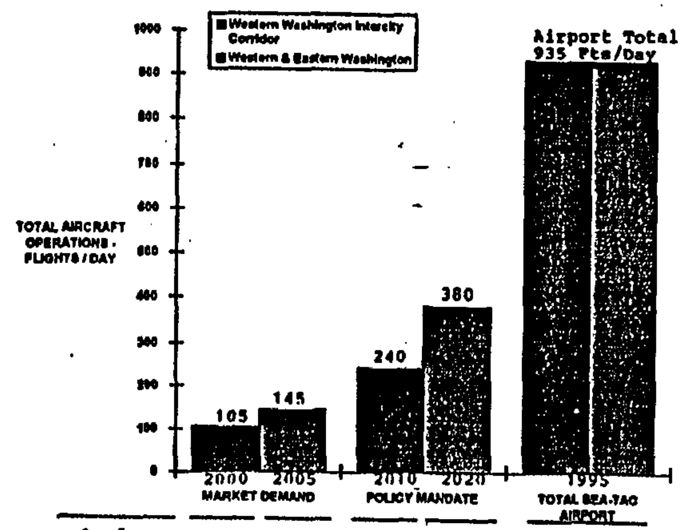
The present document will address the major points as follows: 1) critique of previous responses from the Washington State Department of Transportation in this proceeding involving rail systems improvements as they might affect Sea-Tac Airport operations; 2) prediction of the expected intermodal passenger traffic diversion from air to rail in the Western Washington Cascadia intercity corridor in terms of its ability to alleviate Sea-Tac Airport runway congestion; 3) a listing of unanswered questions and issues which have been identified as possible impediments to the implementation of the rail alternative to Sea-Tac Airport expansion. These specific sections are divided into specific subtopics which are addressed on the following pages of the present document.

The implementation of the proposed rail system improvements in the Western Washington corridor could result in the diversion of between 70 and 240 daily commuter flight operations at Sea-Tac Airport. The addition of high speed rail service to Eastern Washington would increase the potential commuter flight diversions at Sea-Tac Airport by an additional 35 to 140 flights per day. The potential reductions of the present flight operations by intermodal passenger traffic diversion from air to rail could range from 7.5 to 25.7 percent of the present total of 935 operations per day at Sea-Tac Airport. If improved rail passenger service to both Eastern and Western Washington is implemented, the potential commuter flight reductions at Sea-Tac Airport could range from 105 to 380 per day, or between 11.2 and 40.6 percent of the present total flight operations.

The response from the Washington State Department of Transportation to the Expert Arbitration Panel of Puget Sound Regional Council on the ability of improved rail service to alleviate the need for Sea-Tac Airport runway capacity expansion was deficient. The WSDOT response greatly underestimated the market penetration potential of improved rail service to capture passenger trips otherwise taken by air. The WSDOT response erroneously placed the "induced" discretionary ridership increase resulting from the construction of a high speed rail system from rail to automobiles. The WSDOT response also failed to consider the effects of increased highway traffic congestion on rail.

A number of issues have been identified as being potential impediments to the implementation of high speed rail service as an alternative to Sea-Tac Airport expansion. There are the physical problems of freight train service increases, the need for bypass construction, and geographical constraints of wetlands mitigation, hills and mountains, plus rivers and bridges. There are the financial constraints of the need to raise large amounts of money for construction, the possible need for additional taxing and bonding authority, the need to develop an appropriate financing plan mechanism, and to be able to achieve some degree of revenue and expense cash flow balance. There are also the institutional constraints of who will actually develop the project, what will be the roles of the Federal, State and Local governments, what will be the role of the private sector, and of resistance from the existing oil, aviation, auto and highway infrastructure "interests".

ESTIMATED ABILITY OF IMPROVED RAIL PASSENGER SERVICE TO DIVERT AIR TRAFFIC AND DAILY FLIGHTS AT SEA-TAC AIRPORT



	2000	2005	2010	2020	1995
% of Flights	11	16	26	41	100
% of Passengers	3	5	7	12	100

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INFORMATION RESPONSES

A series of questions were presented by the Expert Arbitration Panel (EAP) of the Puget Sound Regional Council (PSRC) to the Washington State Department of Transportation (WSDOT). These questions were intended to elicit additional background information on previous studies conducted by the WSDOT on the relative ability of improved rail passenger service in the State of Washington to alleviate present and future airport runway congestion at Sea Tac Airport. A listing of the questions raised along with an analysis of the adequacy of the response to each question is enclosed in the following paragraphs of this document.

1. Train Service Improvements - House Bill 1617, 1993.

> "Describe the actions the WSDOT is now taking or will take to implement the provisions of House Bill 1617, passed by the Washington State House of Representatives on April 20, 1993, and by the Washington State Senate on April 17, 1993, with respect to (a) the mandated improvements in existing passenger rail service, including improved train speed and frequency (Section 3); and (b) the development of a regional high speed rail system (Sections 2 and 4). Indicate the projects WSDOT is undertaking to carry out this legislation, the estimated cost of implementation, and the timetable for completion of these projects."

The response to this question is sufficient in terms of the literal points raised as a summary. It would be helpful to provide an actual list as a supplement on the description, location, cost and schedule of making improvements made. The description of the legislative request for funding by the Washington State Transportation Commission is sufficient in terms of the plans to reduce travel times in the Portland-Seattle intercity corridor from the present 3.92 hours to 3.43 hours at an expected capital cost of $266 million by the year 2000 in a seven (7) year period.

The above rail travel time improvement of 0.49 hours could actually be achieved at a lower cost and in a shorter time frame, as documented in the previous letter by the author (Ref. 1). The construction of a Tukwila Station plus the addition of automatic switches at the Portland and Seattle terminals could reduce travel times to approximately 3.0 hours for those trains which do not stop at other intermediate stations. The capital cost of this alternative would be less than $50 million which is also much lower than the $266 million cited in the WSDOT response of April of 1995 (Ref. 2).

An additional item was not addressed in either the WSDOT response or the previous report submitted to the Expert Arbitration Panel by the Washington Department of Transportation plus the Port of Seattle, Puget Sound Regional Council and the Federal Aviation Administration (Ref. 3). This report failed to address the fact that the previous

High Speed Ground Transportation (HSGT) Feasibility Study conducted for the Washington State Department of Transportation in 1992 reported that passenger ridership potential for Bellevue and elsewhere on the Eastside would actually be greater than from Seattle itself (Ref. 4).

The WSDOT response in April 1995 (Ref. 2) even overlooked the information presented in its own previous Final Report of December 1994 (Ref. 3). Data was incorporated in the December 1994 Final Report presented in the previous Statewide Passenger Rail Program Preliminary Report of November 1991 (Ref. 5). This report presented a series of minor service improvements which involved only minor service improvements which involved only minor right-of-way expenses plus trainset purchases to increase both Seattle-Portland and Seattle-Vancouver service frequencies by two added round trips each.

The overall Western Washington corridor passenger ridership could be increased from 425,000 per year in 1992 to 1,050,000 per year in 2000 at an estimated capital cost of $62 million with these service frequency increases alone. The total estimated passenger ridership growth rate over this eight year period from 1992 to 2000 was estimated as 246 percent, or 34 percent per year. These estimates have been at least partially validated by the recent experiences in the Portland-Seattle corridor with the Spanish Renfe Talgo train. There was an increase of 56,000 riders in six months (112,000 per year) observed during 1994 from the mere addition of one Talgo train round trip per day. This observed rail ridership increase would explain an annual passenger traffic increase from 213,000 to 325,000 by 112,000 person trips per year for the Talgo train.

The biggest difficulty with both the Washington State Department of Transportation response (Ref. 2) and the Washington State Legislature's mandate in House Bill 1617 is that there has been no effort made to coordinate improved rail passenger service to serving the needs of SeaTac Airport. Nowhere in this Bill or in any WSDOT report is there any mention of providing direct rail service into SeaTac Airport, or of any connecting intermodal bus or shuttle service. Such an oversight can not be explained by any system of logic in attempting to utilize increased rail passenger service to alleviate the need for increased runway capacity at SeaTac Airport at present or in the future.

2. Passenger Traffic Diversion from Air to Rail.

> "Estimate the cross-modal air/rail travel substitution effect and the corresponding effect on demand and delays at SeaTac Airport if these rail improvements produce a maximum rail travel time of two hours and thirty minutes between downtown Seattle and downtown Portland by the year 2000, as mandated in House Bill 1617. Show the estimated effects on airport demand and delays if (a) 20 percent, (b) 30 percent, or (c) 40 percent of the projected air traffic in the Seattle-Portland market switches to rail service in the year 2000."

The response to this question by the WSDOT is erroneous because it understates the degree of potential flight diversions in the Portland-Seattle corridor alone by a factor of two. The flight diversions reported by the WSDOT in its response range from 5 to 18 operations per day, or between 0.45 and 1.70 percent of the present airport total of 935 per day, as shown in Table 1. The actual calculated flight diversions are based on a present total of 138 flights per day between Seattle and Portland. The diversion of between 14 and 55 flights per day would then lie in the 10 to 40 percent flight diversion range for the present 935 daily flight operations at Sea-Tac Airport.

The WSDOT response presents some information on the expected rail ridership increases in the Seattle-Portland intercity corridor from 213,000 in 1994 to 365,000 in 2000 and to 1,225,000 in 2020. During this period, the actual travel times by rail in the Seattle-Portland corridor would decrease from 3.92 hours in 1994 to 2.83 hours in 2000 to 1.50 hours in 2020 as average train speeds increase from 47 miles per hour to 65 miles per hour to 125 miles per hour, respectively. The information presented in the State's own HSGT feasibility study shows a ridership level of 5,121,000 passengers per year in the Western Washington corridor in 2020 (Ref. 4). If it is assumed that 60% of this traffic is in the Seattle-Portland corridor in 2020, then the actual ridership would be 3,073,000 passengers per year, or 2.5 times that reported in this WSDOT response (Ref. 2).

The total capital cost in order to reach a rail travel time of 2.5 hours by 2000 between Seattle and Portland is reported in the WSDOT response to be $266 million. The travel time involves an average train speed of 75 miles per hour where an investment of as low as $150 million could achieve this goal for trains which would not stop between Portland and Seattle. This goal could be more readily achieved for the capital investment of $266 million reported for those trains going from Portland to Seattle with the Tacoma to Nisqually bypass constructed, and with no major additional investments made in the Seattle-Vancouver corridor. However, the upgrading of the entire Portland to Seattle to Vancouver corridor to a 75 mile per hour average speed in order to achieve travel times of 2.5 hours in each would require an estimated capital cost of $720 million (Ref. 7).

The WSDOT response concludes that the diversion of 11 to 40 percent of the flights at Sea-Tac Airport operating between Portland and Seattle would not be a realistic option. In fact, the exact opposite is the case because of the large numbers of small capacity commuter flights operating in the Western Washington corridors between Portland and Seattle, and Vancouver and Seattle, as shown in Table 2. There are 93 commuter flights operating daily between Portland and Seattle out of a total of 138 flights per day, or 67% of the total. These 93 daily flights are estimated to carry only 29% of the total passengers in 32% of the total seats in the corridor at the present time.

A previous report to the Washington State Legislative Transportation Committee on the potential feasibility of high speed rail in the Western Washington corridor was prepared by Parsons Brinckerhoff Quade and Douglas, Inc.(PBQD) and the Washington State Transportation Center (WSTC) in 1984 (Ref. 8). This report did present some

TABLE 1

COMPARISON OF REPORTED AND CALCULATED VALUES FOR PASSENGER TRAFFIC DIVERSION FROM AIR

ESTIMATE SOURCE	PERCENT OF FLIGHTS DIVERTED	TOTAL AIRLINE FLIGHTS PASSENGER TRAFFIC DIVERSIONS PASS/YEAR	PASS/DAY	TOTAL AIRLINE FLIGHTS DIVERSION POTENTIAL FLIGHTS/YEAR	FLIGHTS/DAY	PERCENT OF TRAFFIC [4]	TOTAL FLIGHTS
WSDOT[1] RESPONSE	11	43,450	119	1,778	5	2.03%	0.45%
	20	79,000	216	3,232	9	3.70%	0.82%
	30	118,000	323	4,849	13	5.53%	1.30%
	40	158,000	433	6,466	18	7.40%	1.70%
AUTHOR'S ESTIMATES	10	91,980 * [2]	252	5,110	14	4.31%	1.35%
	20	183,960 *	504	10,220	28	8.62%	2.69%
	34	308,250 *	845	17,125	47	14.44%	4.52%
	40	361,350 *	990	20,075	55	16.92%	5.29%
	50	453,330 * [3]	1,242	25,185	69	21.23%	6.63%
	100	2,135,250 **	5,850	50,370	138	100.00%	13.33%

Notes:

1. Based on a loading of 24.4 passengers per flight (REF. 11)

* 2. Based on loading of 18.0 passengers per flight (REF. 11)

** 3. Based on a total passenger traffic of 2,135,250 passengers per year or 5,850 passengers per day at a weighted average loading of 57.3 percent for all flights with 50.0 percent for commuter flights. for all flights with 50.0 percent for commuter flights.

4. Based on a total of 1,040 flights per day in 2000 or 380,000 total flight operations per year.

TABLE 2

DAILY AIRCRAFT FLIGHT FREQUENCIES BY PLANE SEATING CAPACITY IN THE WESTERN WASHINGTON INTERCITY CORRIDOR IN FLIGHTS PER DAY (REF. 11)

SEAT CAPACITY RANGE	AVG	SEATTLE PORTLAND	SEATTLE OLYMPIA	SEATTLE EUGENE	SEATTLE VANCOUVER	SEATTLE BELLINGHAM	TOTAL FLIGHTS	PERCENT OF TOTAL
0 - 40	35	93	10	29	70	38	240	80.30%
40 - 100	60	11	0	0	0	0	11	3.70%
100 - 150	128	2	0	0	4	0	6	2.00%
150 - 200	178	25	0	0	4	0	29	8.70%
200 - 250	226	4	0	0	4	0	8	2.70%
250 - 380	280	3	0	0	2	0	5	1.80%
TOTAL		138	10	29	84	38	299	100.00%
PERCENT		46.20%	3.30%	9.70%	28.10%	12.70%	100%	–

information regarding the effects of increased train speeds and service on modal splits between rail, air, bus and auto, as illustrated in the enclosed Figure 1.

The alternatives presented in this report are an existing Amtrak service, an enhanced Amtrak service, a high speed rail option, and a magnetic levitation alternative. Interpolations of train speeds for intermediate cases have been made by the author based on the data in this report (Ref. 8). The mode split fractions and the expected annual passenger traffic levels are presented in the attached Table 3 by starting with a 1995 total corridor traffic base of 60 million passenger trips per year (Ref. 3 & 4).

The information about modal split penetration by the rail mode which was reported in the Parsons Brinckerhoff report (Ref. 8) is substantially greater than in the previous Wilbur Smith report (Ref. 9), which is referred to in the previous WSDOT report (Ref. 3). For the high speed rail case, the Parsons Brinckerhoff report indicates a 22.0 percent market penetration at a 1.5 hour travel time, as compared to a 5.7 percent market penetration for the Wilbur Smith report, a difference of 285 percent. For the critical 2.5 hour case for the year 2000, the Parsons Brinckerhoff report interpolated a value which is a 12.0 percent market penetration level. The comparable value reported in the Wilbur Smith report is only 3.3 percent, a difference of 260 percent.

A comparison of the rail modal share penetration using these two different reports as a function of overall travel time is presented in the Figure 2. This information is ostensibly compiled for the conditions of the Portland to Seattle corridor in terms of the route distance of 185 miles. However, both of these data sources present market penetrations for the rail mode which are much less than those which have actually been reported in the New York-Boston corridor (5.9 percent), the Los Angeles-San Diego (6.1 percent), and the New York-Washington (22.0 percent) intercity corridors in the United States. Significantly higher high speed rail passenger market penetrations have been reported for the Tres Grande Vitesse (TGV) in France (30 to 40 percent), and by the Shinkansen (Bullet Train) in Japan (35 to 45 percent).

The expected rail ridership in the Portland-Seattle intercity corridor is then calculated based on the Parsons Brinckerhoff intermediate case, as presented in Figure 3. The value reported at a 75 mile per hour train speed for the year 2000 with the Parsons Brinckerhoff data (Ref. 8) would be 1.2 million passenger trips per year as compared to only 0.3 million using the Wilbur Smith data (Ref. 9). For the year 2020, the expected passenger ridership in the Portland-Seattle corridor would be 1.2 million per year according to the Wilbur Smith estimate, but 3.7 million with the Parsons Brinckerhoff data, a difference of 208 percent. The prorata Portland-Seattle intercity corridor passenger ridership based on the Gannett Fleming HSGT study (Ref. 4) is between 3.1 and 3.3 million per year for purposes of comparison. The passenger ridership level in the Portland-Seattle corridor constitutes between 60 and 65 percent of the total 5.1 million passengers per year in the Western Washington corridor which is in agreement within a range of 15 to 20 percent as reported in the Parsons Brinckerhoff study (Ref. 8).

FIGURE 1

ESTIMATED EFFECT OF AVERAGE TRAIN SPEED ON PROJECTED PASSENGER TRAFFIC MODAL SPLIT IN THE PORTLAND-SEATTLE-VANCOUVER CASCADIA INTERCITY CORRIDOR WITH NO INDUCED DISCRETIONARY RAIL RIDERSHIP TRIPS INCLUDED

Data Estimated Based on PBQD Report Modal Splits
No Induced Ridership Included

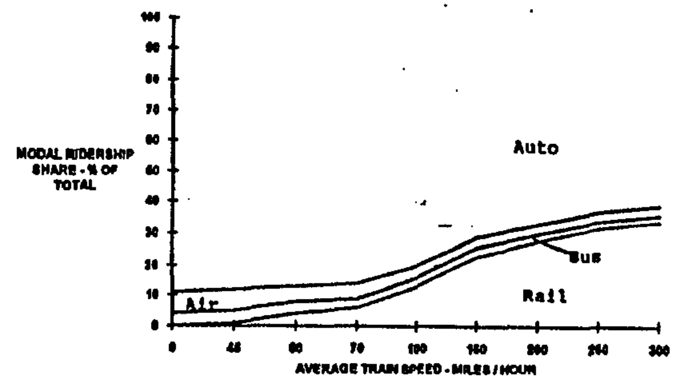

TABLE 3

ESTIMATED INCREASES IN PASSENGER TRAFFIC BY MODE IN THE PORTLAND-SEATTLE-VANCOUVER CASCADIA INTERCITY CORRIDOR WITHOUT INDUCED RAIL RIDERSHIP INCLUDED (REF. 8)

UNITS EMPLOYED	TRAVEL MODE	EXISTING AMTRAK	INCREASED SERVICE	ENHANCED AMTRAK	INTERMEDIATE SERVICE LOW	INTERMEDIATE SERVICE MED	INTERMEDIATE SERVICE HIGH	HIGH SPEED	MAGNETIC LEVITATION
PERCENT	RAIL	1.00	3.00	6.00	10.00	15.00	18.00	22.00	32.00
OF	AIR	6.00	5.50	4.50	4.20	4.00	3.80	3.50	3.00
TOTAL	BUS	3.50	3.20	3.00	2.90	2.80	2.60	2.50	2.00
	AUTO	89.50	88.30	86.50	82.90	78.20	75.60	72.00	63.00
	TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
PASSENGERS	RAIL	600,000	1,875,000	4,050,000	7,600,000	12,750,000	17,100,000	23,100,000	36,800,000
PER	AIR	3,600,000	3,437,500	3,037,500	3,132,000	3,400,000	3,610,000	3,675,000	3,450,000
YEAR	BUS	2,100,000	2,000,000	2,025,000	2,204,000	2,380,000	2,470,000	2,625,000	2,300,000
	AUTO	53,700,000	55,188,000	58,388,000	63,004,000	66,470,000	71,820,000	75,600,000	72,450,000
	TOTAL	60,000,000	62,500,500	67,500,500	75,940,000	85,000,000	95,000,000	105,000,000	115,000,000
IMPLEMENTATION YEAR		1995	1997	2000	2005	2010	2015	2020	2025
AVG SPEED	MILES/HR	45	60	70	75	90	125	150	250
MAX SPEED	MILES/HR	79	79	90	100	120	150	185	300

FIGURE 2

ESTIMATED EFFECT OF TRAVEL TIME AND TRAIN SPEED ON RAIL MODAL SHARE IN THE PORTLAND-SEATTLE-VANCOUVER CASCADIA INTERCITY CORRIDOR

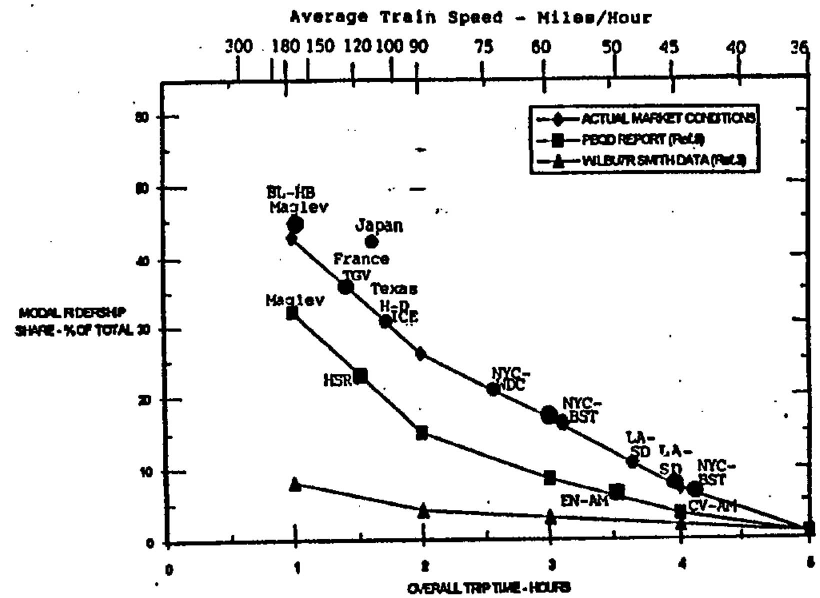

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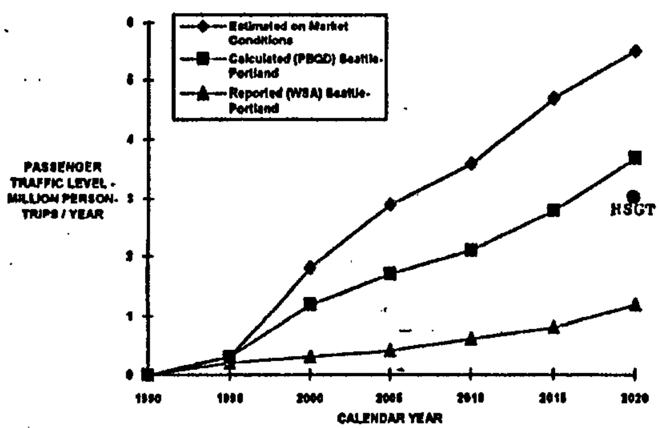
FIGURE 3

COMPARISON OF REPORTED AND CALCULATED VALUES FOR PASSENGER RIDERSHIP IN THE PORTLAND-SEATTLE INTERCITY CORRIDOR



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It can only be concluded that the information presented in the WSDOT response grossly underestimates both the expected rail ridership and the air diversion potential to rail in the Western Washington corridor. Even a modest train service frequency increase could result in the diversion of 170,000 to 310,000 riders per year without significant speed increases at a cost of $150 to $260 million. Additional total air diversions of 510,000 to 750,000 passengers per year could take place at a total capital cost of $670 to $1,250 million, which would fit within the capacity of the rail system. The rail alternative would then be able to achieve substantial diversions of the short distance airline commuter flights in the Portland-Seattle-Vancouver intercity corridor, in contrast to the conclusions presented in the WSDOT response.

3. Comparison of Travel Times by Rail, Air and Auto

> "Identify the average travel time, as a function of time of day (at least differentiating peak and off-peak periods), currently required for (a) automobile trips between downtown Seattle and downtown Portland, (b) combined auto/air trips (including average time spent traveling between the airports and downtown), and (c) passenger train travel. Indicate sources of data used, and include expected weather-related airport delays and estimated weather-related rail service delays in this analysis of average travel time."

The WSDOT response to the question presents the information for the present situation in 1995 with a basic degree of accuracy. However, the WSDOT response does not provide any degree of analysis of how the specific modal travel times could change in the future or what effect weather might have on travel patterns. A revised set of analyses of the comparative travel times for the alternative auto, air and rail travel modes for both peak and non-peak conditions in the Western Washington corridor is presented in Table 4.

The degree of automobile traffic congestion is expected to increase substantially in the Western Washington corridor in the future, whether the proposed rail system is built or not. The total passenger traffic along the I-5 corridor is expected to increase substantially in the future from 54 million annual trips in 1995 to 94 million annual trips in 2020, an increase of 74 percent. If the proposed rail system is built, the expected automobile passenger traffic will increase to 88 million annual trips in 2020, an increase of only 63 percent. Average peak time travel speeds by car in the Portland-Seattle corridor are estimated to be reduced from 60 miles per hour at present to as low as 35 miles per hour in 2020 if the rail system is not built and to 37 miles per hour if it is built.

Air traffic congestion is expected to add an average of at least 20 minutes per flight by 2020 if corrective measures are not taken. As a result, peak air travel times could increase from 2.8 hours in 1995 to 3.8 hours in 2020 if all air, airport and driving time factors are included. For comparative purposes, the auto travel time during peak hours could increase from 4.0 hours in 1995 to 5.5 hours in 2020. Weather-related delays could add

TABLE 4

ESTIMATED COMPARATIVE TRAVEL TIMES BY ALTERNATE AUTO, AIR AND RAIL PASSENGER TRANSPORT MODES IN THE PORTLAND-SEATTLE INTERCITY CORRIDOR IN MINUTES

TRIP TIME	AUTO - 1995		AUTO - 2020		AIR - 1995		AIR - 2020	
ELEMENT	PEAK	NON-PEAK	PEAK	NON-PEAK	PEAK	NON-PEAK	PEAK	NON-PEAK
ACCESS TIME	30	20	45	25	30	20	40	30
AIRPORT TIME	0	0	0	0	40	40	50	40
TRAVEL TIME	187	177	250	187	50	50	70	60
AIRPORT TIME	0	0	0	0	20	10	30	20
EGRESS TIME	23	13	35	23	30	20	40	30
TOTAL	240	210	330	235	170	140	230	180

TRIP TIME	RAIL 3.9 HOURS		RAIL 2.5 HOURS		RAIL 2.0 HOURS		RAIL 1.5 HOURS	
ELEMENT	PEAK	NON-PEAK	PEAK	NON-PEAK	PEAK	NON-PEAK	PEAK	NON-PEAK
ACCESS TIME	20	15	20	15	20	15	20	15
STATION TIME	20	20	20	20	20	20	20	20
TRAVEL TIME	235	235	150	150	120	120	90	90
STATION TIME	10	10	10	10	10	10	10	10
EGRESS TIME	20	15	20	15	20	15	20	15
TOTAL	305	295	220	210	190	180	160	150

to both of these travel times for air and auto trips, but the extent of which would depend upon the type and severity of the rain, fog, snow or ice conditions.

The WSDOT response totally ignores the effect the proposed rail service improvements would have on the overall travel times by rail relative to the other modes. Such a break-even travel time analysis is presented in the enclosed Figure 4. For peak travel conditions, the train will become more time-competitive than the auto by 1998 with even modest service improvements. The rail mode will become more time-competitive than the plane as travel times go below 2.5 hours after 2005 with the expected increases in Sea-Tac Airport travel delays, as long as its on-time service standards are maintained. The rail mode is much less subject to weather delays than either air or auto travel in the Western Washington corridor.

4. Comparative Travel Costs for Air, Auto and Rail Trips.

> "Provide a table showing comparative consumer cost data (current and estimated for the year 2000) for the following Seattle-Portland trips: Downtown-to-downtown by auto; the downtown-to-downtown auto/air travel combination; and downtown-to-downtown rail service. Indicate sources of data used."

The data presented in the WSDOT response very accurately shows that the rail alternative is the least costly mode of travel between air, auto and railroad. However, the numbers as presented are not totally clear, and need to be clarified as shown in the revised Table 5. There were also some calculational errors in the original material presented in the WSDOT response (Ref. 2). The comparative costs for a round trip between Portland and Seattle in the year 2000 are $61.75 for rail travel, $148.85 for auto travel and $176.00 for air travel, as shown in Figure 5.

The rail travel alternative involves a reduction in cost of 62 percent as compared to auto travel and 64 percent as compared to air travel today. By the year 2000, the rail travel alternative is expected to be 58 percent less expensive than alternative auto travel and 65 percent less expensive than air travel in the Portland-Seattle corridor. Alternative estimates of auto travel today by Hertz Rent-A-Car describe a unit cost of $0.49 per vehicle-mile as compared to the value of $0.37 per vehicle mile by the Federal Highway Administration (Ref. 10). An inflation of the automotive operating cost at 5.0 percent per year would actually show that auto travel would be the most expensive of the three modes. The total cost of automobile driving including both internalized and externalized costs has been estimated by the Worldwatch Institute to be as much as $0.83 per vehicle mile when direct and indirect expenses are included.

FIGURE 4

COMPARATIVE TOTAL TRAVELTIMES BY ALTERNATIVE TRANSPORT MODES IN THE PORTLAND-SEATTLE INTERCITY CORRIDOR

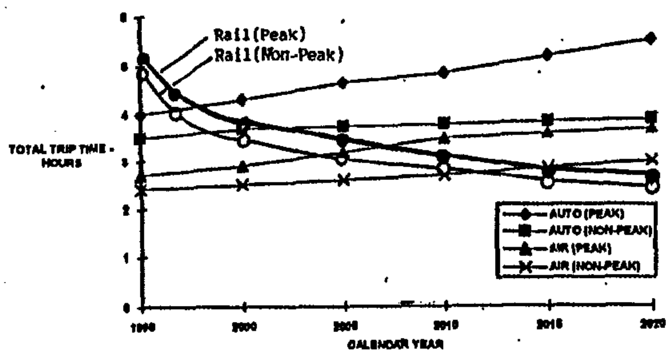


TABLE 5

ESTIMATED COMPARATIVE ROUND TRIP TRAVEL COSTS BY MODE IN DOLLARS IN THE PORTLAND-SEATTLE INTERCITY CORRIDOR (REF. 2)

TRAVEL MODE	RAIL TRAVEL 1995	RAIL TRAVEL 2000	AUTO TRAVEL 1995	AUTO TRAVEL 2000	AIR TRAVEL 1995	AIR TRAVEL 2000
AUTO	--	--	$129.50	$146.65	$6.25	$9.50
PARKING	--	--	--	--	$10.00	$16.50
AIR	--	--	--	--	$120.00	$150.00
RAIL	$42.00	$53.75	--	--	--	--
BUS	$6.40	$8.00	--	--	--	--
TOTAL COST	$48.40	$61.75	$129.50	$146.65	$136.25	$176.00

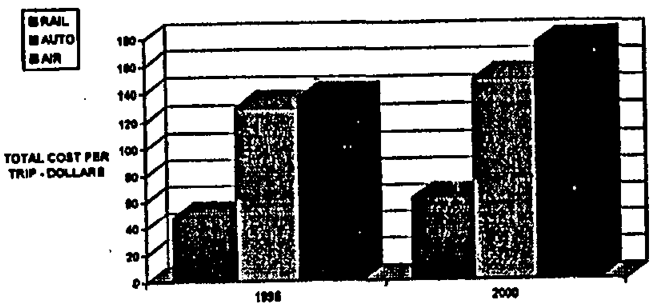
TABLE 6

BOUNDARY ANALYSIS PARAMETERS FOR A 100 PERCENT DIVERSION OF THE INTERSTATE HIGHWAY 5 CORRIDOR MARKET COMMUTER AIR MARKET PASSENGER IN WESTERN WASHINGTON FOR THE YEAR 2000 (REF. 2)

PASSENGER MARKET/ROUTE SEGMENT	ANNUAL TRAFFIC PER PSGR/YR	OCCUPANCY FACTOR PASS/FLT	MAXIMUM AIRPORT OPERATION FLTS/YEAR	PERCENT OF TOTAL OPERATION FLTS/YR
SEATTLE TO PORTLAND:				
DOMESTIC CARRIER	197,500	96	2,057	0.50%
COMMUTER CARRIER	197,500	14	14,107	3.70%
SUBTOTAL	395,000	24	16,164	4.20%
SEATTLE TO VANCOUVER,BC	90,000	36	2,500	0.70%
SEATTLE TO BELLINGHAM	15,000	14	1,071	0.30%
TOTAL	500,000	25	19,735	5.20%

FIGURE 5

COMPARATIVE OVERALL TRAVEL COSTS OF THE ALTERNATIVE RAIL, AUTO AND AIR MODES IN THE SEATTLE-PORTLAND INTERCITY CORRIDOR



5. Gina Marie Lindsey Letter of November 17, 1994.

"Identify and provide the "report on the potential for diversion of air passengers to high-speed rail" mentioned to Ms. Lindsey's letter to the Panel dated November 17, 1994."

This letter has already been provided to the Expert Arbitration Panel, and no additional response is required by the author.

6. Assumption of 100 Percent Air Commuter Traffic to Rail

"Address the following hypothetical "boundary" question: Assuming a 100 percent diversion of commuter traffic from air to rail in the year 2000, show the resulting reduction in the volume of aircraft operations at Sea-Tac, and estimate the effect of that reduction on airport congestion, the amount of delay, and the need for a third runway. Use current data on commuter flight operations and load factors at Sea-Tac and include all commuter air markets on the North-South and East-West Rail Corridors (not merely Portland, Vancouver and Spokane)."

The WSDOT response states that a complete diversion of commuter flights at Sea-Tac Airport would have a negligible impact on airport operations. The data presented in Table 6 is excerpted from the response to show that there would only be a diversion of 500,000 passengers per year (1,370 passengers per day) on 19,735 flights per year (54 flights per day). The WSDOT response states that the diversion of these 1,370 passengers per day in the year 2000 will constitute only 2.1 percent of the total Sea-Tac Airport daily passenger traffic of 65,205 persons. The diversion of the 54 flights per day in the year 2000 constitutes only 5.2 percent of the total expected number of 1,040 flights per day (Ref. 6).

The WSDOT response (Ref. 2) to the Expert Arbitration Panel is completely erroneous. A listing of the current flight frequencies by aircraft types and seating capacities at Sea-Tac Airport has been obtained from the April 1995 North American domestic edition of the Official Airline Guide (Ref. 11). Actual counts of plane flight frequencies to and from Sea-Tac Airport between cities in the Western Washington and Eastern Washington corridors have been made based on specific aircraft seating capacities with the results as shown as presented in the enclosed Table 7.

The Seattle-Portland corridor in Western Washington includes destinations to Olympia, Portland and Eugene, as previously listed in Table 2 of this document. The Seattle-Vancouver corridor in Western Washington includes flights from Sea-Tac Airport to both Bellingham as well as to Vancouver, British Columbia itself. The Eastern Washington intercity corridor includes flights between Sea-Tac Airport and Spokane as well as to Lewiston, Idaho plus Moses Lake, Pasco, Pullman, Walla Walla, Wenatchee and Yakima. A listing of the present flights between these Eastern Washington locations and Sea-Tac Airport is presented in the enclosed Table 8.

TABLE 7

FLIGHT FREQUENCIES AND SEAT NUMBERS BY PLANE TYPE IN THE EASTERN WASHINGTON AND WESTERN WASHINGTON INTERCITY CORRIDORS (REF. 11)

PLANE SEATING CAPACITY	FLIGHTS PER DAY AT SEATAC AIRPORT					SEATS PER DAY ON SEATAC FLIGHTS				
	SEATTLE PORTLAND	SEATTLE VANCOUVER	WESTERN WASH.	EASTERN WASH.	TOTAL FLIGHTS	SEATTLE PORTLAND	SEATTLE VANCOUVER	WESTERN WASH.	EASTERN WASH.	TOTAL SEATS
0 - 40	132	108	240	138	378	4,620	3,780	8,400	4,052	12,452
40 - 100	11	0	11	42	53	660	60	660	2,520	3,180
100 - 150	2	4	16	10	16	256	512	768	1,280	2,048
150 - 200	25	4	29	0	29	4,400	704	5,104	0	5,104
200 - 250	4	4	8	0	8	904	904	1,808	0	1,808
250 - 380	3	2	5	0	5	840	560	1,400	0	1,400
TOTAL	177	122	299	190	489	11,680	6,460	18,140	7,852	25,992
PERCENT	18.7%	12.9%	30.6%	20.0%	51.6%	11.9%	6.6%	18.5%	8.0%	26.5%

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TABLE 8

CURRENT FLIGHT FREQUENCIES BY AIRCRAFT SEATING CAPACITIES BETWEEN SEATAC AIRPORT AND EASTERN WASHINGTON LOCATIONS IN APRIL 1995 (REF. 11)

CITY OF DESTINATION	NUMBER OF FLIGHTS PER DAY				SEATS DAY
	0-40	40-100	100-150	TOTAL	
LEWISTON	9	0	0	9	360
MOSES LAKE	8	0	0	8	96
PASCO	31	0	0	31	958
PULLMAN	6	0	0	6	240
SPOKANE	12	42	10	64	3,852
WALLA WALLA	10	0	0	10	120
WENATCHEE	28	0	0	28	960
YAKIMA	34	0	0	34	866
TOTAL	138	42	10	190	7,452

A summary of the total airline flight operations by aircraft size for these three corridors in the Pacific Northwest to serve Sea-Tac Airport is presented in Table 9. There are a total of 378 daily flights at Sea-Tac Airport which would qualify as commuter flights. These 378 commuter flights comprise 40.0 percent of the total 935 daily flight operations at Sea-Tac Airport. Their combined total is estimated as 12,452 seats per day for the 378 commuter flights per day with an average of 33 seats per plane. This commuter flight seating capacity for these 378 commuter flights is 12.7 percent of the total of 97,750 seats per day for all 945 flights at Sea-Tac Airport with an overall average of 103 seats per plane.

The information provided in the WSDOT response that only 54 commuter flights per day could be diverted to rail corresponding to 100 percent of the total commuter operations, which constitute 5.2 percent of the total daily flights at Sea-Tac Airport is patently erroneous. In point of fact, up to 378 flights per day constituting 40.0 percent of the total could be diverted to rail. The information is in agreement with date regarding commuter flight frequencies at Sea-Tac Airport reported by the Discovery Institute in the recent issue of the Washington CEO magazine (Ref. 12).

A more complete listing of commuter and other flights by plane size and origin-destination affecting Sea-Tac Airport is presented in Table 10 (Refs. 11, 13). The number of total flights to these Washington and adjacent locations has increased from 447 per day in 1991 to 489 in 1995, an increase of 9.3 percent or a growth rate of 2.0 percent per year. Most of this growth has occurred to the Eastern Washington locations, which have increased from 154 daily flights in 1991 to 190 daily flights in 1995. The Eastern Washington flights have increased by 23.3 percent during this 4-year period at an annual rate of 5.25 percent per year at a much higher rate than for Western Washington.

In contrast, the total number of daily flights to the Western Washington corridor locations has only increased from 293 in 1991 to 299 in 1995 for an annual rate of increase of 0.5 percent per year. A major part of the reason for this relatively minimal increase in Western Washington is that larger planes have increasingly appeared in the Portland to Seattle corridor to replace smaller planes. This trend has been counteracted by the increasing service to Bellingham, Vancouver and Eugene in the same period, primarily in smaller planes. There are also 76 flights per day by commuter size planes to Friday Harbor, Oak Harbor, Port Angeles and Victoria, but these flights are not amenable to diversion to rail because they all involve cross Puget Sound water crossings with no land rail access. An illustration of the present flight frequencies to these various locations is illustrated in Figure 6.

7. Northeast Corridor Cross Modal Air Rail Passenger Traffic Diversion

"Provide any available reports or summary data on the cross-modal diversion from air to rail now occurring in the East Coast Corridor (Washington-New York-

TABLE 9

COMMUTER FLIGHT FREQUENCY CONTRIBUTIONS TO OVERALL SEATAC AIRPORT OPERATIONS BY INTERCITY CORRIDOR (REF. 11)

INTERCITY CORRIDOR	SEATS 0-40	SEATS 40-100	SEATS 100-150	TOTAL FLIGHT
SEATTLE - PORTLAND	132	11	34	177
SEATTLE - VANCOUVER	108	0	14	122
SEATTLE - EAST WASH	138	42	10	190
TOTAL	378	53	58	489
TOTAL FLIGHT OPERATIONS				945
% OF FLIGHTS	40%	5.60%	6.10%	51.70%
% OF SEAT CAPACITY	12.70%	3.60%	10.20%	26.50%

Notes:
1. Includes traffic to Portland, Olympia and Eugene
2. Includes traffic to Vancouver and Bellingham
3. Includes traffic to Spokane, Lewiston, Moses Lake, Pasco, Pullman, Walla Walla, Wenatchee and Yakima

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TABLE 10

DAILY COMMUTER FLIGHT FREQUENCIES IN THE STATE OF WASHINGTON AT SEATAC AIRPORT FOR 1991 AND 1995

INTERCITY CORRIDOR	CITY OF DESTINATION	1991 FLTS	1995 FLTS	0-40 COMMUTER	40-100 INTERM.	100-250 DOM
WESTERN WASHINGTON:						
SEATTLE-VANCOUVER:						
	BELLINGHAM	30	38	38	0	0
	VANCOUVER	74	84	70	0	14
	SUBTOTAL	104	122	108	0	14
SEATTLE-PORTLAND:						
	EUGENE	8	29	29	0	0
	OLYMPIA	0	10	10	0	0
	PORTLAND	181	138	93	11	34
	SUBTOTAL	189	177	132	11	34
	TOTAL	293	299	240	11	48
EASTERN WASHINGTON:						
	LEWISTON	5	9	9	0	0
	MOSES LAKE	8	8	8	0	0
	PASCO	19	31	31	0	0
	PULLMAN	10	6	6	0	0
	SPOKANE	46	64	12	42	10
	WALLA WALLA	2	10	10	0	0
	WENATCHEE	24	28	28	0	0
	YAKIMA	40	34	34	0	0
	SUBTOTAL	154	190	138	42	10
	SUBTOTAL	447	489	378	53	58
CROSS WATER - PUGET SOUND:						
	FRIDAY HARBOR		18	18	0	0
	OAK HARBOR		22	22	0	0
	PORT ANGELES		21	21	0	0
	SUBTOTAL		61	61	0	0
	VICTORIA, BC CROSS SOUND		15	15	0	0
	TOTAL ALL CORRIDORS	447	565	454	53	58

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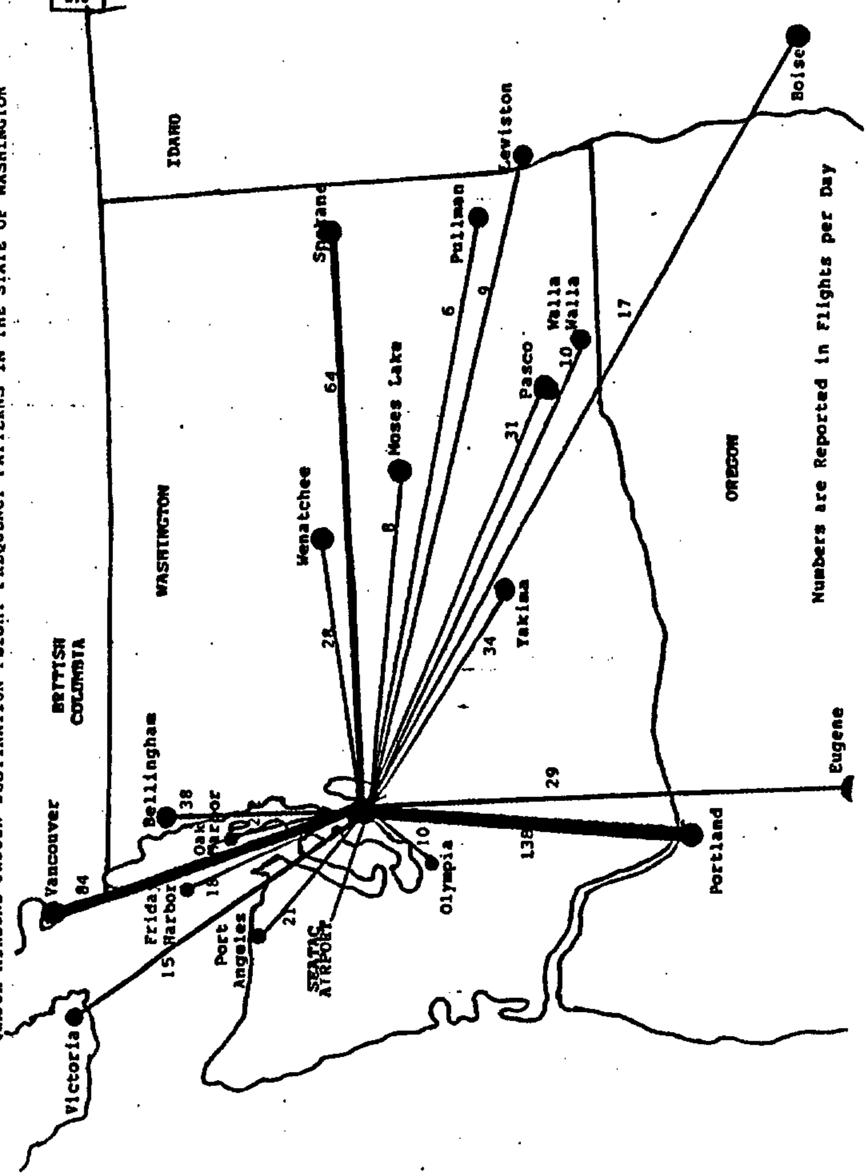

Figure 6
MAJOR AIRLINE ORIGIN-DESTINATION FLIGHT FREQUENCY PATTERNS IN THE STATE OF WASHINGTON

Boston), including any available estimates of fare elasticity's or travel-time elasticity's."

The response from the WSDOT provides useful information on increased traffic in the New York-Boston intercity corridor because of the onset of electrification in the New Haven to Boston route segment (Ref. 14). The rail ridership in the New York - Boston corridor with a population of 14 million over a route distance of 231 miles, is expected to increase from 1.00 million passengers in 1993 to 3.42 million in 2010 at the same time that air travel is due to decline from 3.50 million in 1993 to 2.22 million in 2010. The total passenger traffic in this New York - Boston intercity corridor is expected to increase by 20 percent from 16.95 million person trips in 1993 to 20.35 million person trips in 2010, as shown in Table 11.

The New York - Washington intercity corridor is one of the most heavily traveled in the nation with a population of approximately 32 million in a 225 mile long route. The Northeast Corridor line from New York to Washington is served by nearly 450 passenger trains per day, of which 112 are fast intercity Metroliners. Metroliner trains have been able to penetrate to obtain a 53 percent market share of the air-plus-rail market with a 22 percent share of the total travel market, as shown in Table 12 (Refs. 11, 15).

These Metroliner trains operate at intervals of 20 to 30 minutes throughout the day during the week. They have steadily increased market share in recent years, having reached 50 percent in 1985 and 53 percent in 1993. It is expected that the rail penetration of the total air-plus-rail market could reach as much as 60 percent when the overall New York - Washington travel times are reduced to the two hour range when the new high speed trains are introduced to the corridor within five years.

A third case of intercity rail passenger service which has shown some degree of success is in the 128 mile long Los Angeles - San Diego corridor with a population of 14 million (Ref. 16). Passenger ridership in this corridor has increased from 0.3 million in 1970 to 1.0 million in 1980 to 1.7 million in 1989 and 1.8 million in 1993, as illustrated in Figure 7. During this period, travel times have been reduced from 3.5 hours in 1970 to 3.0 hours in 1989 and to 2.5 hours in 1993 as the result of a $240 million capital improvement program jointly funded by the Federal, State and Local governments.

The Los Angeles - San Diego intercity corridor is remarkably similar to the Cascadia corridor in the State of Washington in that they are heavily auto-travel dominated. Both corridors would be expected to serve both intercity and commuter rail passenger trains with a similar level of capital expenditures required for upgrading. The Los Angeles - San Diego corridor is about 90 percent of the length of the Seattle - Vancouver corridor and 70 percent of the length of the Seattle - Portland corridor. The major differences are that the Los Angeles - San Diego corridor was at least previously primarily single track with only limited freight service. This largely single track line with limited freight service is compared to the heavy freight traffic and primarily double track configuration on the Cascadia corridor, especially on the Portland - Seattle line.

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TABLE 11

EFFECT OF ELECTRIFICATION OF THE NEW HAVEN TO BOSTON ROUTE SEGMENT ON PASSENGER RIDERSHIP MODE SPLIT PATTERNS IN THE NEW YORK-BOSTON INTERCITY CORRIDOR (REF. 14)

TRAVEL MODE	1993 TRAFFIC PASS/ YEAR	1993 TRAFFIC % TOTAL	2010 TRAFFIC PASS/ YEAR	2010 TRAFFIC % TOTAL
RAIL	1,000,000	5.90%	3,420,000	16.80%
AIR	3,500,000	19.50%	2,220,000	10.90%
BUS	340,000	2.00%	410,000	2.00%
AUTO	12,110,000	72.60%	14,300,000	70.30%
TOTAL	16,950,000	100.00%	20,350,000	100.00%

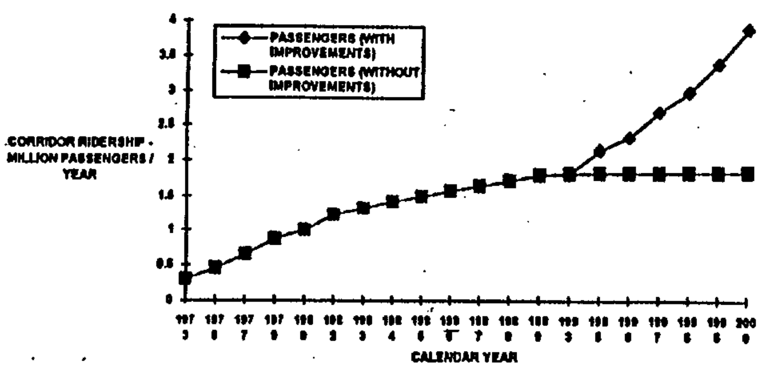
TABLE 12

ESTIMATED RIDERSHIP BY MODE SPLIT IN THE NEW YORK - WASHINGTON INTERCITY CORRIDOR IN 1994 (REF. 11, 15)

TRAVEL MODE	PASSENGER TRAFFIC PASS/ YEAR	PASSENGER TRAFFIC PASS/ DAY	PERCENT OF TOTAL	TOTAL MOVEMENTS
RAIL	10,100,000	27,400	21.50%	112 MTL TRAIN/DAY
AIR	8,870,000	24,300	19.10%	300 FLIGHTS/DAY
BUS	690,000	1,900	1.50%	60 BUSES/DAY
AUTO	26,840,000	73,800	57.90%	50,000 CARS/DAY
TOTAL	46,500,000	127,400	100.00%	

FIGURE 7

OBSERVED INCREASES IN PASSENGER RIDERSHIP IN THE LOS ANGELES-SAN DIEGO INTERCITY CORRIDOR (REF. 16)



The Los Angeles - San Diego corridor provides a successful example of simultaneous improvements in passenger train service frequency and speed increases resulting from right-of-way improvements. Train service frequencies have progressively been increased from three daily round trips in 1973 to eight in 1989 and nine in 1993. It is planned to increase the service frequencies to twelve trips per day in 1995 and sixteen daily round trips in 2000 while commuter trains have also been added from Oceanside to San Diego and from San Juan Capistrano to Los Angeles. At the same time, the average train speeds have gradually been increased from 36 miles per hour in 1973 to 43 miles per hour in 1989 to 51 miles per hour in 1993. It is planned to further increase average train speeds to 53 miles per hour in 1995 and 57 miles per hour in 2000 with a maximum speed limit of 79 miles per hour with up to 8 intermediate stops in this corridor.

The impact of these simultaneous improvements in train service frequencies and average speeds has been to lower the average trip times from 3.5 hours in 1973 to 3.0 hours in 1989 and 2.5 hours in 1993, as listed in Table 13 (Ref. 16). It is planned to further reduce overall travel times in the Los Angeles - San Diego corridor to 2.4 hours in 1995 and to 2.25 hours in 2000. A summary of the present passenger traffic by mode split in the Los Angeles - San Diego corridor is presented in Table 14.

8. Talgo Train Impacts on Cascadia Corridor Rail Ridership

> "The Federal Way letter to the Panel (Mr. Townsend, December 7, 1994) provided material indicating that, according to the Washington Association of Rail Passengers, the Seattle - Portland Talgo train has experienced double the projected ridership. Explain (if this is true) why the ridership is double the level predicted, with particular attention to the shortcomings of the projection technique. Indicate whether those same shortcomings are present in the high speed rail projection method, and, if not, how they have been overcome."

The WSDOT response pointed out that there was a total ridership of 58,000 for the Spanish Renfe Talgo train in its opening service in the Portland - Seattle corridor for the six month period from April to October of 1994. The ridership levels were 67 percent above projections of 35,000 riders for this period made by Amtrak. The response pointed out that major reasons for its success were as follows: 1) European high speed rail technology could be observed and experienced directly by the public; 2) on-board service was very good during this period; 3) public curiosity with the Talgo train was very high. It was not mentioned, but the ride quality was also excellent on the Talgo train.

The basic problem of why there is a continuing propensity to underestimate rail passenger ridership in the Western Washington corridor is not addressed. There is no mention of how any problems can be overcome in making ridership projections, or why they are erroneously low in the first place. There appears to be no concern, awareness or appreciation of the phenomenon of "induced" or discretionary ridership with passenger trains which does not appear to exist with alternative air or auto travel.

TABLE 13

OBSERVED TRENDS IN RAILROAD PASSENGER RIDERSHIP IN THE LOS ANGELES SAN DIEGO INTERCITY CORRIDOR (REF. 16)

CALENDAR YEAR	TRAIN FREQ. ROUND TRIP DAYS	AVG SPEED MILES HOUR	TRAVEL TIME HOURS	RIDERSHIP PASSENGER YEAR
1973	3	36.50	3.50	300,000
1980	6	38.80	3.30	1,000,000
1989	8	42.70	3.00	1,700,000
1993	9	51.20	2.50	1,800,000
1995	12	59.30	2.40	2,200,000
2000	16	56.90	2.25	3,900,000

TABLE 14

ESTIMATED PRESENT PASSENGER TRAVEL BY MODE SPLIT IN THE LOS ANGELES - SAN DIEGO INTERCITY CORRIDOR FOR 1993

TRAVEL MODE	PASSENGER YEAR	TRAFFIC DAY	PERCENT OF TOTAL	TOTAL MOVEMENTS
RAIL	1,800,000	4,930	6.20%	16 RAIL TRIPS / DAY
AIR	3,100,000	8,495	10.70%	116 FLIGHTS / DAY
BUS	600,000	1,645	2.00%	50 BUS TRIPS / DAY
AUTO	23,500,000	64,380	81.10%	50,000 CARS / DAY
TOTAL	29,000,000	79,450	100.00%	

9. High Speed Rail Implementation Time Frame

> "Although the Talgo train results show a significant mode shift even with existing technology, the report entitled "*The Impact of Intercity Passenger Rail on Operations at Sea-Tac Airport: Final Report*" (December 1994) indicates a minimum time-frame of 24 years (1996 - 2020) for implementation of high speed rail. Explain why this time-frame could not be accelerated if the state legislature so desired. Describe the implementation steps that would be required for accelerated implementation, including a stepped phasing that would skip the intermediate 125 mph technology and move straight to 150+ mph technology."

The WSDOT response to the question of accelerating the schedule for implementation of the high speed rail program in the State of Washington. The WSDOT response indicates that a master plan for rail corridor development is now being prepared by a joint effort of the States of Oregon and Washington plus the Province of British Columbia. The WSDOT response indicates that a program of progressive incremental upgrades is being taken to the corridor for providing improved rail passenger service.

The WSDOT response indicates that increased funding from the Washington State Legislature could speed up the process of high speed rail development in the Western Washington corridor. There are elements lacking of an actual project implementation plan and a business development plan. What is perhaps most important is that perhaps the State Government should not be leading the implementation program if it is to be done rapidly. There has been no effort to date in bringing in the private sector to actually develop the proposed high speed rail project from a significant financing standpoint.

An alternative approach would be to utilizé a loan guarantee program such as the Federal 4R-511 program to allow the entire capital budget to be available at the start of the project. Then it is possible for availability of funding to not be the limiting factor in the development of the project. Public-private partnerships are also available as possible financing implementation mechanisms, but are not addressed in the WSDOT response. There also needs to be a will to implement the project if it is to be done rapidly. Alternative mechanisms will need to be utilized so that high speed rail can actually be implemented without grossly underestimating the ridership levels and revenues generated for a proposed system in the State of Washington.

The plan proposed in the previous HSGT feasibility study (Ref. 4) is reiterated in the previous Final Report (Ref. 3) and the WSDOT response (Ref. 2). This implementation calls for a 25 to 30 year program of gradual improvements to achieve a high speed rail system on an incremental basis. Certainly such a plan for high speed rail system development can be implemented over a 30 year period, which would be especially beneficial to those persons who are doing the actual implementing of the project itself. However, such a long term approach for high speed rail system development would not be beneficial to the traveling public at large or to alleviate the need for airport runway capacity expansion at SeaTac Airport unless the project implementation schedule were to be accelerated.

The 25 to 30 year time frame for implementing a high speed rail passenger system in the State of Washington through a series of progressive improvements on an incremental basis already has a precedent established in the United States. The initial efforts to improve the rail passenger service in the New York-to-Washington intercity corridor began in 1965. The program to increase train speeds and to reduce travel times from Washington to New York has occurred over a 30 year period at an estimated cost of $2.4 billion.

There will be some additional right-of-way improvements which will be made over the next five years to further reduce travel times between New York and Washington. However, the main effort will be to purchase tilt-type trainsets which can actually travel at faster speeds so as to further reduce travel times along this corridor. Travel times have been reduced from the 3.5 to 4.0 hour range in 1965 to between 2.5 and 3.0 hours in 1995 and are expected to be further reduced to between 2.0 and 2.5 hours by the year 2000.

Another program of rail passenger corridor improvements is now underway in the New York - Boston intercity corridor. Another corridor improvement program which has already been underway for more than 15 years is the New York to Albany to Buffalo Empire Corridor. In addition, the incremental program of progressive rail passenger service improvements has been underway in the Los Angeles to San Diego corridor over the last 20 years to progressively increase train speeds and reduce travel times which will be completed by the year 2000. The greatest progress in the Los Angeles to San Diego corridor has taken place over the past 5 to 10 years with the onset of active participation by the local county governments involved.

The pace for implementation of high speed rail projects has been much more rapid in other countries than it has in the United States. In Japan, the first Shinkansen high speed rail line from Tokyo to Osaka was actually completed from the time of initiation planning to the startup of rail operations within 10 years in 1964. The loans which were required to finance this project were all repaid within 11 years after the startup of the operation of this system. Other high speed rail projects constructed in Japan since that time have been implemented within a 10 to 15 year time frame. Progress has been held up to some extent by the major need to be concerned with earthquakes for structures design in Japan.

In France, the initial Tres Grande Vitesse (TGV) high speed rail passenger line from Paris to Lyon was completed within a 12 year period starting with planning in 1969 to the actual startup of operations by 1981 with full completion by 1984. The loan and bond financing required to support construction of this project was all completed within 9 years thereafter by 1990. The pace of development was greatly accelerated after the initial oil crisis of 1973 - 1974 for the TGV project as well as of the parallel nuclear energy development program to supply its required electricity by alleviating reliance on foreign oil imports. The construction pace of new TGV lines in France plus Spain and Italy is taking

place within a 7 to 10 year period as the high speed rail network in Europe becomes more extensive with time as well as the Talgo high speed network in Spain.

In Germany, the planning, design, construction and operation of the first two high speed lines from Wurzburg to Hannover and from Manheim to Stuttgart has occurred over a 15 to 20 year period, in part because of environmental concerns and protests. Many of the existing rail lines in Germany have been and are being upgraded over a 10 to 15 year period as the network is becoming more widespread and extensive. A major effort is now underway to rebuild the old rail network of the former Deutsche Reichsbahn in Eastern Germany into this high speed rail network to hopefully be completed by the year 2010. Efforts are now underway to begin upgrading of the connecting rail lines in Poland to facilitate the construction of a direct high speed rail line from Paris to Berlin to Warsaw to Minsk to Moscow over the next 20 years. A connecting line is also being planned from Moscow to St. Petersburg to Helsinki to be built in parallel time frame.

The basic point of these events in foreign countries is that the proposed high speed rail service implementation schedule in the State of Washington could be accelerated considerably from the 25 to 30 year period projected in the HSGT feasibility study to 10 to 20 years. The critical ingredients required for its implementation are a perceived public need, the availability of financing, and the political will to carry the project through to completion. The public need is already there because of the present runway capacity constraints at SeaTac Airport. The availability of financing and the political will to carry out the project must now be put in place in order for improved rail passenger service in the State of Washington to become a reality.

10. Impacts of Congestion upon Rail Passenger Ridership

"In light of the forecast indicating that total travel is expected to increase by 76% by the year 2020 (*High Speed Ground Transportation Study Executive Summary*, October 1992, page 20), explain the validity of the assumption that "the level of congestion on the air and highway system does not change between now and the year 2020" (page 21).

a. Explain how a 76 percent increase in air/auto demand could be accommodated without an increase in travel time. What types of aviation and highway system improvements would have to be made, and at what cost?

b. Estimate average travel time by air, rail, and highway, assuming a 110 mph rail service system and realistic projections of significantly increased air and highway congestion in 2020 and interim years, consistent with the projected 76 percent increase in total travel. Recalculate the number of trips by mode and the rate of diversion from air to rail, using these revised assumptions about congestion. In addition, estimate the expected mode shift from auto/bus to rail based on the projected congested travel time in the highway corridor.

c. Explain how this issue is addressed in the Final Report."

a. Part a. Response.

The previous HSGT feasibility study merely assumed that there would be no net increase in travel time between cities as the result of increased airport runway and highway traffic congestion. The rationalization for this assumption is that the potential degrees of congestion vary widely throughout the State of Washington, and that a so-called "average" degree of congestion was therefore irrelevant. The effect of increased travel times for air and auto traffic with increasing runway and highway traffic congestion was not considered to be "germane to the issue of HSGT feasibility." The WSDOT response (Ref. 2) does present data to indicate that reducing the average freeway driving speed from 55 to 35 miles per hour in the Western Washington corridor would result in an increased rail system ridership of only eight percent.

The WSDOT response regarding the effects of increased airport and highway traffic congestion on rail passenger system ridership grossly underestimates the intermodal diversion potential from air or auto to rail. The increase in air or auto travel time relative to rail in effect raises the train speed relative to the alternative modes with a net decrease in rail travel time. A suggested 110 mile per hour base case for rail travel can be assumed with the modal split applicable as presented from the Parsons Brinckerhoff report (Ref. 8) as previously illustrated in Figure 1. The increased rail modal share of the total traffic can then be roughly estimated from this data assuming no induced ridership based on the increases in net speed and travel time differential.

For the air travel mode between Seattle and Portland an average flight time delay of 10 to 20 minutes would result in an estimated 5 to 6 percent increase in rail ridership. A net increase in rail ridership of as much as 10 to 12 percent could be observed, if the average aircraft flight delay time were increased to between 30 and 40 minutes as a worst case condition by the Port of Seattle (Ref. 6). This information in effect refutes the contention of the WSDOT response (Ref. 4) that there would be only a negligible impact of airport congestion on increased rail ridership.

For the auto travel mode, the HSGT report (Ref. 4) states that there would be only a net increase in rail system ridership of 8 percent resulting from reducing average travel speeds from 55 to 35 miles per hour. In fact, a reduction in average speed from 55 to 45 miles per hour will increase driving times between Seattle and Portland from 3.2 to 3.9 hours, or an increase of 45 minutes.

A further reduction in average driving speed to 35 miles per hour will increase the auto driving time to 5.0 hours, or an increase of 110 minutes (1.8 hours). By using a 110 mile

per hour average train speed as a base, a reduction in average auto driving speed from 55 to 45 miles per hour will increase driving times from 3.2 to 4.0 hours, and result in a 6 to 8 percent increase in net rail ridership. A further reduction in average driving speed from 55 to 35 miles per hour will cause an increased driving time from 3.2 to 5.0 hours, and result in an estimated increased rail ridership of 12 to 15 percent.

The WSDOT response does not list what types of improved airport and highway facilities would be needed or what their costs would be. It has been estimated by the Port of Seattle that a third runway at Sea-Tac Airport may be built for a cost of $500 to 800 million or more over a 10 to 20 year period. The construction of a new interstate highway from Portland to Seattle to Vancouver to handle additional motor vehicles would cost an estimated $20 to 30 million, and require a 20 to 30 year period for completion (Ref. 4). These costs presume that the additional runway capacity and new freeway could actually be built, which is by no means a certainty.

b. Part b. Response

The WSDOT response merely restates the answer previously presented that there would be an increase in ridership caused by increase auto traffic congestion of only 8 percent for high speed rail transportation at a 185 mile per hour speed. The WSDOT response assumes but provides no data to support its contention that the average train speed of 110 miles per hour would have a lesser increase in rail modal share. The WSDOT response basically does not answer the question asked.

The previously reported data results are applicable in this section. For air travel, average flight delays of 10 to 20 minutes could be expected to result in increased rail ridership levels of 5 to 6 percent, while delays of 30 to 40 minutes could cause increased rail ridership levels of 10 to 12 percent. For auto travel, a reduction in average speed from 55 to 45 miles per hour would result in increased rail ridership of 6 to 8 percent, while a further reduction from 55 to 35 miles per hour would result in increase rail ridership levels of 12 to 15 percent. These numbers are preliminary estimates only, and would need to be verified by further analysis on a separate basis.

c. Part c. Response

The WSDOT response (Ref. 2) refers to the previous Final Report (Ref. 6) on the analysis of auto and air traffic congestion, and does not present any new or original date. A single table is presented to indicate these parameter sensitivities, which is incorporated into the present document as Table 15. The WSDOT response indicates that the individual parameters can result in rail ridership increases of as much as 39 percent, and also travel decreases of as much as 18 percent. The WSDOT response does not show how or if these impacts are cumulative or that other variables could be included as well. One variable specifically omitted is possible increases in gasoline or aviation fuel because of "external

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Table 15

SENSITIVITY ANALYSIS OF SPECIFIC TRAVEL PARAMETERS ON 2020 HSGT RIDERSHIP.

A. Specific Travel Parameter Baseline Sensitivity Analysis

Forecasted 2020 HSGT Annual Ridership Sensitivity Analyses

	Alternative 1 North–South 185mph HSGT		Alternative 2 North–South 300mph HSGT		Alternative 3 East–West 185mph HSGT		Alternative 4 East–West 300mph HSGT	
	Riders	%Chg	Riders	%Chg	Riders	%Chg	Riders	%Chg
Baseline Forecasts	5,121,500		5,799,800		2,264,500		2,589,700	
Auto Travel Time								
20% Increase	5,996,400	17%	6,783,900	17%	2,945,100	30%	3,355,600	30%
Auto Cost								
50% Increase	6,305,900	23%	7,129,900	23%	3,151,100	39%	3,588,800	39%
Air Travel Time								
20 Minute Incr.	5,149,200	0.5%	5,831,000	0.5%	2,279,500	0.7%	2,606,700	0.7%
Air Fares								
20% Increase	5,166,700	0.9%	5,850,600	0.9%	2,296,900	1.4%	2,626,600	1.4%
20% Decrease	5,063,400	-1.1%	5,734,200	-1.1%	2,216,100	-2.1%	2,534,000	-2.2%
Air Frequency								
20% Increase	5,085,100	-0.7%	5,759,400	-0.7%	2,257,600	-0.3%	2,581,600	-0.3%
20% Decrease	5,151,800	0.6%	5,833,400	0.6%	2,270,900	0.3%	2,597,000	0.3%
HSGT Travel Time								
20% Increase	4,736,300	-7.5%	5,435,300	-6.8%	1,963,000	-13%	2,308,300	-11%
20% Decrease	5,545,100	8.3%	6,192,800	6.8%	2,610,000	15%	2,901,400	12%
HSGT Fare								
20% Increase	4,512,000	-12%	5,109,300	-12%	1,867,000	-16%	2,131,600	-18%
20% Decrease	5,931,200	14%	6,601,300	14%	2,756,700	22%	3,153,700	22%
HSGT Frequency								
25% Increase (15)	5,487,600	7.1%	6,209,600	7.1%	2,421,800	6.9%	2,765,500	6.8%
25% Decrease (9)	4,779,100	-6.7%	5,416,100	-6.6%	2,117,000	-6.5%	2,424,700	-6.4%
Highway Congestion	5,529,600	8.0%	6,296,400	8.4%	2,395,600	5.8%	2,735,000	5.6%

B. King County Station Location Sensitivity Analysis

Forecasted 2020 HSGT Annual Ridership Alternative Locations for King County Station

King County Station Location	Alternative 1 North–South 185mph HSGT		Alternative 2 North–South 300mph HSGT	
	Riders	%Chg	Riders	%Chg
Bellevue (Baseline)	5,121,500		5,799,800	
Downtown Seattle	4,502,000	-12%	5,147,000	-11%

Data obtained from References 4 and 15.

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forces" and of its possible effect on rail ridership, especially if oil supplies were also constrained at the same time.

11. Effect of Increased Auto Travel Time on Rail Ridership

> "The Executive Summary also notes (page 21) that a 20 percent increase in door-to-door travel time or a 50 percent increase in rail use, respectively, and that these effects "could be cumulative." Explain whether these cumulative effects are addressed in the Final Report, and, if so, how. Provide supporting documentation showing the results of the sensitivity tests and forecast scenarios mentioned on page 21 of the Executive Summary, including these cumulative effects."

The WSDOT response (Ref. 2) presents information on automobile trip delays and expenses in terms of its ability to affect future rail passenger service. The WSDOT response merely refers to the sensitivity analysis from the HSGT study (Ref. 4) to state the following: 1) a 20 percent increase in auto travel time results in a 17 percent increase in rail ridership; 2) a 50 percent increase in automobile operating costs would result in a 23 percent increase in rail ridership; 3) these effects may be cumulative in nature.

Some information has been presented to indicate that increased rail ridership from greater auto travel time resulting from greater highway congestion as well as in auto operating costs could be cumulative in nature. If so, the two impacts could be additive to create up to a 40 percent increase in rail ridership. This matter could become very relevant if there was either suddenly or gradually, another restriction in oil supplies such as occurred in 1973-1974 or in 1979-1980. This issue could become even more immediately relevant if international market crude oil prices were removed from dollar denomination because of the continuing decline in the value of the U.S. dollar in World currency markets. What is known is that major increases were observed in Amtrak intercity rail ridership during these periods of oil shortage which were limited only by finite seating capacities and limited service frequencies of its trains.

12. Rail Speed Impacts on Passenger Ridership Projections

> "Given the importance of reduced travel time in generating modal shifts from air/auto to rail, a rail system designed to ameliorate airport congestion would minimize the number of stops enroute to major destinations, to achieve a higher ratio of average rail speed to top rail speed. Provide data showing the relationship between average speed and number of stops on the North-South Corridor (Vancouver-Seattle-Portland) for the three scenarios presented in the Executive Summary: rail service with a top speed of 110 mph, service with a top speed of 125 mph, and "true high speed rail" at a top speed of 150 mph or more."

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The WSDOT response (Ref. 2) presents a limited amount of information on the effect of increased speeds on reducing travel times for high speed rail and convention rail. The information presented only incorporates the route segment from Sea-Tac Airport to Everett and does not include the entire route. The WSDOT response also does not address the question of elimination of intermediate station stops on the overall trip times in either the Portland-Seattle or Vancouver-Seattle intercity corridors. In addition, no ratios have been calculated between maximum and average train speeds for the cases of intermediate stops in comparison to no intermediate stops in the WSDOT response.

The effect of increasing train speeds on reducing travel times in the Portland-Seattle intercity corridor is illustrated in Figure 8. The increase in average train speed from the present 45 miles per hour to 90 miles per hour reduces the travel time from 4.0 hours to 2.0 hours. A further increase in train speed to an average of 125 miles per hour reduces the overall travel time to 1.5 hours in the Portland - Seattle corridor.

A series of estimates have been made of the expected impact of train speed increases and intermediate stop elimination, on average travel times for the Portland-Seattle intercity corridor, as shown in Table 16. The train speed cases selected were designed to match those selected by the Expert Arbitration Panel as closely as possible. An increase in the maximum train speed from 79 miles per hour to 110 miles per hour will result in an estimated increase in average speed from 45 to 70 miles per hour with five intermediate stops, and to 90 miles per hour without intermediate stops. The average travel time from Seattle to Portland is reduced from 4.0 hours to 2.0 hours without stops, and to 2.5 hours with 5 intermediate stops. The ratio of maximum to average speed is then reduced from 1.32 to 1.22 without stops, and from 1.75 to 1.57 with stops.

A further increase in maximum train speeds from 110 to 125 miles per hour will reduce the travel time from 2.0 hours to 1.7 hours without stops and from 2.5 to 2.0 hours with stops. The speed ratio is further reduced to 1.14 without stops and to 1.39 with stops. A subsequent increase in maximum train speeds to 150 miles per hour will further reduce the overall travel time from Portland to Seattle to 1.5 hours without stops and 1.7 hours with stops. The speed ratio is further reduced to 1.20 without stops and 1.36 with stops for this case.

A further increase to a full high speed rail system at 185 miles per hour could reduce the trip time from Portland to Seattle to 1.2 hours without stops and 1.5 hours with stops. The speed ratio begins to increase from this condition to 1.23 without stops and 1.48 with stops, primarily because of the increase train acceleration capabilities. An overall increase in train speeds from the present average of 45 miles per hour and maximum of 79 miles per hour results in a reduction in travel time from 4.0 hours to 1.2 hours without stops and to 1.5 hours with stops, for an overall reduction of 2.5 to 2.8 hours. The savings in time between stopping and not stopping at intermediate stations is reduced from 1.0 hours to 0.3 hours in going from the minimum to the maximum train speed conditions.

FIGURE 8

ESTIMATED EFFECT OF INTERMEDIATE STOP ELIMINATION ON TRANSIT TIMES WITH INCREASING TRAIN SPEEDS IN THE PORTLAND-SEATTLE INTERCITY CORRIDOR

180 MILE CORRIDOR LENGTH

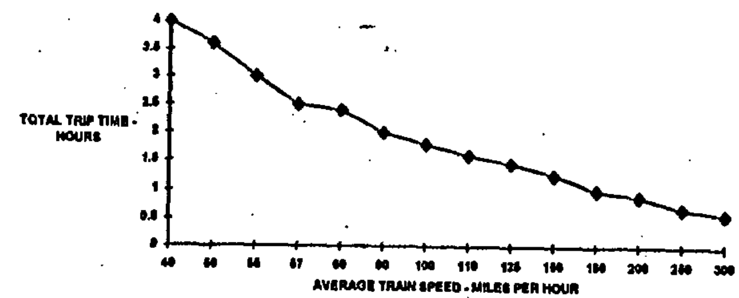


TABLE 16

ESTIMATED EFFECT OF TRAIN SPEED INCREASES AND INTERMEDIATE STOP ELIMINATIONS ON EXPECTED TRANSIT TIMES IN THE PORTLAND - SEATTLE INTERCITY CORRIDOR[2]

TRAIN SPEED FACTOR	TRAIN STOP CASE	PRESENT BASE CASE	INTERMEDIATE CASE NO. 1	SERVICE CASE NO. 2	TRAIN SPEEDS CASE NO. 3	HIGH SPEED RAIL	MAGNETIC LEVITATION SYSTEM
TRAIN SPEED MILES/ HOUR	MAXIMUM	79	110	125	150	185	300
	NON-STOP[3]	60	90	110	125	150	250
	WITH STOPS	45	70	90	110	125	175
TRIP[1] TIME HOURS	NON-STOP[3]	4.00	2.00	1.70	1.50	1.20	0.80
	WITH STOPS	3.00	2.50	2.00	1.70	1.50	1.10
	DIFFERENCE	1.00	-0.50	-0.30	-0.20	-0.30	-0.30
SPEED RATIO MAX AVG	NON-STOP	1.32	1.22	1.14	1.20	1.23	1.20
	WITH STOPS	1.75	1.57	1.38	1.36	1.48	1.71

Notes:
1. Based on a corridor distance of 180 miles from Seattle to Portland
2. Based in part, of information supplied from References 4, 5, 7 and 8.
3. With elimination of five intermediate stops enroute.

13. Future Portland-Seattle Corridor Passenger Traffic Projections

"Figure 3 of the *Final Report* shows a total volume of 62.5 million for Seattle-Portland in 2020 without high speed rail; Figure 4 shows that with the high speed rail, the total increases to 74.5 million. Yet, 11 million of that increase is in auto travel; the projection shows a decrease of only 0.09 million (94,000) in air travel, and an increase of only 0.9 million (900,000) in train travel."

a. Explain, in terms of both the modeling and the real world, how the introduction of high speed rail induces 11 million new auto trips, but only 0.9 million new rail trips and a very modest reduction in air travel.

b. What is the effect of those 11 million new auto trips on highway congestion and the resulting level of automobile travel time, trip quality, and preference for auto travel? Explain why this increase in auto travel time does not drive the model to forecast a high shift to the rail mode.

c. Explain how the numbers in Attachment C are carried over into Figures 2, 3, 4. Please flag the market pairs in Attachment C that are being used to obtain the totals in Figures 2, 3, 4 and add subtotal lines for them in the Attachment's tables.

d. Explain the source of the mode-split chart noted in Attachment A. Specify how it was derived, the assumptions on which it is based, and why it is or is not valid to apply that chart to the high speed rail analysis.

e. Explain why the mode-split is related to total travel time, rather than to the ratio of rail travel time to auto travel time (and rail travel to air plus ground travel time). As page 13 of the *Final Report* states, "... the closer train travel times approximate those of airline travel, the great [the] diversion that will take place."

a. Part a. Response

The WSDOT response merely reiterates the previous statement by the HSGT study team that the implementation of a high speed rail system results in an increase in induced traffic primarily in the highway mode. If so, it is only from the rider's home to the train station, which is not pointed out in the WSDOT response. The induced ridership which should go by the rail mode is then erroneously placed on the highway when it needs to be placed on the train where it actually belongs.

The real difficulty with the WSDOT response is that it does not present the actual increases in projected traffic levels with time in the Western Washington corridor by route segment or by mode split. The enclosed material is an attempt to overcome this difficulty in the WSDOT response so that a more accurate and comprehensible picture of future Western Washington traffic projections can be ascertained. These projections of future passenger traffic will be made by both route segment as well as by mode split to the extent possible with the limitations in the available data.

The estimated total intercity passenger traffic in the Western Washington Cascadia corridor has increased from 40 million person trips in 1980 to 52 million trips in 1990 to 58 million person trips in 1995. If the present rate of increase of 2.3 percent per year in total passenger travel is maintained into the foreseeable future, the total intercity passenger traffic in the Cascadia corridor is expected to increase to 67 million person trips by 2000 to 85 million person- trips in 2010 and to 104 million person trips to 2020, as illustrated in enclosed Figure 9. This increase in total passenger travel in the Western Washington corridor amounts to an estimated 79 percent use over this 25 year period. This value for travel increases compares favorably to the 76 percent increase value estimated by the Discovery Institute (Ref. 12), and is substantially greater than the 40 percent population increase expected during the same period.

The proportion of the total intercity trips taken in the Portland-Seattle route segment has decreased slightly from 62.5 percent in 1980 to 61.2 percent in 1995. The proportion of total trips taken in the Seattle-Portland corridor is expected to be further reduced to 61.1 percent of the total in 2000 and to 60.5 percent 2020 as cross-border trade between Seattle and Vancouver becomes more significant with time. It is even possible that travel between the Seattle and Vancouver metropolitan areas will increase at an even faster rate than projected so that it may constitute as much as 45 percent of the total by the year 2020 if the most optimistic scenario for development actually occur.

The projected mode split for the increased passenger traffic in the Western Washington intercity corridor will depend to a large extent on the construction of the proposed rail system. If the proposed rail system is not built, the estimated present approximate mode split of 1.0 percent rail, 3.5 percent bus, 6.0 percent air, and 89.5 percent auto will be maintained out into the foreseeable future, as illustrated in Figure 10 (Ref. 8). The total rail passenger traffic is expected to increase from the present 0.3 to 0.6 million person trips per year (900 to 1,600 per day) in 1995 to an estimated 1.1 million person trips in 2020 (3,010 per day). This number of 1.1 million person trips is remarkably similar to the value of 1.2 million person trips per year (3,350 per day) in 2020 cited in the WSDOT response (Ref. 2) from the previous Final Report (Ref. 3), but with no significant improvements in the present rail system occurring.

The estimated traffic levels for the other passenger travel modes are expected to increase proportionately at the same rate of 2.3 percent per year into the foreseeable future. The bus traffic is expected to increase from 2.1 million in 1995 to 3.7 million person trips by 2020 as a minor part of the total increase. It is possible that this number may be too high unless it includes some longer distance urban transit system bus trips without rail system development.

FIGURE 9

ESTIMATED INCREASES IN THE PROJECTED ANNUAL INTERCITY PASSENGER TRIPS BY ROUTE SEGMENT IN THE PORTLAND-SEATTLE-VANCOUVER CASCADIA INTERCITY CORRIDOR BY ROUTE SEGMENT WITHOUT DISCRETIONARY INDUCED RAIL RIDERSHIP

Based on data provided from the Washington State Department of Transportation, Olympia, Washington, 1991.

Average long-term traffic growth rate is expected to be 2.3 percent per year for the overall Western Washington corridor.

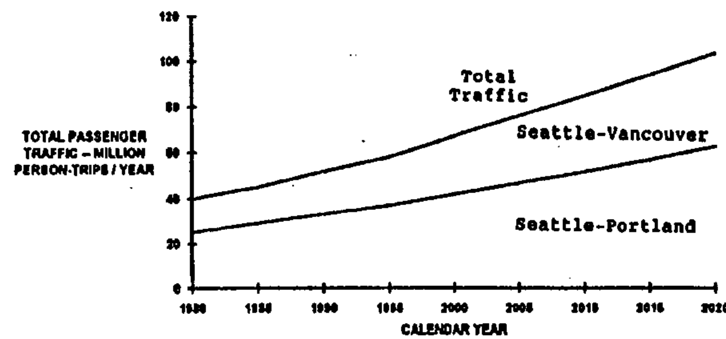
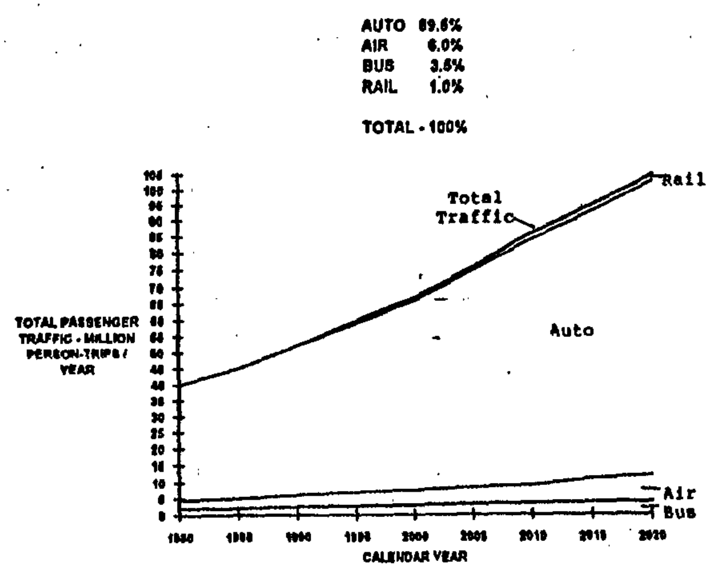


FIGURE 10

ESTIMATED INCREASES IN THE PROJECTED ANNUAL INTERCITY PASSENGER TRAFFIC BY MODAL SPLIT IN THE PORTLAND-SEATTLE-VANCOUVER CASCADIA INTERCITY CORRIDOR WITHOUT IMPLEMENTATION OF THE IMPROVED RAIL SYSTEM



Air passenger traffic in the Western Washington corridor has already increased from 2.4 million trips in 1980 (6,575 per day) to 3.6 million trips in 1995 (9,865 per day). It is expected that total air traffic in the Western Washington corridor will increase to 4.1 million trips in 2000 (11,230 per day), to 5.1 million trips in 2010 (13,975 per day), and to 6.3 million person trips in 2020 (17,260 per day) without any rail system improvements. If the present average number of 36.5 passengers per flight (65 seats per flight) in the Western Washington corridor is maintained into the future, it will be necessary to increase the number of daily flights to serve this expected future traffic from 270 in 1995 to 450 in 2020. It will then be necessary to increase the average number of passengers per flight to 60 on 100 seat aircraft in order to maintain the same number of flights in the Western Washington corridor to end from Sea-Tac Airport.

However, the greatest increase in future passenger traffic impacts will occur for automobile travel. Total auto passengers intercity trips have already increased from 35.8 million person trips in 1980 to 53.7 million person trips in 1995. Auto travel is expected to increase to 93.6 million person trips by the year 2020 if present trends continue and no rail system improvements are made. The approximate total motor vehicle intercity travel is expected to increase from the present 80,000 vehicles per day to as much as 135,000 vehicles per day. There will be substantial increases in highway traffic congestion which will last for longer periods which could reduce average vehicle speeds from the present 55 to 60 miles per hour to as low as 35 to 40 miles per hour by 2020.

The previous assumption in the HSGT study that increasing motor vehicle traffic congestion on intercity freeways will not reduce travel times in the Western Washington corridor is invalid. It is very possible that increases in auto travel times of up to 40 percent will occur if no remedial actions are taken to build a rail system and no new freeway capacity is added. The 17 percent increase in rail ridership with a 20 percent increase in auto travel time could easily translate into a 30 to 35 percent increase in rail ridership as a result of a 40 percent increase in auto travel time in the Western Washington intercity corridor because of increased future roadway traffic congestion.

b. Part b. Response

The WSDOT response states that 11 million new auto trips will add somewhat to the roadway congestion in the Portland-Seattle intercity corridor. In fact, such an increase in traffic would probably add another 15,000 to 20,000 vehicles per day to a highway which already has approximately 50,000 cars per day when based on approximately 1.6 to 1.8 persons per vehicle. The ridership modal split distribution model would be erroneous if it did not show an increase in rail ridership under such conditions for the Western Washington Cascadia corridor.

The construction and implementation of the proposed rail passenger system in the Western Washington or Cascadia corridor will have a significant impact upon the distribution of trips between the alternative travel modes available. This improved rail passenger system will also have a minor impact upon increasing the overall trips taken in the Cascadia corridor because of the phenomenon of "induced" or discretionary ridership. The WSDOT response did not adequately address these concerns raised by the Expert Arbitration Panel, as it misconstrued the phenomenon of "induced" ridership with the high speed rail system construction to be placed with automobile travel instead of with rail travel. The elimination of the confusion involved with induced rail ridership and the projection of future passenger traffic levels in the Western Washington corridor is the subject of the following paragraphs of this document.

The expected increases in overall passenger ridership in the Western Washington Cascadia corridor are presented in Figure 11. There will be some degree of division of intercity passenger traffic from each of the other modes to rail as the overall rail system is gradually improved and overall traffic growth occurs in the Cascadia corridor. There will also be some degree of "induced" ridership resulting by additional discretionary trips by rail not otherwise taken if the improved rail system were not present. The induced ridership levels observed with the French TGV high speed rail system in the Paris-Lyon intercity corridor have progressively increased from less than 17 percent when it was initiated in 1981 to more than 35 percent by 1990 when it was fully operational (Ref. 18).

The estimated total ridership trends in the Western Washington corridor between 1995 and 2020 are expected to be as follows with the gradual upgrading of the present rail passenger system to a full high speed operation. The expected bus ridership is expected to increase from 2.1 million person trips in 1995 to 2.6 million person trips in 2020 with the high speed rail system in place, as compared to 3.7 million person trips per year by 2020 if the rail system is not implemented. However, this number may be invalid because while the numbers of bus trips between the end point cities of Portland, Seattle and Vancouver may be reduced, the numbers of connecting bus trips to intermediate rail passenger stations may go up substantially so as to even show a net increase with time. Such occurrences have already taken place with the so-called "Amtrak Thruway" connecting bus service in California. The rural bus service connecting service to the TGV trains in France has also resulted in ridership increases for both buses and trains.

The construction and implementation of the proposed rail system in the Western Washington corridor is expected to have a significant impact upon air passenger travel in the future. Air travel in the Western Washington corridor is expected to increase from 3.6 million person trips per year in 1995 (9,865 per day) to 3.7 million person trips in 2020 (10,070 per day) as compared to 6.3 million trips per year (17,260 per day) if the rail system is not constructed. In fact, there will be an initial decrease in air traffic with the progressive implementation of the rail system from 3.6 million trips per year (9,865 per day) in 1995, to 3.0 million trips per year (8,220 per day) in 2002, and will then begin to increase to 3.7 million trips per year (10,070 per day) by 2020, as shown in Figure 12.

The expected air traffic decreases in the Western Washington corridor are the result of the diversion of the market-driven or mandated commuter air passenger traffic to rail. The number of commuter flight operations diverted will increase from 23 flights in 1997

FIGURE 11

EXPECTED INCREASES IN THE TOTAL INTERCITY PASSENGER TRAFFIC BY MODAL SPLIT IN THE PORTLAND-SEATTLE-VANCOUVER CASCADIA INTERCITY CORRIDOR WITH THE IMPLEMENTATION OF THE RAIL SYSTEM IMPROVEMENTS

Based on data supplied by the Washington State Department of Transportation (Ref. 4)

Modal split proportions derived from the PBQD report (Ref. 8)

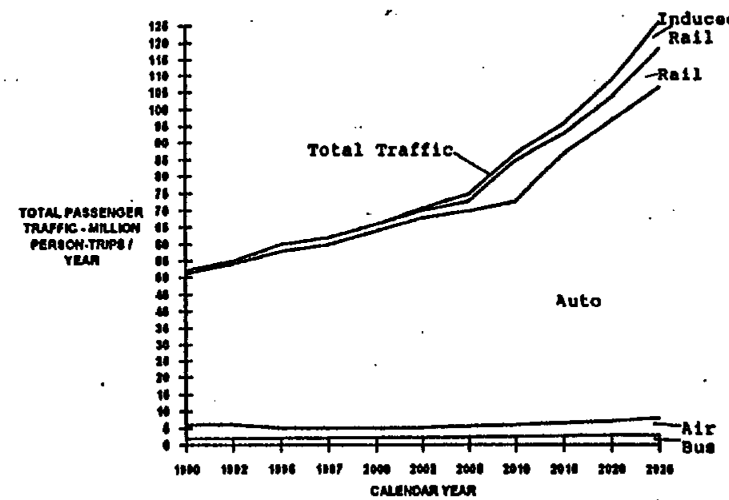
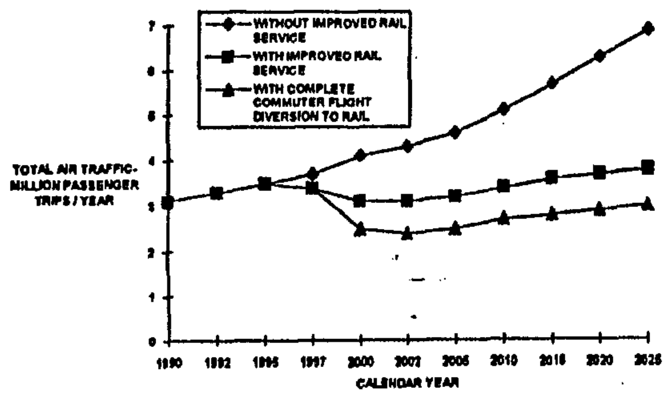


FIGURE 12

EXPECTED EFFECT OF RAIL SYSTEM DEVELOPMENT ON PROJECTED AIRLINE PASSENGER TRAFFIC IN THE PORTLAND-SEATTLE-VANCOUVER CASCADIA INTERCITY CORRIDOR

PBQD Mode Split Modal Results for Improved Rail Service (Ref. 8)



initially to 70 flights in 2000 to as many as 140 out of the 240 total commuter flights at Sea-Tac Airport operating in the Western Washington corridor. These estimated market-driven commuter flight diversions are derived from the results obtained with the mode split data from the Parsons-Brinckerhoff report (Ref. 8). The expected increases in daily commuter flight diversions of passenger traffic from air to rail will increase with train speeds, as shown in Figure 13. The average train speeds in the Western Washington corridor are expected to increase as the proposed railroad right-of-way improvements are gradually implemented on an incremental basis over the period from 1995 to 2020.

It could also be mandated as a policy decision to divert all of the commuter flights operating to Portland, Vancouver, Bellingham, Olympia and Eugene to rail travel in the Western Washington Cascadia corridor. Then the only commuter flights which would still be operating at Sea-Tac Airport are those going to Western Washington water-separated cross Puget Sound locations such as Friday Harbor (San Juan Island), Oak Harbor (Whidbey Island), Port Angeles (Olympic Peninsula), and Victoria (British Columbia) with no reasonable land access. X

Rail passenger traffic is expected to increase significantly in the future with the proposed track system improvements and train service frequency increases. If no provision is made for induced rail passenger ridership, the total rail passenger traffic is expected to increase from the present 0.3 to 0.6 million passengers per year (900 to 1,600 per day) to as many as 1.1 to 2.1 million passengers in 2000 to 2005 time frame (3,010 to 5,250 per day). These increased passenger ridership levels are expected to occur if average train speeds are increased to 65 to 70 miles per hour and service frequencies increased from the present 4 round trips per day to 8 round trips per day in both the Seattle-Portland and Seattle-Vancouver corridors.

The total rail passenger ridership levels are then expected to further increase to between 5.1 and 6.1 million person trips per year (13,900 to 16,700 per day) by 2010 to 2015. The average train speeds are then to be progressively increased to the 110 to 125 mile per hour range as a goal during this period in both the Seattle-Portland and Seattle-Vancouver intercity corridors. The implementation of a full high speed rail system by the year 2020 would result in an expected passenger ridership of up to 6.9 million person trips per year without induced ridership, and to as many as 10.6 million trips per year (29,000 per day) with induced ridership included, as illustrated in the attached Figure 14. A summary of the estimated intermodal passenger traffic diversion sources from alternative modes to rail plus induced ridership factors is presented in Table 17.

c. Part c. Response

The WSDOT response presents a table which has only three market segments. The numbers presented are in a format which is extremely confusing to understand. It would be much better to show route segments and the actual traffic values in persons per day and/or in passengers per year by mode and route segment. It would then be clear to the

FIGURE 13

ESTIMATED EFFECT OF AVERAGE TRAIN SPEED ON POTENTIAL COMMERCIAL AIRCRAFT FLIGHT DIVERSIONS AT THE SEATTLE-TACOMA INTERNATIONAL AIRPORT

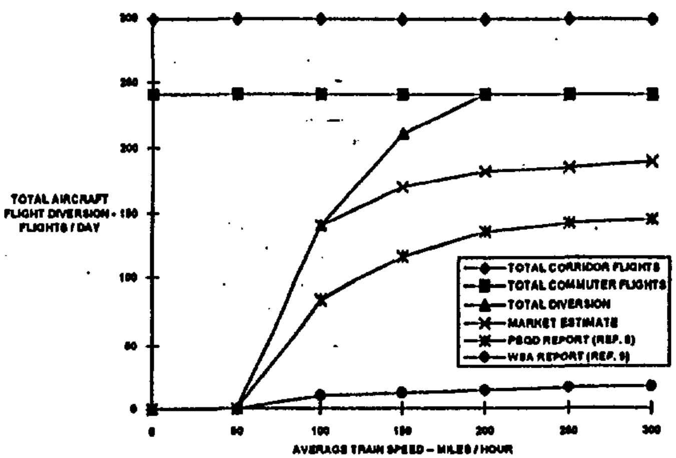


FIGURE 14

EXPECTED INCREASES RAIL PASSENGER RIDERSHIP PROJECTED FOR THE PORTLAND-SEATTLE-VANCOUVER CASCADIA INTERCITY CORRIDOR

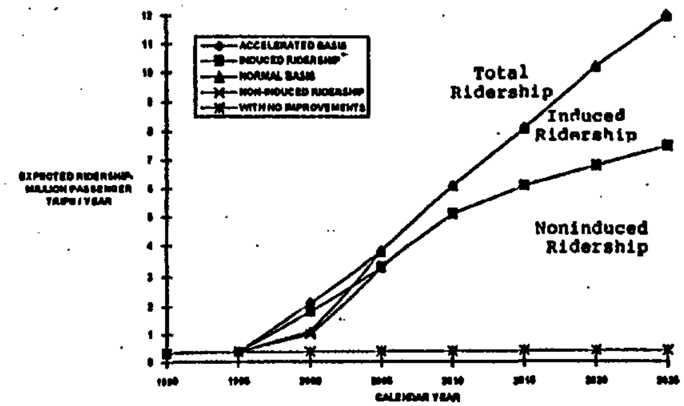


TABLE 17

ESTIMATED SOURCES AND VALUES FOR INTERMODAL PASSENGER TRAFFIC DIVERSION TO RAIL PLUS INDUCED RAIL RIDERSHIP IN THE WESTERN WASHINGTON CASCADIA INTERCITY CORRIDOR

TRAFFIC SOURCE	UNITS EMPLOYED	EXISTING AMTRAK	EXPANDED SERVICE	ENHANCED AMTRAK	INTERMEDIATE SERVICE 75 MPH	INTERMEDIATE SERVICE 90 MPH	INTERMEDIATE SERVICE 110 MPH	HIGH SPEED RAIL 125 MPH	HIGH SPEED RAIL 150 MPH	MAGNETIC LEVITATION
EXISTING RAIL	PERCENT	100.00%	34.00%	16.90%	10.00%	6.70%	5.50%	5.20%	4.90%	5.10%
FROM BUS	PERCENT	0.00%	0.90%	8.50%	6.20%	4.70%	5.00%	5.00%	4.90%	5.10%
FROM AIR	PERCENT	0.00%	17.00%	25.40%	17.30%	13.30%	12.30%	12.30%	12.30%	10.20%
FROM AUTO	PERCENT	0.00%	48.10%	48.20%	68.50%	75.30%	77.20%	77.50%	77.90%	79.60%
TOTAL PERCENT		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
EXISTING RAIL	PASS/YEAR	340,000	340,000	340,000	340,000	340,000	340,000	340,000	340,000	340,000
FROM BUS	PASS/YEAR	0	85,000	170,000	210,000	240,000	305,000	325,000	340,000	510,000
FROM AIR	PASS/YEAR	0	170,000	510,000	590,000	680,000	750,000	800,000	850,000	1,020,000
FROM AUTO	PASS/YEAR	0	405,000	980,000	2,280,000	3,840,000	4,725,000	5,045,000	5,380,000	7,940,000
DIVERTED TRIPS	PASS/YEAR	340,000	1,000,000	2,010,000	3,400,000	5,100,000	6,120,000	6,510,000	6,890,000	9,810,000
INDUCED TRIPS	PASS/YEAR	0	30,000	105,000	375,000	1,045,000	2,030,000	2,875,000	3,710,000	6,650,000
TOTAL TRIPS		340,000	1,030,000	2,115,000	3,775,000	6,145,000	8,150,000	9,385,000	10,600,000	16,480,000
MAX. SPEED	MILES/HOUR	79	79	90	100	190	125	150	185	300
AVG. SPEED	MILES/HOUR	45	60	70	75	90	110	125	150	250
FREQUENCY	TRIPS/DAY	6	12	16	24	28	32	36	44	48
IMPLEMENTED	YEAR	1995	1997-2000	2000-2002	2,005	2,010	2,015	2017-2020	2020-2025	2025-2030+

reader what the actual traffic projections would be in both the present as well as in the future.

The WSDOT response does not present a mode split variation for rail passenger traffic variations with air or auto travel in terms of either train speed or travel time. A mode split variation as a function of train speed for the Western Washington corridor was previously reported in Figure 1 based on no induced ridership occurring (Ref. 8). If a factor of a 17 to 35 percent increase in induced passenger train ridership based on the French TGV with high speed service is included, a revised mode split diagram can be prepared to estimate ridership by mode for the Western Washington intercity corridor, as shown in Figure 15.

One additional factor not previously discussed is the expected effect of the construction of the improved rail system on the potential increase in auto traffic in the Western Washington corridor. The estimated total auto passenger traffic in the Western Washington corridor increased from 35.8 million person trips in 1980 to 46.6 million person trips in 1990 to 53.7 million person trips in 1995. These estimated levels of auto passenger traffic correspond to increases in motor vehicle traffic of approximately 50,000 vehicles per day in 1980 to 70,000 vehicles per day in 1990 to 80,000 vehicles per day in 1995 based on a seating factor 1.6 to 1.8 persons per vehicle.

The total intercity automobile passenger traffic in the Western Washington corridor is expected to increase from the present 53.7 million person trips in 1995 to approximately 93.6 million person trips per year by 2020. The daily equivalent passenger trips corresponding to these annual average estimated values are from 147,000 per day in 1995 to as many as 256,000 per day in 2020. This traffic level is equivalent to approximately 140,000 vehicles per day moving in intercity trips of 50 miles or longer in the corridor by 2020, an increase of 75 percent over the present. If a total of 60 percent of this traffic is in the Portland-Seattle corridor, nearly 85,000 more vehicles per day must be added along Interstate 5 and other main roads plus 55,000 more vehicles per day in the Seattle-Vancouver corridor on already crowded roadways.

If the rail system improvements are made as planned, the expected auto passenger traffic by the year 2020 in the Western Washington corridor will be reduced from 93.6 million person trips per year to 88.2 million person trips per year, for a reduction of 5.8 percent, as shown in Figure 16. The expected total intercity motor vehicle traffic in 2020 is expected to decrease from 140,000 vehicles per day without the improved rail system to 132,000 vehicles per day with the rail system. It is estimated that future motor vehicle traffic levels will be reduced by an average of 5,000 per day in the Portland-Seattle intercity corridor and by 3,000 vehicles per day in the Seattle-Vancouver corridor if present trends continue.

While seemingly not related to Sea-Tac Airport expansion, automobile traffic increases in the future can be an important factor affecting its future growth. People who find air traffic delays an inconvenience or a hindrance will elect to drive their cars to Vancouver, Portland or elsewhere. If the roadways are sufficiently crowded, they will then be forced

FIGURE 15

ESTIMATED EFFECT OF AVERAGE TRAIN SPEED ON PROJECTED PASSENGER TRAFFIC MODAL SPLIT IN THE PORTLAND-SEATTLE-VANCOUVER CASCADIA INTERCITY CORRIDOR WITH INCLUSION OF DISCRETIONARY INDUCED RAIL RIDERSHIP TRIPS.

Data estimated based on the PBQD Report Modal Splits in the Portland-Seattle-Vancouver Corridor Induced Ridership Factors developed from data by French National Railroads in the Paris-Lyon Intercity Corridor

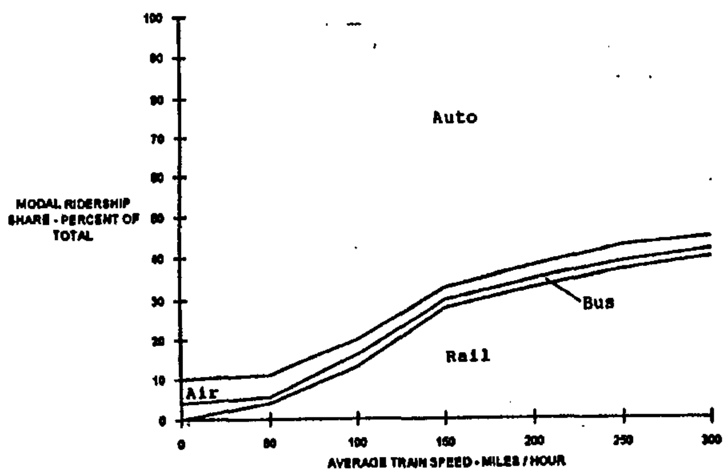
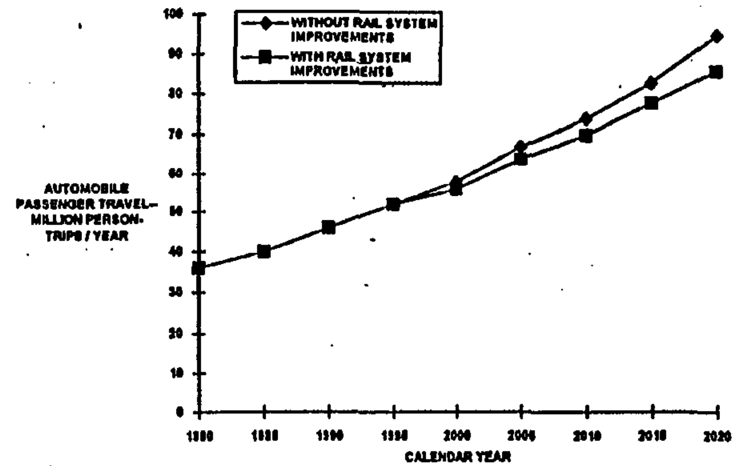


FIGURE 16

ESTIMATED EFFECT OF RAIL PASSENGER SYSTEM IMPROVEMENTS ON PROJECTED FUTURE AUTOMOBILE TRAVEL IN THE WESTERN WASHINGTON CASCADIA INTERCITY CORRIDOR

Based on information provided by the Washington State Department of Transportation, Olympia, Washington



to return to the airport for the next trip. If they then perceive that the congestion problem is unsolvable because no other alternative such as rail service is available, they may then elect to move their business away from the Puget Sound area completely as a very undesirable economic solution for the region.

d. Part d. Response

The WSDOT response (Ref. 2) merely presents the chart from the Wilbur Smith report in the Final Report (Ref. 3). The WSDOT response merely utilizes this chart without verifying its applicability in the Portland - Seattle intercity corridor from its previous Final Report (Ref. 3). The information presented in the previous Figure 2 of this document indicates that the rail modal ridership share for the Portland - Seattle intercity corridor with the Wilbur Smith report (Ref. 9) is much lower than that reported in the Parsons Brinckerhoff study by a factor of 250 to 300 percent. The differences in predicted ridership between the Wilbur Smith chart and what has actually been observed in the real world are actually much greater by as much as 400 to 500 percent. It is suggested that the Wilbur Smith curve not be used in the future to predict railroad ridership levels in the Western Washington corridor unless its deficiencies can be corrected.

X

e. Part e. Response

The WSDOT response does not answer this question. There is a need to review the ridership projection models used and also to bring in actual real world market conditions. The real travel patterns in the real world should be correlated with the results of any travel demand forecast models to assure their relative validities. A summary of the comparative passenger travel modal split distributions for several representative intercity corridors in the United States is presented in Table 18.

The only intercity route in the United States where rail passenger service presently achieves a market penetration of greater than 10 percent is in the 225 mile long New York to Washington corridor. The Amtrak Metroliner service in this corridor is able to achieve a 22 percent penetration at average speeds of 86 miles per hour and maximum speeds of 135 miles per hour with 112 trips per day and up to 6 stops enroute. The rail penetration in this corridor has increased from the 30 to 40 percent range of the total air-plus-rail market segment before the major corridor improvements began with a 3.5 to 4.0 hour travel time in the 1970's.

The rail market penetration is now in the 50 to 55 percent range with travel times of 2.6 to 3.0 hours at average train speeds of 86 miles per hour. The rail market penetration is expected to increase to the 60 to 65 percent range when the rail travel times are reduced to the 2.0 to 2.2 hour range when based on the air-plus-rail market segment. The rail penetration of the total corridor travel market is expected to increase from 22 percent in 1995 to over 26 percent after the year 2000 with these new service improvements on the

TABLE 18

ESTIMATES OF COMPARATIVE INTERCITY PASSENGER TRAFFIC MODAL SPLITS FOR SELECTED CORRIDORS IN THE UNITED STATES

SPECIFIC FACTOR	TRAVEL MODE	NEW YORK WASH.	NEW YORK BOSTON	LOS ANGELES SAN DIEGO	LOS ANGELES SAN FRAN.	HOUSTON DALLAS SAN ANTONIO	SEATTLE PORTLAND	SEATTLE VANCOUVER
TRAFFIC	RAIL	27,400	2,740	4,930	1,200	2,000	1,200	0
PASS/DAY	AIR	24,300	9,500	8,400	40,500	38,500	5,900	3,300
	BUS	1,900	930	1,640	2,000	2,200	600	400
	AUTO	73,800	35,100	64,300	90,500	81,500	85,800	67,500
TOTAL		127,400	48,440	79,450	134,200	124,200	93,500	71,200
SHARE	RAIL	21.50%	5.90%	6.20%	0.90%	1.60%	1.30%	0.00%
PERCENT	AIR	19.10%	19.50%	10.70%	30.20%	31.00%	6.30%	4.60%
	BUS	1.50%	2.00%	2.00%	1.50%	1.70%	0.60%	0.60%
	AUTO	57.90%	72.60%	81.10%	67.40%	65.70%	91.80%	94.80%
TOTAL		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
LENGTH	MILES	225	231	130	380	720	185	145
POPULATION	MILLION	22	14	14	18	9	6	4
MOBILITY	TRIPS/DAY PER MILLION POPULATION	2.10	1.30	2.10	2.70	9.20	8.80	6.50
AIR	FLIGHTS/DAY	300	270	160	538	200	130	84
RAIL	TRAINS/DAY	112	20	18	2	2	6	0
	MILES/HOUR	88	51	51	55	40	45	—

New York - Washington line. The air traffic share is then expected to be reduced from the present 19 percent to an estimated 16 percent of the total New York - Washington corridor travel market.

The 231 mile long New York - Boston corridor rail service has a present market penetration of six percent with an average speed of 52 miles per hour and 20 trips per day with up to five stops. With the present right-of-way improvements underway, the rail passenger market penetration is expected to rise to 17 percent when train speeds reach an average of 77 miles per hour with up to 40 trips per day as the travel time is reduced from 4.5 to 3.0 hours. The air portion of the total New York - Boston travel market is then expected to be reduced from the present 19 percent to less than 11 percent. The auto share of the total travel market is expected to be reduced from an estimated 73 percent at present to 70 percent in the future as the result of these rail system improvements.

The Los Angeles - San Diego intercity corridor provides another example of the ability of rail service to compete with air service in the United States. The travel times between Los Angeles and San Diego will be reduced from 2.5 hours in 1995 to 2.25 hours in 2000 as the service frequencies are increased from 24 to an estimated 48 trips per day and the train speeds are increased from 53 to 57 miles per hour. The rail market penetration level is expected to increase from the present 6 percent to 13 percent by 2000. The air market penetration is estimated to be reduced from 11 percent to 9 percent while at the same time the auto portion of the market is expected to be reduced from 81 to 76 percent.

One other intercity corridor with possible application to the Pacific Northwest in terms of rail ridership is the 380 mile long Los Angeles - San Francisco route in California. This line presently has one through round trip per day along the Coast route and four round trips from the Bay Area to Bakersfield in the San Joaquin Valley. In addition, there are three round trips from San Jose via Oakland and Martinez to Sacramento and Roseville. The Los Angeles - San Francisco region is the most heavily traveled air corridor in the World, with over 500 flights per day over a 400 mile distance, with about 135,000 estimated total passenger trips per day, of whom about 40,000 travel by air.

A previous feasibility study was conducted in 1991 of the impact of high speed rail upon market penetration in the Los Angeles - Bay Area - Sacramento intercity corridor (Ref. 19). This feasibility study showed that the present rail ridership of 0.9 million passengers per year (3500 per day) for the combined Coast Starlight - San Joaquin Amtrak services could be increased to 3.3 million passengers per year (9,040 per day) with a 125 mile per hour enhanced conventional service to 7.7 million passengers per year (21,100 per day) for a 185 mile per hour high speed rail service to 9.1 million passengers per year (24,930 per day) with a 300 mile per hour magnetic levitation system in place.

The overall rail market penetration in the Los Angeles - Sacramento - Bay Area corridor would be increased from the present one to two percent to 6.5 percent of the total at a maximum train speed of 125 miles per hour. The rail market penetration would be further increased to 15.5 percent based on a total travel of about 50 million passenger trips per

year for all modes with a 185 miles per hour maximum train speed and no induced trips. The rail market share could be further increased to 18.5 percent if a full 300 mile per hour magnetic levitation system were employed, as shown in Figure 17. These values are within the market penetration range of 8 to 17 percent reported for the Cascadia Corridor by the Discovery Institute (Ref. 12), and in the 6 to 25 percent range as calculated in this document.

14. Weather Delay Impacts upon Rail Passenger Ridership

"Given that weather delays occur so often at Sea-Tac (44 percent of the time, weather conditions inhibit full airport operation), explain why the mode-split analysis does not account for these delays. Might not the mode shift be different on a bad-for-flying day when weather problems produce multiple airline delays but rail speeds and times are not seriously degraded?

a. Evaluate how the analysis would change if the mode-split were done in two parts: one part reflecting the good-weather travel time ratio (56 percent of the time) and one reflecting the bad-weather travel time ratio (44 percent of the time).

b. Further, on what percentage of the bad-weather days are a significant number of flights in the corridors of interest canceled? How would the mode shift to auto or rail on those days affect the annual ridership projections?"

The WSDOT response (Ref. 2) merely refers to Table IV - 23 of the HSGT feasibility study (Ref. 4), which relies on the market analysis performed by KPMG Peat Marwick (Ref. 17). The information presented states that there would only be a 0.5 percent increase in the rail ridership because of a 20 minute airport delay in Western Washington. The expected incremental ridership increase is only by 25,745 passengers per year in the entire Western Washington corridor. If the Portland - Seattle corridor is assumed to be 60 percent of the total, then the annual rail ridership increase would be 15,000 per year, or a total of only 41 passengers per day.

The actual air traffic diversion to rail resulting from adverse weather conditions is likely to be much greater than this information indicates. While exact data cannot be obtained, an initial estimate can be made using the concept of differential rail-to-air speed increases previously described. A 10 to 20 minute congestion delay would then result in a 5 to 8 percent increase in rail riderships for high speed rail operations above 110 miles per hour. A 30 to 40 minute congestion delay for air traffic at SeaTac Airport would result in an estimated ridership diversion by 10 to 12 percent from air to rail. If adverse weather occurs during 44 percent of the time, the expected annual average diversions from air to rail would be up to 2 to 3 percent with a 10 to 20 minute delay and up to 4 to 5 percent with a 30 to 40 minute delay, as shown in Figure 18.

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FIGURE 17

EXPECTED INCREASES IN ANNUAL RAILROAD PASSENGER RIDERSHIP WITH MAXIMUM TRAIN SPEEDS FOR A PROPOSED HIGH SPEED RAIL SYSTEM IN THE LOS ANGELES-FRESNO-SACRAMENTO-BAY AREA INTERCITY CORRIDOR OF CALIFORNIA (REF. 18)

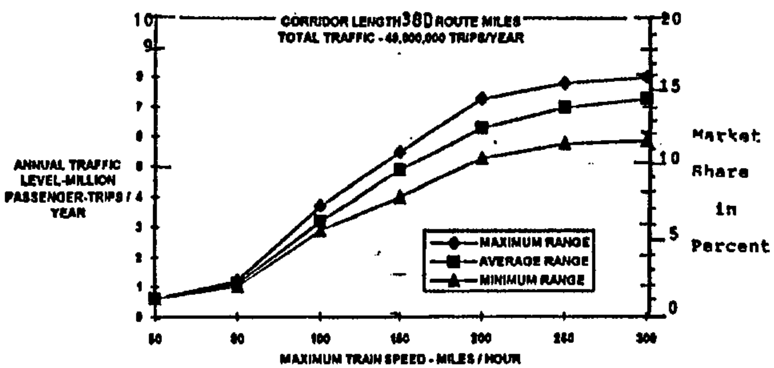

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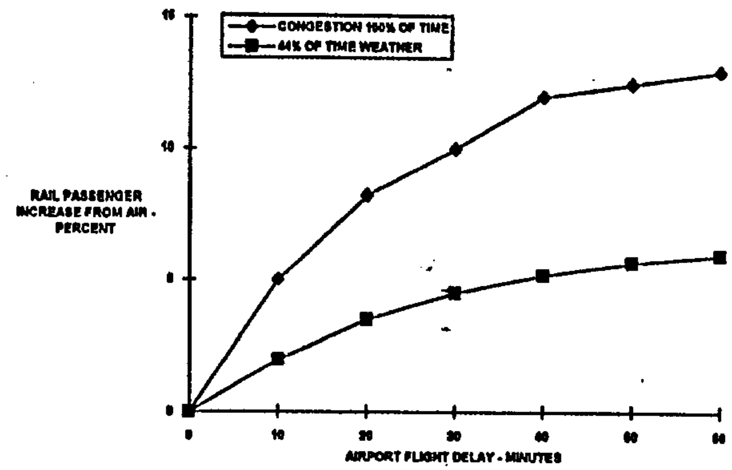
FIGURE 18

ESTIMATED EFFECT OF AIR TRAFFIC DELAYS ON INCREASED RAIL RIDERSHIP PROJECTIONS IN THE PORTLAND-SEATTLE INTERCITY CORRIDOR



a. Part a. Response

The WSDOT response indicates that it does not have access to the required information, so it cannot answer the question. A response by the author to this question is as follows: If the number of 5,121,000 riders per year in 2020 was used as a baseline for Western Washington and 60 percent of those passengers were in the Portland - Seattle corridor, the number of passengers would be 3,073,000 passengers per year. These annual ridership values translate into daily values of 14,030 passengers per day in the entire Western Washington corridor, of which 8,420 passengers per day would be in the Portland - Seattle corridor. Daily ridership levels on those days where adverse weather would be a factor would increase by 8 to 12 percent in the Portland - Seattle corridor by as little as 675 to 1,010 or as much as 9,095 to 9,430 passengers per day. Overall annual average per day ridership increases would then be on the order of 3 to 5 percent, or by 92,200 to 153,600 passengers per year, to between 3,165,200 and 3,226,600 trips annually.

b. Part b. Response

The WSDOT response (Ref. 2) does not present data on the number of days that flights would actually be subject to cancellation because of adverse weather at SeaTac Airport resulting from snow, ice, rain, fog or wind. Such information is also not immediately discernible in the previous Port of Seattle response (Ref. 6). However, the air service in Western Washington is likely to be more adversely affected than the rail service by adverse weather. Therefore, some diversion in air traffic to rail is likely to be the result of any expected aircraft flight cancellations which could be either temporary or permanent in nature.

What is probably more likely to occur is the question not answered by the Expert Arbitration Panel. If the improved rail system is built, it will probably stimulate some permanent diversions of previous air travelers to rail. People will try the rail service during a period of adverse weather, and will then make a permanent travel pattern habit shift. Such an event has already occurred in France with the construction of the TGV high speed train system, and will probably occur elsewhere as well, including in Western Washington.

To verify this fact, in Germany the Lufthansa Airline has made a strategic decision to withdraw from all of its present markets in Germany involving equivalent rail ground travel times of two hours or less (Ref. 20). There is presently a rail-to-air service connecting to Bonn, Cologne and Dusseldorf from the main Frankfurt airport. This rail terminal in the basement of the Frankfurt Airport to facilitates direct intermodal passenger transfers to both commuter and intercity passenger trains as well as to alleviate some short distance flight pressures between the cities. However, the increasingly widespread and frequent Inter City Express (ICE) high speed rail passenger service is progressively capturing greater portions of the intercity travel markets to the detriment of short distance air service so that it is no longer profitable.

The travel markets affected include Frankfurt, Cologne, Dusseldorf, Hamburg, Munich, Stuttgart, Nuremberg and Berlin. There is already a major rail to air intermodal passenger connecting terminal at the main Frankfurt airport which has been in operation for more than 15 years plus a second one now in operation at the Cologne Airport. There will also be major new air to rail connecting terminals in operation at the Dusseldorf and Munich airports before the year 2000. As a result, Lufthansa Airlines has decided to concentrate on those long distance domestic and international flight markets for which it is most competitive and profitable by abandoning those short distance domestic markets for which it is no longer competitive against the ICE train. The same potential situation presently exists at the SeaTac Airport in the Pacific Northwest.

15. Effects of Induced Ridership upon Rail Passenger Traffic

> "*The Executive Summary* (page 21) predicts 5.1 million rail trips in the year 2020 with 185 mph service - a much greater number than the 1.2 million presented in Figure 4 of the *Final Report*.
>
> a. Does the larger number include the other North-South Corridor markets? If so, the *Final Report* should not be limited to the Seattle - Portland market; please include the other markets.
>
> b. Table 3 of the *Executive Summary* provides some data on the other markets, but the total number of trips in those markets is only 1.6 million. Explain whether the remainder of the 5.1 million trips are due to new, induced travel, to auto trip diversions, or to some other factor. Indicate the number of trips attributed to each source."

a. Part a. Response

The Final Report (Ref. 3) presents a value showing only a minimal increase in rail ridership in the Western Washington corridor to only 1.2 million passengers in the Portland - Seattle corridor. The HSGT study (Ref. 4) reported an increase to 5.1 million passengers per year by 2020, of which 3.1 million would be in the Portland - Seattle corridor and 2.0 million in the Seattle - Vancouver corridor. An added ridership of 2.3 million riders per year would come from Eastern Washington to the Seattle area by high speed rail for a total of 7.4 million passengers per year. The WSDOT response ignores this discrepancy.

The WSDOT response does not address the question of induced ridership except that it would go to auto. Induced trips are discretionary in nature, and would only occur because of the existence of the high speed train service. In France, induced ridership levels of 17 to 35 percent of the total trips have been found to occur as the TGV high speed rail service has become increasingly developed (Ref. 18). Using the HSGT study as a baseline, the total number of trips in the Western Washington corridor by rail would increase from 5.1 million in 2020 to as many as 6.1 and 7.8 million per year. When expressed on a daily basis, the expected passenger ridership levels would be expected to increase from 14,030 per day to between 16,710 and 21,370 per day, which is far greater than the value of 3,356 per day presented in the Final Report (Ref. 3).

Induced rail ridership could increase the degree of rail portion of the total travel by mode split based on increased train speed, when based on the French TGV experience, (Ref. 18) as shown in Figure 19. The rail ridership penetration of the entire intercity travel market in the Western Washington corridor could then rise to the 30 to 40 percent range for high speed rail operation because of increasing public awareness of air and auto congestion. The effect of induced discretionary ridership on the overall rail travel market would then constitute an increasing percentage of the expected total trips taken with time in the overall Portland - Seattle - Vancouver intercity corridor, as shown in Figure 20.

The estimated total number of intercity passenger trips in the entire Western Washington corridor would then be expected to increase from 58 million in 1995 to 115 million in 2020 instead of 104 million without induced trips. It is emphasized these new induced discretionary trips would be by rail and not by auto as the previous WSDOT response has suggested. It is perhaps coincidental that the difference between 115 million and 104 million is 11 million passengers per year which is the so-called "increase" reported. Perhaps this is the reason for the mistake in reporting the "induced" passenger traffic going by auto between Seattle and Portland if the high speed rail system were built in the Western Washington corridor.

The WSDOT response is also deficient in that it does not address in a manner other than to present results using the Wilbur Smith model (Ref. 9) and the KPMG Peat Marwick model (Ref. 17) for modal split estimations between air and rail. The intermodal diversion of passenger traffic from air or auto to rail is dependent upon relative service frequencies, comparative travel times, differential costs, plus factors of passenger convenience, ride quality, intermodal interconnectiveness and others as well. With the Parsons Brinckerhoff modal split variations with increasing train speeds as a starting point, the degree of intermodal passenger traffic diversion from air, auto and has been estimated as shown in Figure 21. The primary intermodal diversion takes place from auto to rail in the Western Washington intercity corridor, primarily because automobile travel is the predominant transport mode with 90 to 95 percent of the total Portland - Seattle - Vancouver trips at the present time. The air traffic diversion to rail is very significant in terms of flight operations at SeaTac Airport, however.

b. Part b. Response

The primary source of new intercity passenger traffic in the Portland - Seattle - Vancouver intercity corridor is diversion from the existing automobile travel which comprises 50 to 55 percent of the total. The next largest source of increased rail passenger traffic is the

FIGURE 19

APPROXIMATE TRENDS IN RAILROAD PASSENGER RIDERSHIP ON THE TRES GRANDE VITESSE (TGV) HIGH SPEED RAIL LINE BETWEEN PARIS AND LYON IN FRANCE (REF. 19)

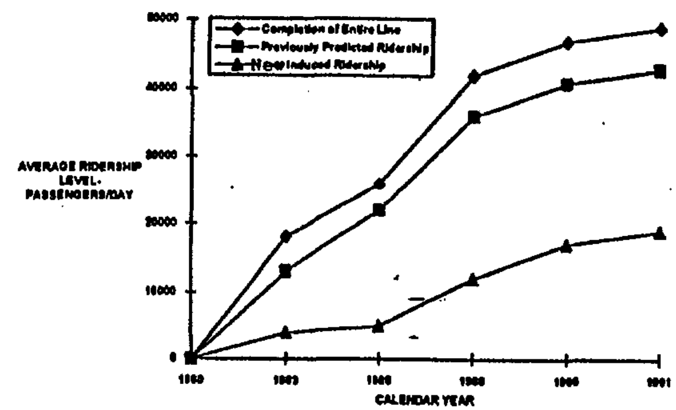


FIGURE 20

ESTIMATED EFFECT OF INCREASED TRAIN SPEEDS ON INDUCED DISCRETIONARY PASSENGER RIDERSHIP ON THE FRENCH TRES GRANDE VITESSE (TGV) HIGH SPEED TRAIN FOR THE PARIS-LYON INTERCITY CORRIDOR

Data obtained from studies by the French National Railroads as presented to Agency for Technical and Economic Cooperation and Development (Ref. 18)

266 MILE CORRIDOR LENGTH

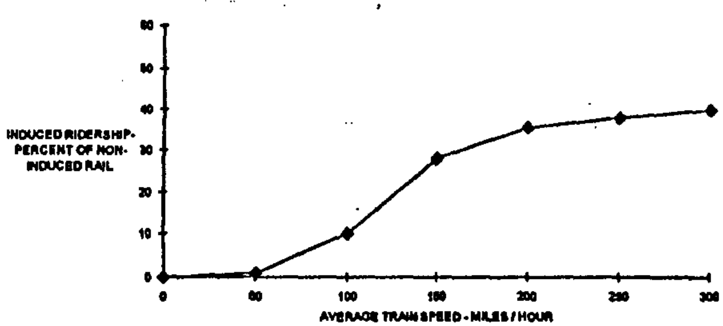
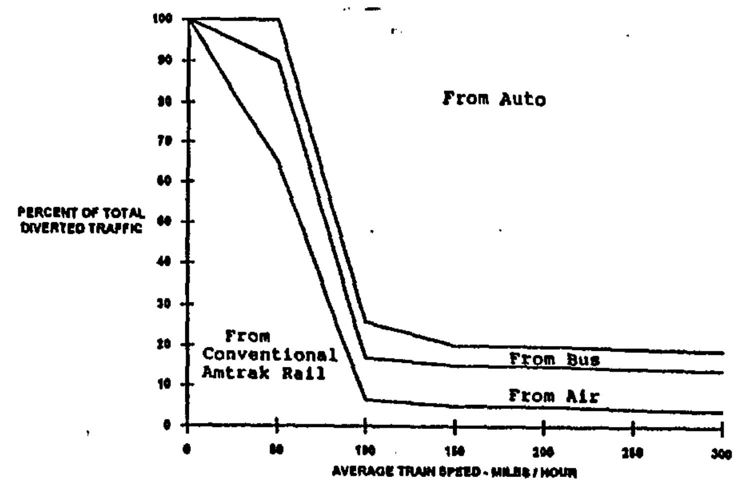


FIGURE 21

ESTIMATED EFFECT OF TRAIN SPEED ON INTERMODAL PASSENGER TRAFFIC DIVERSION TO RAIL IN THE PORTLAND-SEATTLE-VANCOUVER INTERCITY CORRIDOR

Modal Split Ratios based in part on PBQD Report data (Ref. 8)

266 MILE CORRIDOR LENGTH



generation of new induced discretionary trips which would not otherwise be taken, which comprises an estimated 30 to 35 percent of the total. Intermodal diversion from air traffic to rail constitutes approximately 10 percent of the total, primarily because it is only about 5 percent of the trips to begin with. Diversion of passenger traffic from bus to rail is only about 5 percent of the total, primarily because it is only about 2 percent of the present total traffic in the corridor to start with.

The WSDOT response does not address this question adequately if at all. The sensitivity analysis presented in the HSGT study (Ref. 4) only presents ridership data for the one year 2020, and does not present values for intermediate years. It is not possible to discern exactly where the particular trips come from or where they go in terms of their source in most cases. The information presented on rail ridership in the Wilbur Smith study (Ref. 9) appears to be inordinately low and erroneous.

An item not addressed properly in the WSDOT response (Ref. 2) or in the Final Report (Ref. 3) is the ability to divert air traffic to rail from SeaTac Airport to relieve its runway capacity constraints. Both of these documents report that the ability of rail to divert passenger traffic and flights away from SeaTac Airport was negligible even for short distance trips. These documents do not attempt to differentiate or quantify the flight diversion potentials at SeaTac Airport between those flights in the Western Washington corridor or to Eastern Washington, either separately or in combination.

A summary of aircraft flight operations at SeaTac Airport serving the Western Washington and Eastern Washington corridors by plane size is presented in Table 19. There are a total of 240 commuter flights per day operating in the Western Washington corridor plus 138 per day in the Eastern Washington corridor for a total of 378 flights per day for commuter size planes of 40 seats or less. In addition, there are 53 total daily flights where plane seating capacities are between 40 and 100 in the Seattle - Portland and Seattle - Spokane corridors as well.

There are a total of up to 431 flights per day where passengers may be amenable to diversion to rail which presently serve SeaTac Airport. The proportion of direct commuter flights of 40 seats or less of 378 per day which serve SeaTac Airport to these various locations constitutes 40 percent of the total number of 935 flight operations per day. With the intermediate size planes included, the proportion of airline flights which may be amenable to intermodal diversion rises to 431 out of 935, or 46 percent of the total daily Sea Tac flight operations. The total number of daily flights serving the various cities in the Western Washington and Eastern Washington corridors is 489, or 57 percent of the present total Sea Tac Airport operations.

The intermodal diversion potential for SeaTac Airport passenger traffic from air to rail can be either market-driven by consumer preference or else mandated by governmental policy. The total flight diversion potential based on market considerations can range from 110 to 220 flights per day, with 59 to 68 percent from the Western Washington corridor and 32 to 41 percent from the Eastern Washington corridor. However, if a mandated government

X

TABLE 19

INTERMODAL AIRCRAFT FLIGHT DIVERSION BY CORRIDOR FROM AIR TO RAIL AT THE SEATTLE TACOMA INTERNATIONAL AIRPORT

INTERCITY CORRIDOR	ORIGIN DESTINATION	AIRCRAFT FREQUENCIES - FLIGHTS/DAY			TOTAL FLIGHTS	DIVERSIONS - FLIGHTS/DAY	
		8-40 SEATS	40-100 SEATS	100-300 SEATS		MARKET	MANDATE
WESTERN WASHINGTON:							
	SEATTLE - PORTLAND	132	11	34	177	40-75	143
	SEATTLE-VANCOUVER, BC	108	0	14	122	30-55	100
	SUBTOTAL	240	11	48	0 299	75-130	243
EASTERN WASHINGTON:							
	SEATTLE-SPOKANE	12	42	10	64	15-30	52
	OTHER DESTINATIONS	126	0	0	126	20-60	126
	SUBTOTAL	138	42	10	190	35-90	178
	TOTAL ALL CORRIDORS	378	53	58	489	110-220	421

policy requires an intermodal diversion from air to rail for short distance flights at SeaTac Airport, a total of 378 to 429 flights could be diverted, of which 58 to 63 percent would be to the Western Washington corridor destination cities.

An element not addressed at all in the WSDOT response (Ref. 2) or in the Final Report (Ref. 4) is the increased intermodal diversion potential from air to rail with time at SeaTac Airport. An initial evaluation of the intermodal flight diversion potential of short distance passenger traffic at SeaTac Airport with time for both the Eastern Washington and Western Washington corridors is presented in Figure 22. The total number of flights at SeaTac Airport is expected to increase from the present 935 per day in 1995 to as many as 1,210 per day by 2020.

The total number of flights in the Western Washington corridor is expected to increase from 299 per day in 1995 to 338 per day in 2020 if present plane seating capacity patterns remain the same, or by 13 percent. The total number of flights in the Eastern Washington corridor is expected to increase from 190 per day in 1995 to as many as 332 per day in 2020, with Eastern Washington destinations showing the greatest degree of growth. With the rail system constructed in Western Washington, the total number of flights can be reduced from 299 per day in 1995 to 222 in 2020. This reduction of 77 flights per day constitutes 26 percent of the total operations at SeaTac Airport resulting from market forces. A reduction in commuter operations by 240 flights per day from 299 to 59 flights per day could be achieved based on governmental policy mandates in order to achieve a reduction of 80 percent in these short distance flight operations.

The number of daily flights at SeaTac Airport to Eastern Washington destinations will increase from 190 in 1995 to 332 in 2020 if present traffic growth and plane flight frequencies and plane seating capacity patterns remain constant, which is a 75 percent increase. The construction of a new high speed rail system to Eastern Washington from Seattle could reduce the total number of flights from 332 to 222 per day, which is still an increase of 32 flights per day above present levels, or 17 percent. With a governmental policy mandate of intermodal flight diversion from air to rail, the total flights could be reduced to as little as 178 per day as compared to the present 190 per day to Eastern Washington, for a reduction of as much as 93 percent.

For both Eastern Washington and Western Washington combined, the total number of flights could be reduced from the present 489 per day to 446 per day, as shown in Figure 23. This intermodal diversion from air to rail is 43 flights per day by market forces with growth rates considered, or by 9 percent. However, by a governmental policy mandate of intermodal diversion from air to rail, the number of total flights at SeaTac Airport could be reduced by 241 per day, or 36 percent of the future total of 670 flights per day in 2020. This level of reduction in flight frequencies would constitute 26 percent of the present total flight operations at SeaTac Airport, or 20 percent of its future flight operations in 2020.

FIGURE 22

ESTIMATED EFFECT OF RAIL SYSTEM IMPROVEMENTS ON FLIGHT OPERATIONS FROM EASTERN AND WESTERN WASHINGTON TO SEATTLE-TACOMA INTERNATIONAL AIRPORT

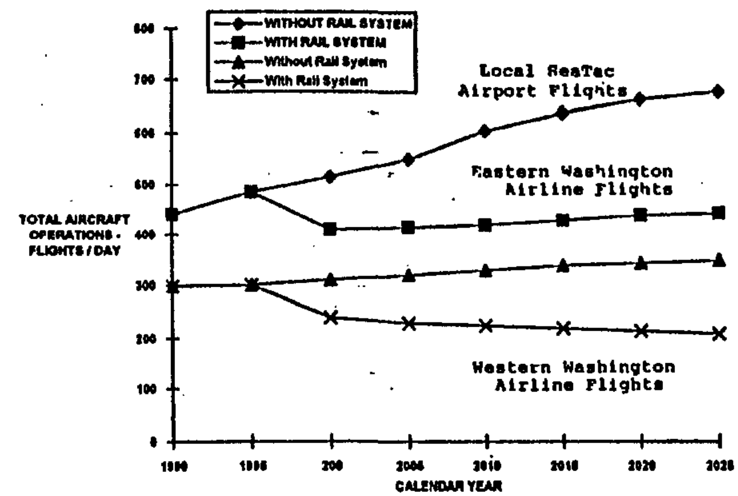
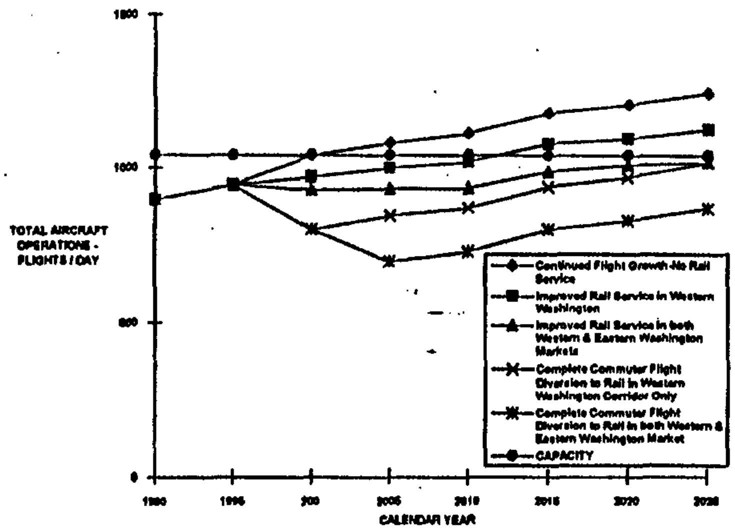


FIGURE 23

ESTIMATED EFFECT OF RAIL SYSTEM IMPROVEMENTS ON ESTIMATED TOTAL AIR TRAFFIC OPERATIONS AT SEATTLE-TACOMA INTERNATIONAL AIRPORT



The potential impacts of intermodal flight diversions from air to rail in terms of present and future operations at SeaTac Airport are considerable. The construction of a high speed rail system in Western Washington alone will cause intermodal sufficient passenger traffic diversion from air to rail so as to reduce average daily flight operations at SeaTac Airport by as much as 90 to 100 per day when market competitive force driven, which is 10 to 11 percent of the present total of 935 per day. The number of flight operations will be reduced by 230 to 240 flights per day if driven by government policy mandates, or from 24 to 26 percent of the present totals. With both Eastern and Western Washington having high speed rail systems in place, the number of daily flights could be reduced by 145 to 200 by market driven forces (15 to 21 percent of the present total flights), and by 380 flights per day (41 percent) if driven by governmental policy mandates.

IMPEDIMENTS

A number of factors may influence the ability to implement improved rail service in the State of Washington as an alternative to the expansion of the Seattle - Tacoma International Airport. A number of these factors may become impediments to the ability of improved railroad passenger service to cause sufficient intermodal traffic diversion from air to rail so as to alleviate the need for increased runway capacity. These potential impediments may include institutional, financial, economic, political, legal, environmental, physical and operational concerns in varying levels of importance. The relative importance of these factors will be discussed in the following paragraphs of this document.

Institutional factors may become the greatest single impediment to the ability to implement improved rail passenger service as an alternative to SeaTac Airport expansion. There is already in place an economic institutional infrastructure of automobile and highway plus airport and aviation interests in place dependent upon continued reliance on oil which must increasingly be imported from foreign countries. These existing aviation and highway interests will not look with favor on transportation alternatives which will reduce their relative economic importance. A major upswelling of public opinion will then be necessary to support improved rail passenger service so as to be able to overcome this institutional resistance to change in existing travel patterns.

This institutional impediment manifests itself in a particular form of behavior and a similar mode of thinking. People who are used to driving cars or flying in planes to reach their destinations do not easily give up those patterns unless there is a good reason to do so. For this reason, it will be necessary to design any future rail passenger service to supplement or replace the real or perceived need for SeaTac Airport expansion so that it actually meets the traveler's needs. These customer satisfaction factors for improved rail service must then include economy, logistics, frequency, comfort and convenience plus ride quality and travel amenities so as to be competitive with the air alternative.

The financial impediments to improved rail passenger service as an alternative to SeaTac Airport expansion are considerable. Rail passenger service does not have a dedicated financing mechanism in place for long term investment as do highway and aviation. Therefore, rail must fight annually for continued appropriations to assure its continued survival in the public sector. The amounts of money which must be raised to develop, construct and implement rail passenger service projects are considerable, which means that a prolonged funding process and construction schedule becomes necessary if only limited funds are available at any one time.

There is a need to provide for some type of dedicated funding source in order to facilitate improved rail passenger service. This dedicated funding source could be a user fee added on to the price of gasoline for automobiles as well as an airport ticket tax. It would also be helpful to have available some type of long term low interest government guaranteed bond or loan financing program such as the present 4R-511 federally guaranteed rail improvement loans. It is also useful to find a way for the private sector to be involved in rail passenger service development through public/private partnerships or other mechanisms.

A related impediment to financial factors is economic impediments. Economic factors are primarily those of an external nature such as the condition of the local or regional economy in terms of public perceptions of prosperity or lack thereof. These economic factors must be sufficiently positive so that there is a feeling of "funding comfort." This funding comfort factor would allow either the public at large or their elected representatives to accept the substantial financial risk of approving major long term funding commitments in major rail passenger development projects.

There are other external economic factors which can influence the ability to realize future rail passenger development projects. Average interest rates on debt financing can affect the overall project financing costs and also their ability to be repaid on an annual basis. The need to generate employment, both directly and indirectly, can affect the degree of public support which is required to approve rail passenger projects. The ability to create jobs in construction, manufacturing and operation within the local area is a major potential advantage of future rail passenger projects in the State of Washington. The effect of improved rail service on reducing personnel travel time losses from congestion and delay can be a significant transportation cost savings to the affected businesses.

There are also political impediments to the implementation of improved rail passenger service in the state of Washington as an alternative to increased runway capacity expansion at SeaTac Airport. There must be sufficient public support for improved rail passenger service so as to facilitate favorable responses and votes by elected officials at the Local, State and Federal levels. There is also a need to assure that all of the affected public and private "stakeholder" groups can perceive that there is sufficient benefit to their particular interests, whether it be of a general parochial nature.

One potentially serious political impediment to actually implementing improved rail passenger service in Western Washington alone is that influential (since the November 1994 election) Eastern Washington legislators may feel that they are being excluded from

participating in its benefits. As a result, they may then tend to vote against such improved rail passenger service unless they have a reason to support it. The best way to obtain their support is to provide at least some rail passenger service improvements to both Eastern and Western Washington, and not merely in the Portland - Seattle - Vancouver Western Washington Cascadia corridor on a timely basis as a part of the program.

Legal impediments to improved rail passenger service may occur in parallel with political impediments. Public transportation (and energy) policies and laws since the end of World War II in the United States have traditionally favored the development of oil-dependent highway and air travel at the expense of energy-efficient rail transport. This favoritism manifests itself in the State of Washington in the form of the 18th Amendment to its Constitution, which prohibits the expenditure of gasoline tax proceeds for anything other than highway improvement projects. Correcting such a legal imbalance to create a more level transportation playing field is no small task in needing to amend the State Constitution.

A more positive legal matter is the possible need to create new administrative entities for developing improved rail passenger service. A recent example of this mechanism is the creation of the Central Puget Sound Regional Transit Authority (RTA) in order to provide for improved non-auto mass transit system development in the Puget Sound area. In California, the respective county governments have formed special districts to support improved rail passenger service in several corridors. In addition, the National Railroad Passenger Corporation (Amtrak) may be able to assist in the operation of future rail passenger service to and from SeaTac Airport. This service could be developed in conjunction with the Burlington Northern and Union Pacific Railroads plus the affected airlines serving SeaTac Airport on a cooperative basis as is now done in Germany between Lufthansa Airlines and the German Federal Railway.

Environmental concerns may serve as impediments to future rail passenger system expansion for alleviating the perceived needs for SeaTac Airport runway capacity expansion. Concerns also exist over noise impacts during operation plus visual impairment from passenger train operations, especially with the onset of electrification. Environmental concerns can also exist with the possible need for wetlands mitigation during construction of the railroad along with the consideration of certain sensitive species at specific locations.

However, the operation of passenger trains is generally a strongly net positive environmental benefit because trains consume less energy, emit fewer air pollutants, generate less solid and liquid wastes (especially from oil storage and refining), and have a lower marine oil spill potential. Railroad line construction will not involve condemning large numbers of homes and in moving large amounts of fill soil as will the construction of a third runway at SeaTac Airport. In addition, railroads are the only transportation mode which can be electrified so as to have no air pollution emissions in the proximity of travel with its source controls to reduce discharges more easily applied at single stationary sources than on large numbers of mobile source motor vehicles.

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A related environmental factor is that passenger trains require only one-third as much energy to operate as automobiles per passenger-mile, and only one-fifth as much energy as for commercial aircraft. Passenger trains do not require petroleum as an energy source as they can rely on domestically available coal, gas, nuclear, solar, wind or geothermal renewable energy in the form of electricity. Passenger train operations can reduce the amount of oil which must be imported into the United States, which was half of the total use in 1994. There is a growing need to reduce the increasingly critical national balance-of-payments deficit resulting in part from continued and increasing oil importation. Reduced oil imports also help to reduce the marine oil spill potential into the environment as well as to help stabilize the value of the falling U. S. dollar in international trade.

Safety impediments may also exist to improved rail passenger service as an additional factor to be considered. It will be necessary to reduce the number of rail-highway grade crossings to an absolute minimum with conventional speed rail passenger service. High speed rail passenger service will necessitate the ultimate elimination of rail-highway grade crossings in the future as well as the complete fencing for isolation of the railroad right-of-way from unauthorized human access. The construction of rail-highway grade separations is an excellent way to create large numbers of jobs and activities for numerous small, medium and large-scale businesses in the State of Washington as a part of the rail passenger service improvement program.

It will be desirable in the future to increase train speeds instead of reducing train speeds at grade crossings in order to minimize the rail-auto contact times and the resultant potential for accidents. Special authorities may be needed to promote local and state construction of grade separations and grade relocations in order to facilitate this effort. Additional tracks may also be needed along the existing railroad rights-of-way in the future so that compatible speed fast passenger trains and rapid intermodal and refrigerator freight trains with time-sense can run on one set of tracks while the slower incompatible speed freight trains carrying bulk and other less time sensitive commodities can then operate on a separate set of parallel tracks along the same right-of-way (Refs. 21, 22 & 23).

There are several other physical and operational concerns which must be considered as potential impediments to improved rail passenger service in the future in the State of Washington. It will be important, if not essential, to have direct rail access into SeaTac Airport in the future for both freight and passenger trains, and also to the Portland and Vancouver airports. Rail bypass lines will need to be constructed across Fort Lewis, and into Olympia. The existing line along the East Side of Lake Washington from Tukwila to Renton to Bellevue to Woodinville to Snohomish will need to be upgraded so that intercity passenger trains operating between Bellevue and Portland plus Bellevue to Vancouver can use this line along with local commuter trains.

A new freight rail bypass line may eventually need to be reconstructed on the right-of-way of the old rail line from Sumas to Snohomish, and from Monroe to North Bend to Tenino because of increased passenger train traffic on the present line from Seattle to Portland

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and to Vancouver. Additional freight service tracks will be needed into the Ports of Seattle and Tacoma with train routings made so as not to interfere with passenger train operations and vice versa. The Stampede Pass line across the Cascade Mountains needs to be reopened and upgraded while the present diesel smoke problem in the Stevens Pass tunnel needs to be reduced or eliminated.

All of the above issues plus others must be considered as a part of the planning effort to facilitate the development and implementation of improved rail passenger service as a viable alternative to the construction of a third runway to increase capacity at SeaTac Airport.

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IMPLEMENTATION OF AN LDA/DME APPROACH TO RUNWAY 16R IN LIEU OF A THIRD RUNWAY AT SEATAC AIRPORT

Prepared for

Regional Commission on Airport Affairs
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June 26, 1995

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June 24, 1995

Regional Commission
on Airport Affairs
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Normandy Park, WA 98166

Enclosed is the Study conducted by G. Bogan & Associates, Inc., on the feasibility of implementing an LDA 16R and ILS 16L operational configuration at Seattle Tacoma International Airport. As stated in the Study it is feasible. The Airport Master Plan Update Draft EIS was analyzed. As you will read we do not agree with several of the DEIS conclusions, especially in the areas of detailed weather analysis and the impact on dual stream capabilities. Additionally, it seems the DEIS does not give full credit to airport and airspace improvements that increase hourly arrival capabilities. We believe current hourly acceptance rates plus increases that can reasonably be expected over the years will satisfy the DEIS year 2020 forecast.

It is our opinion that implementing an LDA 16R and ILS 16L procedure, delays will remain in the "acceptable range" throughout the forecast period and an addition of a third runway is not necessary.

Sincerely,

G. H. Bogan
G. Bogan & Associates, Inc.

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IMPLEMENTATION OF AN LDA/DME APPROACH TO RUNWAY 16R IN LIEU OF A THIRD RUNWAY AT SEA-TAC

EXECUTIVE SUMMARY

The Port of Seattle (Port) is in the process of updating their Airport Master Plan. Part of that process is to prepare an Environmental Impact Statement (EIS) outlining the impact the planned changes will have on the airport environs and surrounding communities.

The EIS concludes that a third runway is necessary to accommodate the year 2020 annual forecast of operations and passengers. The Draft EIS forecasts 441,600 operations and a passenger demand of 38.2 million in the year 2020. The 1993 operations were (339,500) and (18.8 million) passengers.

This study does not support the DEIS findings and subsequent claim that the only solution is to build a third runway. The DEIS is flawed in its assessment of actual weather conditions, the value of a Localizer Directional Aid (LDA) procedure to runway 16R, and the true airport acceptance rate since implementing a series of airfield improvements during the past several years. The DEIS acknowledges delay reductions of 46% and credits airport and airspace improvements since 1988 as the reasons. However; the DEIS analysis does not use those increased hourly arrival rates when calculating the results of the airport improvements.

These THREE KEY ISSUES are the main points of this study. An analysis of sections of the DEIS that are associated with the above mentioned issues, and mitigating conclusions, has been conducted resulting in the following conclusions.

ANNUAL WEATHER CONDITIONS ARE BETTER THAN CLAIMED IN THE DEIS. Detailed analysis concludes only 17% of the yearly weather is such that a single stream arrival flow is required, not the 44% stated in the DEIS.

AN LDA APPROACH PROCEDURE TO RUNWAY 16R WITH AN ILS RUNWAY16L, IS FEASIBLE. An LDA approach will satisfy the need for dual stream arrivals without constructing a third runway.

IMPLEMENTING LDA 16R AND ILS 16L PROCEDURES CAN RESULT IN THE FOLLOWING. 98% of the year the 2020 hourly forecast cited in the DEIS can be accommodated within the acceptable delay parameters outlined in that study.

Therefore the obvious conclusion; A THIRD RUNWAY IS NOT NECESSARY.

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IMPLEMENTATION OF AN LDA/DME APPROACH TO RUNWAY 16R IN LIEU OF A THIRD RUNWAY AT SEA-TAC

I INTRODUCTION

The April 1995 Seattle-Tacoma International Airport Master Plan Update Draft Environmental Impact Statement, (DEIS, Chapter II), identifies seven alternatives to "Improve the Poor Weather Airfield Capability In A Manner That Accommodates Aircraft Activity With An Acceptable Level of Aircraft Delay."

The alternatives are:

a. Use of other modes of Transportation
b. Use of other Airports or Construction of a New Airport
c. Activity Demand Management
d. Runway Development at Sea-Tac
e. Use of Technology
f. Blended Alternative (Combination of other modes, use of existing airports, and activity demand management).
g. Do-Nothing/No-Build

The DEIS concludes that the preferable alternative to improve "poor weather" airfield capability is to construct an 8500 foot runway 2500 feet West of Runway 16L/34R. The DEIS infers that an LDA Approach to Sea-Tac is not viable due to the frequency of "poor weather". The Port attributes this conclusion based on the poor weather conditions they claim exist 44% of the year.

LDA has and will be referred to many times in this report therefore; following is a definition of the term LDA. The Localizer Directional Aid (LDA) is an electronic beam used to guide aircraft to a specific point in space. It works similar to the localizer beam of an Instrument Landing System (ILS). Unlike an ILS the LDA is not aligned with a runway. The beam is used as guidance through the clouds. After descending clear of the clouds the pilot then abandons the course guidance and executes a side-step type of maneuver to the runway of intended landing. In the case of Sea-Tac the landing runway would be 16R.

This report refutes the DEIS analysis of "poor weather" and its impact on the airports ability to accommodate the aircraft activity forecast in the year 2020.

This report supports the following conclusions:

- Detailed analysis of SEA-TAC weather (years 1993 & 1994), refutes the Port's claim that 44% of the time, weather conditions limit the airport to single flow operations. Detailed analysis reduces

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that period of time to approximately 17 % annually.

- An LDA/DME approach procedure to runway 16R is feasible, and will reduce the capacity forecast delay for the year 2020 to an acceptable level.
- With the installation of an LDA runway 16R the year 2020 annual forecast and daily hourly demand identified in the DEIS can be accommodated in an orderly fashion negating the need to construct a third runway.

II DETAILED WEATHER ANALYSIS.

To understand the significance of such detailed weather, when it existed, and how airfield capacity demands can be influenced by bad weather etc., it is necessary to understand the definitions of the weather conditions at Sea-Tac:

- Visual Flight Rule 1 (VFR-1). Ceiling (height of cloud base above the ground) is at least 5,000 feet and visibility at least 5 miles.
- Visual Flight Rule 2 (VFR-2). Ceiling is between 2,500 feet and 4,999 feet and visibility is more than 3 miles.
- Instrument Flight Rule 1 (IFR-1). Ceiling is above 800 feet and less than 2,499 feet and or the visibility is less than 3 miles.
- Instrument Flight Rule 2 (IFR-2), and (IFR-3), and (IFR-4). Ceilings from zero to less than 800 feet and visibility zero to 2 miles. IFR-4 is the worst ceiling and visibility weather condition.

The DEIS states that 10 years of weather was reviewed[1] and concludes a third runway is required at Sea-Tac. That review of the weather data resulted in a determination that 44% of the year weather conditions exist that prevent air traffic control from utilizing dual arrival flows. Delays occur when hourly traffic demands exceed single arrival flow capacity. The DEIS contends that the excess operations are delayed beyond a reasonable time and that the costs to the airlines and the traveling public are not acceptable. The conclusion is that a third runway constructed at Sea-Tac will allow dual arrival streams during inclement weather conditions and that the increase in hourly airport capacity will reduce the remaining delays to an acceptable level.

To determine if the DEIS weather analysis was correct, two years of hourly airport weather observations were obtained from the National Weather Service (1993 and 1994). The data is the exact hourly weather reported 24 hours per day each day of

[1] pgs 54-58 Expert Arbitration Panel Transcript dated 5/4/95.

each month for the two year period. This detailed weather was analyzed with the confidence that it depicted exactly what the weather conditions were any given hour of any day or month during the two year period.

The analysis concluded that weather conditions requiring single stream flow at Sea-Tac is not 44% as claimed in the DEIS. Instead the 1993 and 1994 "poor weather" that requires single stream arrivals after implementing an LDA procedure is approximately 17%.[2] That is a significant difference from the DEIS conclusions, especially when airport efficiency is at issue.

At Sea-Tac during VFR-2 and all IFR weather conditions, the DEIS claims arriving aircraft are limited to a single stream. This is the result of only one runway being equipped with an ILS and the capacity constraints that result from such an arrival configuration. The DEIS states that during VFR-1 conditions the maximum hourly arrival acceptance rate is 60. VFR-2 is 48, IFR-1 36, and IFR-2, 3, and 4 is 24. In the DEIS weather analysis, no consideration is given to what time of day poor weather conditions exist. The DEIS 44% VFR-2 & IFR-1, 2, 3, 4 weather is spread evenly throughout the day which supports the claims of excessive delay and subsequent cost to the airlines and flying public. Logic would say that some of that poor weather had to occur during off-peak hours and therefore, did not cause delays due to a single flow arrival stream. If the proportion of the "poor weather" is higher during off peak hours, the delays due to a single flow arrival stream are less.

To properly analyze the actual weather conditions rather than assuming averages during critical delay calculations, hourly observations had to be examined. Only then could a proper weather impact on delay be developed.

The first analysis was of VFR-1 and VFR-2 weather conditions validating the actual hours these conditions existed. The same analysis was conducted for the hourly IFR-1, 2, 3, 4 weather reports. After determining the actual weather conditions that existed, an analysis was performed to determine if any VFR-2 or IFR-1 weather conditions met or exceeded the criteria established by the Federal Aviation Administration (FAA) when they approved LDA approach procedures at other air carrier airports. Spread sheets were developed to depict hourly weather conditions for VFR-1, IFR-1/VFR-2 that meet and do not meet FAA LDA weather criteria for the years of 1993 and 1994.[3]

After analyzing the hourly VFR-2 and IFR-1 weather, it became obvious there was a significant number of hours that met or exceeded the FAA's weather criteria that has been used in establishing LDA approaches. The in depth hourly analysis confirmed the percent of weather conditions that currently restrict dual flow operations at Sea-Tac is over-stated in the DEIS. To present a true picture of Sea-Tac weather, and demonstrate how dual flow hours within the existing 2 runway configuration can be

[2] Exhibit - LDA weather conditions 1993.

[3] Exhibit - a,b,c,d, weather conditions 1993 & 1994.

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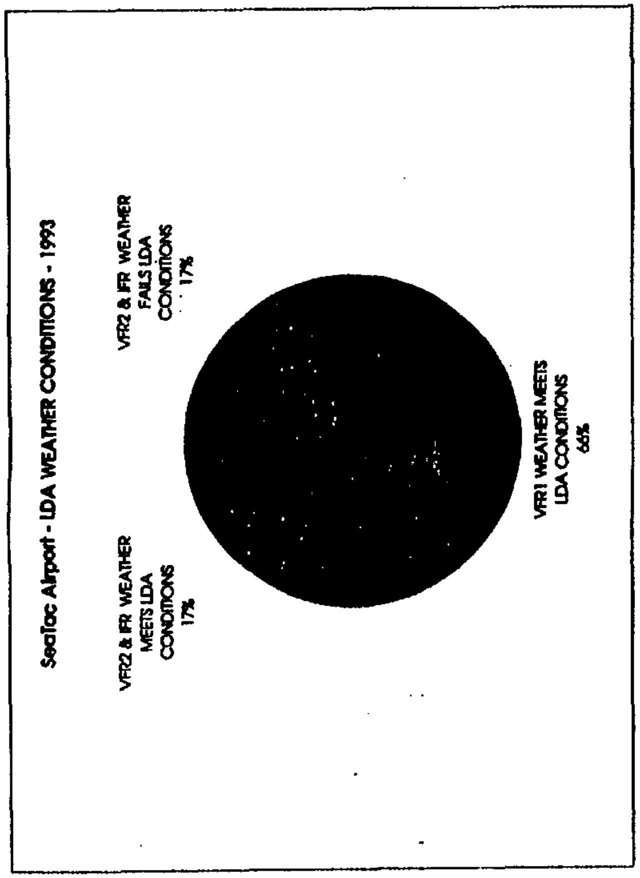

Source: G. Bogan & Associates Inc.

EXHIBIT 2

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SeaTac Airport - 1993 Weather Conditions

		VFR1	VFR2	IFR1	IFR2+	Total
Jan-93	Hrs.	445	82	80	33	640
	%	70%	13%	13%	5%	100%
Feb-93	Hrs.	506	70	22	21	619
	%	82%	11%	4%	3%	100%
Mar-93	Hrs.	463	140	82	41	726
	%	64%	19%	11%	6%	100%
Apr-93	Hrs.	340	171	68	17	596
	%	57%	29%	11%	3%	100%
May-93	Hrs.	573	78	65	9	725
	%	79%	11%	9%	1%	100%
Jun-93	Hrs.	483	123	101	9	717
	%	67%	17%	14%	1%	100%
Jul-93	Hrs.	395	192	132	22	742
	%	53%	26%	18%	3%	100%
Aug-93	Hrs.	521	109	77	30	737
	%	71%	15%	10%	4%	100%
Sep-93	Hrs.	621	23	40	35	719
	%	86%	3%	6%	5%	100%
Oct-93	Hrs.	458	65	103	116	743
	%	62%	9%	14%	16%	100%
Nov-93	Hrs.	441	128	111	40	719
	%	61%	18%	15%	6%	100%
Dec-93	Hrs.	334	205	76	120	735
	%	46%	28%	10%	16%	100%
TOTAL HRS.		5580	1386	958	493	8416
% TIME		66%	16%	12%	6%	100%

Source: G. Bogan Associates Inc. EXHIBIT 3-a

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SeaTac Airport - 1993 Weather Conditions

		VFR1 CONDITION	VFR2 & IFR CONDITIONS MEET LDA CRITERIA	VFR2 & IFR CONDITIONS FAIL LDA CRITERIA	Total
					Total
Jan-93	Hrs.	445	92	104	640
	%	70%	14%	16%	100%
Feb-93	Hrs.	506	67	46	619
	%	82%	11%	7%	100%
Mar-93	Hrs.	463	138	126	726
	%	64%	19%	17%	100%
Apr-93	Hrs.	340	170	86	596
	%	57%	28%	14%	100%
May-93	Hrs.	573	82	69	725
	%	79%	11%	10%	100%
Jun-93	Hrs.	483	136	98	717
	%	67%	19%	14%	100%
Jul-93	Hrs.	395	214	133	742
	%	53%	29%	18%	100%
Aug-93	Hrs.	521	124	92	737
	%	71%	17%	13%	100%
Sep-93	Hrs.	621	26	71	719
	%	86%	4%	10%	100%
Oct-93	Hrs.	458	46	239	743
	%	62%	6%	32%	100%
Nov-93	Hrs.	441	128	151	719
	%	61%	18%	21%	100%
Dec-93	Hrs.	334	186	216	735
	%	45%	25%	29%	100%
TOTAL HRS.		5580	1407	1431	8418
% TIME		66%	17%	17%	100%

Source: G. Bogen Associates Inc.

EXHIBIT 3-b

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SeaTac Airport - 1994 Weather Conditions

		VFR1	VFR2	IFR1	IFR2+	Total
Jan-94	Hrs.	276	171	167	128	743
	%	37%	23%	22%	17%	100%
Feb-94	Hrs.	273	183	138	61	655
	%	42%	28%	21%	9%	100%
Mar-94	Hrs.	523	129	73	18	743
	%	70%	17%	10%	2%	100%
Apr-94	Hrs.	351	149	94	22	616
	%	57%	24%	15%	4%	100%
May-94	Hrs.	503	123	66	17	709
	%	71%	17%	9%	2%	100%
Jun-94	Hrs.	510	80	70	7	667
	%	77%	12%	10%	1%	100%
Jul-94	Hrs.	478	66	60	19	623
	%	77%	10%	10%	3%	100%
Aug-94	Hrs.	653	35	36	13	737
	%	89%	5%	5%	2%	100%
Sep-94	Hrs.	546	78	64	28	717
	%	76%	11%	9%	4%	100%
Oct-94	Hrs.	458	121	109	35	723
	%	63%	17%	15%	5%	100%
Nov-94	Hrs.	302	195	192	30	719
	%	42%	27%	27%	4%	100%
Dec-94	Hrs.	389	232	86	23	730
	%	53%	32%	12%	3%	100%
TOTAL HRS.		5262	1562	1156	403	8381
% TIME	%	63%	19%	14%	5%	100%

Source: G. Bogen Associates Inc.

EXHIBIT 3-c

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SeaTac Airport - 1994 Weather Conditions

		VFR1 CONDITION	VFR2 & IFR CONDITIONS MEET LDA CRITERIA	VFR2 & IFR CONDITIONS FAIL LDA CRITERIA	Total
Jan-94	Hrs.	275	191	277	743
	%	37%	26%	37%	100%
Feb-94	Hrs.	273	174	208	655
	%	42%	27%	32%	100%
Mar-94	Hrs.	523	129	90	743
	%	70%	17%	12%	100%
Apr-94	Hrs.	351	160	105	616
	%	57%	26%	17%	100%
May-94	Hrs.	503	134	72	709
	%	71%	19%	10%	100%
Jun-94	Hrs.	510	87	69	667
	%	77%	13%	10%	100%
Jul-94	Hrs.	478	78	67	623
	%	77%	13%	11%	100%
Aug-94	Hrs.	653	-37	47	737
	%	89%	5%	6%	100%
Sep-94	Hrs.	545	86	86	717
	%	76%	12%	12%	100%
Oct-94	Hrs.	458	130	135	723
	%	63%	18%	19%	100%
Nov-94	Hrs.	302	217	200	719
	%	42%	30%	28%	100%
Dec-94	Hrs.	389	217	124	730
	%	53%	30%	17%	100%
TOTAL HRS.		5262	1640	1480	8381
% TIME		63%	19%	18%	100%

Source: G. Bogan Associates Inc.

EXHIBIT 3-d

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increased, the VFR-2 and IFR-1 weather reports for each hour were sorted and identified into two new categories, IFR-1 good (IFR-1G) and IFR-1 bad (IFR-1B). They are defined as:

- IFR-1G. VFR-2 and IFR-1 weather where the ceiling is between 2,200 feet and 4,999 feet and visibility 6 miles or more. This weather exceeds FAA LDA weather criteria approved for SFO and STL airports.
- IFR-1B. The remaining VFR-2 and IFR-1 weather where ceilings are less than 2,199 feet and or visibility less than 6 miles down to and including IFR-2, 3, & 4 weather conditions. These weather conditions were determined not suitable for LDA approaches at Sea-Tac even though FAA has approved lower ceiling and visibility requirements at STL than has been defined for IFR-1G in this study. An interesting side note, due to the apparent acceptance of LDA approaches, FAA is considering reducing ceiling and visibility criteria for LDA approaches. The new weather criteria, if approved, would increase the number of hours that dual stream arrival flows could be conducted at Sea-Tac beyond what is identified in this report, resulting in even less delay.

IFR-1G weather (IFR-1 & VFR-2 that meets FAA LDA weather criteria) was combined with the VFR-1 weather conditions when analyzing dual stream potential. Our hourly analysis confirmed that VFR-1 weather conditions exist approximately 66% of the year. VFR-2, & IFR-1, 2, 3, and 4 account for the remaining 34 % of the annual weather at Sea-Tac. IFR-1G accounts for approximately 17 % of the "poor weather" conditions, with IFR-1B, (which does not meet the FAA LDA weather criteria) the remaining 17 %.

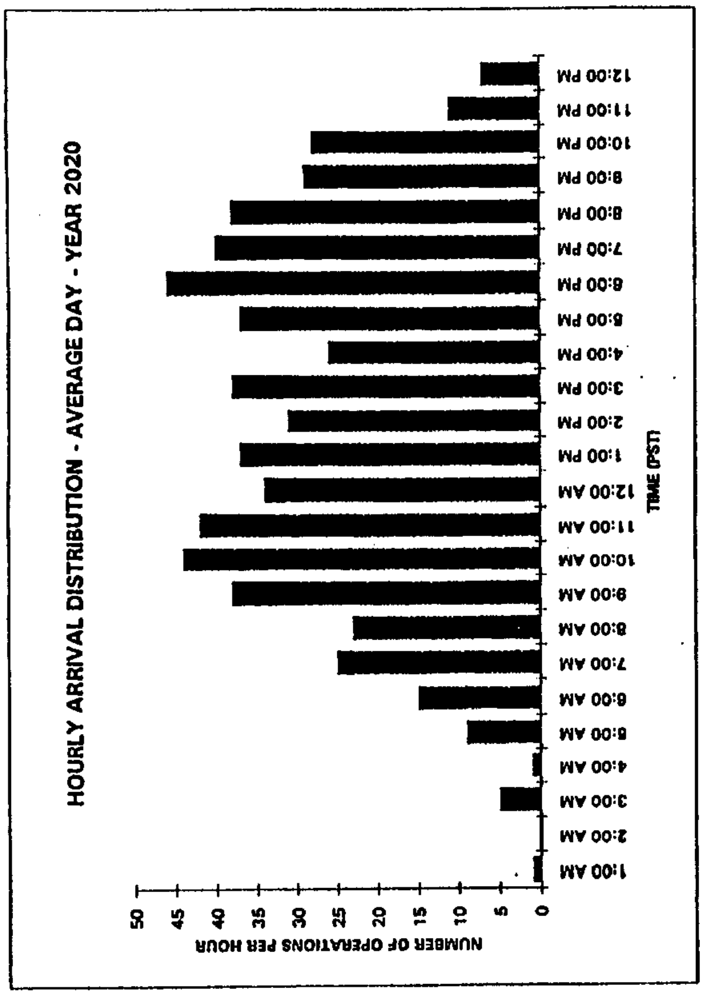
III FEASIBILITY OF AN LDA APPROACH PROCEDURE AT SEA-TAC.

The main thrust of this study is to determine if an LDA approach to runway 16R will allow dual stream arrivals during some of the 44% of poor weather conditions claimed by the DEIS. If LDA approaches can be conducted a sufficient number of hours per day, and reduce delays to an acceptable level, construction of a third runway is not necessary. To determine the actual number of hours that LDA approaches could be conducted, this study compared IFR-1G and IFR-1B weather criteria to the hourly forecast demand identified in the DEIS.[4]

VFR-1 weather exceeds FAA weather requirements for establishing an LDA approach procedure. Hourly VFR-2 & IFR-1 conditions of the 1993 and 1994 weather data was analyzed and separated into IFR-1G and IFR-1B, as defined earlier in this report. IFR-1G criteria was developed by equaling or exceeding the weather criteria required by the FAA when procedures were approved at San Francisco International (SFO) and Lambert Field St. Louis International (STL) airports. Minimum weather requirements

[4] Exhibit - hourly arrival distribution average day year 2020.

4



Source: SeaTac Airport Master Plan Update Draft EIS Exhibit II-35A (DO NOTHING)

EXHIBIT 4

for SFO are 2,100 foot ceiling and 6 miles visibility. STL weather requirements are 1,200 foot ceiling and 5 miles visibility. Instead of utilizing the weather criteria approved for STL, the IFR-1G weather criteria was designed to exceed the SFO criteria. Therefore the IFR-1G weather criteria of a ceiling minimum of 2,200 feet and 6 miles visibility is more conservative than what has been approved by the FAA for either SFO or STL.

IFR-1G weather (by definition meets LDA weather criteria), added to VFR-1 meets or exceeds LDA weather criteria and accounts for approximately 83 % of the year. The remaining 17 % of the year only a single arrival stream can be used in the LDA 16R and ILS 16L scenario. Later in this study the resulting impact on airport capacity of the remaining 17% is discussed in detail. Clearly an LDA approach to 16R plus the planned ILS approach to 16L is a viable alternative to constructing a third runway at Sea-Tac. It reduces the 44% of single arrival stream time claimed by the DEIS to 17%.

The unanswered question is, without a third runway, can Sea-Tac accommodate the year 2020 forecast utilizing a dual stream LDA approach 83% of the year.

IV YEAR 2020 ANNUAL FORECAST AND HOURLY DEMAND.

An hourly analysis of the DEIS 2020 arrival and departure forecast was conducted. The arrival and departure peaks do not occur in the same hours. The arrival peak hours significantly exceed the number of departure peak hours, therefore; arrivals were selected for detailed analysis.[5] The 2020 arrival forecast concludes that 38% of the time, the arrival demand is less than 24 operations per hour. The DEIS has identified 10 minutes as the "maximum tolerable level of total all-weather delay per operation." It concludes this maximum delay will allow Sea-Tac to maintain an efficient and profitable air service. The stated goal is to operate the airport in such a fashion that average delays do not exceed 6 to 7 minutes per operation. The DEIS claims this reduced delay goal is desirable and will minimize airline operating costs and passenger inconvenience.

Using the DEIS acceptable delay factor as a guide the 2020 fleet mix and forecast volume was exposed to an airport operational scenario consisting of the two existing runways and dual arrival streams using ILS 16L and LDA 16R procedures. The airport arrival operating capacity data identified in the Draft EIS is: VFR-1 with an hourly arrival maximum of 60, VFR-2 with a 48 per hour arrival maximum, IFR-1 with a 36 per hour arrival maximum, and IFR-2, 3, and 4 with a maximum hourly arrival rate of 24.

The 2020 arrival forecast does not exceed the VFR-1 maximum hourly acceptance capacity of 60 arrivals during any hour of the forecast period. Therefore, it is assumed that during VFR-1 conditions (66% of the year), additional arrival delays due to weather constraints will not occur. Analysis of other weather conditions such as IFR-

[5] Exhibit - hourly arrival and departure distribution average day, year 2020.

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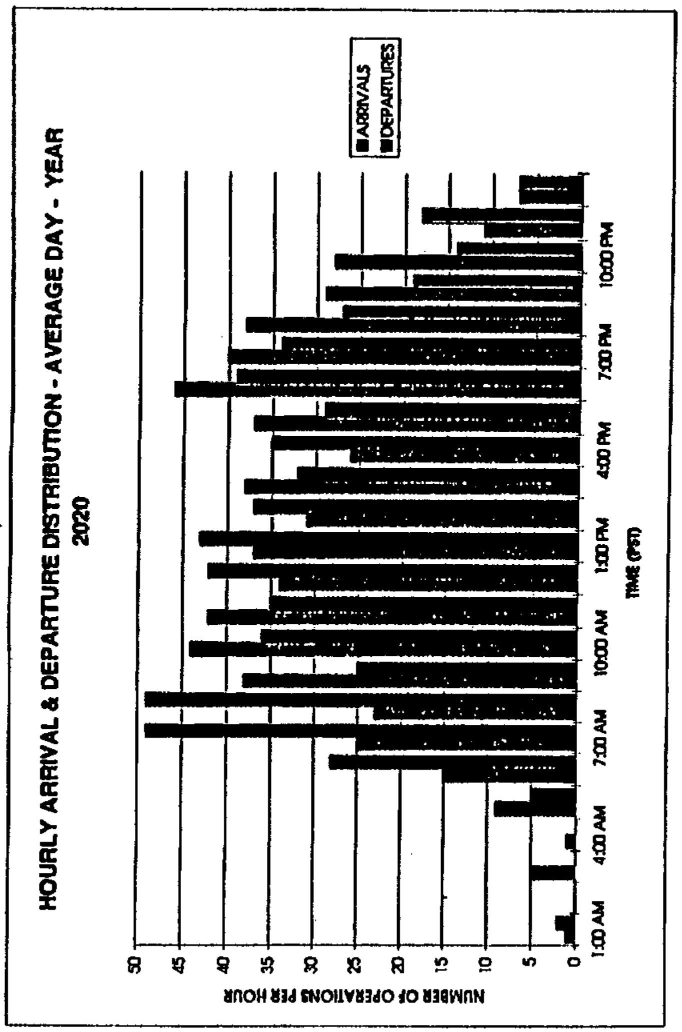

Source: Sea-Tac Airport Master Plan Update Draft ES Exhibit 4-35A (DO NOTHING)

EXHIBIT 5

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1G (weather conditions that meet LDA requirements) was conducted with the same results as that of VFR-1. That is, during IFR-1G dual arrival streams, no additional delays due to airport arrival rates should be encountered. Further analysis was conducted to determine the ability of the airfield to accommodate future arrival demand during those periods of weather (IFR-1B, IFR-2, 3, and 4), when only single stream arrivals can be conducted.

The DEIS indicates that from 1988 to 1993 delays at Sea-Tac have been reduced from 48,000 hours to 26,000 hours, a delay reduction of approximately 46%. The DEIS credits the reduction in delays to several airport improvements and improved air traffic control efficiency. This reduction in hours of delay was accomplished even with an increase in annual operations. The annual operations increased from 316,260 in 1988 to 353,052 in 1994. Examples of airport improvements cited in the DEIS include: relocation of ILS runway 16R aircraft hold lines, installation of runway centerline lights on runway 16L, improved air traffic control monitoring of traffic flows, improved lighting and signage, and a more homogeneous fleet mix.

Upon analyzing weather conditions that have been the cause of airport delays, namely reduced arrival capacity during single stream arrival periods, it is obvious airport delays are attributed to reduced capacity associated with poor weather. Therefore the 46% reduction in delays should be in direct proportion to improved airport acceptance rates during those single stream arrival flows. The DEIS states that all the improvements were directly related to enhancing airport efficiency and mitigating the reduced arrival capacity associated with single stream operations. Yet even with the improvements that reduced the delays, the DEIS does not adjust the hourly arrival acceptance rates in its current analysis from the arrival rates in 1988 prior to the identified delay reduction of 46%.

When the DEIS uses the 1986 arrival rate for IFR-2+ in the 1996-2020 analysis it ignores all of the improvements already made plus any future improvements that may be implemented during the next 25 years.

The Sea-Tac single stream acceptance rate in 1988 was 24 arrivals per hour. As previously stated since the airport improvements, the reduction in delays equal 46%. Therefore; it is reasonable to assume the single stream arrival rate increased proportionately. 24 operations increased by 46% (24 ops. X 46% = 35 ops.) which is a substantial increase in hourly acceptance rates. One can reasonably assume that the airfield will continue to operate in an ever increasing efficient manner. Accordingly, runway acceptance rates should increase. FAA Advisory Circular 150/5060, Airport Capacity and Delay, identifies what hourly operations should be expected for different runway configurations. The numbers below, identified as runway capacity arrival expectations, parallel the hourly runway arrival figures found in the FAA Advisory Circular. The figures on the right (DEIS Runway Capacity: Arrival Expectations) represent hourly arrival rates used in the DEIS study encountered prior to all the airport operational improvements cited since 1988. Those improvements are the basis

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for the 46% reduction in delays. Obviously, the improvements fostered increased hourly acceptance rates during bad weather. Without increased acceptance rates, delay reductions of 46% could not have been attained.

Conditions:	Runway Capacity: Arrival Expectations	DEIS Runway Capacity: Arrival Expectations
Good Weather		
VFR-1	65 +	60
Poor Weather		
VFR-2	52-55	48
IFR-1	48-50	36
IFR-2, 3, & 4	36-38	24

Analysis of dual stream capacity (LDA 16R and ILS 16L) concludes delays can be kept to an acceptable level. Although 46% equals an arrival rate of 35 per hour, this analysis is based on a single stream capacity of 36 arrivals per hour which is within the calculations of runway acceptance rates cited in the FAA Advisory Circular. In keeping with the improving airport operating efficiency described in the DEIS, a conservative 36 arrival rate should easily be attained by the year 2020. When comparing the airport arrival rate of 36 to the DEIS 2020 Hourly Arrival Distribution data, those hours that did not exceed the arrival capacity of 36 (per the DEIS) were considered to not cause additional delays and dropped from further review.

The DEIS 2020 Hourly Arrival Distribution chart identifies 8 hours per day that forecast demand exceeds an arrival capacity of 36 per hour. Those 8 hours were analyzed using the detailed 24 hour weather data for December 1993 and February 1994[6]. The purpose of this study is to prove that with proper instrumentation (LDA 16R and ILS 16L), Sea-Tac can operate in an efficient manner without having to construct a third runway. To assure credibility of conclusions formed as a result of this study, December 1993 and February 1994, were selected for weather computations. December and February recorded the lowest percentage dual stream weather condition during the two years of detailed weather analyzed. Following is a description of the analysis process used in the forecast demand and detailed weather breakdown that was analyzed.

Detailed weather, December 1993:

9:00 AM — Arrival demand is forecast to be 38 operations for the 9:00 AM hour. For seven days the 9:00 AM hourly arrival rate is 36 per hour during the weather conditions that require a single stream scenario. 2 operations exceed the arrival capacity for those 7 days; or 14 operations (7 x 2), have experienced additional delays at that hour during the month of December, 1993. Using this calculation method the excess hours of demand in December 1993, are listed below.

[6] Exhibit - a,b, non- LDA weather conditions by hour of day Dec 1993, Feb 1994.

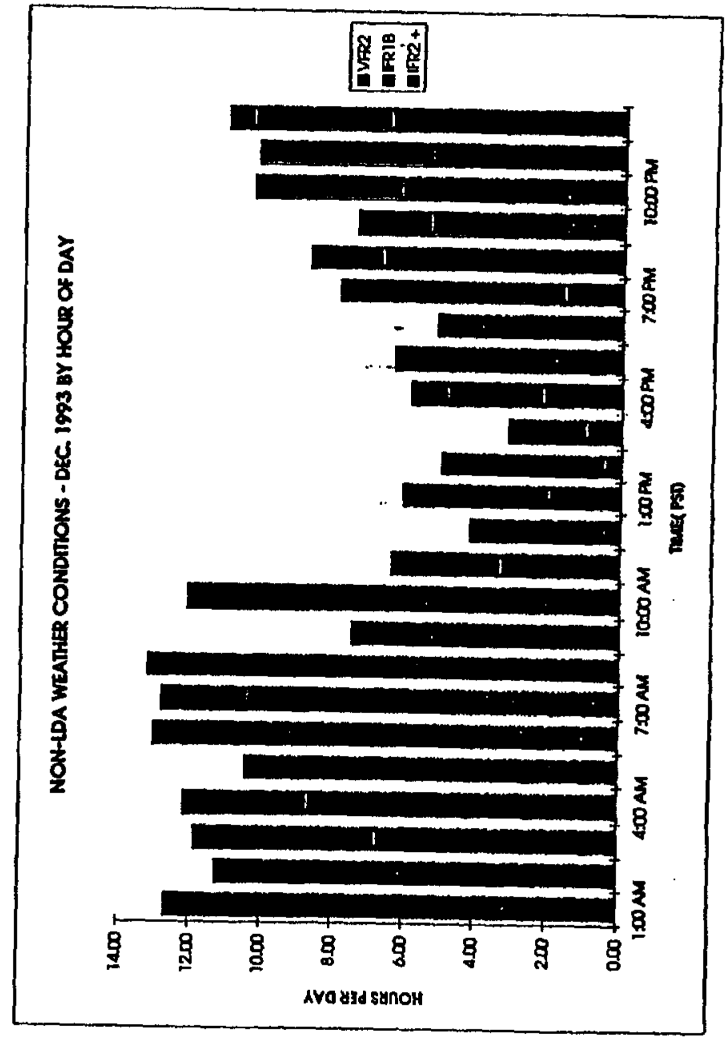

EXHIBIT 6-a

Source: G.Bogan Associates Inc.

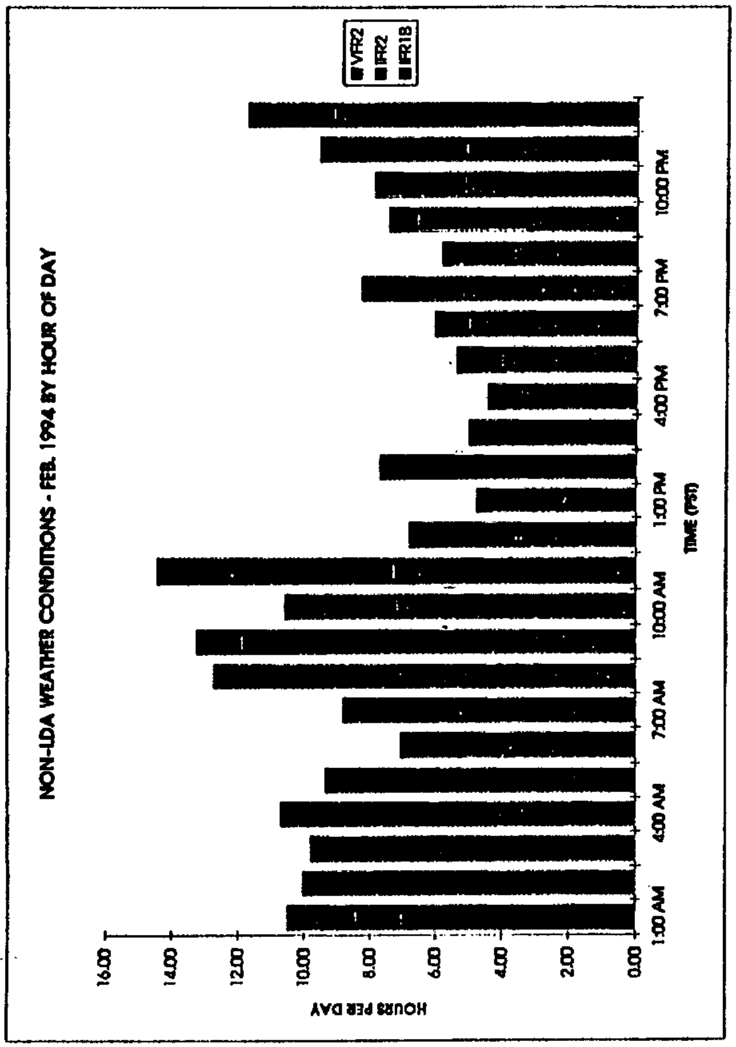

EXHIBIT 6-b

Source: G. Bogan Associates Inc.

9:00 AM 14 operations exceed the monthly arrival rate for that hour.

10:00 AM 104 operations exceed the monthly arrival rate for that hour.

11:00 AM 42 operations exceed the monthly arrival rate for that hour.

1:00 PM 6 operations exceed the monthly arrival rate for that hour.

3:00 PM 6 operations exceed the monthly arrival rate for that hour.

6:00 PM 50 operations exceed the monthly arrival rate for that hour.

7:00 PM 36 operations exceed the monthly arrival rate for that hour.

8:00 PM 18 operations exceed the monthly arrival rate for that hour.

A total of 276 operations during that month exceed the 36 hourly runway operation single flow capability.

Detailed weather, February 1994:

Using the same methodology as described for the December analysis, the hours of excess demand for February 1994, are listed below.

9:00 AM 28 operations exceed the monthly arrival rate for that hour.

10:00 AM 86 operations exceed the monthly arrival rate for that hour.

11:00 AM 90 operations exceed the monthly arrival rate for that hour.

1:00 PM 5 operations exceed the monthly arrival rate for that hour.

3:00 PM 10 operations exceed the monthly arrival rate for that hour.

6:00 PM 60 operations exceed the monthly arrival rate for that hour.

7:00 PM 32 operations exceed the monthly arrival rate for that hour.

8:00 PM 12 operations exceed the monthly arrival rate for that hour.

A total of 323 operations during that month exceed the 36 hourly runway operation single flow capability.

In the year 2020 the DEIS forecasts annual operations to be 441,600, an average of 36,800 operations per month, or an average of 18,400 arrivals. Of the 18,400 arrival operations forecast per month, 276 operations or approximately 1.5% of the total December arrival demand could encounter some additional delay due to a single stream arrival flow. For the February arrival demand, the percent of delay due to a single stream arrival flow is approximately 1.8%. When considering the possible inaccuracies acceptable in long range forecasting, this delay of less than 2%, is negligible. This low estimate of delay is because the DEIS claims 44% weather where single stream is required, versus the 17% identified in the detailed analysis conducted in this study.

Additionally, the DEIS underestimates the success of the past airport and airspace improvements it identifies as the cause of the 46% reduction in delays since 1989. Because the DEIS does not properly credit their contribution to delay reduction the DEIS underestimates the true hourly acceptance rates at Sea-Tac. When the cited improvements are properly considered and single stream arrival rates adjusted accordingly unwanted delays rapidly decline. Unlike the DEIS conclusion this can be accomplished without the addition of another runway. Finally, the 2020 arrival peak hours have a smaller proportion of the 17% single flow arrival stream weather than the off peak hours.

An annual average analysis was made for 1993 using acceptance rates of 36 operations per hour for the expected case, and decreasing to 24 operations per hour during IFR2+ portions for the worst case during non LDA weather. The annual results also indicate that the acceptance rate is exceeded less than 1% of the year for the "expected case" and less than 2% for the "worst case". The analysis of 1994 weather should produce similar results. [7]

The purpose of this study was to evaluate methods of satisfying forecast demand versus the airport acceptance capability. During the preliminary analysis it became obvious that three key issues drove the focus of this study. The need to analyze the weather in greater detail to determine specific weather conditions i.e., VFR, IFR, etc., and when that occurs by hour. Predicated on the outcome of the detailed weather analysis, could dual stream arrivals using LDA 16R and ILS 16L with the existing two runway configuration be a viable solution to demand forecasts. Lastly, the third and probably most crucial issue was, is the above mentioned airport configuration compatible with the forecast demands and possible delays. As in the DEIS an important goal of this study was to limit delays to an acceptable level.

Without doubt the extensive analysis of the three key issues and secondary concerns that surfaced all validated the following conclusions and recommendations.

The DEIS claims to have analyzed ten years of Sea-Tac hourly weather observations. Upon a review of the conclusions and assumptions it is obvious that the analysis was

[7] Exhibit - expected case, worst case, annual ops analysis 1993.

ARRIVALS EXCEEDING AIRPORT ACCEPTANCE RATE DURING NON-LDA WEATHER CONDITIONS - 1993

MONTH	EXPECTED CASE	WORST CASE
JANUARY	157	244
FEBRUARY	70	108
MARCH	177	379
APRIL	84	113
MAY	66	65
JUNE	90	128
JULY	135	210
AUGUST	96	118
SEPTEMBER	48	125
OCTOBER	240	612
NOVEMBER	212	303
DECEMBER	276	685
TOTAL	1,650	3,090

PERCENT OF TOTAL YEARLY ARRIVALS EXCEEDING AIRPORT ACCEPTANCE RATE:

YEARLY TOTAL, EXPECTED CASE:	1650 / 220800	=	0.75%
YEARLY TOTAL, WORST CASE:	3090 / 220800	=	1.40%

NOTES:

1) EXPECTED CASE: BASED ON ACCEPTANCE RATE OF 36/HOUR (SINGLE FLOW NON-LDA WEATHER)

2) WORST CASE: BASED ON ACCEPTANCE RATES OF 36/HOUR EXCEPT 24/HOUR DURING THE IFR2+ PORTION OF NON-LDA WEATHER (SINGLE FLOW LDA WEATHER)

Source: G. Bogan Associates Inc.

EXHIBIT 7

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not in sufficient detail to identify when and how often weather conditions really limit the arrival flow to single stream. A detailed analysis identifies what hours of the day or night that certain weather conditions exist. This is especially important when the purpose of the DEIS is to determine if the airport can accommodate the year 2020 forecasts with or without the need for a third runway.

The DEIS weather analysis was not detailed enough to give credit for off peak hours when weather is poor.[8] That oversight erroneously leads one to believe demand will suffer due to "poor weather" even though a large portion of inclement weather occurs during low or non demand periods. This study refutes the DEIS conclusion regarding the percentage of "poor weather" and the ability to conduct dual stream approaches to accommodate forecast operations.

Those peak hours when arrivals exceed 36 per hour significantly exceed the number of hours when departures would not be accommodated without unacceptable delays. Arrivals are exposed to the most delay and are the main thrust of this study.

The detailed analysis of the 1993 and 1994 Sea-Tac annual weather concludes that the ceiling and visibility impact on single stream arrivals is only approximately 17% of the year. Annual weather in the Seattle area is such that ceiling and visibility conditions that will support LDA criteria equals or exceeds FAA requirements approximately 83% of the year. This means that dual stream arrival flows can be utilized to satisfy nearly all the airport's forecast hourly demand. This includes the long range forecast period of 2020 and the 441,600 annual operations and approximately 38.2 million passengers.

The DEIS annual hourly demand forecast was analyzed with special emphasis on the following issues.

a. Actual detailed hourly weather observations
b. The Port's runway use plan, and fleet mix, cited in the DEIS
c. Dual flow capabilities of an LDA 16R and an ILS 16L arrival plan
d. The impact of single flow when dual streams can not be used
e. Keeping the airport runway layout at two runways only

The sum of the analysis of these issues concludes, constructing a new third runway is unnecessary to reasonably accommodate current and future (year 2020) operations. The recent airport and air traffic control improvements have resulted in an significant reduction in delays and subsequent costs to the airlines and flying public. There is no reason to think that this efficiency will not continue and even increase over the years. If all these gains have been accomplished with the current airport configuration, then increasing dual flow operational periods by use of an LDA approach should accommodate the DEIS forecast for the year 2020.

8 Exhibit - non-LDA weather conditions by hour of day Jan. to Dec. 1993

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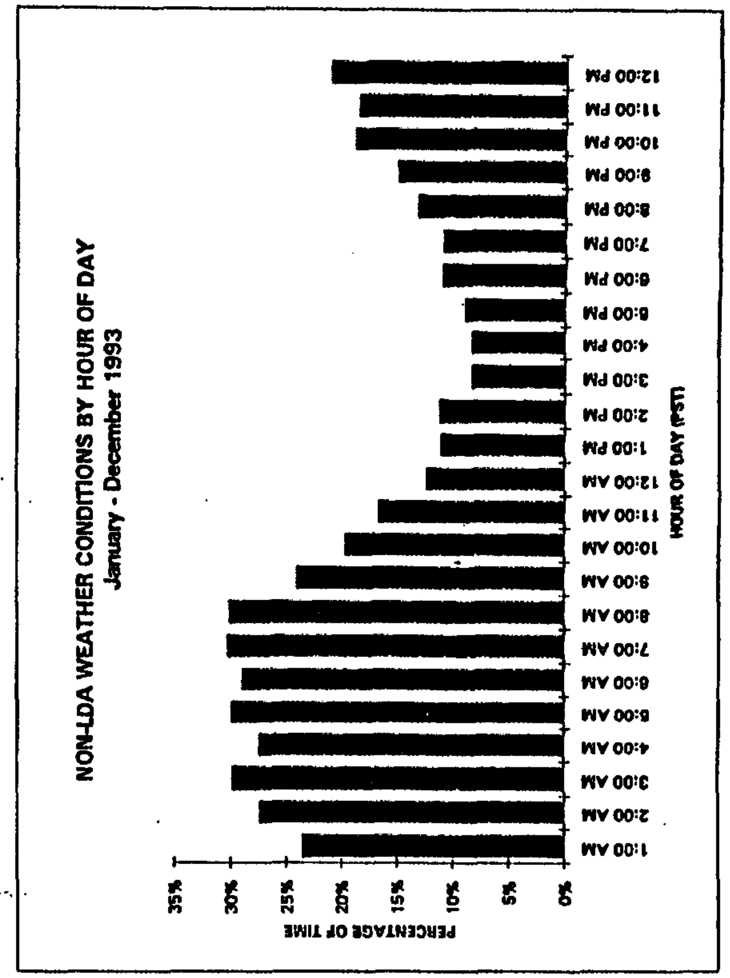

EXHIBIT 8

Source: G. Bogan Associates Inc.

With weather conditions that equal or exceed LDA criteria (83% of the year) all that is required is to get the aircraft below the clouds in an efficient and orderly manner. This can be done. When aircraft are below the clouds the airport can reasonably accommodate the volume, including the long range forecasts, with the current two runway configuration.

V CONCLUSION

Detailed analysis indicates that a third runway is unnecessary, and that the DEIS conclusions are based on faulty assumptions. The Port has not exhausted all alternatives including LDA approach procedures in an effort to resolve future capacity problems without constructing a third runway. Equipping the airport in its present configuration with LDA capability to an existing runway can reasonably accommodate the activity forecast for the year 2020. LDA approach procedures have been implemented at San Francisco and St Louis and soon will be at Charlottesville. It proves that implementing LDA procedures can be accomplished quicker and cheaper than building an additional runway.

TABLE OF CONTENTS AND SOURCE DOCUMENTS

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GLOSSARY

Sea-Tac	Seattle Tacoma International Airport.
SFO	San Francisco International Airport.
STL	Lambert Field St. Louis International Airport.
16L	The easterly of the 2 parallel runways, south flow.
16R	The westerly of the 2 parallel runways, south flow.
DME	Distance Measuring Equipment.
EIS	Environmental Impact Statement.
DEIS	Draft EIS.
ILS	Instrument Landing System.
LDA	Localizer Directional Aid.
Ops	Operations.
Wx	Weather Report.
TERPS	FAA Handbook, Terminal Instrument Procedures.
VFR	Visual Flight Rule conditions.
IFR	Instrument Flight Rule conditions.
VFR-1	Local definition of VFR (ceiling at least 5,000 feet and visibility 5 miles or more).
VFR-2	Local definition of VFR (ceiling between 2,500 feet and 4,999 feet and visibility 3 miles or more).
IFR-1	local definition of IFR (ceiling above 800 feet and less than 2,499 feet and or visibility is less than 3 miles).
IFR-2 IFR-3 IFR-4	All three of these categories. Ceilings from less than 800 feet down to zero and visibility 2 miles down to zero. IFR-4 is the worst weather condition.

IFR-1G Weather defined for this study. A combination of VFR-2 and IFR-1 where the ceiling is 2,200 feet to 4,999 feet and the visibility is 6 miles or more.

IFR-1B Weather defined for this study. A combination of VFR-2 and IFR-1, or worse, with a ceiling of 2,199 feet or less and the visibility is less than 6 miles.

EXHIBITS

2 Sea-Tac Airport LDA Weather Conditions 1993 - (pg 3).

3 a- Sea-Tac Airport Weather Conditions 1993 - (pg 3).

3 b- Sea-Tac Airport Weather Conditions 1993 - (pg 3).

3 c- Sea-Tac Airport Weather Conditions 1994 - (pg 3).

3 d- Sea-Tac Airport Weather Conditions 1994 - (pg 3).

4 Hourly Arrival Distribution, Average Day, Year 2020 - (pg 4).

5 Hourly Arrival and Departure Distribution, Average Day, Year 2020 - (pg 5).

6 a- Non-LDA Weather Conditions, by Hour of Day, December 1993 - (pg 7).

6 b - Non-LDA Weather Conditions, by Hour of Day, February 1994 - (pg 7).

7 Annual Operations Exceeding Hourly Acceptance Rate, Non-LDA Weather Conditions, 1993 - (pg 9).

8 Non-LDA Weather Conditions, by Hour of Day, January to December 1993 - (pg 10).

SOURCE DOCUMENTS

Sea-Tac Airport Master Plan Update Draft EIS Apr.1995 (select sections).

U.S. Weather Bureau Service Hourly Surface Weather Observations Sea-Tac Airport 1993 & 1994.

FAA Technical Center - Sea-Tac Capacity Enhancement Plan Update Data Package # 11.

FAA approved LDA Procedures - SFO and STL International Airports.

FAA Advisory Circular - Airport Design.

FAA Advisory Circular - Airport Capacity and Delay.

FAA Handbook - Airspace Procedures.

FAA Handbook - National Airspace System Plan.

FAA Handbook - Aviation Capacity Enhancement Plan.

FAA APO 80 - Terminal Area Forecasts.

United States Standards for Terminal Procedures (TERPS).

G. Bogan & Associates, Inc.

Aviation Consultants

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In the world of Aviation Consulting, the best way to measure a company's competence is by its track record. G. Bogan & Associates, Inc., is a highly experienced and well established consulting firm uniquely qualified to evaluate and coordinate the implementation of all types of aviation projects, ranging from initial feasibility studies to facility layout and design.

Jerry Bogan, President of the firm, has over 31 years of personal experience as well as an extensive network of professionals to draw upon. Over the years, he has developed strong personal relationships with key players in the Federal Aviation Administration (FAA), The National Transportation & Safety Board (NTSB), individuals in the private and public sector, and all branches of the United States Military.

As a result, for the past eight years, G. Bogan & Associates, Inc., has developed a team of experts with the background and knowledge to analyze current trends, forecast future needs and effectively assist in all facets of planning and development of air transportation facilities both domestically and internationally.

The company has a results-oriented history of completing jobs ahead of schedule, within budgetary parameters and offering services in the following areas:

- Air Traffic Control Systems, Navigational Aid planning and development.
- Air Traffic / Airspace Procedures analysis and planning.
- Accident Investigation and Expert Witness.
- Federal Air Regulation Enforcement actions.
- Obstruction Evaluation analysis including FAR (Part 77), and Terminal Instrument Procedures (TERPS).
- Airport Masterplanning and Improvement studies.
- FAR (Part 150) Noise and Land Use Studies.
- Aviation Forecasting / Airport Capacity analysis.
- Environmental Impact studies and assessment.
- Heliport design and development.
- Airport economic analysis and planning.

Over the years, such notable clients as NASA, The U.S. Department of Defense, Southern California Association of Governments and The California Department of Transportation have come to rely on the firm's expertise.

G. Bogan & Associates, Inc. - Page two

Additionally, G. Bogan & Associates have performed airport and aviation studies for major facilities in the cities such as Los Angeles and Newport Beach, California, Tempe, Arizona, Eagan, Minnesota and Chicago Illinois. The company has also been retained by many foreign interests, providing services for airports located in China, Saudi Arabia, England, Turkey and the Republic of Indonesia.

G. Bogan and Associates, brings a list of impressive credentials and an extensive aviation background to any project they are assigned. The firm operates on the philosophy of solid teamwork and a commitment to providing the air transportation community with services that not only fill current needs but those projected into the next century.

GERALD H. BOGAN
President

EDUCATION

University of Arizona, School of mines, Tucson, AZ
Long Beach City College, Long Beach, CA

FAA TRAINING
FAA Executive School...Managerial Training Course.. Manpower Utilization...Operational Supervision for Air Traffic Control Facilities...Labor Management & Relations Course...National Airspace Systems Stage III Automated Radar.

EXPERIENCE

G. Bogan & Associates, Inc.
PRESIDENT

* Provided a wide variety of developmental, analytical and technical support for numerous aviation clients.

PROJECTS

* Feasibility analysis of joint civil/military use at MCAS El Toro, California.
* Master plan development for Jeddah Airport in Saudi Arabia.
* Preliminary master plan development and feasibility study for Schenzen International Airport in China.
* Audit of the Republic of Indonesia's civil aviation structure.
* Development of procedures, routes and other setup details compatible with airport authorities for Airspur Helicopter Service.
* Development and installation of microcomputer system in U. S. Navy and Marine Air Facilities.
* Prepared all training documentation and coordinated the installation of a microcomputer system serving six FAA air traffic control towers.
* Provide consulting on aircraft noise and related airport problems for the City of Tempe, AZ., Eagan MN., Citizen Groups in Chicago IL., Newport Beach CA., Newark NJ., and Boone County Kentucky.

GERALD H. BOGAN
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* Analysis of air traffic control procedures, communications, and navigational aid requirements necessary for hypersonic aircraft operations for McDonald Douglas and NASA.

* IFR procedure analysis including feasibility recommendations on helicopter IFR route system for the Southern California Association of Governments.

* Airport and airspace capacity analysis for all air carrier airports in California for the California Department of Transportation.

* Analyze flight tracks and noise mitigation plans proposed by FAA and airport proprietor at Seattle-Tacoma International airport, for citizens committee involved with airport problems.

* Review airport master plan and capacity forecasts at Vancouver International Airport, B.C., for citizens involved with airport problems.

* Member of National Transportation Safety Board Team investigating an air carrier/civil aircraft collision in San Louis Obispo, California.

* Provide litigation service as expert witness in air traffic control matters, airport design, obstruction evaluation, and Federal Air Regulations affecting airport safety,

* Provide aircraft noise analysis, flight track, and capacity forecasts for clients developing property adjacent to airports. Assist in obtaining required permits and approvals from the FAA for the projects.

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FEDERAL AVIATION ADMINISTRATION (Positions Held)
Chief, Los Angeles Air Route Traffic Control Center
Chief, Coast TRACON, MCAS El Toro
Supervisor, Los Angeles Tower/TRACON
Air traffic controller, Los Angeles Tower/TRACON
Military Activities Officer
Noise Abatement Officer
Plans and Program Specialist

MILITARY
U.S.A.F. Air traffic and radar controller

LICENSES
Control Tower Operator...Weather Observer
Commercial Pilots License

AWARDS
FAA Citations and Special Achievements Awards, 1967, 1968, 1976, 1980
FAA Outstanding Rating Awards, 1969, 1976
U.S. Air Force Special Achievement Medal

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GERALD M. DALLAS
Associate

EDUCATION

University of Idaho
Bachelor of Science in Civil Engineering.

Federal Aviation Administration Executive School

EXPERIENCE

PROJECTS

- Provided services in a variety of airport related projects including FAR Part 150 noise and land use studies, airport master plans, runway design and layout, environmental impact reports, airport economic studies, and runway landing systems design and installation.
- Participated in numerous airport planning and engineering projects for the military, aircraft manufacturers, and airlines, including the design and construction of two corporate headquarters and maintenance bases for major airlines.
- Conducted airport planning studies for Los Angeles International Airport and San Diego Airport. Provided land use and noise studies for San Diego Airport, Torrance Airport, Sky Harbor Airport, and Chicago O'Hare Airport.
- Produced regional aviation system plans for the Southern California Association of Governments and the San Diego Association of Governments.
- Developed and supervised preparation of plans and specifications for over 35 airport inspection projects.
- Conducted and prepared reports for air cargo facility studies for Boeing Aircraft Company.
- Coordinated and participated in new airport site evaluation studies for cities in California and Oregon.

Federal Aviation Administration
AIRPORT PLANNING / PROGRAMMING BRANCH MANAGER

Responsible for all FAA airport systems plans, including master planning, site location, environmental impact report preparation and processing, noise studies, airport engineering, and regional and state systems plans.

DISTRICT OFFICE CHIEF

MILITARY

United States Navy - Lieutenant

PROFESSIONAL

Member of the American Society of Civil Engineers

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STATE OF WASHINGTON
PUGET SOUND REGIONAL COUNCIL

In the Matter of:)

Expert Arbitration Panel's Review of Noise and Demand/System Management Issues at Sea-Tac International Airport)

FINAL PHASE I ORDER ON DEMAND/SYSTEM MANAGEMENT ISSUES

July 27, 1995

The Expert Arbitration Panel on Noise and Demand/System Management Issues (the "Panel") has held three rounds of hearings on Demand/System Management Issues. We announced, at the close of our May 1995 hearings, that the Panel would soon issue its Phase I decision on Demand/System Management Issues. This is that Order.

Background.

On August 12, 1994, we heard preliminary presentations by Claire Barrett of Claire Barrett & Associates, consultant to the Port of Seattle ("POS") on Demand Management, and from Brian Ziegler, speaking for the Washington State Department of Transportation ("WSDOT"), on the System Management option of "high-speed rail." A few comments from the public, both oral and written, were then also received. On December 2, 1994, we returned to these issues. The WSDOT, through Mr. Ziegler, presented its "Final Report on The Impact of Intercity Passenger Rail on Operations at SeaTac Airport." The POS, through Michael Feldman, Manager of Aviation Planning for the POS, Claire Barrett, and Ronald Ahlfeldt of P&D Aviation, presented a "progress report" on their review of the feasibility of two kinds of demand management programs: congestion pricing and gate controls. We also received oral comments from Alaska Airlines and Horizon Airlines, and both written and oral comments from various members of the public.

On February 24, 1995, the Panel issued its Preliminary Order on Demand/System Management Issues. Our Preliminary Order laid out the framework of the Panel's consideration of Demand/System Management Issues. We summarized the pertinent provisions of Resolution A-93-03 adopted by the Puget Sound Regional Council ("PSRC"), the PSRC's "Implementation Steps" for the Panel, and the Memorandum of Understanding ("MOU") among the PSRC, the Federal Aviation Administration ("FAA"), the POS and the WSDOT. The Resolution, which we have considered to be the controlling document, provides that "the region should pursue vigorously ... a third runway at Sea-Tac" and that the third runway "shall be authorized by April 1, 1996 ... [a]fter demand management and system management programs are pursued and achieved, or determined to be infeasible, based on independent evaluation ...."

In our Preliminary Order, the Panel addressed some basic questions about the scope and nature of our inquiry. After careful consideration of the Resolution, the Implementation Steps and the MOU, we concluded that the Resolution must be interpreted to require the Panel to consider whether any demand or system management options are "feasible" in the sense that they could be implemented in a way that they could be expected to obviate or defer the need to construct the third runway. With this understanding, we announced that we would address the Demand/System Management Issues in two phases. We said that in Phase I, we would continue to focus our attention on the existing capacity constraints, the current and expected levels of demand, and the existing and expected levels of delay at Sea-Tac if the third runway is not built, and would address the determinative questions raised by each of the three methods of demand or system management that had, at that time, been offered to us:

1. When could a method of congestion pricing (for the use of the airfield) be implemented at Sea-Tac, and what impact would it be expected to have on the level of aircraft operations or the amount of delay at Sea-Tac?

2. When could a method of gate controls be implemented at Sea-Tac, and what impact would it be expected to have on the level of aircraft operations or the amount of delay at Sea-Tac?

3. Could a system of true high speed rail be put in operation before 2020, and if so, what impact would it be expected to have on the level of aircraft operations or the amount of delay at Sea-Tac? What is the greatest reduction in the level of aircraft operations or the amount of delay at Sea-Tac that could be expected to result from more readily achievable improvements in existing rail service connections to the principal short-haul air destinations (for example, Seattle - Portland)?

We emphasized that we felt that it was essential, for the Panel responsibly to discharge its duties and for the public to appreciate what motivates the proposal to build a new runway, that the POS present us with a succinct, but well-documented statement of the capacity and delay problems that justify the construction of the third runway, including a reasonable estimate of when the new runway is likely to be put in use if the PSRC gives its approval in April 1996. We went on to underscore that if the POS and WSDOT wished us to find that the implementation of demand management or system management options cannot reasonably be expected to obviate or defer the need to construct the third runway, they should show us why, relating their analysis of the timing and impact of such options to the justifications they offer for constructing the runway. We invited comments from the PSRC, the FAA and the public on these matters.

Finally, we noted that if the Panel determined, in its Phase I decision, that any methods of demand or system management could reasonably be expected to obviate or defer the need to construct the third runway, we would then turn in Phase II, sometime later, to the question of whether such feasible methods were being pursued and achieved as required by the Resolution. We observed, however, that if we determined that no feasible demand or system management options would obviate or defer the need for a third runway within the foreseeable future, the POS and WSDOT would have satisfied the demand/system management condition of the Resolution and our inquiry on Demand/System Management Issues would come to an end.

In an effort to elicit as much pertinent evidence as we could, we established a formal comment period and then, by our Information Requests of March 3, 1995, we solicited a variety of detailed information on these issues from the POS, the WSDOT, the FAA, the airlines and the public.

We held our third round of hearings on Demand/System Management Issues on May 3 and 4, 1995. The POS, mainly through Michael Feldman, Manager of Aviation Planning for the POS, Claire Barrett of Claire Barrett and Associates, and Ronald Ahlfeldt of P&D Aviation, presented evidence and arguments that the two "demand management" programs for which the POS is the "lead agency" under the MOU — congestion pricing and gate controls — are not "feasible" within the meaning of the Resolution. The WSDOT, through Charles Howard, Planning Manager for WSDOT, and Brian Ziegler, revisited its "Final Report on The Impact of Intercity Passenger Rail on Operations at SeaTac Airport" and asserted that the system management option of "high-speed rail" — assigned to the WSDOT as "lead agency" — was not feasible. The FAA, represented by Carolyn Read and Sarah Dalton of its Regional Office, offered a few of its own comments, submitted its Draft Environmental Impact Statement ("DEIS") with respect to the Proposed Master Plan Update Development Actions at Sea-Tac, including the proposed third runway, and offered some useful data on delays at Sea-Tac. Mary Vigilante of Landrum & Brown, Incorporated, who helped prepare the DEIS for the FAA, engaged in limited dialogue with the Panel. During the May hearings, we also received both written and oral comments from the public, including a formal presentation on demand management from Stephen Hockaday, who testified for the Airport Communities Coalition ("ACC"), and on the rail option from Hal B.H. Cooper, Jr., who testified for the Regional Commission on Airport Affairs ("RCAA"). We also heard from representatives of Air Washington and the Airport Noise Group. Regrettably, no representatives of any of the airlines serving Sea-Tac submitted any comments or appeared before the Panel. On June 26, 1995, long after the close of the Phase I hearings and while the Panel was considering its present decision, the RCAA submitted to the Panel a study by O.H. Bogan of G. Bogan & Associates, Inc., which suggested that the use of Localizer Directional Aid ("LDA") procedures might obviate or defer the need for the third runway.

Introductory Comments.

Before turning to our conclusions, we want to comment on the quality of the evidence and to explain why our decision has been difficult, and time-consuming, for us to make.

The Panel does not believe that it has been charged with generalized responsibility for determining whether there is a need to build the proposed third runway. Rather, as we interpret the Resolution, it is our responsibility to determine whether particular methods of demand or system management presented to us could reasonably be expected to defer or obviate the need to construct the new runway. As we said in our Preliminary Order, in order to make that assessment on a sound basis, we felt that it was important (a) for the POS to provide us with a succinct, well-documented statement of the delay and capacity problems that justify the construction of the new runway *and* (b) if they claimed that congestion pricing, gate controls or high-speed rail were not "feasible," for the POS and the WSDOT to show us why, relating their analysis of the timing and impact of such options to the justifications they offer for constructing the runway.

The evidence offered to us during the hearings has not satisfied our desire for rigorous analysis of these admittedly difficult technical issues. The capacity and delay problems that precipitated the proposal to build the third runway are complex and dynamic. There appears to be no dispute, however, that the effective capacity of the airport has been increased in recent years through the introduction of a variety of technological and operational improvements, and that the occurrence of significant delays has been reduced. We have not found in the evidence presented to us a succinct, well-documented statement of the delay and capacity problems that have led the POS to seek approval of the third runway.

More disturbing to us is the failure of both the POS and the WSDOT to justify their positions that the alternatives are not "feasible" by relating the timing and impacts of these methods to the justifications they rely upon for the construction of the new runway. The potential impacts of the various demand or system management methods under consideration are difficult for us to assess on the basis of the evidence offered during the hearings. Neither the POS nor the WSDOT has offered a fully developed analysis that shows, for example, how much of the delay at Sea-Tac (either experienced in the past or forecast for the future) is attributable to the coincidence of peak demand and poor visibility, and how sensitive the resulting delays are to relatively small changes in the level of peak operations.

We would prefer, as experts in the field, to have abundant opportunity to explore these technical issues until we are satisfied that we have been given the best available evidence of the potential cumulative impact of all of the demand and system management methods on the problems of airfield capacity and aircraft delays that appear to motivate the proposal to build a third runway. However, our obligation as members of the Panel is to render a decision based upon the evidence that has been presented to us.

We recognize that the decision as to whether to build the third runway is an important, and controversial, public matter that will affect the entire regional community. Our Order should not be read as the final word on the Demand/System Management Issues we have addressed. We encourage the POS, the WSDOT, the FAA, the airlines and the public to continue rigorous examination of the planning assumptions that underlie the proposal to build the runway and to persist in efforts to determine whether adequate solutions to the problems of capacity and delay can be found without building a new runway at Sea-Tac.

We will now turn to the specific methods of demand and system management that have been presented to us.

Feasibility Determinations.

Congestion Pricing. The Panel has determined that "congestion pricing" is not feasible within the meaning of the Resolution. There are three basic reasons for this determination.

First, even if congestion pricing could be introduced at Sea-Tac today, the Panel could not say, based upon the evidence we have seen, that it could reasonably be expected to have such a significant impact on the delays at the airport that it would warrant deferring or eliminating construction of a third runway. The POS claims that it would not, and no party has shown that the POS is wrong.

Second, there are serious legal questions (which the Panel does not presume to have authority to resolve) as to whether the POS could implement congestion pricing before the year 2001 without the approval of a majority-in-interest of the signatory airlines serving the Airport. Although the United States Department of Transportation ("USDOT") has recently said that airport owners may implement "properly structured" congestion pricing methods, this power is constrained by existing agreements with airlines that prescribe how aeronautical rates and charges are to be established at Sea-Tac. (In the future, we encourage the POS and the airlines to fashion agreements that allow for the introduction of properly structured peak hour pricing.) Even though congestion pricing might reduce the total costs of airline operations at Sea-Tac by reducing the costs of delays, the airlines serving Sea-Tac have not yet given the POS approval to implement congestion pricing and it would be unrealistic to expect them to do so during the term of the existing signatory agreements. The Panel therefore cannot confidently say that the POS has the ability to introduce peak hour pricing before the year 2001.

Third, while there are sound economic reasons to expect peak pricing to reduce airport delays, the potential impact of congestion pricing is very sensitive to the particular configuration of operations and delays at an airport. Local conditions will determine whether the introduction of congestion pricing will alter the level or pattern of demand for use of the airfield and, if it does, what impact the change will have on expected levels of delay. The structure of the market and the nature of the delay function can change significantly over time, as the experience of Sea-Tac in recent years demonstrates. We cannot say whether, in the year 2001 or later, congestion pricing is likely to be effective at Sea-Tac, especially if the USDOT maintains its current policy limiting charges for the common use of an airfield to the recovery of historical costs.

While the Panel is confident that congestion pricing is an important tool that could improve the efficiency of the use of scarce airfield resources in Seattle, and therefore deserves careful study by the POS and the airlines, the Panel finds the potential impact of congestion pricing in the future to be too speculative to rely upon as a justification for eliminating or deferring the construction of the third runway.

For all of these reasons, the Panel has concluded that it is not reasonable to expect that congestion pricing will obviate or defer the need to construct the third runway and, therefore, that congestion pricing is not "feasible" within the meaning of the Resolution.

Gate Controls. The Panel has determined that the use of "gate controls" is not feasible within the meaning of the Resolution. In theory, gate controls (in the form of minimum passenger flow-through requirements) could lead to improved airfield efficiency, and hence fewer delays, if they induced airlines to reduce the number of aircraft operations they use to serve a given flow of passengers, either by consolidating flights on larger aircraft or by improving the load factors on smaller aircraft. Such a system of gate controls would, however, raise a series of questions, in practice, that remain unanswered on the record before us: (i) how would such gate controls be structured; (ii) how would the airlines, and their passengers, respond; and (iii) could the POS lawfully implement such a system of gate controls without the agreement of affected airlines? Gate controls may be useful, in the future, as one component of an overall program to encourage greater airfield efficiency at Sea-Tac, but no party has offered any empirical evidence that the implementation of gate controls could reasonably be expected, in the near term, to obviate or defer the need to construct the third runway. As a result, the Panel must reject gate controls as a feasible alternative to the construction of a third runway. We nevertheless strongly encourage the POS to continue to examine the potential benefits of gate controls as a means of improving the efficiency of use of scarce airport resources.

High-speed Rail. The Panel has determined that a new *system* of high-speed rail is not "feasible," within the meaning of the Resolution. We reached this conclusion because even under the most optimistic scenarios, the time frame for implementing a newly-constructed, high-speed rail link between Portland, Seattle and Vancouver is exceedingly long and highly uncertain. Because of the inevitably very long period of time required to put true high-speed rail in service, and because of the uncertainties about the economics and financing of high-speed rail, there is no assurance that a system of high-speed rail would offer any basis for deferring or eliminating the construction of the third runway, even though, if a new high-speed rail link were ultimately put in service, we would expect there to be a very substantial diversion of travelers from air to rail transportation in the Portland-Seattle-Vancouver corridor.

The Panel has, however, been unable to determine, based upon the evidence presented to us, whether more readily achievable improvements in existing rail service connections to the principal short-haul markets served by Sea-Tac — Portland and Vancouver — are "feasible."

The following facts and circumstances suggest that improved rail service along the Portland-Seattle-Vancouver corridor using existing railroad rights-of-way could have a significant impact on the level and pattern of aircraft operations at Sea-Tac and might allow the POS to defer construction of the third runway without suffering unacceptable amounts of delay at the Airport:

- Sea-Tac is not currently a highly congested airport. According to the most recent ASQP data available from the USDOT (for May 1995), Sea-Tac ranks #1 in on-time departures (90.0%) and #6 in on-time arrivals (84.6%). In recent years, the total annual hours of delay (as defined in the 1995 FAA Capacity Enhancement Update) have dropped from 48,000 (in 1988) to only 26,000. Reported delays as compiled in the FAA's ATOMS data series show a similar decline, from 30 delays per thousand operations in 1990 to six delays per thousand operations in 1994.

- The problems of airfield capacity and operational delays that appear to motivate the decision to build the new runway occur when poor visibility coincides with peak demand.

- A small reduction in the total level of aircraft operations occurring during peak periods can have a significant impact upon the delays that would occur during conditions of poor visibility at the Airport.

- The structure of air demand at Sea-Tac includes a large number of flights to and from Portland and Vancouver, especially during peak periods. These high-frequency flights add significantly to airport congestion (particularly in poor-visibility conditions, when capacity is restricted).

- Currently, the airlines have low load factors on many of their flights serving the Portland-Seattle-Vancouver markets.

- More than half of the passengers carried on flights serving Portland and Vancouver are O&D passengers, who are more likely than connecting passengers to opt for improved rail service.

If improved rail service along the Portland-Seattle-Vancouver corridor induced even a relatively small number of airline passengers to switch to rail, and if the resulting reduction in aircraft load factors caused the airlines to eliminate some of their peak period operations, it is likely that there would be a significant reduction in the levels of delay experienced at Sea-Tac, which could defer the need for the new runway.

Unfortunately, despite the Panel's repeated requests for detailed input on these questions, no party has submitted satisfactory evidence on the likely rate of diversion of passengers from air to rail travel, on the impact such a diversion of passengers would have on airline operations at Sea-Tac or on the resulting delay profile at the Airport that could reasonably be expected.

The WSDOT has attempted, in good faith, to meet its burden, as the "lead agency" under the MOU, to show that the high-speed rail option is not feasible within the meaning of the Resolution. The Panel has concluded, however, that the WSDOT (together with the POS and FAA) has not met this burden. (For example, the evidence offered on the diversion of passengers on the Talgo route is not persuasive. Upon review of the underlying survey, it appears to the Panel that there is no support for the claim that all of the new rail passengers have been diverted from automobile travel. In fact, there appears to be a 20 to 1 preference for rail over air travel reflected in the survey results.) We cannot, therefore, find that improvements in rail service are *not* a "feasible" method of system management. At the same time, however, the Panel is reluctant to find that rail improvements *are* feasible, within the meaning of the Resolution, without more persuasive evidence on the issues of passenger diversion and its likely impact on airline operations and airport delay. As a result, after much deliberation, we have concluded that we should continue to examine the rail option during Phase II of our consideration of Demand/System Management Issues.

We will seek, in Phase II, additional evidence from the WSDOT, the POS, the FAA, the airlines and the public, focused on the following issues:

- What improvements in rail service on the Portland-Seattle-Vancouver rail corridor are now underway under the auspices of the WSDOT?

- What improvements in rail service on the Portland-Seattle-Vancouver rail corridor, and along the entire West Coast, are or will be incorporated in WSDOT's Statewide Transportation Plan or other long-range transportation plans?

- How have the elapsed travel times and convenience of scheduling been altered and what further improvements are anticipated?

- What has been the impact on ridership during 1995?

- What are the best estimates of expected air-rail diversion of O&D passengers on the Portland and Vancouver routes served by Sea-Tac?
- What impact would such air-rail diversion be reasonably expected to have on aircraft operations, and resulting delays, at Sea-Tac?

We intend to resolve the question of whether the rail option is "feasible," and if it is, whether it has been "pursued and achieved" as required by the Resolution, before April 1, 1996. In due course, the Panel will issue Information Requests and a Notice of Hearing with respect to these matters.

LDA. Although the MOU and the Implementation Steps do not contemplate the Panel's consideration of methods of demand or system management that have not been offered for consideration by the Coordinating Committee, we have reviewed the Bogan Report (submitted after the close of the hearings by the RCAA) which suggests that the use of LDA might be a technological improvement in system management that could obviate the need to construct the third runway. The Bogan Report is a provocative document that deserves scrutiny by, and a response from, both the POS and the FAA. The Panel has determined, however, that we will not consider LDA as a method of system management to be assessed under the Resolution for a variety reasons.

First, the RCAA submission was not timely. Under our Preliminary Order, comments from all members of the Coordinating Committee and from the public on the Demand/System Management Issues were to be submitted by April 14, 1995. We established this requirement to ensure that all participants in this process would have a reasonable opportunity to review the comments before the hearings began on May 3, 1995. The RCAA failed to meet this deadline by ten weeks.

Second, we could not fairly consider the Bogan Report without providing an opportunity to the POS and the FAA to offer their comments on it. To do so would require us to reopen the record and defer the completion of our Phase I deliberations for far longer than was ever contemplated when the Resolution was enacted and the April 1996 decision point was established.

Third, the Panel itself has many questions about the Bogan Report. We are concerned that it may not have taken full account of the complex, dynamic interaction between effective airfield capacity, operational activity and airport delays.

Accordingly, the Panel has concluded that it will not consider LDA. We emphasize, however, that nothing in this Order should be interpreted as expressing any opinion about the potential impact of LDA on the problems of congestion and delay that have been offered as justifications for the construction of the third runway. Indeed, the potential impacts of rapidly improving air traffic control technology should continue to be a focus of attention for both the POS and the FAA in their assessments of the need for the new runway.

Closing Comments.

We have now completed our Phase I consideration of Demand/System Management Issues. Under the terms of the PSRC's Resolution, our inquiry was narrow in scope. We have determined that, within the meaning of the PSRC's Resolution as we interpret it, congestion pricing, gate controls and high-speed rail are not "feasible" methods of demand or system management. We have, however, left open the question of whether more readily achievable improvements in existing rail service may be "feasible." This is the only method of system management we will consider in Phase II.

We have not been appointed, and we are unable, to comment upon the entire DEIS or to attempt to resolve two critical questions that remain open for public discourse: (i) whether the need for the third runway has been established, and (ii) whether a combination of improvements in air traffic control, in airport and airline management and in regional transportation infrastructure could defer or obviate the need to build the proposed third runway at Sea-Tac.

Scott P. Lewis, Chair

William Bowlby

Martha J. Langelan

Federal Aviation Administration

GPS IMPLEMENTATION PLAN for AIR NAVIGATION & LANDING

SATNAV
SATELLITE NAVIGATION

August 1994

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This plan describes the activities of the Federal Aviation Administration (FAA) to implement the use of the Global Positioning System (GPS) by aviation for navigation and landing. Through its Satellite Navigation Program, the FAA is developing new capabilities that will provide significant economic and safety benefits to the entire aviation community. To bring these benefits to aviation users at the earliest possible date, the FAA is working concurrently on the technical, operational, and institutional aspects of its program.

Within the U.S. National Airspace System (NAS), the FAA is implementing a satellite navigation capability in an evolutionary manner in three consecutive stages:

- *Multisensor* -- GPS can be used by an aircraft for navigation, but only after its data has been compared with another approved navigation system onboard the aircraft.
- *Supplemental* -- GPS, as augmented, can be used by an aircraft for navigation by itself, without comparison to another navigation system. However, a primary navigation system must be onboard the aircraft and usable if GPS is not available.
- *Primary* -- GPS, as augmented, meets all of the requirements for navigation without the need for any other navigation system onboard the aircraft. However, GPS may be used with one or more other navigation sensors if desired (e.g., GPS with an inertial reference system).

As shown in Figure 1, the FAA approved the use of GPS as a multisensor in oceanic and domestic en route airspace in Fiscal Year 1991 (FY91), and for non-precision approaches in the following year. Near the end of FY93, the use of GPS as a supplemental means of navigation was initiated during all phases of flight except precision approach. Early in FY94, the Department of Defense (DOD) declared that GPS had achieved its initial operational capability (IOC). Shortly thereafter, the FAA announced that GPS was an integral part of NAS.

It is anticipated that in FY95 GPS will be approved for use as a primary means of navigation in oceanic airspace. In FY97, the FAA will begin to operate a Wide Area Augmentation System (WAAS) to augment the basic GPS radionavigation signals. This will permit the use of GPS as a primary means of navigation in all phases of flight except precision approach. Early in FY98, WAAS will enable the use of GPS for Category I precision approaches, subject to a national decision to allow the use of the differential component of WAAS for accuracy improvement.

With regard to precision approaches, two other activities are also under way:

- On a case-by-case basis, privately owned, local area differential GPS (LADGPS) landing systems (indicated by a "U" in Figure 1) are in the process of being approved for Special Category I (SCAT I) precision approaches.
- The technical and operational feasibility of using local area augmentation to conduct Category II and III precision approaches is being determined. Although the feasibility of

this approach will not be completely known until FY95, the initial results have been very encouraging.

In accelerating its Satellite Navigation Program to provide GPS capabilities to the aviation community at the earliest possible date, the FAA accepts a certain amount of risk, some of which is beyond its ability to control. This may cause a certain amount of delay in the initiation of a scheduled service, possibly as much as 12 to 18 months. For example, a communications satellite may be lost during launch, or there could be a protest of a contract award. If an event like this should occur, then the FAA will develop alternative approaches to minimize its impact on the initiation of GPS services. To reflect this uncertainty in the implementation schedule shown in Figure 1, 18-month "windows" (illustrated by the areas containing slanted lines) are used to bound the period when the GPS services will initially become available. If no delays occur, then a particular capability will be provided at the start of each 18-month window.

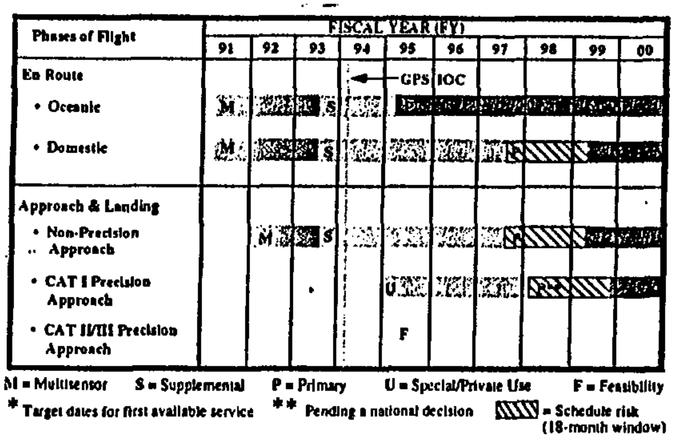

Figure 1
GPS Implementation Schedule*

-2

Inside

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High speed rail: Florida comes through

Luther S. Miller

Florida is again on the high speed passenger rail track, and this time around, the state is offering the private sector "a full and functioning public-private partnership," including substantial public funding for capital investment as well as start-up studies.

These are the magic words in the request for proposals issued by the Florida Department of Transportation:

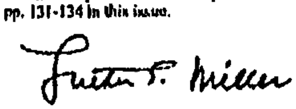
"This public-private partnership will be a cooperative and coordinated joint venture between the Department and the franchisee to establish the Florida high speed rail transportation system. The Department's role will be to provide assistance and financial support to the franchisee for the certification of the project (routing, environmental assessment, coordination with Metropolitan Planning Organizations, Regional Planning Councils, local jurisdictions, state agencies, comprehensive plan compliance and permitting), and to provide financial assistance from state and federal sources for engineering, right-of-way acquisition, infrastructure, and other capital investment. . .

"Applicants shall assume that $70 million in state funds will be available each state fiscal year for 25 years starting July 1, 1996. . . Additional funding may be available from federal sources."

They are words that dramatically distinguish this high speed initiative from the one that failed a few years ago. As the High Speed Rail/Maglev Association's Joe Vranich recalls, "The first Florida initiative was based on unrealistic notions of how much capital could be raised through real estate value capture, and those notions hit a stone wall when the recession came and real estate values plummeted. Florida is now injecting into high speed rail planning what they've done for years in aviation and highway planning."

Former Federal Railroad Administrator Gil Carmichael also has high praise for the route to high speed that Florida is taking—and he speaks with considerable feeling on the subject. Carmichael is now a senior vice president of Morrison Knudsen, which headed the consortium that invested $40 million in start-up studies and planning for a TGV high speed route in Texas. On Aug. 19, the Texas High Speed Rail Commission formally rescinded the MK consortium's franchise, an action that had been expected ever since the consortium early this year failed to meet a deadline for raising private equity capital. The Texas effort was doomed, Carmichael now says, because "the High Speed Rail Commission was created as a stand-alone agency not connected to the transportation policies of the State of Texas." He believes that in any future high speed planning, "the Texas DOT needs to be a player." He hopes Texas will follow the lead of Florida and join a high speed initiative as a full-fledged partner. "We have accumulated a great store of knowledge in Texas. We want the door open so we can come back again," Carmichael told *Railway Age*.

Financing is a major (though not the only) barrier to high speed rail planning in the U.S., and innovative financing approaches — like that now adopted by Florida—will be high on the agenda at a high speed rail conference that *Railway Age* and its sister publications, *Railway Track & Structures* and *Transit Connections*, will conduct in Washington, D.C., Nov. 9-10. Appropriately, this portion of our conference will be moderated by Charles H. Smith, manager of the High Speed Transportation Program for the Florida Department of Transportation. For information about this conference, see pp. 131-134 in this issue.



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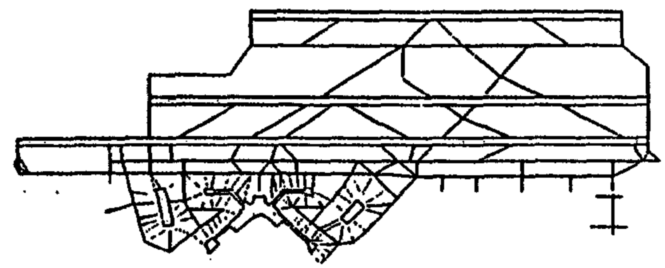
Impact of Boeing Field Interactions on the Benefits of a Proposed New Runway at Seattle-Tacoma International Airport



prepared for
FAA Northwest Mountain Region
under subcontract from
MITech Incorporated, Washington, D.C.

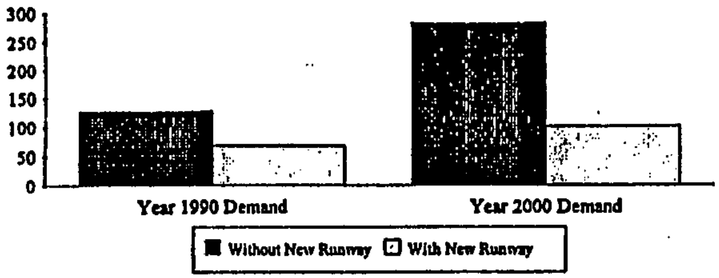
Aviation Simulations International, Inc.
Huntington, New York
July, 1992

1.4 Summary of Findings and Conclusions

The principal conclusions reached from the analysis of the results of the simulation experiments are as follows:

- The construction of the proposed new runway will alleviate the current constraints on IMC capacity in south flow, thus permitting SEA to economically accommodate forecast demand levels beyond year 2000.
- The airport will not adequately accommodate year 2015 traffic during north flow IMC conditions due to interaction of SEA departures with BFI operations, even with the new runway in place.
- Availability of the new runway, even if SEA and BFI do not operate independently under VAPS and VMC conditions, will reduce annual aircraft operating costs for the two airports as shown below:

Figure 1-3
Annual Aircraft Operating Costs
SEA and BFI combined
($ millions)



- If it is determined that the new runway is independent of BFI arrivals in south flow under VMC, then the benefits cited above will increase by about 0.5 percent.
- The forecast BFI traffic levels can be accommodated beyond the year 2000, at delay levels no larger than those at SEA, without significantly impacting SEA delay.

to docking at the gate for arrivals) for the system was sensitive to the strategy used only at the highest demand level.

3.4 Impact of North Flow Interactions Under IMC Conditions

Departures from SEA pass near, if not over, BFI. During VMC and VAPS, visual separation is used and no reduction in capacity is experienced. During IMC, horizontal separation must be maintained between SEA departures and BFI arrivals and between SEA departures and BFI departures. Basically, no flights may go into or out of BFI while flights depart from SEA during IMC.

In the simulation, no SEA departures from any runway were allowed when a BFI was within 4 nm of touchdown. No BFI departure was allowed after a SEA departure until the SEA departure had passed BFI.

The new runway did not alleviate the impact of north flow interactions so this would become the limiting capacity. At the highest, year 2015 demand level, the departure queue at SEA backed up, preventing all taxiing. It was therefore not possible to provide annualized cost data for this demand level.

occur which exceed these levels (TA) using both the A-weighted and C-Weighted noise metrics.

Comment IV-1-10: Recently, a panel of experts reviewing the issue of noise reductions in communities affected by noise from SeaTac airport noted "*the use of the DNL metric by itself, is inadequate to show the required reduction in noise impacts because, taken alone, as an aggregate value it does not permit us to review the intensity, duration or frequency of single noise events or to consider when, during the day or night, they occur (even though all of these attributes contribute to teh measured DNL) As a result, we encourage the POS [Port of Seattle] to develop a method that supplements the use of the DNL observations with various additional metrics(including sound exposure level (SEL), Time Above (TA) an appropriate sound level threshold, and unweighted sound pressure levels). The revised mothod should also explicitly report changes in the total number, as well as in the composition and day/night mix, of aircraft operations at the Airport. Unless the reduction in sound le vels is more fully characterized then the use of only DNL allows, we will be unable to find thet there has been a meaningful reduction in real on-the ground noise impacts, ...*". [8]

R-3-5 R-6-33

Comment IV-1-11: This expert panel also found that areas subjected to noise impacts "*should include sites beyond the boundaries of the predicted 65 dB DNL contours*" and "*farther out along major flight corridors and farther out to the east and west of the airport.*" [9] We agree and the Final EIS should do so. Other authorities have also held the findings of the expart panel on the sbject of both noise metrics as well as the threshold detrmination of what populations are affected by noise impacts. For a detailed exposition of current scientific literature on the subject of the effects of noise on humans see Chapter IV, Section 7. The FEIS should contain all references to the literature which substantiates its claim that DNL 65 is the threshold for determing aircraft noise impacts.

R-6-9

[8] Order on Phase 1 Noise Issues issued January 9, 1995, pp. 3-4
[9] Ibid, pg. 2

Comment IV-1-12: In studying the effect of noise in the classroom one of the authors of the present EIS recently admitted "*...[N]oise levels up to 35 dBA will allow satisfactory speech communication in a normal voice level up to a distance of 32 feet. The sound level of 45 dBA is used since it represents average teacher to student distance of 16 feet, where a normal voice level is satisfactory for communication.* [10]

Comment IV-1-13: In discussing the issue of various noise levels on specch interference inthe classroom, the preparer of the current EIS discussed the relationship between interior and exterior noise in the classroom teaching environment"

> *[Ms. Vigilante] A. I can't speak to the ability to conduct education at a sound level. I can speak to the normal criteria for speech interference. And in any instance where the sound levels are in excess of 65 Ldn the interior sound level would be in excess of 45 decibels, and, therefore, speech would be interfered with.*
>
> *Q. So you are saying, when you have an exterior of 65, it is normally considered the fact that the resulting interior will be in excess of 45, and that 45 interferes with normal speech pattern?*
>
> *A. In excess of 45 will interfere with normal speech communication.*
>
> *Q. All right. So that we have this straight now. The sequence then is as a rule of thumb, an outside or external of 65 or greater will produce an internal of 45 or greater, is that right?*
>
> *A. In a normal northern climate structure with the windows closed, you normally will get a 20 decibel attenuation.*

R-6-7

[10] Vigilante deposition, Exhibit No. 22 (emphasis added)

Q. With the windows closed?

A. Yes.

Q, What attenuation do you get with the windows open?

A. It can vary, but normally around 15.

Q. Normally around 15 and can it be less that?

A. It can be less.

Vigilante deposition, page 141 (emphasis added) [11]

Q. So that if you have-a decibel level of 60 with the windows open, you can have interference with speech communication, can you not?

A. If those conditions exist, presumably yes.

Vigilante deposition, page 142 (emphasis added)

Relying solely on its "contour" map and no actual witness or actual measurements, the preparer of the DEIS has suggested that the schools outside SeaTac's INM "contour" map are not adversely affected by noise. But on examination, Mary Vigilante admitted that her INM model showed many hours per day of noise interference at the schools which had not yet been

R4-7

[11] In point of fact, measurements taken by Chicago at a variety of schools scheduled for soundproofiixg show that the attenuation between the exterior and interior of the schools can be considerably less than 15 decibels -- e.g. less than 5 decibels attenuation. See School Noise Monitoring Analysis (July-September 1991) (Hamill deposition, E@bit 6). Ms lack of attenuation means that exterior levels less than 65 dBA can have a-n adverse impact on speech communication in the classroom, since the level for interference is considered by Vigilante to be 45 dBA.

soundproofed. [12] As to those schools, Exhibit 11 shows the hypothetical average number of minutes per day that the aircraft noise level at these schools is estimated by Chicago's INM model to be above 65 dBA:

The Court should be aware that these values are most likely bogus. They are based on an INM model, the inputs to which produce the classic "GIGO" ("Garbage In, Garbage Out") (see discussion below). But they are the numbers that Chicago claims represent "scientific" and "objective" measures of the noise experienced at these schools. Accepting arguendo these numbers, it means that for each of the schools, the aircraft induced noise totals several hours per day above the level that Chicago's own witness says causes interference with speech communication in the classroom. For example:

Q. For Medinah South, according to your computer model, Medinah South has these numbers time above 65 which represents the minutes in a day, isn't that right?

A. That is correct. Minutes in a 24-hour period.

Q. And with respect to the minutes in the 24-hour period, that would be 214 minutes for 1983, would it not?

A. That is correct.

Q. That is according to my arithmetic about three and a-half hours?

A. Approximately.

R4-7

[12] These schools are Medinah South, Lake Park East (partially soundproofed entirely at owners expense), Lake Park West, Edison, Emerson, Field, Sandburg, and Churchville.

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the physiological effects of noise. An example is when the sound of finger nails on a blackboard causes human beings to cringe.

A nationally recognized noise expert recently observed that the measurement of noise does not occur for its own sake and noted *"most people understand that if aircraft noise did not affect people, nobody would go to bother and expense of measuring it"*.[1] A fundamental consIusion which may be gleaned from this assertion, is that the meaning of the term "*noise*" is separate and distinct from the the effects which noise produces, or the "*noise impacts*" on human beings and their surrounding environment. In other words, a noise level is not a noise impact.[2] **The central focus of the DEIS must therefore be the effects of noise**, both under the existing conditions, as well as the proposed alternative conditions, **on people and their surrounding environment**, not on microphone diaphrams.[3] Merely because some faceless technocrat preparing (or revising) an EIS understands how to spell decibel does not mean this person is appointed, elected or in any way qualified to specify what is a meaningful noise impact.

Comment IV-1-2 Sea-Tac airport sits on just 2400+ acres in the middle of an existing densely populated area. The North/South runways send heavy jet aircraft low over the most densely populated metropoliten corridor north of San Françisco and west of Minneapolis. **Sea-Tac has the third to the fifth worst noise exposure problem in the nation**, comparing the source of the noise (number of operations) to the number of people living in the high noise areas. [4] Many thousands more live in the still bad 55 LDN area. Still more live in the 45+ LDN upon which residential neighborhoods are affected [5]. The DEIS should address why the third to fifth worst noise impacted mini-sized airport in the US should be even further impacted with up to one third more flights. R-6-1A

[1] Dr. Sanford Fidell, Expert Arbitration Panel, May 5, 1995, pg. 75, line 6
[2] Dr. Sanford Fidell, Expert Arbitration Panel, May 5, 1995, pg. 74, line 14
[3] Dr. Sanford Fidell, Expert Arbitration Panel, May 5, 1995, pg. 75, line 9

[4] See attached Appendix #1--Aircraft Noise Coalition Press Release dated March 24, 1993
[5] See Report to the Administrative Conference of the U.S., Suter, Alice. 1990.

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Comment IV-1-3 A large increase in the number of operations occured At SeaTac during the 1970's and 1980's. During this time flight operations increased from 114,372 per year in 1971 to 345,000 operations per year in 1990. [6] Also, in 1989 the FAA changed the approach and departures flight tracks to SeaTac under the "Four-Post Plan" Both actions have produced widespread complaints of increasing airport noise produced by the airport operations at SeaTac. R-6-1A R-5-4

Comment IV-1-4 FAA regulations require that the noise impacts associated with the proposed actions and the alternatives to those actions be considered in the E.I.S. Accordingly, noise levels at all alternatives including each of the supplemntal airport sites, Paine Field, McChord, King County International Airport. and all other sites must be considered in this DEIS. Accordingly, the E.I.S. must examine the increased noise impacts that would result from increased operations at Sea Tac under the Port's proposal and under each alternative. Noise levels at the proposed supplemental airport sites must be considered in the DEIS. Despite efforts by PSRC's executive board (Resolution EB-94-01) to delay a search for a supplemental regional airport sites the study of alternative sites has not been foreclosed by the Puget Sound Regional Council therefore, noise impacts on populations areound each of the proposed supplemental airport sites should be studied in this EIS. As previously stated, the central focus of the DEIS must be the effects of noise on people at each of the alternatives. In Chapter 2, the results of the Major Supplemental Airport Feasibility Study are included. The population exposed to noise levels of 45 dBA, 50 dBA, 55 dBA, 60 dBA, 65 dBA, 70 dBA, 75 dBA, 80 dBA, 85 dBA, 90 dBA and above, using both the DNL and SEL metrics, should be published in the FEIS to show the relative population impacted under each of the alternatives. R-6-9 R-4-4

Comment IV-1-5: This impact statement must discuss and fully disclose the existing, actual noise levels (not just computer R-6-5-

[6] Favro et al v. Port of Seattle, Second Amended Compaint for Violation of Constitutional Rights and Trespass, U.S. District Court No C92-C1634, pg. 4

generated predictions,) at SeaTac. It must also address projected increases, and detailed mitigation plans including costs, timing, etc.

R-4-3

Comment IV-1-6: The DEIS states *"[t]he difference between the noise impacts of the three "With Project" alternatives are very small:"* The DEIS should quantify and define the meaning of the term "small."

After dismissing the noise impacts under all proposed alternatives as "small" with no prior analysis, the DEIS immediately assumes the use of the metric DNL and establishes the metric "DNL 65 and greater" as the threshold which establishes the population, housing, and area subjected to noise "impact". No explanation, methodology, or reference is provided explaining:

R-4-1B

Comment IV-1-7: The FEIS should provide a comprehensive search of the literature, which cites all references, documentation, and the scientific basis explaining:

(a) Why the DEIS establishes the metric DNL as an adequate descriptor of noise impacts.

(b) Why DNL 65 establishes the threshold of impacts using the DNL metric.

(c) What noise metrics are useful in determining the impacts of noise upon people.

(d) Using metrics other than DNL, what metrics are useful in determining the effects of noise impacts upon human beings, residences, and the natural environment.

(e) How metrics for comparing noise impacts are related and how they are distinguished

R-4-4

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Comment IV-1-8: In a recent rule making,[7] the FAA apparently endorsed the EPA's position that it should "modify the definition of (noise study area) so as to eliminate the perception that the area with the DNL 65 dB contour is the sole area to be considered for noise impacts, while retaining the flexibility of extending beyond the DNL 65 dB contour. We note that the daily LDN for a stick of dynamite (194 decibels) would be zero. This mathematical phenomenon explains why people who live with aircraft noise find the LDN metric so inadequate as the sole measure. The DEIS must acknowledge, therefore, that relatively low average noise levels (lower than 65 DNL) can adversely affect a community when pre-existing noise levels were comparatively low or when single noise events are particularly intrusive. It must further explain the effects of these noise levels below DNL 65 on a community.

R-4-9

R-4-4

Comment IV-1-9: The authors of the DEIS are responsible for researching and articulating existing standards, methodologies and thresholds used to determine whether the impacts of noise assiciated with the project and alternatives are sufficiently addresed in the DEIS. Many authorities hold that metrics supplementary to the DNL are necessary to determine the impacts of aircraft noise upon populations. For a detailed synopsis of these authorities see RCAA comments on DEIS Chapter IV, Section 7 titled Human Health. This section should discuss in detail, how project and alternatives, would affect the SEL noise contours surrounding SeaTac airport and show maps protraying the 80 SEL, 85 SEL, 90 SEL, 95 SEL, and 100+ SEL noise contours. For example, show how the diversion of commuter air traffic to rail would affect the noise impacts on the population exposed to noise levels of 45 dBA, 50 dBA, 55 dBA, 60 dBA, 65 dBA, 70 dBA, 75, dBA, 80 dBA, 85 dBA, 90 dBA using both the DNL as well as the SEL noise metric. Also provide a compaison of the same decibel levels using the C-weighted noise metric and the incidences and cumulative amount of time during which noise levels

[7] Letter from Richard E. Sanderson, Director, Office of Fed. Activities, U.S. Envt'l. Protection Agency, to Office of the Chief Counsel, Fed. Aviation Admin. (Jan. 18, 1989).

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Table 4.4 below lists the percent of the 752 arrivals, or 755 departures that were assigned to the new runway for each of the operating directions and visibility conditions shown in the figure 4-3.

Table 4.4 Percent of SEA Operations Assigned to New Runway for Year 2015 Demand.

	South			North		
	VAPS	VMC	IMC	VAPS	VMC	IMC
Arrivals	23.1	17.6	31.6	23.9	17.4	*
Departures	10.6	3.8	0.0	11.3	4.1	*

* In north IMC the SEA departure capacity was exceeded.

CHAPTER IV
ENVIRONMENTAL IMPACTS
SECTION 1 - NOISE IMPACTS

Chapter IV, Section 1 - Noise Impacts

General.

Introduction to Comments on Chapter I. Our commnets on this Chapter are in two groups. In the first group, Comments I-A through I-F, we include six studies of certain issues included within the scope of the Chapter; these studies present materials, data, findings, & analyses not included in the DEIS, which should be addressed in the FEIS. In the second group, Comments I-G through I-N, are our comments on particular points raised in the DEIS or suggested by it.

Listing of items included as Comments I-A - I-F:

Comment IV-1-A: A Comparison of FAA Integrated Noise Model Flight Profiles with Profiles Observed at Seattle-Tacoma by George W. Flathers, II December 1981 Report No. FAA-EE-82-10

Comment IV-1-B: FAA Advisory Circular 36-1F Noise Levels for U.S. Certificated and Foreign Aircraft, June 5, 1992

Comment IV-1-C: Preliminary Noise Analysis of the Proposed FAA 4 Post Plan Noise Mediation Options Subcommittee - January 4, 1990

Comment IV-1-D: FAA Decision and Order issued April 2, 1990 by Temple H. Johnson, Jr. Manager, Air Traffic Division, Northwest Mountain Region, Federal Aviation Administration

Comment Iv-1-E: Jorgen Bader, Letter to Editor Seattle Times dated April 6, 1990 re: FAA Decision and Order issued April 2, 1990

Comment IV-1-F: Letter from Laurene McLane former member of SeaTac Noise Advisory Committee (SNAC) to SeaTac Noise Advisory Committee dated August 16, 1993

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Comment IV-1-G: Single Event Aircraft Contribution to SeaTac Ldn Levels prepared for Regional Commission on Airport Affairs by Errol Nelson, PE - Optimum Environment Inc. - October 27, 1994

Comment IV-1-H: Comparison of Measurement Weighting Metircs near SeaTac prepared for Regional commission on Airport Affairs by Errol Nelson, PE - Optimum Environment Inc. - April 17, 1995

Comment IV-1-J: Memorandum to Expert Arbitration Panel - Puget Sound Regional council from Errol Nelson, PE - Noise Consultant to RCAA Re: Testimony at August 11, 1994 hearing of Expert Panel

Comment IV-1-K: RCAA Input to Attachment 2 to Procedual Order Information Requests to the Public prepared by G. Bogan & Associates, Inc.

Comment IV-1-L: Implementation of an LDA/DME Approach to Runway 16R in Lieu of a Third Runway at SeaTac Airport prepared for the Regional Commision on Airport Affairs by G. Bogan & Associates Inc. June 26, 1995

Comment IV-1-M: Order on Phase 1 Noise Issues Issued January 9, 1995

Comment IV-1-N: Expert Arbitration Panel, Transcript of May 4, 1995)

Comment IV-1-O: Interim Technical Addendum Regarding the city of Chicago's Use of the Integrated Noise Model State of Chicago ex. rel. Ryan vs. City of Chicago 18th Judicial District Court Dupage County, Illinois

Comment IV-1-1 Noise is a complex phenomena and current methods of measurement are crude. Although loudness can be measured in decibels, existing instruments cannot determine many of

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Q. In the day?

A. Yes.

Q. And according to the way you calculate the INM, that's the average number of hours per day over a year that school --

A. That's correct, it is an average annual condition.

Q. So there are days by definition, because it is an average annual, where the number of hours that that school gets hit with, the numbers of minutes are less than 214; and, there are also days where the number of minutes is greater than 214, isn't that right?

A. That would be correct.

Q. That would be true for the minutes of exposure in Exhibit 11 for any of the schools mentioned, isn't that right?

A. They would represent average conditions, yes.

Q. So my statement and your answer with respect to the fact that by using an average, it necessarily means that all of the schools are exposed to 65 decibels on some days less than the number shown in Exhibit 11 to Vigilante Deposition Exhibit No. 9, and on other days more than the number of minutes shown on Exhibit 11 to Vigilante Deposition Exhibit No. 9?

A. That is correct.

Q. So for Sandburg Junior High for example, which is school 22, you show in 1983 that it experiences noise at -- is that two and a-half hours a day above 65?

A. Approximately 152.7, which is about two and a-half hours.

R-6-7

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Q. All right. Based on the use of the annual average, that necessarily means that some years or some days I should say within the year, that the noise exposure at Sandburg in 1983 was less than 152 minutes and on other days it was more?

A. That is correct.

Q. Do you know the range, for example, for Sandburg Junior High School, take for example 1983, the range, the minimum number of minutes that it would be affected by aircraft noise on a given day versus the maximum number of minutes, 152.7 being the average?

A. I do not know the minimum or the maximum.
Vigilante deposition, pages 142-44 (emphasis added)

Thus the DEIS's own witness demonstrates its admission -- hoist by the petard of its own "scientific" computer model -- that all of the schools (including the schools not yet soundproofed) suffer from several hours per day -- some days more, some days less -- of significant noise interference above the levels which its authors say interfered with speech communication in classrooms. Yet the author suggests in its DEIS that these schools are not adversely impacted by noise.

R-6-7

The FEIS should identify and locate on a map <u>all</u> schools where classroom interior noise levels caused by each of the proposed alternatives would exceed 45 dBA. The FEIS should discuss the relationship between interior and exterior noise in school classrooms, especially in classrooms not equipped with air conditioning where exterior windows must be opened to provide adequate ventilation in classrooms. The FEIS must identify the total number of aircraft noise incidences and total minutes per school year for each school where exterior noise levels exceed 60 dBA, and interior noise levels exceed 45 dBA.

R-7-8

Comment IV-1-12: In order to gain a satisfactory understanding of the meaning of the term "noise impacts" the preparer of the correct

DEIS should visit each of the schools presently impacted with aircraft noise levels of 60 dBA and above.

Comment IV-1-13: The DEIS states *"because the new dependent parallel runway is proposed to reduce poor weather delay, which is predominantly arrival related, the runway would be expected to be used primarily for arrivals."* Recently however, FAA officials have disclosed that the delay calculations for the 3rd runway in the DEIS are based on a computer simulation model (SIMMOD) which has not correlated the relationship between the airport's demand profile and weather variations when calculating the delay figures published in the DEIS.[13] Additionally, a recent study has challenged the 44% "bad weather" figure cited in the DEIS.[14] This study proposed the addition of existing navigation technology in the form of a Localizer Directional Aid (LDA) aircraft navigational system to allow parallel dual stream arrivals under weather conditions with ceilings as low as 2200 feet, a system which obviates the need for a third runway. (For a detailed exposition of LDA see Chapter II, Purpose and Need.) The FAA's 1993 Aviation System Capacity Plan LDA recommendeds LDA as an impreovement to SeaTac's existing airfield including provision on an LDA approach to Runway 16L/34R [15] The DEIS must consider potential noise impacts caused by implementation of this FAA recommended approach procedure which according to the recent study referenced above, would obviate the need for a third runway at SeaTac. Care should be take to analyze the noise impacts of LDA approaches only when capacity needs required such approaches. The study cited above concluded this would ooccur less than 2% of the time.

Comment IV-1-14: The foregoing discussion raises concerns about the accuracy of noise predictions based upon consideration of weather conditions different from those projectsed in the DEIS as well as tha effects which implemantation of the FAA recommended LDA navigational aid would have on noise impacts. This in turn

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[13] Expert Arbitration Panel, May 4, pg. 68, line 14)

[14] Implementation of an LDA/DME Approach to Runway 16R in Lieu of a Third Runway at SeaTac Airport prepared by O. Bogan & Associates Inc. June 26, 1995

[15] 1993 Aviation System Capacity Plan Report DOT/FAA/ASC-93-1 Appendix C-53

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raises the issue of the impacts of proper utilization of flight tracks used to develop the INM noise contours for the proposed third runway. If the need for the third runway is obviated by the use of an LDA system and instead is used instead predominantly for takeoff's, then the noise contours related to a third runway are obviously not modeled correctly in the DEIS and must be recalulated.

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Comment IV-1-15: The DEIS states the number of people, housing units, and area affected by DNL 65 and greater sound levels are expected to decline in the future in comparison to 1994 noise exposure regardless of future development at Sea-Tac Airport. The DEIS states this decline in impacts is expected due to the Port's noise reduction program and the Federal mandate to phase-out Stage 2 aircraft no later than the year 2000. This DEIS further confines its analysis to *"the impacts within DNL 65 and -greater noise exposure; however, areas exposed to DNL 60-65 were evaluated and are presented for information purposes."*

Comment IV-1-16: The phase out of stage 2 aircraft is currently required under 14 CFR pt. 161, the Airport Noise and Capacity Act (ANCA). Under an exemption to the ANCA Act, the Port of Seattle is conducting a program to phaseout existing stage 2 aircraft operating at SeaTac which do not meat noise certification requirements specified in 14 CFR pt. 36 titled Noise Standards: Aircraft Type and Airworthiness Certification[16] the FEIS should provide a detailed analysis explaining how signifigant noise reductions will occur if the remaining 17% of SeaTac's existing Stage 2 fleet is phased out through a 33% increase in Stage 2 and Stage 3 flight operations predicted in the DEIS.

Comment IV-1-17: The DEIS assumes that all Stage 2 aircraft are quieter than Stage 3 aircraft. In fact many cases stage 3 noise certifications reduce aircraft engine noise by only 3 dBA to 5 dBA forequivalent aircraft. [17] The statement in the DEIS that noise levels will be reduced due the conversion of the remaining 17% of its fleet

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[16] SeaTac Forum December 1994

[17] Comments of Noise Aspects of the Regional Airport System Plan by Dr. James D. Chalupnik January 12, 1993 pg. 1

hypothetical concepts. They are not railroad tracks in the sky. [24] The locations of flight tracks are subject to the discretion of the operator of the INM program and much controvery has existed on the issue of whether the flight track assignments used in the INM model have accurately reflected the actual airport situation. [25] The FEIS must include valid and statistically signifigant flight track information for annual periods, indicating aircraft type per operation for each of the alternatives.

Comment IV-1-24: Accurate flight track data from the FAA's Aircraft Radar Traffic System (ARTS) has only been available for the past several years. Prior to this time *"consultants for years have exercised considerable latitude in trying to represent these flight tracks, and its only been within the last few years that the FAA released the information which one needs to pin them down."* [26] Such latitude is illustrated In a infamous recent case the court found that (the preparer of this DEIS may remember) the preparer of an INM model for a proposed runway expansion project in the Chicago area, had used flight tracks in the INM model which did not comport with the tracks she observed during her observations from a control tower. Flight tracks used to produce INM noise model contours in the FEIS must be be verified with ARTS data by aircraft type and statisically correlated to the INM model input file.

An FAA study [27] has compared INM flight profiles with flight profiles observed at Seattle-Tacoma airport. This report noted that the INM database has a set of defined profiles for wach aircraft type *"which were constructed under the assumption that the FAA procedure is being followed by all arcraft."* [28] the report noted *"the INM estimates departure weight by using stage length"*. [29]

[24] Expert Arbitration Panel, May 5, 1995, pg. 137, line 6
[25] Expert Arbitration Panel, May 5, 1995, pg. 136, line 10

[26] Expert Arbitration Panel, May 5, 1995, pg. 137, line 12

[27] A Comparison of FAA Integrated Noise Model Flight Profiles with Profiles Observed at Seattle-=Tacoma by George W. Flathers, II December 1981 Report No. FAA-EE-82-10
[28] Ibid. pg. vii
[29] Ibid.

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In studying flight profiles this report observed departure flight tracks and noted that observed altitude profiles for B-737 aricraft were much lower than the INM profiles for the portion of the departure within 3 nautical miles of the Brake Release Point (BRP) [30] In comparing B-727 departures, this study found and that *"the assumption that weight estimation can be based on stage-lengths may not always be true."* and *"differences between INM profiles for the shortest and longest stage-length tend to be masked by variation from other sources."* [31] and were several times greater than the sensitivity of the INM to stage length.

This study also observed effects of varying departure procedures of different airlines including differences of 1000 feet in altitude at 8.5 n.m from SeaTac. [32] The report recommended that the number of stage-length categories for B-727 aircraft in the INM noise modeling program be reduced to two or three. [33]

This report came to the stunning conclusion *"a possible reasin for this observation is that the procedures used by the pilots of these ... aircraft types are not fashioned after the FAA profile which the INM assumes."* [34]

A subsequent FAA study of INM flight profiles at SeaTac Airport also noted that *"assumed departure altitudes and thrust do not comport with the real owrld behavior of planes actually taking off for commercial airports: .."* [35] This study confirmed that during departures at SeaTac airport : *"At cutback thrust, the INM underestimated observed noise levels by a considerable margin. This underestimation was explained by the fact that most airlines do*

[30] Ibid.
[31] Ibid. pg. x
[32] Ibid. pg. viii
[33] Ibid. pg. x
[34] Ibid.
[35] Flathers, FAA Integrated Noise Model Validation: Analysis of Air Carrier Flyovers at Seattle- Tacoma Airport, FAA Report FAA-EE-82-19 (September 1982) pp. v

not emply the deep thrust cutback assimed by the INM, but use the higher normal climb thrust." [36]

Comment IV-1-25: Obviously, the author of the DEIS has (intentionally?) failed to correct flight profiles in the DEIS. the authors of the DEIS were aware of these studies yet have failed to acknowledge or incororate their findings. The FEIS must provide a detailed explanation of how the flight profiles in the INM noise model have been validated with actual flight conditions at SeaTac and recommendations of FAA studies which recommend modifocations to the standard INM database flight profiles. R-6-14

Comment IV-1-26: Chicago's consultant has admitted that the INM model has not been used in a takings case.

Comment IV-1-27: The EIS claims that the INM model is widely used as a generic planning tool. However, it ignores the fact that the quality, accuracy and representativeness of what is put into the model severely impacts its utility. Given the demonstrated problems of Chicago and its consultant in providing accurate inputs to the model, as well as the admitted limitations of the model itself, it is little wonder that Chicago's consultant admitted that the model results have not been used to establish the presence or absence of a taking: R-6-7

Q. Have you ever engaged in the use of the INM model -- have you yourself ever engaged in the use of the INM model to locate or to determine the amount of noise that has impacted, on property for purposes of eminent domain proceedings?

A. No, I have not.

Q. Last (sic: Has) Landrum & Brown?

A. To my knowledge, no.

[36] Ibid, pg. vi

Q. Are you aware of any judicial proceeding where the INM values, such as the ones shown in Exhibit 11, have been used for the basis of the awarding eminent domain damages?

A. I'm not aware of any.

Vigilante deposition, pages 146-47 R-6-7

The INM is simply a computer program. And, as one commentator noted, the "final printout -- 'the deceptively neat package in which the computer [displays] its work product' -- can be a shield behind which is hidden a multitude of programming sins. Here, as the INM's shield is being removed, a multitude of sins are becoming quite apparent. And those sins show that the INM is, in this action, irrelevant, inappropriate, and inaccurate. " [37]

Comment IV-1-28: Steps must be taken to validate the data used in the computer program to verify that the results can be calibrated by recognizable standards, especially those established by the National Institite of Standards. R-6-32

Comment IV-1-29: It is extemely important to note there is no substantiation in the DEIS that changes in the NM input file have been accomplished and factoed into the INM input file used to produce the noise levels in the DEIS. R-6-5

(a) Ground terrain

(b) Run-up noise

(c) Departure climbs adjusted for local elevation and temperature

(d) Aircraft taxiing noise

[37] Interim Technical Addendum Regarding the city of Chicago's Use of the Integrated Noise Model State of Chicago ex. rel. Ryan vs. City of Chicago 18th Judicial District Court Dupage County, Illinois, pg. 9
citing Elliot, Computer-Nourished Experts: An Evidentiary and Procedural Perspective, 43 Brooklyn L. Rev. 1119,1132 (footnote omitted).

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to Stage 3 aircraft, while expnding operations to a level of 38 million passengers per year from its current level of 20 million is not rational, and must be substantiated with a detailed explanation and documentation.

Comment IV-1-18: Also equivalent stage 3 aircraft produce noise levels which vary signifigantly in noise depending on engine configuration and other characteristics including aircraft weight. For example, a Stage 3 Boeing 767-200 aircraft equipped with Model CF6-80A2 engines with a mean take off weight of 279.9 thousand pounds produces an Equivalent Perceived Noise Level (EPNL) of 84.2 dBA during takeoff. [18] However the same aircraft with the same engines, loaded with a mean take off weight of 360.0 thousand pounds produces an EPNL of 91.7 dBA (7.5 decibels higher) during takeoff.
The statement in the DEIS that noise levels will be reduced due the conversion of the remaining 17% of its fleet to Stage 3 aircraft, while expanding operations to a level of 38 million passengers per year from its current level of 20 million is not rational, and must be substantiated with a detailed explanation and documentation.

Comment IV-1-19: Additionally, comparing noise levels between Stage 2 and Stage 3 aircraft, a Stage 3 Boeing 747-100 with a mean takeoff weight of 710 thousand pounds produces an EPNL noise level of 104.6 dBA on approach [19] while a Stage 2 Boeing 727-100 produces an EPNL noise level of 97.8 EPNL on approach, [20] a 6.8 decibel difference. The statement in the DEIS that noise levels will be reduced due the conversion of the remaining 17% of its fleet to Stage 3 aircraft, while SeaTac's operations expand to a level of 38 million passengers per year from its current level of 20 million is thus *non-sequitur*, and must be substantiated with a detailed explanation and documentation.

R-4-11

[18] FAA Advisory Circular 36-1F Noise Levels for U.S. Certificated and Foreign Aircraft, June 5, 1992, pp.16-18
[19] Ibid, Appendix 3, pg. 4
[20] Ibid, Appendix 1, pg. 5

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Comment IV-1-20: The DEIS states development of a new parallel runway *"would be expected to result in as much as a 4.4 percent increase in dwelling unit impacts over the Do-Nothing alternative in the year 2000. However, in all instances, these future impacts would be less than the current noise exposure."* As discussed above decreasing noise impacts must be predicated upon the validation of the INM model noise contours and certification of the noise levels in the affected areas by independent means. The Noise Expert Panel recently rejected the Port of Seattle's proposed noise reduction methodology including the Port's Nighttime Limitations Program and phaseout of Stage 2 aircraft as a valid method of producing reductions of noise impacts on the affected communities. [21] Mediation Agreement. used in conjunction with the Port's of the existing noise levels by a in the affected

R-4-6

The DEIS also states "*a 7,000-foot longer runway, with a north threshold steggered south. could result in even less impacts then the shorter 7,000-foot long runway.*"

The DEIS presents aircraft noise impacts represented only as land areas and numbers of people and residences exposed to aircraft noise above predetermined DNL noise levels. Contour lines representing average annual noise conditions were generated showing the Day-,night Average Sound Level (DNL or Ldn) of 60, 65, 70 and 75 dBA for aircraft operations. The number of existing residents and dwelling units located within the noise exposure pattern of the noise levels of 60, 65, 70, and 75 Ldn were calculated for each of the the current and each future alternatives. There are many problems with this approach. First, the selection of the population residing in areas subjected to 60 through 75 DNL as the only population affect by aircraft noise woefully underestimates the extent of the impacts of aircraft noise upon human beings. Our comments responding to Chapter 4, Section 7 of the DEIS (Health Effects) explain the tremendous amount of reaseach on the human health effects which exist caused by the impacts of noise levels of 45 DNL and above.

R-5-2

[21] Order on Phase I Noise Issues issued January 9, 1995, pg. 2

Comment IV-1-21: See Chapter 4, Section 7

The INM Noise Modeling Program

The DEIS preparer states that the noise contours used in this part of the report were developed using Version 4.11 of a computer program developed b the FAA called the Integrated Noise Model (INM).

The INM computer modeling programs relies, as all computer models do , upon the accurate input of information into the to the model used to simulate the physical event or events modeled. The purpose of any modeling effort is to repoicate the real world -- *i.e.* to insure that the results estimated by the model accurately reflect the real world. In the field of computer modeling, the process of confirming that the model accurately mimics the real world is called validation..[22] As in a recent Chicago case, the preparers of this DEIS, have failed to validate the INM model to see if it produces accurate results. As in Chicago "*[t]his lack of validation is made even more egregious by Chicago and Vigilante's failure thus far to provide the step by step back-up material and sequencing for the running of the model so that [commenters] can determine of the model results can be replicated.*" [23] Accuracy of the INM relies upon the periodic calibration of the model to verify that the physical event or eventsfs modeled comport with the physical world. If these important steps are not taken and verified, the results of any computer model will be subjected to criticism, potential ridiclue, and recitations of the familiar nostrum: "Garbage In = Garbage Out. The computer generated noise levels and contour maps produced in the DEIS are supplied with no evidince or assurance that the results can be substantiated. Among the backup materials currently missing are:

R-6-5 R-6-7

[22] Interim Technical Addendum Regarding the city of Chicago's Use of the Integrated Noise Model State of Chicago ex. rel. Ryan vs. City of Chicago 18th Judicial District Court Dupage County, Illinois, pg. 9
[23] Ibid. pg. 11

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a. The sequential steps assigning flights to various runways and flight tracks.
b. The stasistical and data basis for selection of the flight tracks used.
c. The data basis for the flight track profiles made in hte model.
d. The data basis for assigning sircraft and engine types in the model.
e. The data basis which verifies the physical distance and height of aircraft used in the model relative to the recepter site (*i.e.* rader track data - ARTS data) for the annual period during which the INM model is calculated.
f. The validation that the above paramters have been accurately enterd into the input file of the INM modeling program.

As indicated below, a signifigant body of evidence exists showing first that the purported noise levels in the DEIS, under the "Do-Nothing" option have not been substantiated or corroborated by scientific methodologies, or indepedent means, and second, that the purported noise levels under the alternatives are predicated upon a methoological apprlach which casts doubt as to their validity.

According to the DEIS, features allowing the INM model to include the effects of ground terrain, run-up noise, departure climbs adjusted for local elevation and temperature, and aircraft taxing noise were used in this DEIS analysis.

R-6-5 R-6-7

Comment IV- 1-22:

Comment IV-1-23: One of the key assumptions used in developing the INM noise model foar a particular airport are the flight tracks locations. The INM model allows the user to assign the route of departing and arriving aircraft according to a systematic process which assigns aircraft to particilar flight tracks. Until very recently aircraft flight tracks, from the standpont of the INM, have been

R-4-14

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(e) Existing INM Data

The Port's noise remedy programs are predicated upon decling noise levels. This essumption is based upon noise contours based upon these noise contour maps.

Public information request to the Port of Seattle have disclosed INM noise modeling data used to produce the Port's 1991 and 1996 noise exposure maps. An anlysis of these files has revoealed that many of the concerns raisedin hte the 1981 FAA report have not been addressed. R-4-36 R-4-5

Comment IV-1-30: At a minimum, an appendix must be added in the DEIS which includes a complete listing of the input file information used to produce the INM noise contours for each of the exhibits in the DEIS. The input files should include all of the parameters included in each input file, including those describing ground terrain, run-up noise, departure climbs, adjusted for local elevation and temperature, aircraft taxiing noise.

Comment IV-1-31: The DEIS states that a noise budget went into effect on January 1, 1991 which sets forth limitations on the amount of aircraft noise energy which may be generated bv the airlines serving the Airport. According to the program, this level is gradually reduced until an all Stage 3 fleet is reached. This program and others are monitored on a quarterly basis by the Port of Seattle Noise Abatement Staff and reported to the public through Port publications and a noise advisory committee. Explain what portion of the aircraft noise energy is exempted by International flights. Also perform a colculation of the relative decrease of annoyance according to the FICON caused by changes in the total amount of noise energy generated by the airport since 1991. R-7-7 R-6-29

Comment IV-1-32: A nighttime limitations program was implemented in October. 1990, to phase-out all noisier aircraft (Stage 2) during the nighttime hours. During the first two years, only pre-existing Stage 2 flights were allowed between midnight and 6 a.m. In

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succeeding years, the restricted hours have expanded. Bv October 1995, no Stage 2 will be allowed between 10 p.m. and 7 a.m. without special permission. Explain how the exemption of International flights under the nighttime limitations program affects the communites exposed to single event aircraft noise levels of 80 SEL and above .

Comment IV- 1-33: The so-called "Mediation Agreement" may not be used as mitigation in Part 150 communities. The Port's purported "Noise Mediation Agreement" between the airport proprietor and the citizens in the noise impacted communities both inside and outside the current DNL noise impacted area. This agreement between the Port of Seattle and the airlines is described most clearly, by a member who participated as a citizen in the Port's "mediation" process. [16] As the author indicates, shortly after the Port and the airlines agreed to its provisions , the FAA changed all flight tracks into SeaTac, by implementing the "four-post" plan. The program did not meet Part 150 requirements for both process and substence, has no representative constituency, no signatures, does not comport with the requirements of commercial mediation, and has elicted public renunciations by citizens. The term "agreement" is a misnomer, insofar that there were no signatories appointed by the respective communities to the agreement. The process did not include consideration of iincreasing air traffic levels at Sea-Tac from either the 4-Post routing or through additional runways at SeaTac. The DEIS should provide a detailed analysis, including and INM analysis with flight tracks, fleet mix, aircraft type with engine configuration and weights, which demonstrates how a "50% reduction in noise" will be accomplished under the Port's "Noise Mediation Agreement" despite a 30% increase in flight operations. R-6-28

Comment IV- 1-34: The DEIS states the ground noise control program is intended to reduce both the peak levels and duration of - ground noise events. The DEIS further states the focus of the program is to restrict noise events during- the nighttime hours, and that measures include the prohibition of power back operations at the gates and restrictions on maintenance ennine run-ups at night. King County code exempts aircraft noisa levels completley during daylight R-6-30

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hours (between and 7:00 AM. Explain how this program prohibits peak noise levels during the daytime. Explain how the ground control noise program restricts . R-6-30

Comment IV- 1-35: The DEIS states the Port's "sophisticated flight track monitoring system" has the capability to track individual flights, and allows its Noise Abatement Office to observe compliance with the noise abatement procedures. Other airports regularly impose monetary penalties for aircraft operators who violate noise abatement procedures. Explain what steps the Port has taken to secure complaince. List any incidences where the Port has levied or assessed a fine or penalty against a pilot or airline not following noise abatement flight corridor procedures. R-6-26

The DEIS notes that the Port maintains a permanent noise monitoring system which provides continual noise measurements at 11 stations located around the Airport. Further as stated above this system has not been calibrated in accordance with WAC requirements. [39] The data collected by the Port's noise monitoring program during periods exceeding the annual period during which the Port's equipment was calibrated to a recognized source is subject to verification and therefore unusable for the purpose of calibrating the INM noise contours.

Comment IV- 1-36: Although Chapter IV, Section 2-"Land Use" describes the Noise Remedy Program which purportedly "has reduced noise and surrounding land use incompatibilities." several comments are in order. The Port of Seattle's Noise Insulation program has recently been subjected to intense criticism. Port of Seattle employee Rick Herz who suparvises the Port's Noise Insulation program recently testified the Port has found that the STC 35 windows installed on homes were not adequate to meet the noise reduction goals of the program. [40] a recent analysis by a Citizens Watchdog Organization has raised concerns about the effectiveness of the Noise Insulation Program. Explain when the STC 35 windows R-7-23

[39] Letter to Expert Panel dated May 1995 from the Pork Patrol

[40] Expert Arbitration Panel May 5, 1995, page 66, line 9

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installed on homes which have previously undergone the Port noise insulation program will be replaced.

Comment IV- 1-37: [41]The DEIS citing Federal Aviation Regulation Part 150 and the Federal Interagency Committee on Noise (FICON) states "*[o]n the basis of scientific surveys and analysis, the FAA has established 65 DNL as the -,critical level for the determination of noise impacts.*" There is simply no substantiation for this claim. Neither Part CFR pt. 150 or FICON make this statement. The literature is replete with references Provide a detailed explanation of the source of the statement "*[o]n the basis of scientific surveys and analysis, the FAA has established 65 DNL as the -,critical level for the determination of noise impacts.*" Including all references to scientific litierature. R-6-34 R-6-10

Comment IV- 1-38: The 65 DNL contour incorporates 12.23 square miles (7,827 acres), including much of Airport property. The predominant use of southerly traffic flows at the Airport results in a larger portion of the contour pattern falling, south of the airfield due to the prevailing winds. Owing to the -greater thrust levels used, departures are typically several decibels louder than approaches at the same distance from the aircraft, resulting in larger noise contours in the principal direction of departing traffic. Therefore, the noise contours for the existing condition reach farther into communities south of the Airport than into those to the north. Given the above information it is clear there is no substantiation for the DEIS claim that "future impacts will be less than the current noise exposure regardless of which Master Plan Update alternative is pursued" or that "the 'With Project' alternatives would result in slightly greater noise exposure m comparison to the Do-Nothing." Please comment on what approach the Final EIS will take to address these unanswered issues. R-6-13

The attached reports were available and well-known to the co-authors of the DEIS and should have been addressed in the

[41] Federal Aviation Regulation Part 150 and the Federal Interagency Committee on Noise

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DEIS, especially in responding to our comments above but also in toto.

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SCOPING COMMENTS

- The FAA must examine the effect of aircraft noise on newly exposed and noise-sensitive areas, as well as the dispersion of noise over a over King County and North Pierce County. Such areas include the following:

parks and recreation areas;
historic structures and locations,
residential communities;
schools;
health related facilities;
cultural resources;
businesses; and
houses of worship.

The noise analysis must include an examination of impacts within the LDN, contour of 65 dB and the effect upon noise-sensitive areas outside the LDN, contour of 65 dB. The EPA has stated that "limiting noise analysis to the LDN 65 contours does not provide adequate disclosure of all significant noise impacts."

Flight paths for the proposed runway likely would cause aircraft to over fly many areas that do not currently experience unacceptable levels of aircraft noise, thereby subjecting new properties to the effects of airport noise. The noise effects of the proposed third runway would be most acute in residential neighborhoods in South Seattle, Tukwila, Federal Way Des Moines, Normandy Park, Burien and the North Hill communities, together with the Minority neighborhoods in the Rainier Valley area of Seattle Many of the potentially affected residential neighborhoods are not included in the Port's noise mitigation program (which provides for installation in residences of sound insulation materials). Even residences that are eligible for the Port's sound insulation program would obtain relief only from high interior noise levels. High outdoor noise levels would continue to erode the enjoyment of property and the quality of life in these and other communities.

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The third runway proposal also would increase noise levels in area schools. The Port's most recent noise exposure map indicates that a large number of schools currently are located within the 65 LDN contour for 65, 70 or 75 dB.[42] Interior single event noise levels in excess of 85 dB have been measured in at least one school district.[43] With approximately 6,000 students enrolled in schools within a few miles of Sea Tac, increased aircraft operations and altered flight paths would harm the quality of education in local schools.

Current operations at SeaTac subject many other noise sensitive resources -- such as hospitals, nursing homes and churches to average noise levels of 65 dB or greater.[44] The Port has estimated that the number of noise sensitive areas exposed to LDN in excess of 65 dB would decline *by 1996*, a prediction upon which cities and residents have relied. The construction and operation of a third runway at Sea Tac, however, likely would prevent a number of hospitals, nursing homes and churches near Sea Tac from realizing significant reductions in their noise exposure levels. Moreover, many locations could be expected to be exposed to even higher numbers of over flights and to greater noise levels than they experience today.

• **The E.I.S. must investigate and fully disclose studies of existing conditions, including actual measurement of existing noise levels.** The Flightplan E.I.S. used only the heavily criticized and recently revised theoretical "INM" computer generated noise model, and did not document any of the assumptions (such as fleet mix) in constructing the model. Further, noise impacts missing from the model, such as all ground noise (from "runups" and airport ground activities), noise from aircraft from foreign carriers and others exempt from Stage III requirements, weight and flight profiles appropriate to Sea-Tac, land & atmospheric effects at Sea-TAC etc.

[42] Sea-Tac International Airport, Noise Exposure Map Update (Draft) (1991) App. D ('1991 NEM Update)

[43] RCAA, James C. Chulupnik, Noise from Sea-Tac Airport: Adverse Affects on the Heath of Puget Sound Citizens (Jan. 26, 1993) at 2.

[44] 1991 NEM Update at D-10, Table D-3. Order 5050.4A 11 85&

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were not included. All sources of noise must be fully disclosed and raw measurement data and assumptions used must be included. All sources of assumptions must be fully documented and properly cited per our earlier comment.

• **The E.I.S. must investigate and fully disclose all impacts of noise to human health and to the education of children.** We specifically reference Hansen & Sanders report titled The Adverse Health Impacts of Airport Expansion with Particular Reference to Sea-Tac International Airport, previously submitted.

• **Techniques for measuring noise are called "metrics." Because no one metric can measure noise and because noise studies use a variety of metrics, existing and projected noise levels must be displayed in--at minimum--the following metrics:**

1) *Maximum decibels (both A & C weighting)* plus the number of events. Maximum decibels should include values for each aircraft in the fleet mix, including heavy jets and must be displayed for any aircraft, such as foreign carriers, exempt from Stage III, as well as ground noise.
This matric defines the loudness of the noise and the number of noise intrusions. Maximum decibels are the most widely used measurement of noise and are required to compare noise levels to most studies linking noise to hearing loss, to measure construction and insulation standards and as well as establishing maximum levels required by hospitals and other noise sensitive structures and areas. The E.I.S. should show maximum noise levels down to 35 dBA and identify all noise sensitive structures in that area.

2) *SEL (Single Event Level), including all SEL (both A & C weighted)* above 50 in increments of 5 plus the number of events. Maximum decibels should include values for each aircraft in the fleet mix, including heavy jets and must be displayed for any aircraft, such as foreign carriers, exempt from Stage III, as well as ground noise. The method for calculating the noise including the assumed event length must be documented along with the rationale and a fully cited bibliography justifying those assumptions.

A Comparison of FAA Integrated Noise Model Flight Profiles with Profiles Observed at Seattle-Tacoma Airport

George W. Flathers, II

December 1981

MTR-81W238

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The MITRE Corporation
Metrek Division
1820 Dolley Madison Boulevard
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EXECUTIVE SUMMARY

The Federal Aviation Administration's Integrated Noise Model (INM) is a series of computer programs designed to assess the noise impact of aircraft operations in the vicinity of an airport. The user of the INM supplies data concerning the airport and runway layout, the number and types of aircraft, and description of the flight tracks they use. The INM computes and reveals the noise environment in terms of preselected noise metrics of the user's choice. As part of MITRE's overall effort to check the validity of the results of INM computations for the FAA, a comparison was made between the arrival and departure profiles contained in the INM data base and those observed in actual operations at the Seattle-Tacoma International Airport. A flight profile describes aircraft altitude and velocity as a function of distance from the runway during a takeoff or an approach to landing. The extensive data base in which the INM profiles are stored also contains noise and other performance data for various types of aircraft.

In the spring and summer of 1979, MITRE conducted a similar flight profile study which is presented in MTR-80W00119, "Comparison of FAA INM Flight Profiles with Observed Altitudes and Velocities at Dulles Airport," Reference 1. The main conclusion of that study was that, for departure operations, most airlines were using procedures which differed significantly from those assumed by the then-current Number 7 INM data base. Due to the sparsity of data sampling locations and limitations in the data-collection mechanisms, however, the exact nature of observed departure profiles could not be determined. Since the time of the Dulles study, the FAA has prepared a new data base (Number 8) which includes revisions based on a relatively recent FAA Advisory Circular (AC91-53, Reference 2) outlining recommended standard noise abatement departure procedures. The comparisons in the present study are made with respect to the Number 8 INM data base.

Methodology

The basic approach taken in this study is an extension and a refinement of that taken in Reference 1. ARTS-III radar data provided the raw information upon which statistical inferences could be made about actual flight operations. Using the target reports provided by the ARTS-III system, and a special smoothing technique called cubic spline function smoothing, the altitude and velocity of each aircraft on arrival or departure was determined over several

points within 10 nautical miles of the airport. The altitudes and velocities of nearly 3000 arriving or departing aircraft were determined in this manner from data collected in the period between May and July, 1981.

This large sample was aggregated into smaller samples according to the type of operation conducted (namely, arrival or departure) and the type of aircraft involved. In this study, sample sizes were large enough to permit investigation of the following six aircraft types: DC-9, B-737, B-727, DC-10, L-1011, and B-747. Profiles for each type of aircraft were characterized statistically and compared directly with appropriate profiles taken from the Number 8 INM data base.

Results for Arrivals

The INM approach profile for standard air carrier arrivals depicts a continuous vertical decent along a 3° glide slope to the point of touchdown approximately 1000 feet beyond the runway threshold. The speed of the aircraft within 10 nautical miles of the runway is assumed to be constant at the INM supplied final approach speed. When compared to this profile, the following trends were noted:

- Observed altitude profiles suggested that all six types of aircraft closely follow the 3° glide slope. The usual sources of descent guidance for an air carrier pilot on an approach to landing are the Instrument Landing System (ILS) glide slope, or an optical aid called the Visual Approach Slope Indicator (VASI), both of which provide an approximately 3° glide slope. Observed altitudes varied around the glide slope as a function of distance from the runway: as aircraft approached the runway, variations in observed altitude became progressively smaller and more centrally distributed about the 3° glide slope.

- Observed velocity profiles revealed that most aircraft were performing a decelerating approach rather than one of constant speed. Most aircraft approached the airport area at a significantly higher speed but slowed to within a few knots of the INM designated final approach speed as they came within 2 nautical miles of the runway. The frequent occurrence of the decelerating approach is consistent with the predominant conditions at Seattle: VFR weather and fairly light traffic, both of which make decelerating approaches practical.

Results for Departures

There are many other factors associated with departures which contribute to considerably more variation in observed operations. There are procedural differences in the way the departures are performed by various airlines. In addition, there are performance-limiting factors such as aircraft weight, pressure altitude, temperature, and wind which introduce additional sources of variation. Accordingly, a more detailed analysis of departures was performed.

All airlines specify their own standard departure procedures in their flight operations manuals. These procedures are usually fashioned after the FAA suggested noise abatement departure profile, (as outlined in FAA Advisory Circular 91-53, Reference 2), with various levels of compliance. The profiles of most airlines resemble each other for aircraft with high bypass ratio engines. For low bypass ratio engines, however, the FAA procedure specifies a greater thrust reduction after takeoff than some airlines use. This would result in a steeper climb angle than under the FAA procedure, with all other factors held equal.

The INM data base, on the other hand, has a set of completely defined profiles for each aircraft type which were constructed under the assumption that the FAA procedure is being followed by all aircraft. In addition, the data base has up to seven slightly different profiles for each aircraft type to reflect differences in departure performance attributable to varying departure weights. Under the assumption that aircraft departure weight and stage-length (the non-stop flight distance) are proportional, the INM estimates departure weight by using stage-length as an index. The profile for the most likely stage-length was used as the INM baseline for the comparisons and the following results were noted:

- Observed altitude profiles for the DC-9 and B-737 were much lower than the INM profiles for the near field segment (the portion of the departure within 3 nautical miles of the Brake Release Point (BRP)). There was fairly close agreement between observed and INM profiles for the other aircraft in the near field segment. For the far field segment (the portion further than 3 n.m. from BRP) the DC-9 and B-727 were much higher than the INM profiles. A possible reason for this observation is that the procedures used by the pilots of these two aircraft types are not fashioned after the FAA profile which the INM assumes.

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This metric represents not only the loudness of the noise but the length of time the noise lasts. It is used in most sleep disturbance and school disruption studies, most particularly the N.A.S.A. sleep disturbance studies.

3) *Ldn (both A & C weighted) above 45 Ldn at 5 decibel intervals and the and CNEL(Combined Noise Event Level) equivalent.* The Ldn must include ground noise and document the assumptions about aircraft fleets.
Both of these metrics--although much in dispute- for the measurement of aircraft noise--attempt to average noise on 24 hour basis and then on an annual basis. They have been used to define the 65 LDN area subject to Part 150 requirements and for EPA standards at 55 Ldn, and are used in studies documenting blood pressure, heart disease, and mental illness.

4) *Unmeasurable, but annoying noise.* The impact statement should identify noises which, like finger nails on a blackboard, have unwanted impacts and to display them. High scream noises, back up whistles for airport loaders, etc. would fall in this category.

The LDN metric obscures the true noise impacts and does not provide any useful information about the level of noise attributable to individual over flights. The effect of noise upon a number of noise-sensitive areas in the vicinity of Sea-Tac cannot be described adequately or analyzed solely using the LDN metric. Activities that take place primarily during the day or in the early evening when the number of Airport operations are at their peak can not be represented accurately by an LDN contour. Therefore, the impact of noise on citizens, public schools, on health care and retirement facilities, or on the normal business activities of commercial establishments cannot be evaluated through the exclusive use of the LDN metric. A number of different noise metrics must be used to examine the effects on these noise-sensitive institutions and activities.

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- **All noise studies and projections should include ground noise, runups and maintenance operations. Runups, in particular, produce high decibel noise (over a hundred decibels) lasting many minutes and can be heard over four miles from the airport.**

- **All noise measurements and projections must be given in both the A-filter frequency and the C-filter frequency. C-filter frequency identifies low rumble noise sources such as made by many jet engines. Noise at these frequencies are more penetrating--like the baseline on the neighbor's stereo--and therefore must be given.**

- **The "Noise Remedy Program" may not be used as mitigation in Part 150 communities.** This program was offered as mitigation in 1976 for noise created by the second runway, is incomplete and a source of controversy--including a lawsuit. Completing previously promised mitigation cannot be used as mitigation for new noise created by 30% more operations.

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DOT/FAA/EE-82/10

Office of Environment and Energy
Washington, D.C. 20590

A Comparison of FAA Integrated Noise Model Flight Profiles with Profiles Observed at Seattle-Tacoma Airport

George W. Flathers, II

MTR-81W288

December 1981

Final Report

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Federal Aviation Administration

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Conclusion
if it doesn't fit the INM – make

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Technical Report Documentation Page

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16. Abstract

The Federal Aviation Administration's Integrated Noise Model (INM) is a series of computer programs designed to estimate environmental noise levels in the vicinity of an airport. As part of MITRE's efforts to validate INM computations for the FAA, a comparison was made between arrival and departure profiles contained in the INM data base and those observed in actual operations at the Seattle-Tacoma International Airport. ARTS-III radar data were used to determine actual altitude and velocities of aircraft at various distances from the runway during arrival and departure operations. This report presents the results of the comparison.

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- Observed velocity profiles were within reasonable agreement with INM profiles for the near field segment for all six types of aircraft. For the far field segment all observed velocity profiles were close to the INM profiles, with the exception of the B-727 which was faster than the INM profile.

- An analysis of observed B-727 departures was performed to determine if differences in departure procedures of different airlines have observable effects on actual departure performance. The median B-727 departures of five major airlines were compared with each other. No real differences were observed in altitude profiles of the five airlines for the departure segment within 3 n.m. from BRP. Beyond this point, however, the disparity became more distinct. At 8.5 n.m. from BRP the highest median departure was approximately 1000 feet higher than the lowest. There were no tangible differences in the velocity profiles for the entire departure. A review of available flight operations material revealed that the airline with the lowest median altitude at 8.5 n.m. also employs a sharp thrust cut-back which was ultimately intended by FAA AC91-53. The expected and observed result of this cut-back was the shallower climb angle.

- To measure the sensitivity of both observed and INM profiles to differences in stage-length, an analysis was performed on B-727 departures grouped into four different stage-lengths. It was found that slight but palpable differences exist in both INM and observed profiles due to stage-lengths. However, variation from other sources is several times greater than the sensitivity of the INM to changes in stage-length.

- Based on the findings of this study, the FAA Office of Energy and Environment proposed a few revisions to the Version 8 INM departure profiles for the DC-9, B-737, and B-727. The revised profiles were the result of recomputing departure performance based on the departure procedures which were evidently in use by pilots of these aircraft. The agreement of observed profiles with the revised Version 8 profiles was found to be significantly improved.

Conclusions and Recommendations

This profile study represents the most comprehensive comparison made to date between observed operations and profiles contained in the INM data base. In general, the new Number 8 profiles have significantly improved observed-INM profile agreement. Because the version of the INM which implements the Number 8 data base had not yet been released, the sensitivity of noise estimates to differences in flight profiles was not investigated. This sensitivity should be quantified in a future effort. However, it is anticipated that improvements in the flight profiles will, in most instances, result in more accurate noise estimates. Major observations, and recommendations to make the INM easier to use and to improve the accuracy of results, are listed below:

- For arrivals, the agreement between observed operations and likely INM profiles was generally good. Observed arrivals for all six types of aircraft followed the 3° glide slope and exhibited decelerating approaches

- At present, the Number 8 data base contains predefined approach profiles which describe approaches of constant speed for the last 10 nautical miles before touchdown. The predictable pattern of observed arrivals at Seattle-Tacoma suggest that inclusion of a decelerating profile in the data base may also be of benefit to the user, especially at locations where weather and traffic conditions make decelerating approaches popular.

- For departures, observed-INM profile agreement was good for aircraft with high bypass ratio engines, but the agreement was not as good for low bypass ratio engines. The disparity for the case of low bypass ratio engines was attributed to differences between assumptions under which the INM profiles were constructed and actual operating practices used by various airlines. This hypothesis was supported by the analysis of B-727 departures grouped according to airline which indicated that differences in observed profiles could be traced to procedural differences. The revised INM profiles for the DC-9, B-737, and B-727 proposed by the FAA result in significantly improved agreement with observed profiles, and they should be incorporated as a permanent part of the INM data base.

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- The analysis of B-727 departures grouped according to stage-length revealed that differences between INM profiles for the shortest and longest stage-length tend to be masked by variation from other sources. In addition, the assumption that weight estimation can be based on stage-length may not always be true. Based on these findings the number of stage-length categories should be reduced from a maximum of seven to a maximum of two or three.

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1. INTRODUCTION

The Federal Aviation Administration's Integrated Noise Model is a series of computer programs designed to forecast the noise environment in the vicinity of an airport. The user of the INM supplies data concerning the airport and runway layout, the number and types of aircraft, and the flight tracks they use. The INM computes and reveals the noise environment in terms of preselected noise metrics. As part of MITRE's efforts to check the validity of the results of INM computations for the FAA, this report describes a comparison made between arrival and departure profiles contained in the INM data base and those observed in actual field operations at the Seattle-Tacoma International Airport. A flight profile describes aircraft altitude and velocity as a function of the distance from the runway. MITRE is also involved in the validation of other aspects of the INM, including noise versus distance relationships, which will be documented in a subsequent report.

1.1 Background

In the course of calculating noise exposure in the vicinity of an airport, the INM performs four primary functions. It first estimates the noise generated at the source (the aircraft engine). Secondly, it estimates the distance from the source to the receiver (at some point on the ground). It then computes the losses and other adjustments to noise as it travels from the source to the receiver. In the fourth and final function it compounds the effects of multiple-aircraft operations to provide a time-based environmental noise descriptor or metric. In performing these functions the INM uses data supplied by the user, several theoretical noise relationships, and its own extensive data base containing noise data and flight profile data for various types of aircraft.

The focal point of this study was the flight profile section of the INM data base. The specific objective was to determine the level of agreement or disagreement between the profiles contained in the data base and those observed in actual operations within a 10 nautical mile distance from the airport. This study was performed in conjunction with other aspects of MITRE's INM validation efforts based on data collected at the Seattle-Tacoma International Airport. Because the version of the INM which implements the Number 8 data base had not yet been released, the sensitivity of noise estimates to differences in flight profiles was not investigated.

1.2 Previous Research

In the spring and summer of 1979, MITRE conducted a similar flight profile comparison study which is presented in MTR-80W00119, "Comparison of FAA INM Flight Profiles with Observed Altitudes and Velocities at Dulles Airport," (FAA Report No. FAA-EE-80-4), Reference 1. In that report, comparisons were made using the then-current Number 7 INM data base profiles. The main conclusion of the study was that, for departure operations, most of the airlines were using procedures which differed significantly from those assumed by the INM. Due to the sparsity of data sampling locations and limitations in the data collection and processing mechanisms, however, the exact nature of the observed departure profiles could not be determined. For arrival operations, some differences were noted between INM profiles and observed profiles, but the magnitude of the differences was much less than for the case of departures.

Since the time of the Dulles profile study mentioned above, the FAA has prepared a new data base (Number 8) with updated arrival and departure profiles for most types of aircraft. The new profiles include revisions based on a relatively recent FAA Advisory Circular (AC91-53, Reference 2) outlining recommended standard noise abatement departure procedures. The comparisons in the present study are made with respect to the Number 8 INM data base.

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2. METHODOLOGY

The basic approach taken in the current study is an extension and refinement of the approach described in Reference 1. ARTS-III radar data recorded at the Seattle-Tacoma Airport provided the raw information upon which statistical inferences could be made about actual flight operations. Appropriate profiles taken from the Number 8 INM data base were used as the baselines for the comparisons. This section gives a brief description of the operating environment at Seattle and the processing of raw radar data to determine aircraft altitude and velocity at specified distances from the runway. A more complete description of the analytical techniques used in the data processing is given in Appendix A.

The Seattle-Tacoma Airport was selected for the collection of actual operations data because of three favorable characteristics: first, it had an established noise monitoring system which was essential to other tasks in the INM validation effort; second, it had an appropriate mix of air traffic in terms of aircraft types and stage-lengths (the non-stop flight distances); and third, the arrival and departure policies of local airport authorities did not interfere or conflict with the standard operating practices of most airlines. A diagram of Seattle-Tacoma Airport is given in Figure 2-1.

2.1 Data Processing Overview

The raw data used in the profile analysis came from Seattle-Tacoma in the form of ARTS-III radar extractor tapes. The data contained on each tape included, among other things, radar target reports and interfacility flight plan messages. A target report was generated for each instance when an aircraft's position was determined based on its response to a Mode A interrogation from the ATC Radar Beacon System (ATCRBS) and its altitude was reported in response to a Mode C interrogation. The aircraft's position was recorded in the target report in terms of range from the radar antenna and the bearing to the aircraft with respect to Magnetic North. Updated target reports containing revised position and altitude data were generally available for each scan of the radar, or approximately every 4.7 seconds. A flight plan message was recorded on tape for each IFR flight which was about to enter the airspace under the jurisdiction of the Seattle Terminal Radar Control Facility. These messages contained the aircraft identification, aircraft type, proposed operation, and other supporting data about the flight.

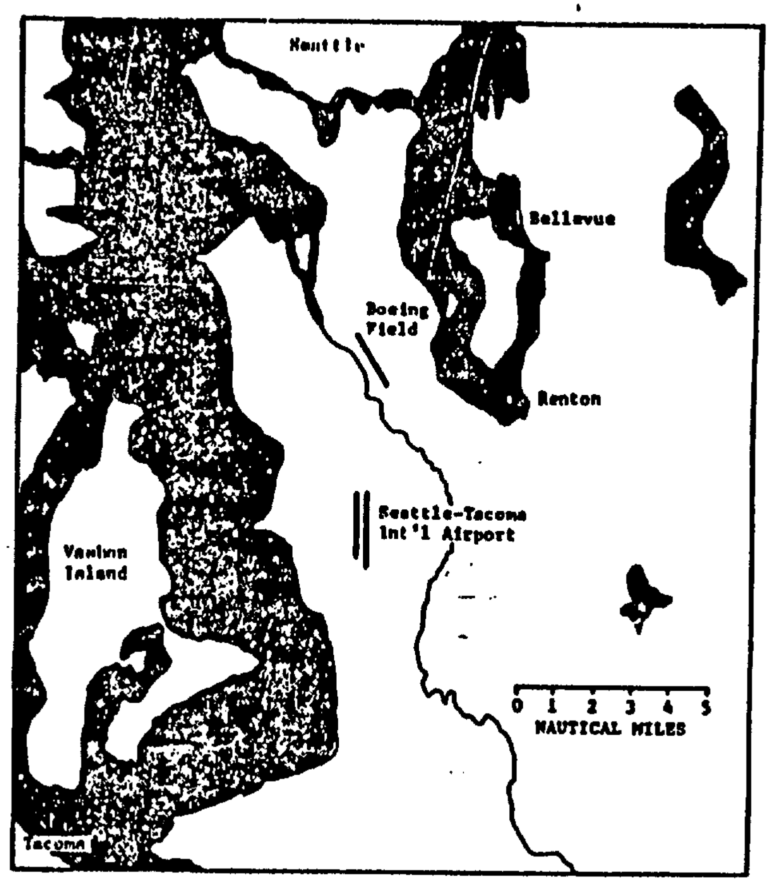

FIGURE 2-1
THE SEATTLE-TACOMA INTERNATIONAL AIRPORT

Target reports and interfacility flight plan messages were extracted from the radar tapes by means of a MITRE developed computer program called ARTS81. Once extracted, these two blocks of data were then submitted to another program, SMOOTH, which was designed to process the Seattle data. In the latter program, a unique flight plan message was assigned to each track, or string, of target reports from an aircraft departing or approaching Seattle. In this way, the identity and type of airplane could be established for each track of target reports.

Because individual target data are subject to errors, a smoothing operation was performed before estimating altitude and velocity. A description of the method used in this study, cubic spline function smoothing, is offered in Appendix A. The end result of the smoothing process was a set of three cubic equations which described the position of the aircraft as a function of time. In analytical terms, the three functions were X(t), which described lateral displacement from the extended runway centerline, Y(t), which described longitudinal displacement from an arbitrary point on the runway, and Z(t), which described the aircraft's height above the runway surface. Once X(t) and Y(t) were known, it was a simple matter to determine absolute velocity at a particular time by taking the first derivative of those two functions to find the velocity vector in each direction. Vector addition was then performed to find actual absolute velocity.

2.2 Sampling Stations and Lateral Boundaries for Aircraft Flyovers

It was determined that an adequate representation of the velocity and altitude profiles could be made by considering each aircraft flyover at strategically located "sampling stations". A sampling station was simply a longitudinal position located with respect to the runway. Eight sampling stations were used for departures and arrivals, thereby permitting a detailed view of flight profiles over a much greater distance than previously available. For departures, sampling stations were positioned at a point 1.5 nautical miles (NM) from the point where the take-off roll commenced (the Brake Release Point (BRP)), and at 1 NM intervals thereafter to 8.5 NM from BRP. For arrivals, sampling stations were positioned one-half nautical mile from the threshold of the runway, and at 1 NM intervals before that to 7.5 NM from the threshold. A diagram of sampling station location for both arrivals and departures is given in Figure 2.2.

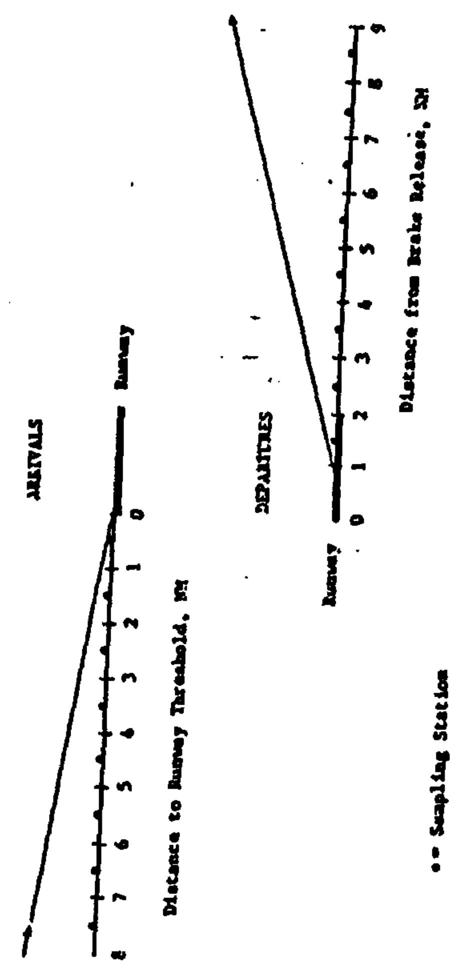

FIGURE 2-2
POSITIONS OF SAMPLING STATIONS FOR ARRIVALS AND DEPARTURES

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As an aircraft passed over a sampling station on its departure or its approach to landing, the time of the closest point of approach (CPA) to the sampling station was determined. The CPA was merely the point at which the aircraft was directly over the sampling station. The time of CPA was determined using linear interpolation on the raw target data. Altitude and velocity were then determined at the time of the CPA.

Lateral boundaries, as shown in Figure 2-3, were established around the runway centerline to eliminate from consideration the portion of those operations which involved turns shortly after departure or shortly before landing. Such turns affect aircraft performance and consequently distort the resulting flight profiles. As evident in Figure 2-3, however, which also shows the distribution of aircraft ground tracks for a typical day at Seattle-Tacoma, these "turning operations" were a small percentage of the total number of operations.

Radar data for eleven typical days of operations at Seattle-Tacoma were processed in the manner mentioned above. The eleven days occurred within the period May to July, 1981. Operations were extracted for an average period of 18 hours per day, usually from 0600 to 2400 hours local time. The weather for the 11 days included some brief periods of IFR conditions and winds were predominantly light. Table 2-1 shows the total number of operations extracted from tape and smoothed, and also provides a breakdown of the operations according to aircraft type. Because a disproportionate share of arrivals occured during the portion of the day when radar data was being extracted and processed, the number of departures does not equal the number of arrivals.

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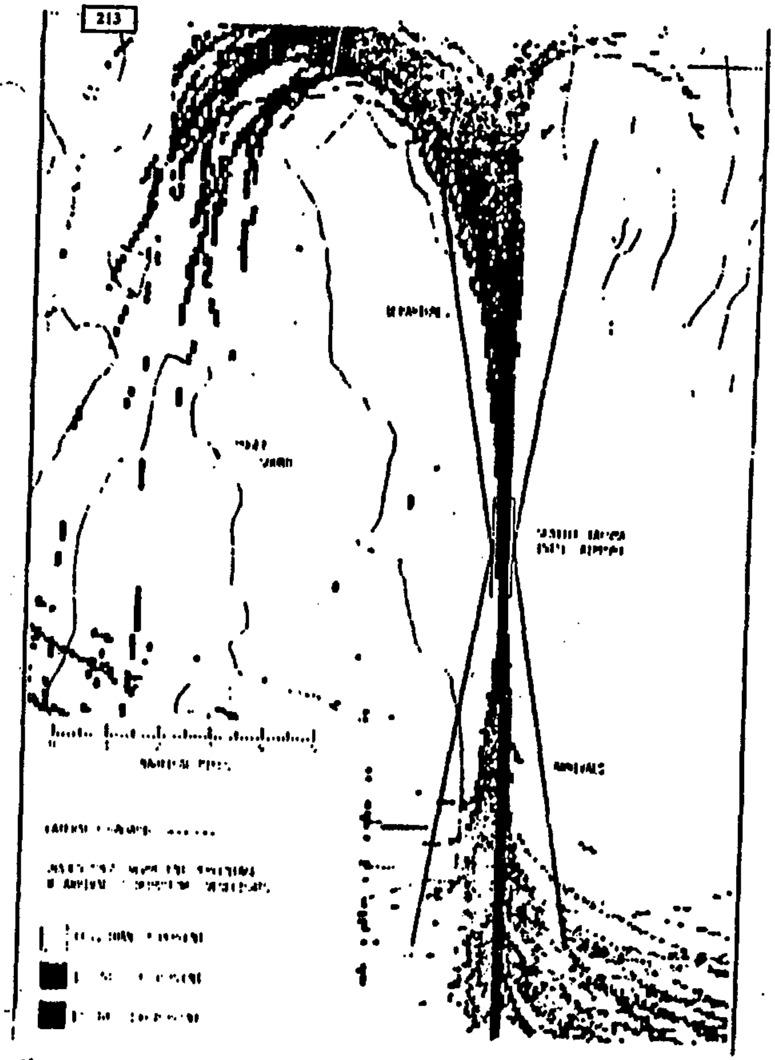

FIGURE 2-3
LOCATION OF LATERAL BOUNDARIES AND DISTRIBUTION OF GROUND TRACKS FOR TYPICAL DAY

TABLE 2-1
TOTAL NUMBER OF OBSERVED ARRIVALS AND DEPARTURES BY AIRCRAFT TYPE

Aircraft Type	Number of Arrivals	Number of Departures
Boeing 727	671	567
Boeing 737	122	111
Boeing 747	47	26
McDonnel Douglas DC-9	167	130
McDonnel Douglas DC-10	156	152
Lockheed L-1011	49	42
Other	379	345
Total	1585	1373

3. ANALYSIS OF ARRIVALS AND RESULTS

Once the radar data had been extracted and processed to yield flight profile data, the profile data were used in a series of statistical tests to determine the nature of actual flight operations. The analysis of flight profiles was divided into two operational sectors: arrivals and departure. This section describes some supporting information on arrival procedures employed by the airlines, assumptions on arrivals made by the INM profiles, and briefly reviews the statistical techniques used to characterize the observed data.

3.1 Common Operating Practices for Arrivals

To gain a feeling of the operational issues confronting air carrier pilots on an approach to landing, the Flight Operations Manuals (FOM) of several airlines were reviewed. It was found that the arrival procedures of most airlines were very similar with respect to each other. The variables which determine the manner in which approaches are to be flown are weight, prevailing weather conditions, and the type of navigational guidance used (e.g., visual approach, ILS, or other instrument approach).

Landing approach speeds are based on weight and flap configuration, and can be determined by the flight crew for a specific case by reference to a table of values in the flight manual. Vertical profile or decent guidance is usually provided by reference to the electronic glide slope of the ILS, or optically by reference to a Visual Approach Slope Indictor (VASI). Both sources of decent guidance provide an approximately 3° glide slope.

For operations conducted in marginal weather (low ceilings and visibility) where an ILS glide slope is being used, pilots are instructed to stabilize the aircraft on the approach at a point about 3 to 4 miles from the landing threshold. An aircraft is stabilized when it is established on the extended runway centerline and the glide slope, at its designated approach speed, and when only minor adjustments are necessary to remain within acceptable limits. Under average conditions pilots are usually able to maintain speed within 10 knots of the designated approach speed and maintain the glide slope to within 100 feet.

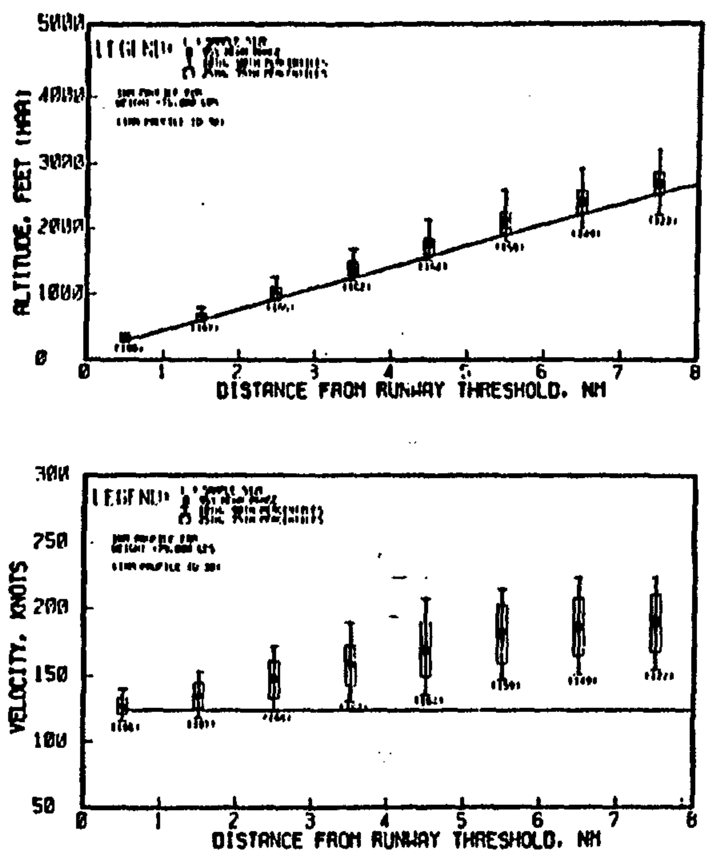

FIGURE 3-2
OBSERVED AND INM PROFILES FOR DC-9 ARRIVALS AT SEATTLE-TACOMA AIRPORT

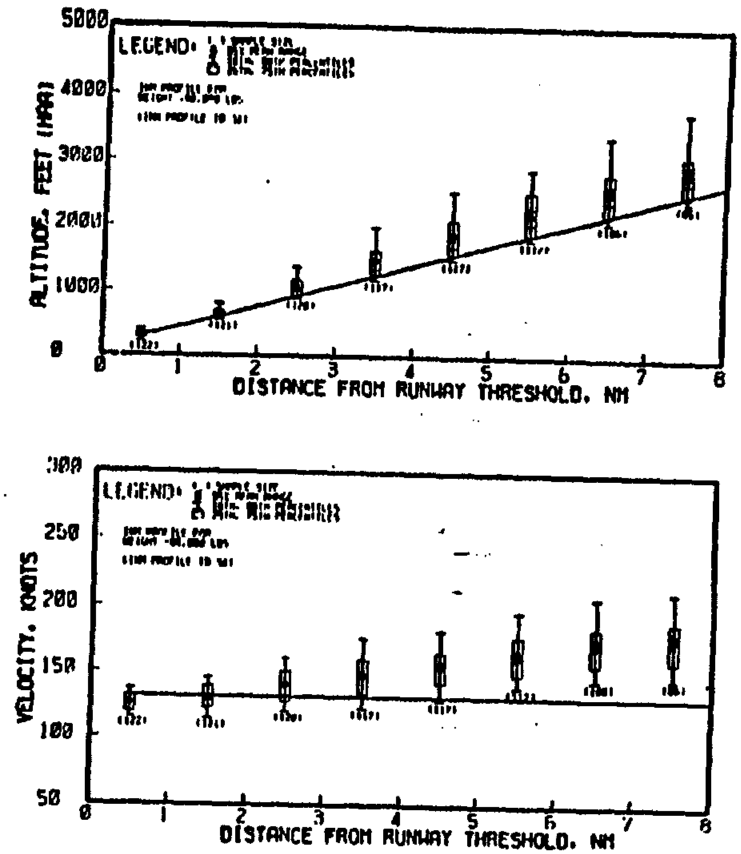

FIGURE 3-3
OBSERVED AND INM PROFILES FOR B-737 ARRIVALS AT SEATTLE-TACOMA AIRPORT

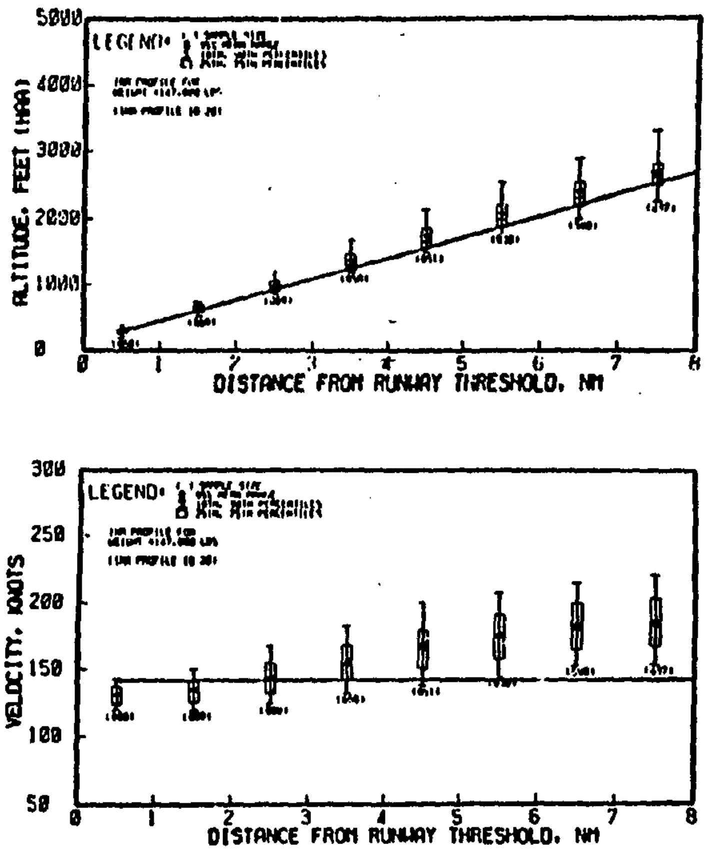

FIGURE 3-4
OBSERVED AND INM PROFILES FOR B-727 ARRIVALS AT SEATTLE-TACOMA AIRPORT

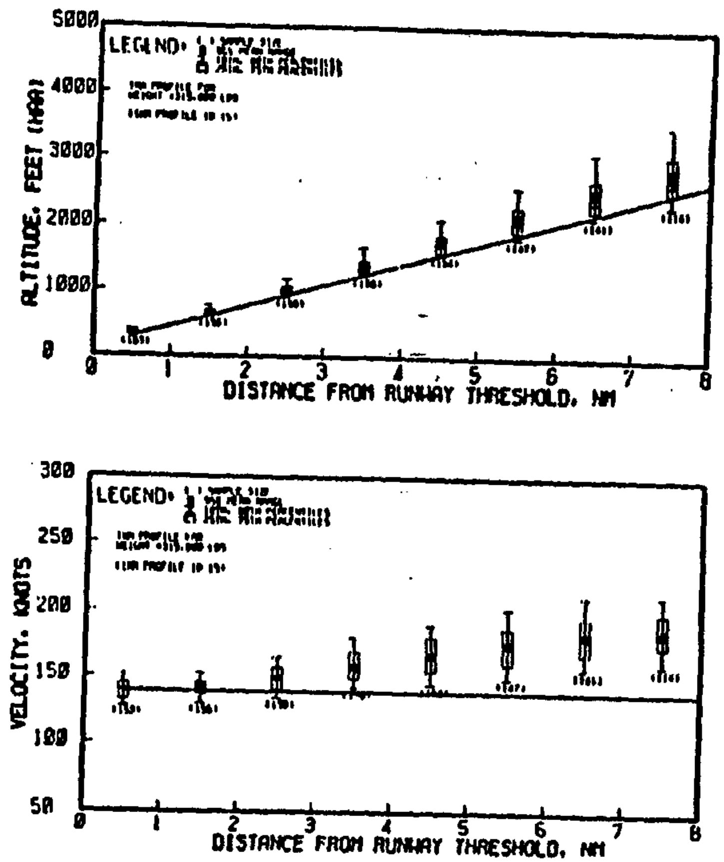

FIGURE 3-5
OBSERVED AND INM PROFILES FOR DC-10 ARRIVALS AT SEATTLE-TACOMA AIRPORT

For approach operations conducted in visual weather conditions, pilots are given more latitude concerning speed management, although a 3° glide path is still followed by reference to a VASI or ILS glide slope. Under better weather conditions, pilots can wait until they are about one-half mile from the runway threshold before establishing the designated approach speed. The tendency for air carrier pilots, given more freedom in the management of airspeed, is to approach the airport area at a significantly higher speed and gradually reduce speed so as to arrive at one-half mile from the runway at the designated approach speed. These "decelerating" approaches enable aircraft to land sooner while still remaining within safe operating limits at the point of touchdown. Even in ideal weather conditions, however, heavy air traffic conditions may constrain the speed management styles of pilots. Such constraints may come in the form of speed restrictions by ATC for the purposes of separating and sequencing air traffic.

3.2 INM Approach Profiles

The Number 8 INM data base includes standard approach profiles for three general classes of aircraft: commercial turbojet, general aviation, and military. The standard profiles continuously describe aircraft velocity, altitude, and thrust setting for the last 19 nautical miles of each landing approach. The only differences among the standard profiles for the three classes of aircraft are in approach speeds and thrust management. All the INM approach profiles used in this comparison come from the standard commercial jet class of approach profile which is described below.

Each of the three classes of approach profiles depicts a continuous vertical decent on a 3° glide slope from the point where aircraft first enters the area to the runway surface. Like the actual glide slopes provided by aids such as a VASI or ILS, the INM approach profile glide slope usually intersects the runway surface at a point about 1000 feet beyond the runway threshold. This results in a threshold crossing height of 50 to 60 feet. The INM assumes each aircraft touches down at the glide slope-runway intersection, at which point each aircraft continues a roll-out using standard braking techniques.

The INM velocity profile for standard commercial jet approaches include one speed transition at a point nearly 10 nautical miles from the threshold. All commercial jet aircraft initially approach the area at "terminal speed," which is maintained until

approximately 10 nautical miles from the threshold. At that point, speed is reduced to the unique final approach speed for that aircraft type. The terminal speed is usually the maximum authorized indicated airspeed for operations conducted under 10,000 feet Mean Sea Level (MSL), which is 250 knots. The final approach speed is a computed speed for each type of aircraft within the class, and is based on a nominal weight and flap configuration. The last 10 nautical miles of the INM approach are made in a "stabilized" state, i.e., the aircraft is established on the glide slope and maintains a constant speed to the point of touchdown. The roll out distance used in braking the aircraft after touchdown is based on aircraft arrival weight and final approach speed.

The inclusion of standard approach profiles in the Number 8 INM data base represents a significant improvement over older versions of the data base. Prior versions did not have completely predefined approach profiles and required the user to provide his own profiles based on what he believed were common operating practices. Even though the Number 8 data base specifies all aspects of a standard approach, the user is still given the flexibility of modifying a standard profile, or completely designing one of his own.

3.3 Statistical Issues and Graphic Presentation of Statistics

Operations that were extracted and processed were first broken down into two groups according to the type of operation conducted, namely, arrival or departure. Each group was then further aggregated into samples of aircraft operations at each sampling station according to aircraft type. These samples were the subject of a series of statistical measurements from which actual operations could be characterized. The following discussion, which is equally applicable to arrivals or departures, makes reference to Figure 3-1. This figure shows a "box-and-whisker" plot which provides a graphic presentation of the computed statistics for altitude and velocity at each sampling station.

The dark shaded box in Figure 3-1 encloses the 95% confidence interval for the mean of the population. The mean is the arithmetic average of the population. The confidence interval expresses the range within which the population mean is likely to exist. The 95% confidence interval, then, specifies an interval constructed in such a way that the population mean is expected to lie within it for 95 out of 100 similarly drawn samples. The confidence interval is constructed on the assumption that the underlying distribution of the population is a normal distribution.

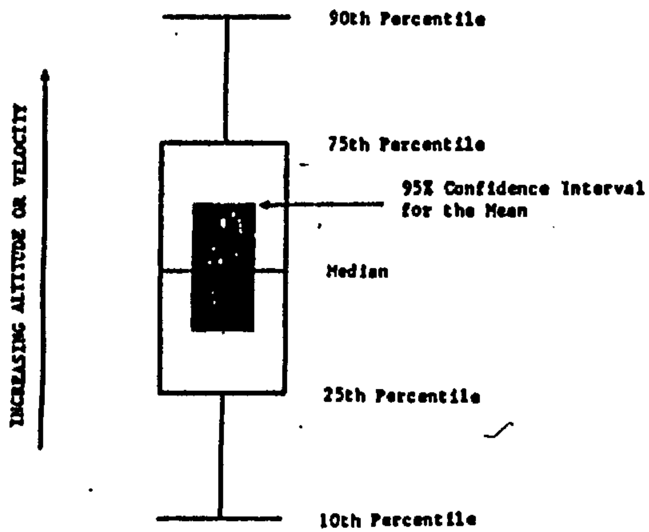

FIGURE 3-1
BOX-AND-WHISKER PLOT FOR THE GRAPHIC REPRESENTATION OF COMPUTED STATISTICS FOR OBSERVED ALTITUDES AND VELOCITIES

Another method used to characterize sampled data involves the use of nonparametric, rank-order statistics. The use of such statistics provides a simple view of sample distributions and requires no assumption about the underlying distribution of the population from which the sample was taken. In the box-and-whisker diagram of Figure 3-1, the 90th 75th, 25th, 10th percentiles, and the median are given.

Rank-order statistics are based on the ordering of the sampled values from highest to lowest. The median, or 50th percentile, represents the value above which and below which lie one half of the sampled values. The 90th percentile represents the value above which is 10 percent of the sampled values and below which is 90 percent. Similar definitions apply to the other percentiles given in the box-and-whisker plot. A close spacing of these values indicates the population values are concentrated, or closely spaced. Conversely, wider spacing indicates the population values are more widely spread.

3.4 Results of INM - Observed Approach Profile Comparison

Figures 3-2 to 3-7 on the next few pages show the comparison of observed profile data to INM profiles for six aircraft types. In each case the INM profile selected for the comparison represents the most likely aircraft model for each type of aircraft observed at Seattle. The INM profile is depicted by the solid black lines. Statistics for the observed altitudes and velocities of each aircraft type are provided in the form of a box-and-whisker plots over each sampling station.

From visual inspection of the altitude profiles for each aircraft type, it is evident that all six aircraft types closely followed the 3° glide slope (depicted by the INM) with only minor variations around it. Variations in observed altitudes behaved as a function of distance from the runway: as aircraft approached the runway, variations in observed altitude became progressively smaller (as evidenced by the compression of the box-and-whisker plots) and more centrally gathered around the INM 3° glide slope.

A visual inspection of the velocity profiles reveals a somewhat different story. As aircraft initially approached the runway,

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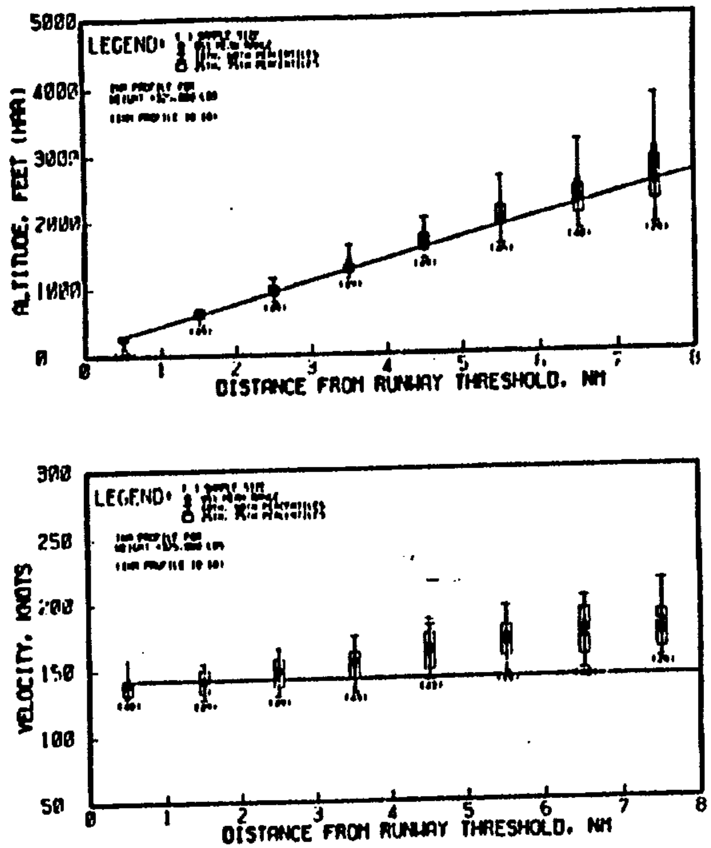

FIGURE 3-6
OBSERVED AND INM PROFILES FOR L-1011 ARRIVALS AT SEATTLE-TACOMA AIRPORT

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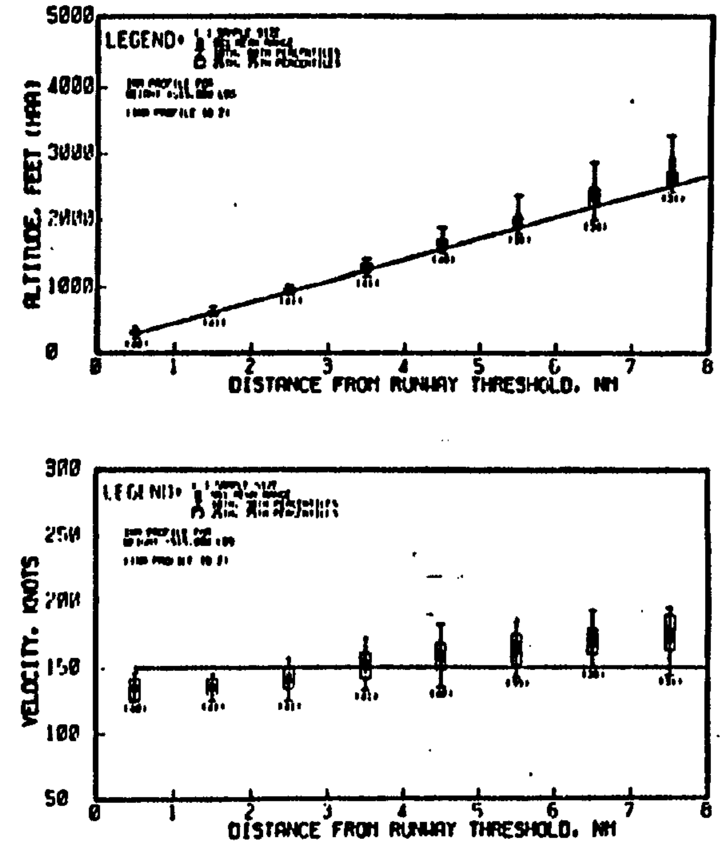

FIGURE 3-7
OBSERVED AND INM PROFILES FOR B-747 ARRIVALS AT SEATTLE-TACOMA AIRPORT

3-11

their speeds were much higher than the INM final approach speed. However, most of the air aircraft types slowed to within a few knots of the INM approach speed as they neared the runway. Under these decelerating approaches, the observed aircraft were usually established at near the INM speed before reaching a point 2 nautical miles from the end of the runway. The frequent occurrence of the decelerating approach in the Seattle data is consistent with the predominant conditions at Seattle: VFR weather conditions and fairly light traffic. These two factors enabled pilots to maintain a higher approach speed to a point closer to the runway.

The fairly close agreement between observed data and the INM for both altitude and velocity profiles close to the runway substantiates the accuracy of the data and the techniques used to process it. The presence of a VASI and/or an ILS glide slope gives all pilots more precise decent information and one would expect fairly close groupings of observed altitudes around the INM 3° glide path. In addition, given the weather conditions and traffic loads of the Seattle-Tacoma Airport, one would expect pilots to employ a decelerating approach.

4. ANALYSIS OF DEPARTURES AND RESULTS

Unlike the fairly well-defined and standardized procedures for aircraft approaches and landings, there are many other factors associated with departures which contribute to considerably more variation in observed operations. Aside from procedural differences in takeoffs and departures, certain performance-limiting factors such as gross weight, pressure altitude, temperature, and runway surface conditions introduce additional sources of variation in observed departure profiles. A more detailed breakdown of departure operations was performed in order to assign specific causes to observed variations. This section describes an analysis of departure operations considered as a whole, and also describes two smaller analyses performed on subsets of the observed departures from Seattle.

In general, air carrier pilots are given more latitude in the execution of departures and can make tradeoffs between altitude, speed, and thrust. At a fixed thrust setting, for example, a pilot could elect to climb at a faster airspeed and sacrifice his rate of climb, or vice versa. In an attempt to standardize departure performance and enhance the safety and noise compatability of such operations, airline flight operations manuals specify well-defined departure procedures. However, pilot-to-pilot variability and the presence of extenuating circumstances such as turbulence or mountainous terrain near the airport suggest that less than strict adherence to procedures may be noted in observed profiles.

4.1 Common Operating Practices for Departures

A review of several flight operations manuals revealed that most airlines employ departure procedures which are in basic compliance with the suggested FAA procedures contained in AC91-53. This advisory circular has been in effect since October 1978, and outlines a suggested noise abatement procedure for turbine powered aircraft departures. There are differences between the procedures of various airlines, however, which could result in tangible differences in the resulting profiles.

The FAA departure procedure is designed to reduce the noise generated by the turbine engine itself through reductions in thrust and to increase the distance between the source (the airplane) and the noise affected area on the ground by increasing climb gradient. The departure is also intended to be consistent with the objectives of safety and fuel efficiency.

A diagram of the FAA departure is given in Figure 4-1. Speed, thrust, and flap changes are scheduled according to gains in altitude. After lift-off, all aircraft climb at a speed of V_2 plus 10 to 20 knots at takeoff thrust. The symbol V_2 represents "takeoff safety speed" and it varies with aircraft weight and flap setting for each aircraft type. It is the speed at which, should one engine fail, the airplane is still capable of maintaining a specified minimum climb gradient. When the airplane reaches a height of 1000 feet above the airport, flaps are retracted according to the schedule in the flight operations manual and an acceleration is made to V_{zf}, the minimum zero flap maneuvering speed. At this point, thrust is reduced from takeoff power. The difference between the FAA and some airline procedures is the size of the thrust "cutback".

Under the procedures of some airlines, a reduction is made to the normal climb thrust for all aircraft types. The FAA procedure, however, specifies a cutback which is based on the type of engines involved. Airplanes with high bypass ratio engines reduce to normal climb thrust while those with low bypass ratio engines reduce to a value somewhat below normal climb thrust. The lower thrust must still be capable of providing a prespecified minimum climb gradient in the event an engine fails. Aircraft with the quieter high bypass ratio engines are predominantly two, three, and four engine wide-bodied aircraft while most of the narrow bodied fleet are powered by low bypass ratio engines. Regardless of which power setting is used, both the FAA and the other procedures recommend the climb be continued at or near V_{zf} until reaching 3000 feet. At that altitude all aircraft accelerate to 250 knots and resume a normal en route climb configuration.

Of the several airlines conducting operations at Seattle, some have adopted the FAA departure while others have used their own type of departure. The FAA and other departures for wide bodied aircraft with high bypass ratio engines are essentially the same and one would expect similar performance profiles if all other factors are equal. On the other hand, the difference between the FAA and other departures for aircraft with low bypass ratio engines is the thrust cutback at 1000 feet altitude. Under the FAA procedure, one would expect a shallower climb profile above 1000 feet than the one obtained using other procedures. Other factors may obscure the differences attributable to the use of varying procedures, however. Almost all flight operations manuals, in addition, include a caveat stating that the noise abatement profiles may be abandoned, including the thrust reduction at 1000 feet, to meet turbulence, air traffic, or obstacle clearance requirements.

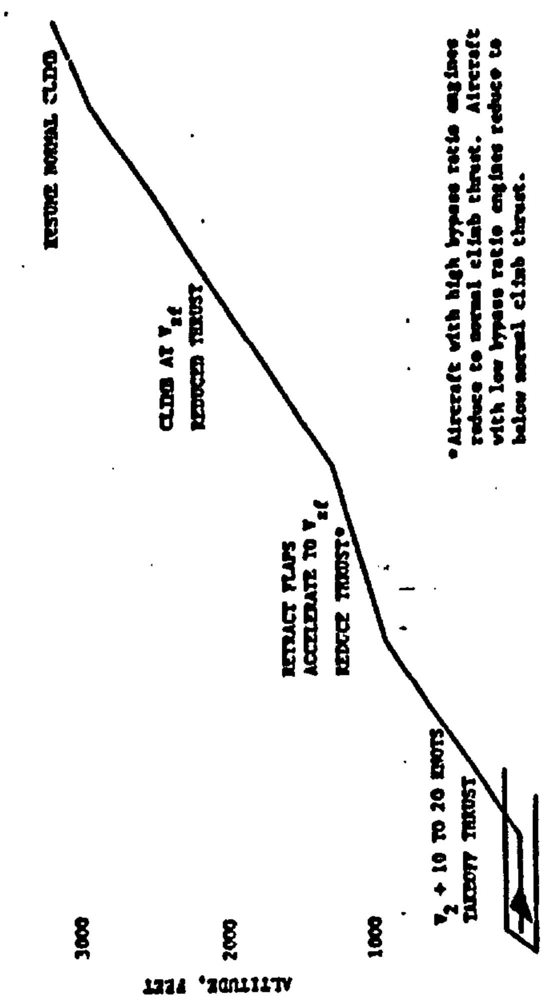

FIGURE 4-1
FAA NOISE ABATEMENT DEPARTURE PROFILE

4.2 INM Departure Profiles

The departure profiles contained in the INM data base are completely defined profiles and have been constructed from theoretical relationships based on engineering data. In constructing the profiles, all aircraft were assumed to follow the FAA departure as described in AC91-53. To control the effect of varying aircraft departure weights, the INM has up to seven slightly different profiles to reflect departure performance of each aircraft type at different weights. The user of the INM supplies information on the weight of each proposed departure indirectly by specifying the stage-length (the non-stop distance) of the flight. The INM bases its estimation of weight on stage-length under the assumption that weight and stage-length are proportional. This appears to be a reasonable assumption since, as the length of a flight increases, the fuel load must also increase. There are cases, however, where this assumption is not true. An aircraft making a series of short flights, for example, may depart on the first leg with enough fuel for all the legs of the flight to eliminate the need to refuel at each stop. Airlines will sometimes refuel only at certain airports where the price of fuel is lower and carry enough fuel to fly through other airports where prices may be higher.

For the purposes of comparing INM profiles with observed profiles, the INM profile for the most likely stage-length was chosen for each aircraft type. The determination of the most likely stage-length was based primarily on the type of aircraft. Some aircraft are intended for short-haul flights and others are designed for long range flights. For those aircraft types which fly a wide range of stage-lengths the actual stage-length was determined for specific flights by consulting airline schedules, and the most frequently occurring stage-length was selected as the representative stage-length.

4.3 Results of INM - Observed Departure Profile Comparison

Figures 4-2 to 4-7 on the next pages show the comparisons of observed profile data to INM profiles for the same six types of aircraft. Like the comparisons made for arrivals, the INM profile for the most likely aircraft model and stage-length is presented in the form of a solid line for each aircraft type. Observed profile data are again characterized by box-and-whisker plots. Unlike the case for arrivals, however, no uniform trends are apparent when the comparisons are made. To facilitate the

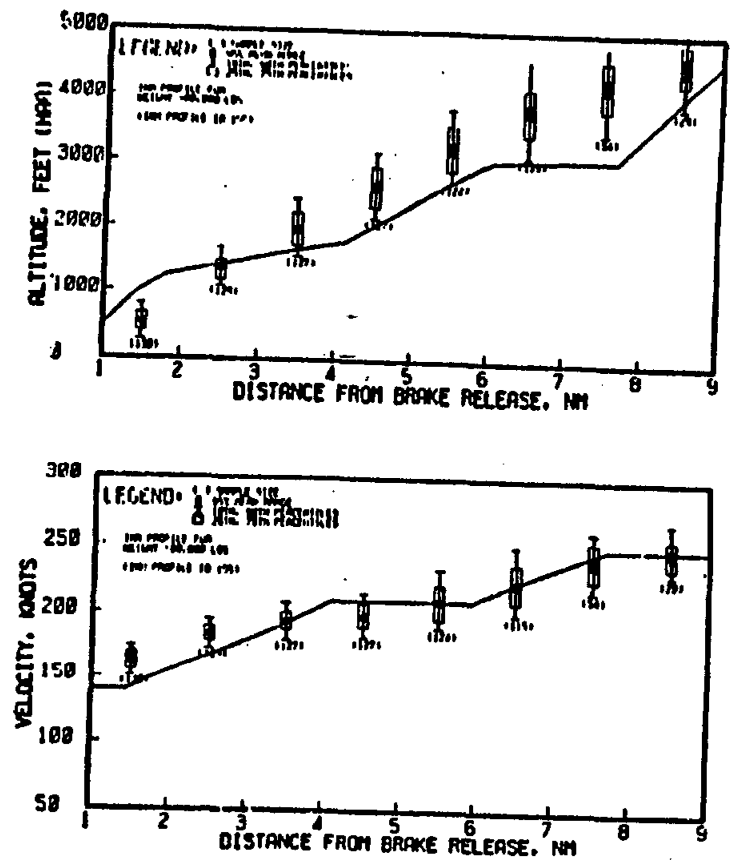

FIGURE 4-2
OBSERVED AND INM PROFILES FOR DC-9 DEPARTURES FROM SEATTLE-TACOMA AIRPORT

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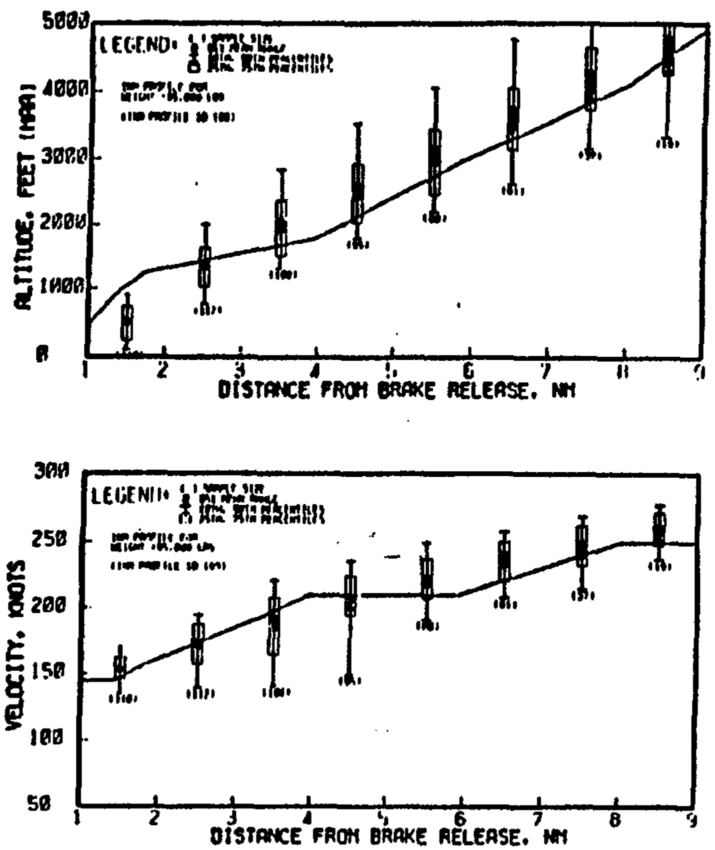

FIGURE 4-3
OBSERVED AND INM PROFILES FOR B-737 DEPARTURES FROM SEATTLE-TACOMA AIRPORT

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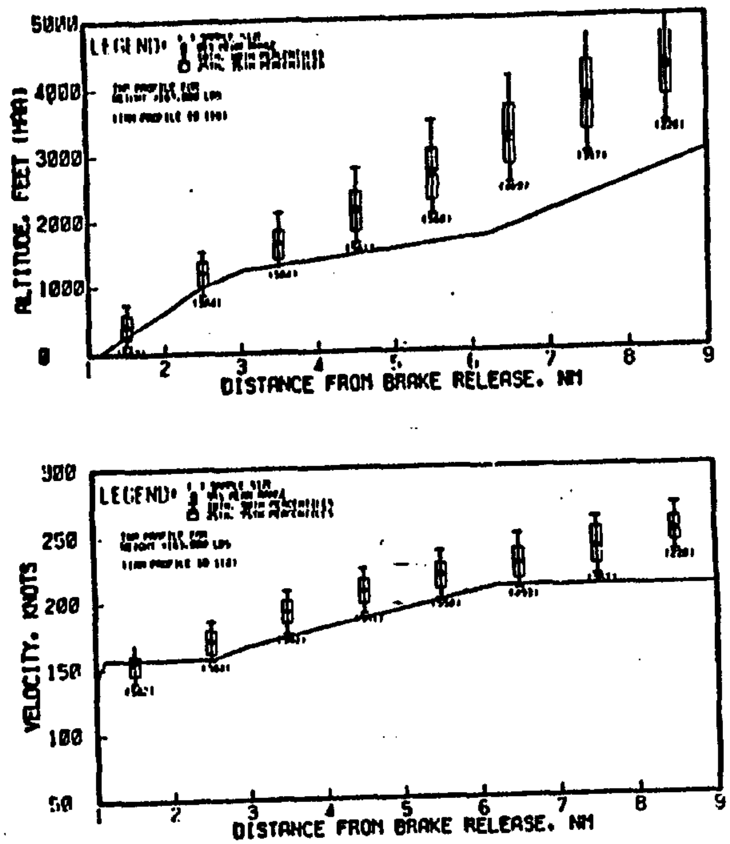

FIGURE 4-4
OBSERVED AND INM PROFILES FOR B-727 DEPARTURES FROM SEATTLE-TACOMA AIRPORT

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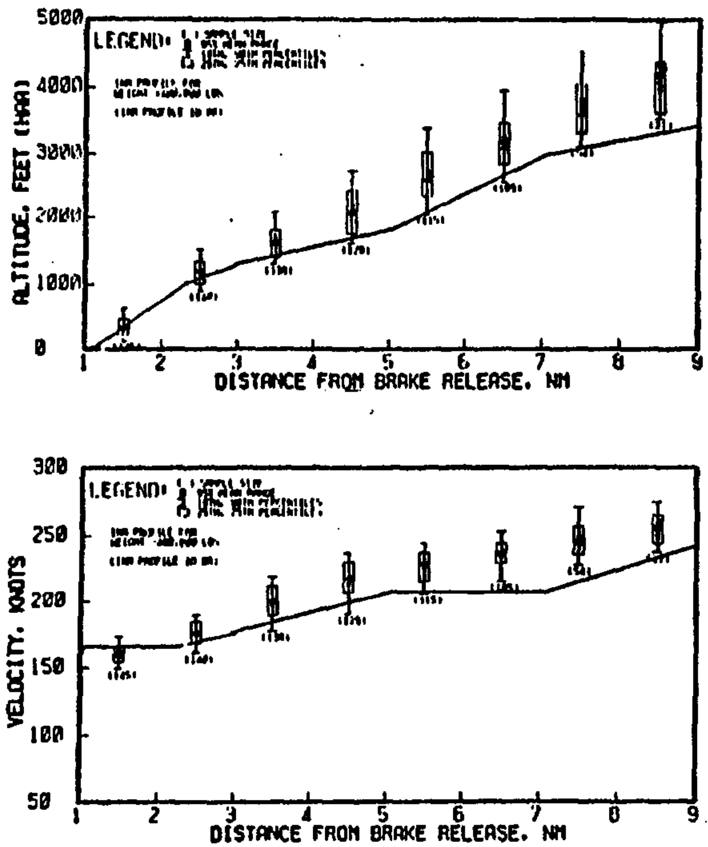

FIGURE 4-5
OBSERVED AND INM PROFILES FOR DC-10 DEPARTURES FROM SEATTLE-TACOMA AIRPORT

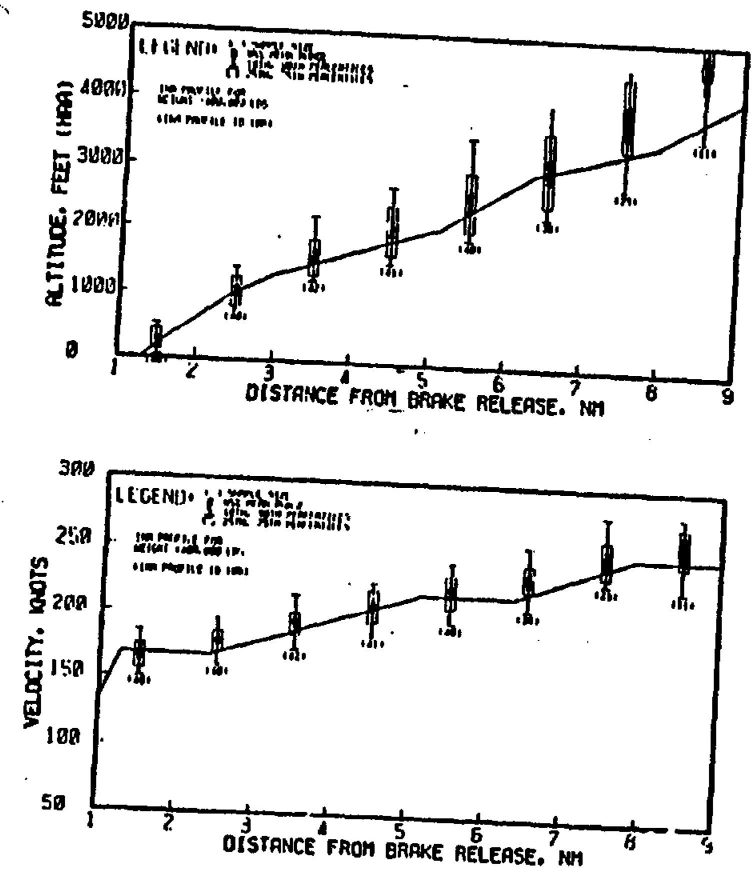

FIGURE 4-6
OBSERVED AND INM PROFILES FOR L-1011 DEPARTURES FROM SEATTLE-TACOMA AIRPORT

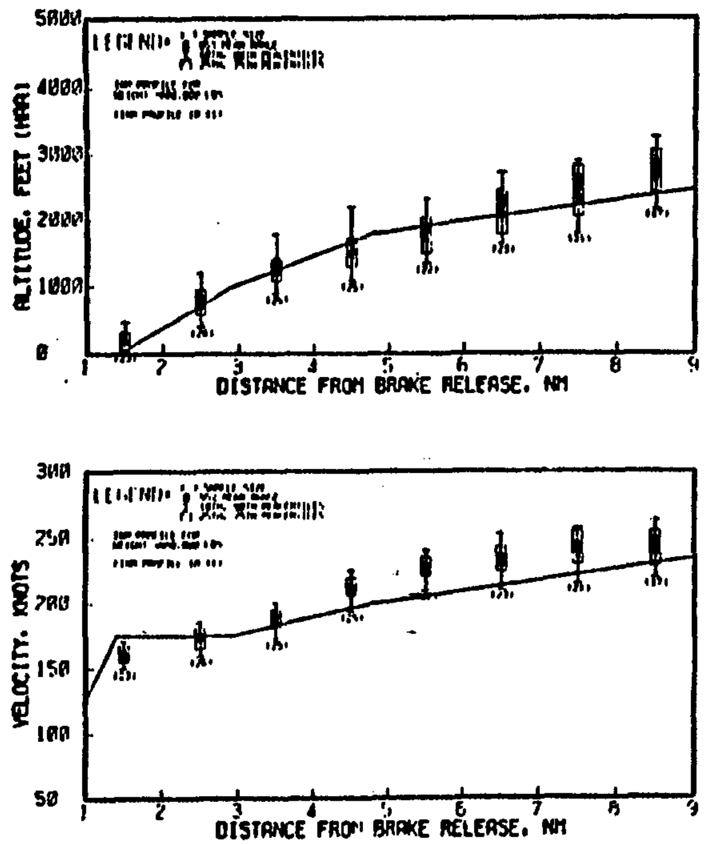

FIGURE 4-7
OBSERVED AND INM PROFILES FOR B-747 DEPARTURES FROM SEATTLE-TACOMA AIRPORT

discussion of the level of agreement between INM and observed profiles, the departure profile is divided into two segments: the near field segment (which includes the portion of the departure within 3 nautical miles from the BRP) and the far field segment (which includes the portion more than 3 nautical miles from the BRP).

A visual inspection of the altitude profiles for observed departures and the INM for the near field shows that the two were in fairly close agreement for the B-727, DC-10, L-1011, and B-747. For the two twin-engine, narrow bodied aircraft, however, the DC-9 and B-737, the observed altitudes for the near field were much lower than specified by the INM. The difference in altitude was approximately 500 feet for these aircraft. The near field velocity profiles for observed operations were within reasonable agreement with INM velocities for all six aircraft types. A closer inspection of the near field INM profiles for the DC-9 and B-737 reveals that the INM predicts an altitude gain of 500 feet by the time the aircraft has traveled one mile from the BRP. Although such performance is attainable under optimum conditions, it is probably not representative for these two types of aircraft.

For the far field segment, the observed altitude profiles for the DC-9 and B-727 were much higher than specified by the INM. The altitude difference was in the range of 500 to 1500 feet. For the four other aircraft types, observed altitudes were fairly close to INM altitudes. The observed velocity profiles for the far field were in close agreement with INM velocities for all aircraft except the B-737. For this aircraft observed velocities were 20 to 30 knots higher than INM velocities.

One reason for the differing levels of agreement is the difference in the thrust reduction specifications of the departure profiles. As mentioned earlier, the FAA and other types of departures are essentially the same for aircraft with high bypass ratio engines such as the DC-10, L-1011 or B-747. Because the INM profiles reflect theoretical performance using the FAA departure procedures, and because most airlines use either the FAA or similar procedure as the standard departure, one would expect fairly close agreement between the observed operation and INM profiles for wide-bodied aircraft. This expected close agreement is evident in Figures 4-3 through 4-7.

The FAA and some departure procedures for low bypass ratio engines, on the other hand, are somewhat different. The expected result of the difference is for those airlines not using the FAA procedure to have a steeper climb gradient for the segment between 1000 feet and 3000 feet above field elevation. The low bypass engine aircraft in this study, the DC-9, B-727, and B-737 were all observed to be higher for this phase of the departure than the INM profile, as evident in Figures 4-2 through 4-4.

4.3.1 Analysis of B-727 Departures Grouped According to Airline

An analysis was made of Boeing 727 departures to determine if differences in departure procedures in the flight operations manuals of different airlines have observable effects on actual operations. B-727 operations made up, by far, the majority of operations at Seattle. It was possible, therefore, to group B-727 departures according to airline and still have reasonably large sample sizes. Five major airlines were considered in this analysis.

Rather than making comparisons with INM profiles, the observed departure profiles for each airline are compared directly with other airlines in Figure 4-8. The dashed lines in this figure connect median values over each sampling station for each airline.

By referring to the altitude profiles in Figure 4-8, it is evident that there is no real difference in climb performance between the different airlines for the departure segment within 5 nautical miles of the BRP. Beyond this point, however, one finds the disparity becoming more distinct. At 8.5 nautical miles from BRP the highest median departure is approximately 1000 feet higher than the lowest median departure. A review of available flight operations material indicates that this is an expected result. The airline with the lowest median departure uses a procedure which represents a unique approach to noise abatement and was constructed in the manner ultimately intended by FAA AC91-53. This airline reduces to a significantly lower thrust value at 1000 feet altitude than specified by manuals of other airlines. The expected result of this cutback is the shallower climb angle evident in the median of these departures.

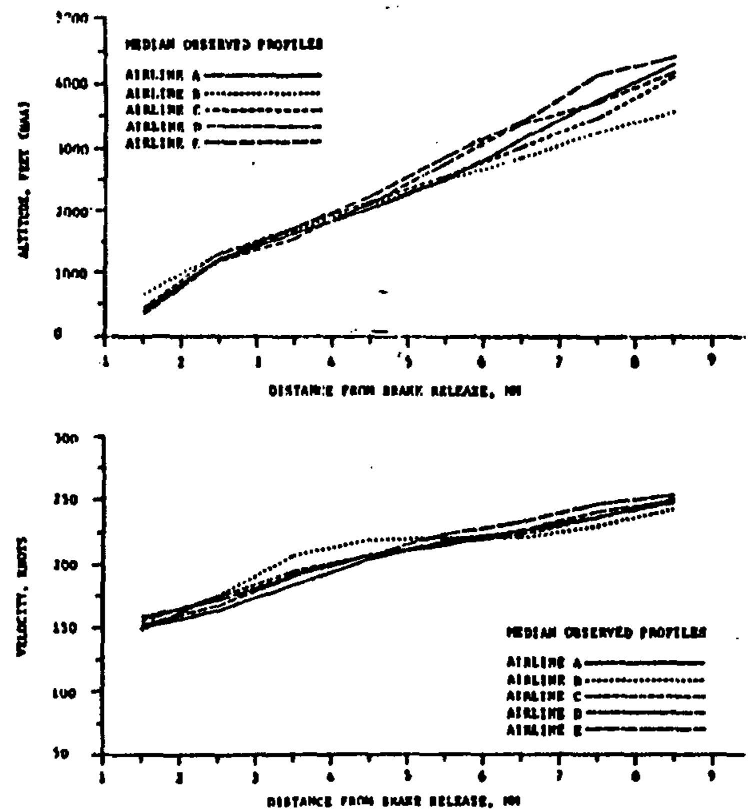

FIGURE 4-8
OBSERVED PROFILES FOR B-727 DEPARTURES GROUPED ACCORDING TO AIRLINE

Reference to the velocity profiles in Figure 4-8 on the other hand, reveals no significant differences in the airspeed schedules used by the five airlines studied. This is also an expected result since the departures of most all airlines use the same target speeds. The similarity of the velocity profiles provide additional support to the hypothesis that differences in thrust cutbacks provides the largest single source of variation in the altitude profiles in Figure 4-8.

4.3.2 Analysis of B-727 Departures Grouped According to Stage-Length

As mentioned earlier, the INM estimated the weight of each departing aircraft on the basis of the stage-length for the flight. To measure the sensitivity of both observed operations and INM profiles to differences in stage-length, a separate analysis was conducted on B-727 departures grouped according to stage-length. The actual stage-length of each flight was determined by reference to the flight intinerary in airline schedules. Each B-727 departure for which the first point of intended landing could be determined was assigned to one of four stage-length categories: 0 to 500 nautical miles, 501 to 1000 miles, 1001 to 1500 miles, and 1501 to 2500 miles. The same statistical analyses were performed on B-727 grouped as such and the results were compared with the INM B-727 profiles for the corresponding stage length. The same conclusions apply to B-727 departures grouped according to stage-length as for B-727 departures considered as a whole in Figure 4-4. For all four stage-lengths observed altitudes were close to the INM profiles for the near field segment, but for the far field segment the differences approached 1500 feet. Observed velocities in each case were slightly higher than corresponding INM profiles.

A direct comparison of the INM profiles for the four stage-lengths is given in Figure 4-9. The median profiles for observed operations are also given. The INM altitude and velocity profiles in this figure indicate that there is little difference between the shortest stage-length and the longest stage-length. The median altitude profiles for observed operations indicate only a slightly greater sensitivity to differences in stage-length than the corresponding INM altitude profiles.

An important observation to make at this point concerns the sensitivity of INM profiles to stage-length differences in Figure 4-9 and the fairly wide variation in observed

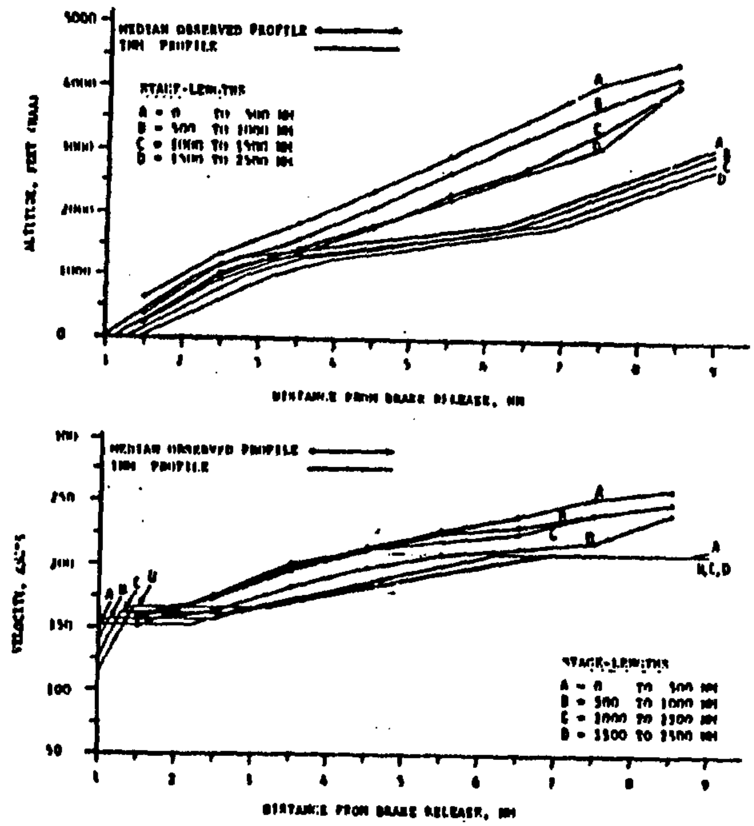

FIGURE 4-9
INM AND OBSERVED PROFILES FOR B-727 DEPARTURES GROUPED ACCORDING TO STAGE-LENGTH

operations (as evidenced by the wide spacing of the 10th and 90th percentiles in the box-and-whisker plots in Figures 4-2 through 4-7). The variation in observed operations is several times greater than the sensitivity of the INM to changes in stage-length. The result of such a situation is for the slight effects of stage-length to be obscured by variations caused by other factors. It is not necessary, then, to maintain such precise differences in INM profiles for the stage-length factor if such differences are small compared to real world variation from other sources. Fewer and more broadly defined stage-length categories may be more efficient.

4.3.3 Comparison of Observed Departure Profiles for DC-9, B-737, and B-727 with Revised INM Profiles

The original Number 8 INM departure profiles were constructed under the assumption that, for all aircraft types, airlines employed the FAA noise abatement departure profile as outlined in AC91-53. However, the observed data for the low bypass ratio engined aircraft in the study (DC-9, B-737, B-727) suggested that for these three types of aircraft, this may not be the case. In an effort to improve the level of agreement between Version 8 INM profiles and observed data, the FAA Office of Energy and Environment proposed a few revisions to the INM profile data base for these three aircraft types. The revised profiles were not merely molded to fit the observed data but rather were constructed using the same theoretical relationships under different assumptions about the departure procedures used. As shown in Figures 4-10 through 4-12, which show the original and revised INM profiles and the observed profile data, the level of agreement is considerably improved with the revised INM profiles.

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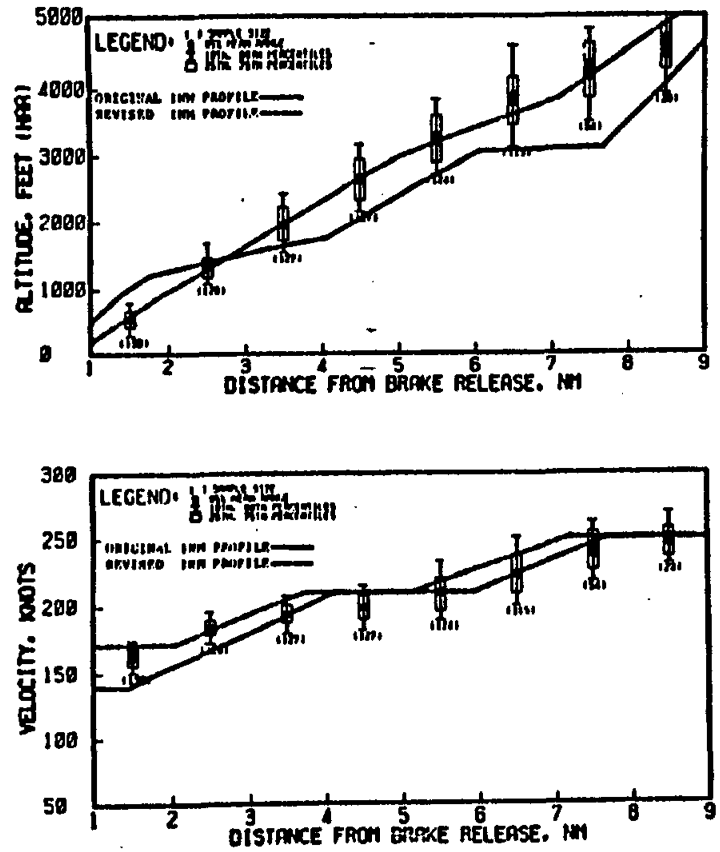

FIGURE 4-10
ORIGINAL AND REVISED INM PROFILES FOR DC-9

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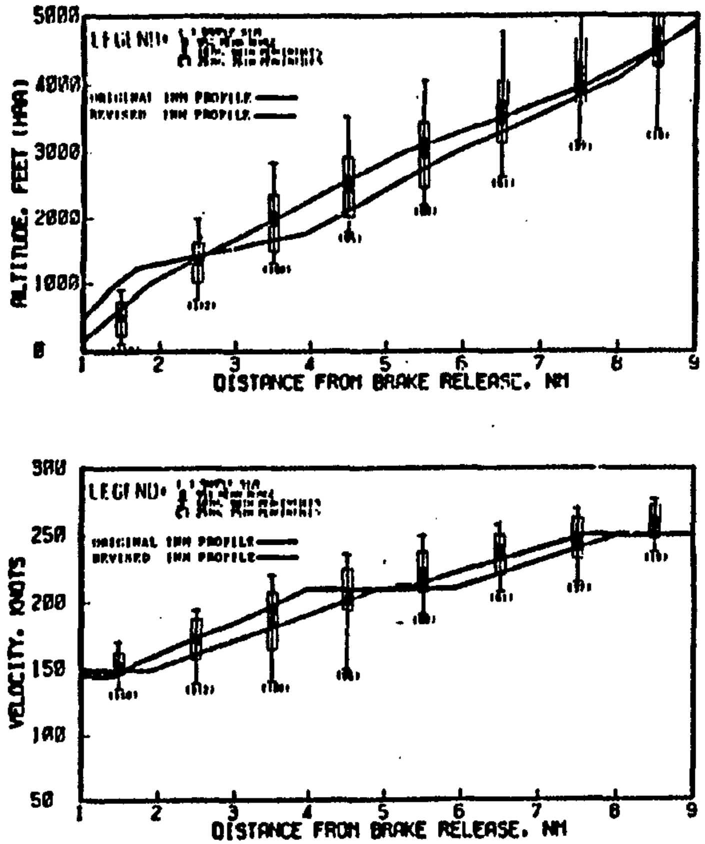

FIGURE 4-11
ORIGINAL AND REVISED INM PROFILES FOR B-737

4-18

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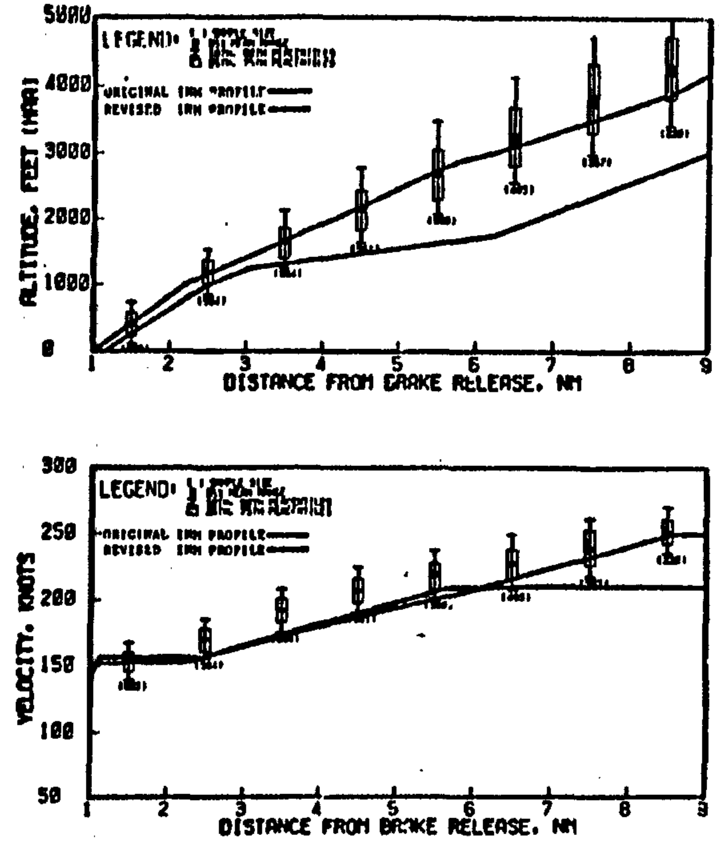

FIGURE 4-12
ORIGINAL AND REVISED INM PROFILES FOR B-727

4-19

5. CONCLUSIONS AND RECOMMENDATIONS

This analysis of aircraft profiles represents the most comprehensive comparison made to date between observed operations and profiles contained in the INM data base. A more complete review of airline operating practices has been included to reveal those operational variables which are likely to influence the shape of observed profiles. In general, the new Number 8 INM data base profiles have made significant improvements in observed-INM profile agreement. There are, however, a few areas where the agreement could be improved even further and INM ease-of-use and efficiency enhanced.

For arrivals, the agreement between observed operations and standard INM approach profiles was generally good. The standard INM altitude profile depicts a continuous descent on a 3° glide slope to the point of touchdown. Observed arrivals for all six types of aircraft were closely grouped around this glide slope. A difference was noted, however, in the comparison of observed and INM velocity profiles for arrivals. Standard INM velocity profiles depict an approach of constant speed for the last 9 nautical miles before the threshold. Observed aircraft, however, approached the airport area at a significantly higher speed and gradually reduced speed to the final approach speed approximately 2 nautical miles from the runway threshold. This observation was attributed to the prevalence of weather and traffic conditions which made decelerating approaches feasible.

Though the INM user could construct his own decelerating approach to accommodate such a situation, the predictable patterns of observed operations suggest that the addition of a completely predefined decelerating approach would be more efficient, consistent, and of greater benefit to the user. The user would have to be informed of the weather and traffic conditions which make either the constant speed or decelerating approach applicable, but the benefit gained in establishing this choice is the simplicity in which the user can specify entire approach profiles which are based on predictable and fairly invariant observed operations.

Another issue concerning decelerating approaches is the effect they have on estimated and observed noise levels. The thrust values contained in the INM approach profile data base are specified for aircraft maintaining a given configuration in a

"steady state". An aircraft which is decelerating, however, is not in a steady state and is probably using less thrust than an aircraft maintaining a constant speed in the same configuration. The end result of the decelerating approach should be some reduction in noise generated at the source. However, the size of the noise reduction may be small because thrust levels are generally low even in constant speed approaches.

For departures, the comparisons made between INM profiles and observed operations showed little difference for some aircraft types and greater differences for others. In general, observed-INM profile agreement was better for wide-bodied aircraft with high bypass ratio engines. The close agreement was attributed to the similarity between assumptions under which the INM profiles were constructed and actual operating practices used by various airlines.

The observed-INM agreement was not quite as good for narrow-bodied, low bypass ratio engined aircraft. For the near-field segment of the departures, INM profiles for the B-737 and the DC-9 were much higher than observed operations. The INM profiles for these two aircraft for this segment reflect rather steep climbs which are probably not attainable in everyday operations. On the far field, differences were noted for the DC-9 and B-727. The observed trends suggest that the thrust cutbacks in actual operations are not as great as those assumed by the INM profiles. Some airlines employ a departure which specifies a smaller thrust reduction than the FAA departure for low bypass ratio engines.

The analyses of B-727 departures grouped in various ways also contributed to a greater understanding of the pertinent variables involved in departures. An analysis of B-727 departures grouped according to airline revealed that some differences in observed profiles could be traced to differences in operating procedures. Another analysis performed on B-727 departures grouped according to stage-length resulted in the same conclusions as when they were considered in aggregate. Differences between INM profiles for the shortest and longest stage-lengths are not great and tend to be masked over by variation from other sources. In addition, the assumption that weight estimation can be based on stage-length may not be true for all instances. Based on these findings the number of stage-length categories should be reduced from seven to two or three.

The revisions to the INM profiles proposed by the FAA for the DC-9, B-737, and B-727 aircraft resulted in much improved observed-INM profile agreement. The revised profiles were the result of recomputing departure performance under different assumptions about the departure procedures being used. To guarantee that the INM profiles maintain relevance with general observed operations, the revised profiles should become a permanent part of the INM data base.

In conclusion, the INM profiles contained in the new Number 8 data base generally agree with current observed profiles. The level of agreement is much better than afforded by the older Number 7 data base. However, the improvements suggested above would lead to even closer agreement and ease the tasks presented to the INM user.

APPENDIX A

ANALYTICAL TECHNIQUES USED TO PROCESS RADAR DATA

ATC Radar Beacon System (ATCRBS) target data as reported to the ARTS-III system were used to determine the altitudes and velocities of aircraft as they passed over the sampling stations on an arrival or departure. It was necessary to smooth the data before it could be used to yield altitude, position, and velocity information. This Appendix describes the cubic spline function smoothing technique, used to account for the above mentioned problems, and the other analytical techniques used to determine altitude and velocity at the closest point of approach.

An ARTS-III target report describes an aircraft's position in terms of the Mode C altitude reported by the aircraft's transponder, azimuth angle (relative to Magnetic North), and range from the ATCRBS antenna. The range value is quantized to the nearest one-sixteenth of a nautical mile and the altitude to the nearest 100 feet. The ARTS-III system automatically corrects the reported altitude for non-standard pressure and yields the aircraft's altitude relative to Mean Sea Level (MSL). The MITRE ARTS81 data extraction program translates each pertinent target report to a position report in terms of a 3-axis Cartesian coordinate system.

A radar track history of an aircraft arrival or departure consists of a chronologically ordered series of position reports, $\{p\}$. The ith position report in the series can be written parametrically as

$$P_i = (x_i, y_i, z_i, t_i)$$

where

x_i = aircraft displacement from the extended runway centerline, in feet,

y_i = aircraft displacement along the extended runway centerline from a fixed arbitrary point on the runway, in feet,

z_i = altitude of aircraft, in hundreds of feet above the runway,

t_i = the time at which the position report occurred, in seconds.

The time interval between successive position reports, $(t_i - t_{i-1})$, was approximately 4.7 seconds.

An estimate of the time of closest point of approach, CPA, to each sampling station was based on the raw position data. For sampling station j, with a location y_j^*, a consecutive pair of position reports (p_i, p_{i+1}) was found such that

$$y_i \geq y_j^* \geq y_{i+1}$$

The time of the closest point of approach, t_j^* was then estimated using linear interpolation.

The four reports preceeding and following the time of CPA were then used in a smoothing operation called cubic spline function smoothing. The desired product of the smoothing process was a set of 3 cubic equations, x(t), y(t), and z(t), which provides a continuous description of aircraft position along the appropriate dimensions with time as the independent variable. The three equations describing aircraft position have the form

$$x(t) = A_x + B_x t + C_x t^2 + D_x t^3,$$

$$y(t) = A_y + B_y t + C_y t^2 + D_y t^3,$$

$$z(t) = A_z + B_z t + C_z t^2 + D_z t^3.$$

The coefficients A, B, C, and D, were determined using polynomial interpolation. In performing the interpolation, however, the smoothing process is introduced by having the objective that the acceleration on any axis (e.g., $\ddot{x}(t)$, $\ddot{y}(t)$, and $\ddot{z}(t)$) be minimized. This objective is applicable to the treatment of the equations of motion for transport category aircraft because the accelerations (changes in velocity or direction) in such aircraft operations are relatively slow. To meet this objective, the "strict" polynomial interpolation technique, where the equations must pass exactly through the data points, is relaxed so that candidate curves need only come within a specified range of the data points. This acceptable range is proportional to the magnitude of the error expected in the raw data. The errors associated with the input data are such that tolerable ranges through which the curves must pass permit considerable smoothing without oversmoothing the data to a straight line. A full discussion of the cubic spline smoothing technique is presented in Reference 3.

Once the three smoothed equations of motion were known, the altitude and velocity of the aircraft at the time of CPA was determined. The altitude at the time of CPA was determined by the evaluation of

$$z(t_j^*) = A_z + B_z t_j^* + C_z (t_j^*)^2 + D_z (t_j^*)^3.$$

The velocity was determined by first taking the first derivatives of x(t) and y(t). The velocity was then determined along each dimension using the resulting velocity equation, $\dot{x}(t)$ and $\dot{y}(t)$.

$$\dot{x}(t_j^*) = B_x + C_x t_j^* + D_x (t_j^*)^2$$

$$\dot{y}(t_j^*) = B_y + C_y t_j^* + D_y (t_j^*)^2$$

The absolute velocity estimate was then determined by

$$V^* = \sqrt{\dot{x}^2 + \dot{y}^2} \quad \text{at } t_j^*$$

As an example of the desirability of cubic spline function smoothing in the treatment of ARTS data, Figure A-1 shows the averaged velocity profile and the smoothed velocity profile of an actual departure from the Seattle-Tacoma airport. The averaged velocity profile was determined from untreated ARTS-III position data by the following relation on a report-to-report basis.

$$AVG = \frac{\Delta d}{\Delta t}$$

where Δd = distance traveled
Δt = the time interval (usually 4.7 seconds).

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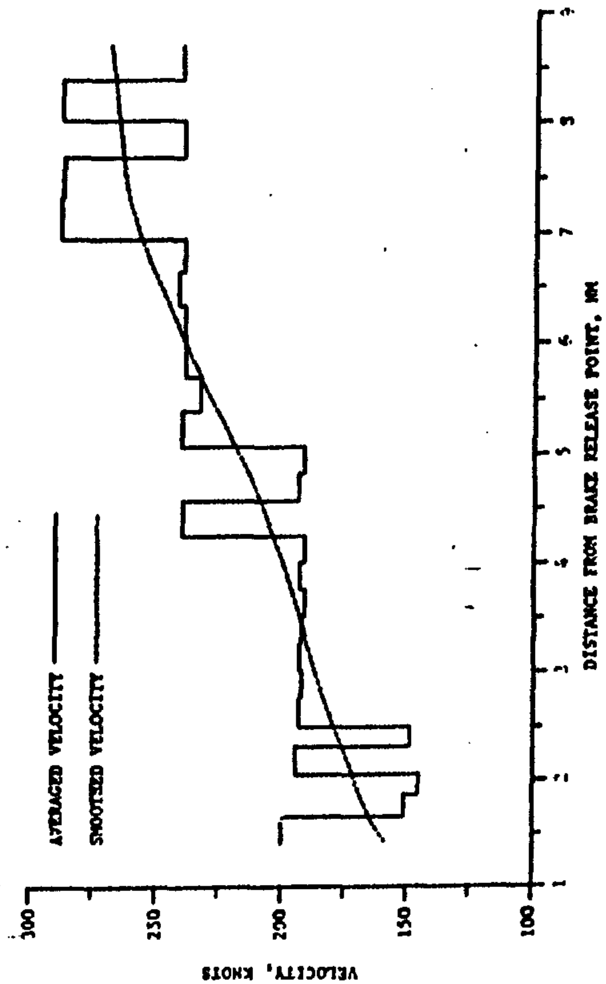

FIGURE A-1
COMPARISON OF AVERAGED AND SMOOTHED VELOCITY FOR AN ACTUAL DEPARTURE FROM SEATTLE-TACOMA AIRPORT

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APPENDIX B

REFERENCES

1. Gados, R. C., "Comparison of FAA Integrated Noise Model Flight Profiles with Observed Altitudes and Velocities at Dulles Airport," The MITRE Corporation MTR-80W00119, March 1980.

2. Federal Aviation Administration, "Noise Abatement Departure Profile for Turbojet Powered Aircraft Weighing over 75,000 Pounds," Advisory Circular 91-53, October 1978.

3. Reinsch, C. H., "Smoothing by Spline Functions," Numerische Mathematik, 1967, 10, 177-183.

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MITRE Department
and Project Approval: *[signature]*
Dr. Balraj G. Sokkappa

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END

DATE
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DTIC

U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: NOISE LEVELS FOR U.S. CERTIFICATED AND FOREIGN AIRCRAFT

Date: 6/5/92
Initiated by: AEE-110

AC No: 36-1F
Change:

1. PURPOSE. This circular provides noise level data for aircraft certificated under FAR Part 36. Noise level data for foreign airplanes certificated to ICAO Annex 16 standards are also provided in a separate appendix for informational purposes. Other appendices list selected configurations of U.S. certificated aircraft and provide listings of noise levels ranked in descending order.

2. CANCELLATION. Advisory Circular 36-1E, Noise Levels for U.S. Certificated and Foreign Aircraft, dated June 30, 1988, is canceled.

3. BACKGROUND. The agency's regulatory program for airplane noise requires the quantification of airplane noise levels. Progress in the control and abatement of aircraft noise continues to be made to achieve further relief and protection to the public. This updated Advisory Circular, containing certificated airplane noise levels, will provide both private and public exposure to this progress, as well as offering a common noise level reference for potential future reductions.

4. NOISE LEVELS. Noise levels measured during type certification under FAR Part 36 and ICAO Annex 16, and definitions are presented in Appendices 1 through 11. Formulas for calculating the appropriate FAR Part 36 noise level requirements, as contained in sections C36.5, F36.301, G36.301, and H36.305 follow the appropriate appendix.

Appendix 1 provides noise levels of turbojet powered aircraft, measured during type certification under FAR Part 36, Appendix C. This appendix includes tabulations of engine model, maximum takeoff weights, landing weights, flap settings, the "Stage" with which aircraft noise levels comply, and the measured noise in Effective Perceived Noise Level (EPNdB). Data are not presented for all of the maximum certificated takeoff weights for each aircraft type. Rather, the data presented generally represent the highest and lowest maximum certificated takeoff weight.

Airplane noise levels are shown as complying with either Stage 2 or Stage 3. A "Stage 2 airplane" means an airplane that has been shown under FAR Part 36 to comply with the Stage 2 noise levels prescribed in section C36.5 of Appendix C (including use of the applicable

tradeoff provisions) and that does not comply with the requirements for a Stage 3 airplane. A "Stage 3 airplane" means an airplane that has been shown under FAR Part 36 to comply with Stage 3 noise levels prescribed in section C36.5 of Appendix C (including use of the applicable tradeoff provisions).

As required by Part 36, certification noise levels for approach are those which are most critical from a noise standpoint, for the airplane configurations used to show compliance with the landing requirements in the airworthiness regulations constituting the type certification basis of the airplane. Takeoff certification noise levels are presented for takeoff with thrust cutback unless there is an asterisk (*) in the "NOTES" column, in which case full takeoff thrust certification noise levels are presented.

It should be noted that the sideline noise levels are generally presented for the current 450-meter distance. However, some four-engine aircraft configurations were certificated to the earlier 650-meter standard; these configurations are denoted with a double asterisk (**) in the "NOTES" column.

Since the original measurement locations and noise test conditions cited in FAR Part 36, November 18, 1969, have been amended through the years, the noise levels contained herein are for the measurement locations and noise test conditions applicable at the time of certification. In each case, the measured data have been corrected to sea level, 77F, 70% relative humidity conditions using the procedures outlined in FAR Part 36. Specific information providing more detail on either the measurement locations or noise test conditions, if available, are indicated by the notes accompanying each listing. Blank spaces or lack of notes in the report indicate the data were not available.

Appendix 2 provides noise levels of foreign turbojet powered aircraft certificated to ICAO Annex 16, Chapters 2 and 3. These noise levels are provided for informational purposes. Aircraft certificated to both U.S. and foreign standards are only listed in Appendix 1.

Appendix 3 provides a listing of U.S. certificated Stage 3 turbojet powered aircraft. These aircraft are also included in Appendix 1.

Appendix 4 and 5 represent selected listings of noise levels for turbojet powered aircraft certificated under FAR Part 36, Appendix C. Appendices 4 and 5 provide listings of takeoff and approach noise levels in EPNdB, respectively, in descending order. Representative models of each aircraft are listed, using the maximum takeoff weight available. These listings are presented as a convenience in locating noise level data on specific aircraft models. For a more detailed listing on variations of a representative model, see Appendix 1.

Appendix 6 contains noise levels of U.S. propeller-driven aircraft certificated in the transport category. Noise levels measured during type certification were obtained under FAR Part 36, Appendix C. This appendix includes tabulations of maximum takeoff weights, landing weights, engine type, horsepower, propeller type, diameter, and flap settings. The "Stage" with which the aircraft noise levels comply is also provided, as well as the Effective Perceived Noise Level (EPNdB).

Appendix 7 lists the certificated airplane noise levels for propeller-driven small airplanes certificated under FAR Part 36, Appendix F. This appendix includes a tabulation of maximum takeoff weights, landing weights, engine type, horsepower, propeller type and diameter. The measured A-weighted sound levels (dBA) for flyovers have been corrected to sea level 77F, 70% relative humidity conditions where required by FAR Part 36, Appendix F.

Appendix 8 lists the certificated airplane noise levels for propeller-driven small airplanes and commuter category airplanes certificated under FAR Part 36, Appendix G. Note that the FAR Part 36, Appendix G noise certification requirements for propeller-driven small airplanes and commuter category airplanes superceded those of FAR Part 36, Appendix F for noise certification tests conducted on or after December 22, 1988.

Appendix 9 contains listings of foreign propeller-driven small aircraft certificated under ICAO Annex 16, Chapter 6. Noise levels are listed for informational purposes.

Appendix 10 lists the certificated noise levels for helicopters certificated under FAR Part 36, Appendix H. Helicopter noise levels are classified as either Stage 1 or Stage 2. A "Stage 2" helicopter means a helicopter which has been shown under FAR Part 36 to comply with the Stage 2 noise levels prescribed in section H36.305 of Appendix H (including use of applicable tradeoff provisions).

Appendix 11 provides definitions that apply to column headings of the preceding appendices.

5. REVISIONS. The airplane noise level listings of this Advisory Circular will be revised and updated periodically.

Louise E. Maillett
Director, Office of Environment and Energy

LIST OF APPENDICES

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STG	NOTES	REF.
AIRBUS	A320-211	162.00	142.20	CFM56-5A1	2	25.00			35	87.8	94.3	96.4	3		UK
AIRBUS	A320-211	149.90	142.20	CFM56-5A1	2	25.00			35	85.3	94.4	96.4	3		UK
AIRBUS	A320-231	162.00	142.20	V2500.A1	2	25.00			40	86.6	92.8	96.6	3		UK
AIRBUS	A320-231	149.90	142.20	V2500.A1	2	25.00			40	84.0	93.0	96.6	3		UK
BAe	1-11 200	80.00	71.00	SPEY 506-14	2	10.40	1.0	3	45	93.3	99.1	97.8	2	12	BA
BAe	1-11 400	87.00	77.20	SPEY511-14/14W	2	11.40	0.7	0	45	94.8	103.4	99.7	2	12	BA
BAe	1-11 400	89.50	79.00	SPEY511-14/14W	2	11.40	0.7	0	45	95.7	103.3	99.9	2	12	BA
BAe	125-1000	31.00	25.00	PW305	2			0	25	81.8	85.9	91.6	3		UK
BAe	125-800	27.40	23.35	TFE731-5R-1H	2	4.30	3.3	0	45	80.9	87.2	96.5	3		BA
BAe	125-800A	27.40	23.35	TFE731-5R-1H	2	4.30	3.3	0	45	80.9	89.6	96.5	3	25	BA
BAe	146-100A	76.00	72.35	ALF502R-3	4	6.70	5.9	18	33	88.7	87.2	95.1	3		BA
BAe	146-100A	76.00	72.35	ALF502R-3A	4	6.97	5.7	18	33	79.0	88.0	94.9	3		BA
BAe	146-100A	82.25	73.35	ALF502R-3A	4	6.97	5.7	18	33	82.3	87.6	95.2	3		BA

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AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STG	NOTES	REF.
AEROSPATIALE	SN601 CORVETTE	13.90	12.40	JT15D-4	2	2.50	2.5	15	35	80.4	85.6	89.5	3	*	A-1
AEROSPATIALE	SN601 CORVETTE	14.60	13.20	JT15D-4	2	2.52	2.5	15	35	74.0	81.0	90.0	3		A-1
AIRBUS	A300B2-203	313.10	286.60	CF6-50-C2	2	51.00	4.3	16	25	91.1	97.9	103.1	3		AI
AIRBUS	A300B4-103	347.20	295.40	CF6-50-C2	2	51.00	4.3	16	25	93.6	97.7	103.0	3		AI
AIRBUS	A300B4-203	313.05	286.60	CF6-50C2	2	51.00	4.3	0	25	90.5	97.3	102.4	3	31	EU
AIRBUS	A300B4-203	363.70	299.83	CF6-50-C2	2	51.00	4.3	0	25	94.0	96.9	102.4	3	31	EU
AIRBUS	A300B4-605R	375.10	308.00	CF6-80-C2-A5	2	60.22	5.2		40	91.1	98.9	99.8	3		UK
AIRBUS	A300B4-622R	328.00	275.00	PW-4158	2	58.00		0	40	88.0	98.3	101.3	3		UK
AIRBUS	A300B4-622R	385.00	304.50	PW-4158	2	58.00		0	40	93.1	97.9	101.9	3		UK
AIRBUS	A310-221	305.60	267.90	JT9D-7R4D1	2	48.00	4.5	15	40	90.5	94.8	100.6	3		UK
AIRBUS	A310-304	275.50	261.25	CF6-80C2A2	2	53.50		0	40	85.7	96.5	98.5	3		EU
AIRBUS	A310-304	352.74	286.60	CF6-80C2A2	2	53.50		0	40	92.9	96.1	98.8	3		EU
AIRBUS	A310-324	330.69	271.16	PW-4152	2	52.00		15	40	90.6	97.2	100.2	3		UK

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA: MODEL	NO.	THRUST 1000#	BPR	FLAPS: TO	FLAPS: AP	NOISE LEVEL (EPNL): TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
BAe	HS 125-400A	23.60	20.00	TFE731-3-1H	2	3.70	2.7	0	45	85.5	89.8	95.7	3		BA
BAe	HS 125-600A	25.50	22.00	TFE731-3-1H	2	3.70	2.7	0	45	88.8	89.2	96.3	3		BA
BAe	HS 125-600A	25.50	22.00	VIPER 601-22	2	3.65	0.0	0	45	92.3	99.2	102.9	2	12	BA
BAe	HS 125-700A	25.50	22.00	TFE731-3-1H	2	3.70	2.7	0	45	88.0	89.2	96.3	3	33	BA
BAe	HS 125-700A	25.50	22.00	TFE731-3-1H	2	3.70	2.7	0	45	91.6	92.1	96.0	2	25,33	BA
BEECH	BEECHJET 400	15.78	14.22	JT15D-5	2	2.88		10	30	88.6	91.7	91.4	3	*	SW
BOEING	B-707-100B (QHC)	241.30	190.00	JT3D-1	4				30	103.4	102.8	102.8	2	6,**	NM
BOEING	B-707-100B (QHC)	258.00	190.00	JT3D-3B	4				30	103.8	102.7	102.8	2	6,**	NM
BOEING	B-707-120B (SHANNON)	258.00	190.00	JT3D-1	4				30	103.5	97.6	105.3	2	21,**	B-1
BOEING	B-707-138B (SHANNON)	258.00	190.00	JT3D-2	4				30	103.2	97.6	105.3	2	22,**	B-2
BOEING	B-707-300B ADV/C QHC	335.00	247.50	JT3D-3B	4				25	104.4	98.9	107.9	2	6,**	NM
BOEING	B-707-300B ADV/C SHN	330.00	201.00	JT3D-7	4				25	104.7	99.6	108.3	2	6,**	NM
BOEING	B-707-300B ADV/C SHN	321.00	240.00	JT3D-3B	4				25	104.5	99.2	108.2	2	6,**	NM

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA: MODEL	NO.	THRUST 1000#	BPR	FLAPS: TO	FLAPS: AP	NOISE LEVEL (EPNL): TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
BAe	146-100A	82.25	73.35	ALF502R-5	4	6.97	5.7	18	33	82.3	87.6	95.2	3		BA
BAe	146-100A	84.00	77.50	ALF502R-5	4	6.97	5.7	18	33	81.8	87.7	95.6	3		BA
BAe	146-200A	89.50	77.50	ALF502R-3	4	6.70	5.9	18	33	85.9	86.6	95.6	3		BA
BAe	146-200A	89.50	77.50	ALF502R-3A	4	6.97	5.7	18	33	84.9	87.3	95.6	3		BA
BAe	146-200A	89.50	77.50	ALF502R-5	4	6.97	5.7	18	33	84.9	87.3	95.6	3		BA
BAe	146-200A	93.00	81.00	ALF502R-5	4	6.97	5.7	18	33	85.2	87.3	95.8	3		BA
BAe	146-300A	95.00	83.00	ALF 502R-5	4	6.97	5.7	18	33	86.0	87.0	96.0	3		BA
BAe	146-300A	97.50	84.50	ALF502R-5	4	6.97	5.7	18	33	86.5	86.7	95.6	3		BA
BAe	C-29A	28.00	23.35	TFE731-5R-1H	2	4.30	3.3	0	45	81.4	87.3	95.8	3		BA
BAe	HS 125-1A	21.70	19.60	TFE731-3-1H	2	3.70	2.7	0	45	84.2	90.0	96.0	3		BA
BAe	HS 125-1A	21.20	19.60	TFE731-3-1H	2	3.70	2.7	0	45	83.4	90.1	96.0	3		BA
BAe	HS 125-3A	21.70	20.00	TFE731-3-1H	2	3.70	2.7	0	45	84.2	90.0	96.3	3		BA
BAe	HS 125-3A/RA	23.60	20.00	TFE731-3-1H	2	3.70	2.7	0	45	85.5	89.8	95.7	3		BA

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA: MODEL	NO.	THRUST 1000#	BPR	FLAPS: TO	AP	NOISE LEVEL (EPNL): TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
BOEING	B-727-100 (FED. EX.)	169.50	142.50	JT8D-7(A)(B)	3			5	30	94.4	96.5	97.9	3	6,28	NR
BOEING	B-727-200	190.50	142.50	JT8D-15QN	3	15.50		5	40	100.0	102.2	103.2	2	2,18	B-1
BOEING	B-727-200	184.20	142.50	JT8D-15QN	3	15.50		5	40	98.8	102.2	103.2	2	2,18	A-1 B-1
BOEING	B-727-200	190.50	142.50	JT8D-17QN	3	16.00		5	40	99.6	103.7	103.2	2	2,19	A-1 B-1
BOEING	B-727-200	208.00	142.50	JT8D-17RQN	3	16.40		5	40	102.4	104.2	103.2	2	2,20	A-1 B-1
BOEING	B-727-200	190.50	142.50	JT8D-17RQN	3	16.40		5	40	98.9	104.7	103.2	2	2,20	A-1 B-1
BOEING	B-727-200	172.50	142.50	JT8D-7PCD	3	14.00	1.1	15	40	100.0	100.4	106.3	2	3,16	B-1
BOEING	B-727-200	177.60	142.50	JT8D-7PCD	3	14.00	1.1	5	40	99.8	99.8	106.3	2	3,16	B-1 NR
BOEING	B-727-200	172.50	142.50	JT8D-7QN	3	14.00	1.1	15	40	100.0	100.4	104.9	2	2,16	A-1 B-1
BOEING	B-727-200	172.50	142.50	JT8D-9QN	3	14.50		15	40	99.8	100.4	103.2	2	2,17	B-1
BOEING	B-727-200	184.80	142.50	JT8D-9QN	3	14.50		15	40	101.5	100.2	103.2	2	2,17	A-1 B-1
BOEING	B-727-200	170.00	150.00	JT8D-9PCD	3	14.50	1.0	5	30	100.7	99.8	105.8	2	3,17	B-1 NR
BOEING	B-727-200	203.10	150.00	JT8D-17QN	3	16.00		5	40	102.0	103.5	104.5	2	2,19	B-1

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA: MODEL	NO.	THRUST 1000#	BPR	FLAPS: TO	AP	NOISE LEVEL (EPNL): TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
BOEING	B-707-300B ADV/C SER	322.30	247.00	JT3D-1-3B(IC)	4			14	25	105.5	99.3	105.7	2	6,21,**	B-1
BOEING	B-720B (QWC)	234.00	175.00	JT3D-1	4				30	102.3	102.9	101.6	2	6,**	NR
BOEING	B-720B (QWC)	234.00	175.00	JT3D-3B	4				30	99.3	103.2	101.6	2	6,**	NR
BOEING	B-720B ([illegible])	234.00	175.00	JT3D-1	4				30	98.9	98.0	104.7	2	6,**	NR
BOEING	B-720B ([illegible])	234.00	175.00	JT3D-3B	4				30	97.3	99.5	104.7	2	6,**	NR
BOEING	B-727-100	152.50	135.00	JT8D-7PCD	3	14.00	1.1	5	40	94.4	100.3	104.1	2	3,16	B-1
BOEING	B-727-100	160.50	137.50	JT8D-1PCD	3	14.00	1.1	5	40	96.6	99.2	104.3	2	3	A-1 B-1
BOEING	B-727-100	169.50	137.50	JT8D-1PCD	3	14.00	1.1	5	40	98.5	99.1	104.3	2	3	A-1 B-1
BOEING	B-727-100	169.50	137.50	JT8D-7PCD	3	14.00	1.1	5	40	97.9	100.0	104.3	2	3,16	B-1
BOEING	B-727-100	160.50	137.50	JT8D-9PCD	3	14.50	1.0	5	40	96.1	100.2	105.8	2	3,17	A-1 B-1
BOEING	B-727-100	169.50	137.50	JT8D-9PCD	3	14.50	1.0	5	40	98.3	100.0	105.8	2	3,17	A-1
BOEING	B-727-100 (FED. EX.)	160.00	137.50	JT8D-7/A/B	3			5	30	92.5	96.6	97.0	3	6,28	AA
BOEING	B-727-100 (FED. EX.)	169.50	142.00	JT8D-9/A	3			5	30	94.0	97.3	98.0	3	6,27	AA

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA: MODEL	NO.	THRUST 1000#	BPR	FLAPS: TO	AP	NOISE LEVEL (EPNL): TAKE-OFF	SIDE-LINE	APPR.	STG	NOTES	REF.
BOEING	B-747-100	710.00	564.00	JT9D-3A	4	44.20	5.1	10	30	108.4	99.7	107.2	2	* **	B-1
BOEING	B-747-100	734.00	564.00	JT9D-3A	4	44.20	5.1	10	30	109.4	99.6	107.2	2	* **	B-1
BOEING	B-747-100	710.00	564.00	JT9D-7	4	46.30	5.1	10	30	108.0	100.2	107.4	2	* **	B-1
BOEING	B-747-100	750.00	585.00	JT9D-7A	4	47.00	5.1	10	30	107.8	98.8	106.9	2	* **	B-1
BOEING	B-747-100	750.00	585.00	JT9D-7F	4	48.00	5.1	10	30	107.7	99.0	107.4	2	* **	B-1
BOEING	B-747-100	750.00	585.00	JT9D-7FW	4	50.00	5.1	10	30	107.6	99.4	107.4	2	* **	B-1
BOEING	B-747-100	750.00	585.00	JT9D-7WET	4	47.90	5.1	10	30	107.4	99.3	106.9	2	* **	B-1
BOEING	B-747-100	750.00	585.00	RB.211-524C2	4	51.60	4.5	10	30	104.5	96.9	106.5	2	* **	B-1
BOEING	B-747-100	734.00	630.00	JT9D-7A	4	46.95	5.1	10	25	104.3	102.6	105.5	3	29	B-1
BOEING	B-747-200	770.00	475.00	JT9D-7J	4	50.00	5.1	10	30	103.6	103.0	105.9	3	30	B-1
BOEING	B-747-200	710.00	520.00	JT9D-3A	4	43.60	5.1	10	30	104.4	100.8	106.9	3	30	B-1
BOEING	B-747-200	750.00	520.00	JT9D-7F	4	48.00	5.1	10	30	103.5	102.0	106.9	3	30	B-1
BOEING	B-747-200	734.00	540.00	JT9D-7	4	46.30	5.1	10	30	104.2	101.3	106.7	3	30	B-1

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA: MODEL	NO.	THRUST 1000#	BPR	FLAPS: TO	AP	NOISE LEVEL (EPNL): TAKE-OFF	SIDE-LINE	APPR.	STG	NOTES	REF.
BOEING	B-737-400	150.00	124.00	CFM56-3B-2	2	22.00	4.9	5	40	87.7	91.7	100.2	3		B-1
BOEING	B-737-400	150.00	124.00	CFM56-3C-1	2	23.50	4.9	5	40	87.1	93.1	100.2	3		B-1
BOEING	B-737-500	115.50	105.00	CFM56-3-B1	2	20.00	5.0	5	40	82.7	90.0	99.4	3		B-1
BOEING	B-737-500	115.50	105.00	CFM56-3-B1(R)	2	18.50	5.0	5	40	83.6	89.9	99.4	3		B-1
BOEING	B-737-500	133.00	110.00	CFM56-3-B1	2	20.00	5.0	5	40	87.3	90.0	99.8	3		B-1
BOEING	B-737-500	132.00	110.00	CFM56-3-B1(R)	2	18.50	5.0	5	40	87.7	88.9	99.8	3		B-1
BOEING	B-747-100	710.00	400.00	JT9D-3A	4	43.60	5.1	10	30	105.4	102.1	104.6	3	29	B-1
BOEING	B-747-100	750.00	400.00	JT9D-7F	4	48.00	5.1	10	30	104.5	103.5	104.5	3	29	B-1
BOEING	B-747-100	734.00	425.00	JT9D-7	4	46.30	5.1	10	30	105.1	102.7	104.6	3	29	B-1
BOEING	B-747-100	734.00	460.00	JT9D-7A	4	46.95	5.1	10	30	104.3	102.6	105.3	3	29	B-1
BOEING	B-747-100	750.00	520.00	JT9D-7F	4	48.00	5.1	10	25	104.5	103.5	104.5	3	29	B-1
BOEING	B-747-100	710.00	540.00	JT9D-3A	4	43.60	5.1	10	25	105.4	102.1	104.6	3	29	B-1
BOEING	B-747-100	734.00	540.00	JT9D-7	4	46.30	5.1	10	25	105.1	102.7	104.1	3	29	B-1

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA: MODEL	NO.	THRUST 1000#	BPR	FLAPS: TO	AP	NOISE LEVEL (EPNL): TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
BOEING	B-747-200	734.00	630.00	JT9D-7	4	46.30	5.1	10	25	104.2	101.3	105.2	3	30	B-1
BOEING	B-747-200	820.00	630.00	JT9D-70A	4	53.00	4.9	10	30	101.1	98.5	106.0	3		B-1
BOEING	B-747-200	734.00	630.00	JT9D-7A	4	46.95	5.1	10	25	103.5	101.2	105.0	3	30	B-1
BOEING	B-747-200	785.00	630.00	JT9D-7A	4	47.00	5.1	10	30	109.3	98.7	107.3	2	* **	B-1
BOEING	B-747-200	800.00	630.00	JT9D-7F	4	48.00	5.1	10	30	109.7	98.8	107.8	2	* **	B-1
BOEING	B-747-200	750.00	630.00	JT9D-7F	4	48.00	5.1	10	25	103.5	102.4	106.0	3	30	B-1
BOEING	B-747-200	805.00	630.00	JT9D-7FW	4	50.00	5.1	10	30	109.4	99.2	107.8	2	* **	B-1
BOEING	B-747-200	812.00	630.00	JT9D-7FW/-7J	4	50.00	5.1	10	30	109.7	99.2	107.4	2	* **	B-1
BOEING	B-747-200	800.00	630.00	JT9D-7J	4	50.00	5.1	10	30	109.3	99.2	107.8	2	* **	B-1
BOEING	B-747-200	770.00	630.00	JT9D-7J	4	50.00	5.1	10	25	103.6	103.0	106.0	3	30	B-1
BOEING	B-747-200	833.00	630.00	JT9D-7Q	4	53.00	4.9	10	25	103.2	103.5	104.4	3		B-1
BOEING	B-747-200	833.00	630.00	JT9D-7R4G2	4	54.75	4.8	10	30	102.4	97.9	106.6	2	**	B-1
BOEING	B-747-200	785.00	630.00	JT9D-7[illegible]	4	47.90	5.1	10	30	108.7	99.1	107.3	2	* **	B-1

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA: MODEL	NO.	THRUST 1000#	BPR	FLAPS: TO	AP	NOISE LEVEL (EPNL): TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
BOEING	B-747-200	767.00	564.00	JT9D-3A	4	44.20	5.1	10	30	110.0	98.2	106.5	2	* **	B-1
BOEING	B-747-200	770.00	564.00	JT9D-7	4	46.30	5.1	10	30	108.9	98.8	106.7	2	* **	B-1
BOEING	B-747-200	734.00	564.00	JT9D-7A	4	46.95	5.1	10	30	102.5	101.2	106.9	3	30	B-1
BOEING	B-747-200	775.00	564.00	JT9D-7F	4	48.00	5.1	10	30	108.6	98.9	107.2	2	* **	B-1
BOEING	B-747-200	785.00	564.00	JT9D-7R4G2	4	54.75	4.8	10	30	100.1	98.6	105.4	2	**	B-1
BOEING	B-747-200	775.00	585.00	CF6-50E	4	52.50	4.1	10	30	100.7	101.1	105.9	3		B-1
BOEING	B-747-200	773.00	585.00	JT9D-3[illegible]	4	45.00	5.1	10	30	109.1	90.7	106.7	2	* **	B-1
BOEING	B-747-200	833.00	585.00	RB.211-524C2	4	51.60	4.3	10	30	106.5	99.7	107.0	3	*	B-1
BOEING	B-747-200	833.00	600.00	JT9D-7Q	4	53.00	4.9	10	30	103.2	103.5	106.6	2		B-1
BOEING	B-747-200	820.00	630.00	CF6-50E	4	52.50	4.1	10	30	102.5	100.9	107.0	3		B-1
BOEING	B-747-200	820.00	630.00	CF6-50E2	4	52.50	4.1	10	30	102.1	101.7	106.5	3		B-1
BOEING	B-747-200	833.00	630.00	CF6-50E2	4	52.50	4.1	10	30	102.6	101.7	106.5	3		B-1
BOEING	B-747-200	720.00	630.00	JT9D-3A	4	43.60	5.1	10	25	104.6	100.8	105.7	3	30	B-1

APPEN... 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
BOEING	B-757-200	255.50	210.00	PW 2037	2	38.20	5.8	5	30	91.4	93.7	98.1	3		B-1
BOEING	B-757-200	255.50	210.00	PW 2040	2	41.70	5.7	5	30	89.7	94.2	98.1	3		B-1
BOEING	B-757-200	255.50	210.00	RB.211-535-E4	2	40.10	4.1	5	30	86.8	93.0	95.2	3		B-1
BOEING	B-757-200	240.00	210.00	RB.211-535C	2	37.40	4.5	5	25	88.1	93.8	99.6	3		B-1
BOEING	B-757-200	255.50	210.00	RB.211-535E4-B	2	43.10	4.1	5	30	85.7	94.1	95.2	3		B-1
BOEING	B-767-200	279.90	257.00	CF6-80A	2	48.00	4.6	1	30	84.9	95.5	101.4	3		B-1
BOEING	B-767-200	279.90	257.00	CF6-80A2	2	50.00	4.6	1	30	84.2	97.2	101.4	3		B-1
BOEING	B-767-200	282.00	257.00	JT9D-7R4D(A)	2	48.00	5.0	1	30	87.7	95.7	101.8	3		B-1
BOEING	B-767-200	282.00	257.00	JT9D-7R4D(B)	2	48.00	5.0	1	30	88.4	95.9	101.9	3		B-1
BOEING	B-767-200	282.00	257.00	JT9D-7R4E	2	50.00	5.0	1	30	87.5	96.8	101.9	3		B-1
BOEING	B-767-200	300.00	270.00	CF6-80C2-B2	2	52.50	5.0	1	30	85.2	94.1	95.7	3		B-1
BOEING	B-767-200	351.00	270.00	CF6-80C2-B4	2	57.90	5.9	1	30	87.7	95.3	95.7	3		B-1
BOEING	B-767-200	335.00	270.00	PW4052	2	52.00	4.8	1	30	89.4	95.0	97.0	3		B-1

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
BOEING	B-747-200	820.00	630.00	RB.211-524B/B2	4	50.10	4.3	10	30	105.5	95.6	107.3	2	**	B-1
BOEING	B-747-200	800.00	630.00	RB.211-524B/B2	4	50.10	4.3	10	30	105.3	96.0	107.3	2	* **	B-1
BOEING	B-747-200	833.00	630.00	RB.211-524D4	4	53.10	4.2	10	30	103.9	99.7	104.9	3		B-1
BOEING	B-747-300	600.00	564.00	CF6-80C2B1	4	56.70	5.0	10	30	89.8	99.1	102.5	3		B-1
BOEING	B-747-300	775.00	564.00	RB.211-524D4	4	53.10	4.2	10	30	101.5	97.1	104.3	2	**	B-1
BOEING	B-747-300	800.00	585.00	JT9D-70A	4	53.00	4.9	10	30	99.2	95.8	105.4	2	**	B-1
BOEING	B-747-300	775.00	585.00	RB.211-524B2	4	50.10	4.3	10	30	103.3	96.1	106.5	2	**	B-1
BOEING	B-747-300	800.00	630.00	CF6-50E2	4	52.50	4.3	10	30	101.6	101.8	106.5	3		B-1
BOEING	B-747-300	820.00	630.00	JT9D-70A	4	53.00	4.9	10	30	100.2	95.5	105.3	2	**	B-1
BOEING	B-747-300	833.00	630.00	JT9D-7R4G2	4	54.80	4.8	10	30	102.4	101.3	106.6	3		B-1
BOEING	B-747-300	785.00	630.00	JT9D-7R4G2	4	54.80	4.8	10	30	100.1	101.5	106.6	3		B-1
BOEING	B-747-300	820.00	630.00	RB.211-524B2	4	50.10	4.3	10	30	105.5	95.6	107.3	2	**	B-1
BOEING	B-747-300	833.00	630.00	RB.211-524D4	4	53.10	4.2	10	30	103.9	96.5	104.9	2	**	B-1

BOEING									
BOEING	B-757-200	220.00	198.00	PW 2037	2	38.20	5.8	3	**

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA: MODEL	NO.	THRUST 1000#	BPR	FLAPS: TO	FLAPS: AP	NOISE LEVEL (EPNL): TAKE-OFF	NOISE LEVEL (EPNL): SIDE-LINE	NOISE LEVEL (EPNL): APPR.	STG	NOTES	REF.
BOEING	B-747-300	833.00	666.00	CF6-80C2B1	4	56.70	5.0	10	30	99.0	98.2	105.2	3		B-1
BOEING	B-747-400	600.00	564.00	CF6-80C2B1F	4	57.90	5.0	10	30	89.6	99.1	101.7	3		B-1
BOEING	B-747-400	600.00	564.00	PW4056	4	56.75	4.8	10	30	89.5	100.7	103.1	3		B-1
BOEING	B-747-400	600.00	564.00	RB.211-524G	4	58.00	4.3	10	30	90.3	98.5	102.6	3		B-1
BOEING	B-747-400	600.00	564.00	RB.211-524H	4	60.60	4.1	10	30	89.7	99.7	102.4	3		B-1
BOEING	B-747-400	870.00	652.00	CF6-80C2	4	60.20	5.2		25	99.7	98.3	101.4	3		NR
BOEING	B-747-400	870.00	652.00	CF6-80C2B1F	4	57.90	5.0	10	30	99.7	98.3	103.8	3		B-1
BOEING	B-747-400	870.00	652.00	PW 4056	4	56.75	4.8	10	30	101.5	99.7	104.7	3		B-1
BOEING	B-747-400	870.00	652.00	RB.211-524G	4	58.00	4.3	10	30	100.9	98.1	103.8	3		B-1
BOEING	B-747-400	870.00	652.00	RB.211-524H	4	60.60	4.1	10	30	99.5	98.8	103.8	3		B-1
BOEING	B-747-SP	702.00	410.00	RB.211-524D4	4	51.60	4.2	10	30	99.2	99.8	107.0	3		B-1
BOEING	B-747-SP	660.00	450.00	JT9D-7A	4	47.00	5.1	10	30	99.6	101.3	102.5	3		B-1
BOEING	B-747-SP	702.00	450.00	JT9D-7J	4	50.00	5.1	10	30	100.1	103.3	103.2	3		B-1

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA: MODEL	NO.	THRUST 1000#	BPR	FLAPS: TO	FLAPS: AP	NOISE LEVEL (EPNL): TAKE-OFF	NOISE LEVEL (EPNL): SIDE-LINE	NOISE LEVEL (EPNL): APPR.	STG	NOTES	REF.
BOEING	B-767-200	340.00	270.00	PW4056	2	56.75	4.8	1	30	88.5	96.0	97.8	3		B-1
BOEING	B-767-200	351.00	285.00	PW4052	2	52.00	4.8	1	30	90.9	94.9	98.2	3		B-1
BOEING	B-767-200	360.00	300.00	CF6-80A	2	48.00	4.6	1	30	92.8	94.8	101.7	3		B-1
BOEING	B-767-200	360.00	300.00	CF6-80A2	2	50.00	4.6	1	30	91.7	96.5	101.7	3		B-1
BOEING	B-767-200	351.00	300.00	CF6-80C2-B2	2	52.50	5.0	1	30	89.5	93.7	96.4	3		B-1
BOEING	B-767-200	387.00	300.00	CF6-80C2-B4	2	57.90	5.0	1	30	90.6	95.0	96.4	3		B-1
BOEING	B-767-200	351.00	300.00	JT9D-7R4D(A)	2	48.00	5.0	1	30	95.1	95.2	102.7	3		B-1
BOEING	B-767-200	360.00	300.00	JT9D-7R4D(B)	2	48.00	5.0	1	30	96.2	95.3	102.6	3		B-1
BOEING	B-767-200	360.00	300.00	JT9D-7R4E	2	50.00	5.0	1	30	95.4	96.2	102.6	3		B-1
BOEING	B-767-200	400.00	300.00	PW 4056	2	56.75	4.8	1	30	93.7	95.5	98.6	3		B-1
BOEING	B-767-300	300.00	200.00	CF6-80A	2	48.00	4.6	5	30	87.5	95.2	101.7	3		B-1
BOEING	B-767-300	300.00	200.00	CF6-80A2	2	50.00	4.6	5	30	86.7	96.9	101.7	3		B-1
BOEING	B-767-300	300.00	200.00	CF6-80C2-B4	2	57.90	5.0	5	30	90.2	95.3	96.5	3		B-1

APPENDIX 1
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UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA: MODEL	NO.	THRUST 1000#	BPR	FLAPS: TO	FLAPS: AP	NOISE LEVEL (EPNL): TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
BOEING	B-767-300	380.00	280.00	CF6-80C2-B6	2	61.50	5.0	5	30	89.2	96.4	96.5	3		B-1
BOEING	B-767-300	288.70	280.00	CF6-80C2B2	2	52.50	5.0	5	30	83.1	94.3	96.5	3		B-1
BOEING	B-767-300	380.00	280.00	CF6-80C2B6F	2	61.50	5.0	5	30	89.1	96.1	96.6	3		B-1
BOEING	B-767-300	300.00	280.00	JT9D-7R4D(B)	2	48.00	5.0	5	30	91.0	95.7	102.3	3		B-1
BOEING	B-767-300	300.00	280.00	JT9D-7R4E	2	50.00	5.0	5	30	90.0	96.5	102.3	3		B-1
BOEING	B-767-300	380.00	280.00	PW 4056	2	56.75	4.8	5	30	92.0	96.0	98.8	3		B-1
BOEING	B-767-300	380.00	280.00	PW4060	2	60.00	4.8	5	30	91.2	97.2	98.8	3		B-1
BOEING	B-767-300	340.00	280.00	RB.211-524G	2	58.00	4.3	5	30	89.4	94.3	98.5	3		B-1
BOEING	B-767-300	340.00	280.00	RB.211-524H	2	60.60	4.1	5	30	88.7	95.2	98.5	3		B-1
BOEING	B-767-300	351.00	320.00	CF6-80A	2	48.00	4.6	5	30	92.8	94.9	101.7	3		B-1
BOEING	B-767-300	351.00	320.00	CF6-80A2	2	50.00	4.6	5	30	91.2	96.5	101.7	3		B-1
BOEING	B-767-300	407.00	320.00	CF6-80C2-B4	2	57.90	5.0	5	30	92.1	95.2	98.4	3		B-1
BOEING	B-767-300	407.00	320.00	CF6-80C2-B6	2	61.50	5.0	5	30	91.1	96.3	98.4	3		B-1

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA: MODEL	NO.	THRUST 1000#	BPR	FLAPS: TO	FLAPS: AP	NOISE LEVEL (EPNL): TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
BOEING	B-767-300	407.00	320.00	CF6-80C2B6F	2	61.50	5.0	5	30	90.9	96.0	98.5	3		B-1
BOEING	B-767-300	351.00	320.00	JT9D-7R4D(B)	2	48.00	5.0	5	30	95.7	95.4	103.0	3		B-1
BOEING	B-767-300	351.00	320.00	JT9D-7R4E	2	50.00	5.0	5	30	95.0	96.2	103.0	3		B-1
BOEING	B-767-300	407.00	320.00	PW 4056	2	56.75	4.8	5	30	94.2	95.7	100.2	3		NR
BOEING	B-767-300	407.00	320.00	PW 4060	2	60.00	4.8	5	30	93.2	97.0	100.2	3		NR
BOEING	B-767-300	407.00	320.00	RB.211-524G	2	58.00	4.3	5	30	93.8	94.0	99.8	3		B-1
BOEING	B-767-300	407.00	320.00	RB.211-524H	2	60.60	4.1	5	30	92.9	94.8	99.8	3		B-1
CANADAIR	CL-600	36.00	33.00	ALF-502	2	7.50	5.0	20	45	81.6	89.3	91.2	3	*	CR
CANADAIR	CL-601 CHALLENGER	42.10	36.00	CF34-1A	2	8.65	6.3	20	45	73.4	84.9	89.4	3	*	CR
CESSNA	500 CITATION	10.30	9.90	JT15D-1	2	2.20	3.3	15	40	76.4	86.1	87.7	3	*	CE
CESSNA	500/501 CITATION I	11.80	11.30	JT15D-1/-1A	2	2.20	3.3	15	40	78.0	86.2	87.9	3	*	CE
CESSNA	550 CITATION II	13.30	12.70	JT15D-4	2	2.50	3.3	15	40	80.1	86.7	90.5	3	*	CE
CESSNA	550 CITATION II	14.10	13.50	JT15D-4	2	2.50	3.3	0	40	71.6	86.4	90.5	3		CE

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UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA: MODEL	NO.	THRUST 1000#	BPR	FLAPS: TO	AP	NOISE LEVEL (EPNdB): TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
CESSNA	551 CITATION II	12.50	12.00	JT15D-4	2	2.50	3.3	15	40	88.1	88.7	90.5	3	*	CE
CESSNA	552	15.50	14.30	JT15D-5	2	2.90	2.1	20	35	89.3	94.7	88.5	3	*	CE
CESSNA	560 CITATION V	16.30	15.20	JT15D-5A	2	2.90	2.1	7	35	84.6	94.6	88.9	3		CE
CESSNA	560 CITATION V	15.90	15.20	JT15D-5A	2	2.90	2.1	7	35	83.7	94.7	88.9	3		CE
CESSNA	650 CITATION III	21.00	17.00	TFE731-3B-100S	2	3.65	3.1	20	37	84.9	92.5	92.4	3		CE
CESSNA	650 CITATION III	22.00	20.00	TFE731-3B-100S	2	3.65	3.1	7	37	88.1	92.4	93.8	3	22	CE
CESSNA	S550 CITATION S/II	14.70	14.00	JT15D-4B	2	2.50	3.3	20	35	87.9	91.6	85.1	3	*	CE
CESSNA	S550 CITATION S/II	15.10	14.40	JT15D-4B	2	2.50	3.3	7	35	88.0	91.3	86.2	3		CE
DASSAULT BREGUET	FALCON 10	18.30	17.20	TFE731-2	2	3.20	2.8	15	52	82.9	86.4	95.3	3		CR
DASSAULT BREGUET	FALCON 10	19.30	17.64	TFE731-2-1C	2			15	52	81.6	86.2	95.4	3		EU
DASSAULT BREGUET	FALCON 20- /D/E	28.70	27.30	CF700-2D-2	2	4.50		15	40	90.0	92.3	103.0	2		
DASSAULT BREGUET	FALCON 20-C5/D5/E5	29.10	27.76	TFE-731-5AR-1C	2			15	40	80.3	90.7	90.7	3	34	NR
DASSAULT BREGUET	FALCON 20-C5/D5/E5	29.10	27.76	TFE731-5AR-2C	2	4.50	3.5	15	40	82.9	88.4	90.7	3		EU

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UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA: MODEL	NO.	THRUST 1000#	BPR	FLAPS: TO	AP	NOISE LEVEL (EPNdB): TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
DASSAULT BREGUET	FALCON 20-F	28.66	27.32	CF700-2D-2	2			10	40	90.0	92.3	103.0	2		EU
DASSAULT BREGUET	FALCON 20-F5	29.10	27.76	TFE-731-5AR-1C	2			10	40	79.3	90.9	90.0	3	34	NR
DASSAULT BREGUET	FALCON 20-F5	29.10	27.76	TFE731-5AR-2C	2	4.50	3.5	10	40	81.0	88.6	90.0	3		EU
DASSAULT BREGUET	FALCON 20-G	32.00	27.56	ATF3-6-2C	2			10	40	87.5	88.3	95.9	3		EU
DASSAULT BREGUET	FALCON 200 MYSTERE	32.00	27.60	ATF3-6-4C	2	5.66	2.9	5	40	83.9	89.0	93.9	3		EU
DASSAULT BREGUET	FALCON 200 MYSTERE	32.00	28.00	ATF3-6A-4C	2			5	40	83.9	89.0	94.2	3		EU
DASSAULT BREGUET	FALCON 50	38.80	35.70	TFE731-2	3	3.70	2.8	20	40	84.3	91.6	97.4	3		CR
DASSAULT BREGUET	FALCON 50	40.78	35.71	TFE731-3-1C	3			20	40	84.0	91.5	97.1	3		EU
DASSAULT BREGUET	FALCON 900	45.50	42.00	TFE731-5AR-1C	3	4.50	3.5	20	40	81.9	89.5	91.7	3		EU
DASSAULT BREGUET	FALCON 900B	46.50	42.00	TFE731-5BR-1C	3	4.75		20	40	80.7	91.2	91.7	3		NR
FOKKER	F100	90.00	80.00	TAY MK650-15	2	14.73	3.0	0	42	81.0	91.7	93.0	3		FR
FOKKER	F28 MK1000	65.00	59.00	SPEY MK555-15	2	9.30	1.0	6	42	90.0	99.5	101.2	2		NR
FOKKER	F28 MK2000	65.00		SPEY MK555-15	2	9.90		6	42	90.0	99.3	101.0	2	*	A-1

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AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
FOKKER	F28 MK3000	71.00	64.00	SPEY MK555-15H	2	9.77	1.0	6	42	91.0	99.3	99.4	2		NH
FOKKER	F28 MK4000	73.00	65.00	SPEY MK555-15H	2	9.77	1.0	6	42	91.9	99.2	99.4	2		NH
FOKKER	F28 MK4000	73.00	69.50	SPEY MK555-15P	2	9.85	1.0	6	42	92.9	101.7	101.4	2		NH
GULFSTREAM	G-II GULFSTREAM	62.00	58.50	SPEY 511-8	2	11.40		20	39	90.0	102.7	98.2	2	12	A-1 SO
GULFSTREAM	G-II GULFSTREAM	65.50	58.50	SPEY 511-8	2	11.40		10	39	92.5	103.0	98.4	2	12	SO
GULFSTREAM	G-IIB/G-III	69.70	58.50	SPEY 511-8	2	11.40		10	39	91.1	103.4	97.3	2	12	SO
GULFSTREAM	G-IV	73.20	58.50	TAY 611-8	2	13.85		10	39	76.0	87.3	91.0	3		GW
GULFSTREAM	G-IV GULFSTREAM	71.70	58.50	TAY 610-8	2	12.40		20	39	79.0	86.5	91.0	3		CR
ISRAEL AIRCRAFT	1124 WESTWIND	22.90	19.00	TFE731-3-1G	2	3.70	2.8	20	40	81.2	88.4	93.0	3		
ISRAEL AIRCRAFT	1124A WESTWIND 2	23.50	19.00	TFE731-3-1G	2	3.70	2.8	20	40	85.4	88.7	92.8	3	*	
ISRAEL AIRCRAFT	1125 ASTRA	23.50	20.70	TFE731-3A-200G	2			12	40	82.3	89.8	89.0	3		IA
ISRAEL AIRCRAFT	1125 ASTRA	24.70	20.70	TFE731-3A-200G	2			12	40	84.1	89.7	89.8	3		IA
LEARJET	23 Raisbeck MK II	12.50	11.90	CJ610-1/-4	2	1.34		10		88.0	103.0	98.0	2		CR

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UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
LEARJET	24 Raisbeck MK II	13.00	11.90	CJ610-1/-4	2	1.39		10		89.0	103.0	98.0	2		CR
LEARJET	24/24D	13.50	11.90	CJ610-6	2	2.95		20	40	91.8	99.3	100.7	2	13	A-1,GA-1
LEARJET	24B/D Raisbeck MK II	13.50	11.80	CJ610	2			10	40	87.6	104.0	98.0	2		CR
LEARJET	24D	13.50	11.90	CJ610-6	2	2.95		20	40	91.9	99.3	101.7	2	14	GA-2
LEARJET	24D	13.50	11.90	CJ610-6	2	2.95		20	40	91.9	104.0	96.7	2		CR,GA-1
LEARJET	24E	12.90	11.90	CJ610-6	2	2.95		8	40	84.3	103.9	95.3	2		A-1,GA-1
LEARJET	24F	13.50	11.90	CJ610-6	2	2.95		8	40	85.2	103.7	95.3	2		A-1,GA-1
LEARJET	24F-A	12.50	11.90	CJ610-6	2	2.95		8	40	83.6	103.9	95.3	2		GA-2
LEARJET	25	16.00	13.30	CJ610-6	2			10	40	93.5	103.9	99.0	2		
LEARJET	25	15.00	13.30	CJ610-6	2	2.95				94.0	99.3	100.0	2		A-2
LEARJET	25/25B/C Raisb MK II	15.00	13.30	CJ610	2			10	40	91.0	103.0	99.0	2		CR
LEARJET	25B/C/D/F XR Dee Hwd	16.30	13.30	CJ610-6/8A		2.95		20	40	93.5	103.9	99.0	2		SW
LEARJET	25C	15.00	13.30	CJ610-6	2	2.95		20	40	94.0	99.3	100.0	2	22	A-1,GA-1

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UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
LEARJET	25D	15.00	13.30	CJ610-6	2	2.95		20	40	94.0	99.3	102.7	2	14	A-1,GA-1
LEARJET	25D/25F	15.00	13.30	CJ610-6/8A	2	2.95		8	40	90.9	103.7	95.2	2		GA-1
LEARJET	28/29	15.00	14.30	CJ610-8A	2	2.95		8	40	87.0	99.7	101.7	2		GA-1
LEARJET	31	16.50	15.30	TFE731-2-3B	2	3.50		8	40	81.0	87.0	92.6	3	*	ACE
LEARJET	31	15.50	15.30	TFE731-2-3B	2	3.50		8	40	79.6	87.2	92.6	3		CE
LEARJET	35/36	17.00	14.30	TFE731-2-2B	2	3.50	2.0	20	40	84.0	86.9	92.2	3	*	CE,GA-1
LEARJET	35/36	18.00	14.30	TFE731-2-2B	2	3.50		20	40	84.5	87.9	92.2	3	*	GA-1
LEARJET	35A	18.00	14.30	TFE731-2-2B	2	3.50		8	40	83.6	87.4	91.3	3	*	GA-1
LEARJET	35A/36A	18.00	14.30	TFE731-2-2B	2	3.50		8	40	78.7	87.4	91.3	3		CE
LEARJET	35A/36A	18.30	15.30	TFE731-2-2B	2	3.50		8	40	79.2	86.7	91.4	3		CE
LEARJET	36A	18.30	15.30	TFE731-2-2B	2	3.50		20	40	83.9	87.8	91.4	3	*	GA-1
LEARJET	55	19.50	17.00	TFE731-3A-2B	2	3.70		8	40	84.2	90.9	90.6	3	*	CE,GA-1
LEARJET	55	21.00	17.00	TFE731-3A-2B	2	3.70		8	40	85.5	90.7	90.6	3	*	CE,GA-1

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UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
LEARJET	55B	21.50	18.00	TFE731-3A-2B	2	3.70		20	40	86.3	90.7	91.0	3		GA-1
LEARJET	55C	21.00	18.00	TFE731-3AR-2B	2	3.90	2.9	20	40	86.2	91.0	92.4	3	*	CE
LEARJET	55C	21.50	18.00	TFE731-3AR-2B	2	3.90	2.9	20	40	86.7	90.9	92.4	3	*	CE
LEARJET	M55C	21.00	17.00	TFE731-3AR-3B	2			20	40	86.7	91.5	92.4	3	*	CE
LEARJET	M55C	21.50	17.00	TFE731-3AR-3B	2			20	40	87.0	91.4	92.4	3	*	CE
LOCKHEED	1329-23 (AIRESEARCH)	43.00		TFE731-3-1E	4	3.70	2.8	20	59	92.7	88.1	96.9	2	* **	A-1,SD
LOCKHEED	1329-25 (AIRESEARCH)	44.50	36.00	TFE731-3	4	3.70	2.8			93.1	88.1	96.9	2	* **	SD
LOCKHEED	L-1011	430.00	358.00	RB.211-22B	3	41.00		14	42	95.9	95.1	102.8	3	5 *	A-1
LOCKHEED	L-1011-1	430.00	358.00	RB.211-22B	3	42.00		10	42	96.0	95.0	102.8	3	5 *	L-1
LOCKHEED	L-1011-100	466.00	368.00	RB.211-22B	3	42.00		10	42	98.5	94.9	102.8	3	5 *	L-1
LOCKHEED	L-1011-200	466.00	368.00	RB.211-524B	3	50.00		10	33	98.1	97.9	101.4	3	5 *	L-1
LOCKHEED	L-1011-500	496.00	368.00	RB.211-524B	3	50.00		14	33	98.4	97.8	101.5	3	5 *	L-1
LOCKHEED	L-1011-500	496.00	368.00	RB.211-524B3	3	50.00		14	33	97.4	96.7	100.3	3	5 *	L-1

APPENDIX 1
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UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
LOCKHEED	L-1011-500	504.00	368.00	RB.211-524B3	3	50.00		22	33	98.0	96.9	100.2	3	5 *	L-1
LOCKHEED	L-1011-500	510.00	368.00	RB.211-524B4	3	50.00		10	33	99.3	96.4	102.0	3	*	L-1
LOCKHEED	L1011-385-1-14/15	474.00	368.00	RB.211-22B	3	42.00		4	42	98.6	94.2	102.8	3		
LOCKHEED	L1011-385-1-14/15	466.00	368.00	RB.211-524B4	3	50.00		10	42	97.9	95.9	103.3	3	*	NM
MCDONNELL DOUGLAS	DC-08-51 (QNC ON)	276.00	199.50	JT3D-3B	4			15	25	99.9	103.1	104.5	2	6,**	SO
MCDONNELL DOUGLAS	DC-08-51 (QNC ON)	276.00	199.50	JT3D-3B	4			15	25	99.3	103.1	104.2	2	6,26,**	SO
MCDONNELL DOUGLAS	DC-08-51 (QNC ON)	286.00	207.00	JT3D-3B	4			15	25	101.3	103.0	104.6	2	6,26,**	SO
MCDONNELL DOUGLAS	DC-08-51 QNC FLS ON	276.00	199.50	JT3D-1	4				35	101.9	99.9	107.1	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-51 QNC FLS ON	276.00	199.50	JT3D-3B	4				35	99.1	101.5	107.0	2	6,26,**	NM
MCDONNELL DOUGLAS	DC-08-51 QNC FLS ON	276.00	199.50	JT3D-3B	4				35	99.5	101.5	107.1	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-51 QNC FLS ON	286.00	207.00	JT3D-3B	4				35	100.7	101.4	107.1	2	6,26,**	NM
MCDONNELL DOUGLAS	DC-08-51 W/RAC ON	276.00	199.50	JT3D-1	4				50	99.5	101.2	107.8	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-51 W/RAC ON	286.00	199.50	JT3D-3B	4				50	98.4	101.5	107.8	2	6,**	NM

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
MCDONNELL DOUGLAS	DC-08-51 W/RAC ON	276.00	199.50	JT3D-3B	4			15	50	97.0	101.5	107.8	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-52 (QNC ON)	300.00	202.00	JT3D-3B	4			15	25	103.7	102.9	104.3	2	6,26,**	SO
MCDONNELL DOUGLAS	DC-08-52 (QNC ON)	300.00	202.00	JT3D-3B	4			15	25	104.2	102.9	104.7	2	6,**	SO
MCDONNELL DOUGLAS	DC-08-52 QNC FLS ON	300.00	202.00	JT3D-3B	4				35	102.9	101.3	107.0	2	6,26,**	NM
MCDONNELL DOUGLAS	DC-08-52 QNC FLS ON	300.00	202.00	JT3D-3B	4				35	103.2	101.3	107.2	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-52 W/RAC ON	305.00	201.90	JT3D-3B	4			15	50	100.9	101.4	108.0	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-53 (QNC ON)	306.00	207.00	JT3D	4			15	25	105.2	102.8	105.0	2	6,**	SO
MCDONNELL DOUGLAS	DC-08-53 (QNC ON)	315.00	207.00	JT3D-3B	4				25	104.9	102.2	107.1	2	6,**	SO
MCDONNELL DOUGLAS	DC-08-53 (QNC ON)	309.00	207.00	JT3D-3B	4			15	25	105.2	102.8	104.6	2	6,26,**	SO
MCDONNELL DOUGLAS	DC-08-53 QNC FLS ON	318.00	207.00	JT03D-3B	4				35	105.3	101.2	107.1	2	6,26,**	NM
MCDONNELL DOUGLAS	DC-08-53 W/RAC ON	315.00	203.30	JT3D-3B	4			15	50	102.3	101.3	108.1	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-54 W/RAC ON	315.00	217.00	JT3D-3B	4			15	35	102.3	101.3	105.1	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-54 W/RAC ON	315.00	240.00	JT3D-3B	4				50	102.3	101.3	107.9	2	6,**	NM

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UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MGTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STG	NOTES	REF.
MCDONNELL DOUGLAS	DC-08-55 (QNC QN)	309.80	217.00	JT3D-3B	4			15	25	105.2	102.8	105.2	2	6,26,**	SO
MCDONNELL DOUGLAS	DC-08-55 QNC FLS QN	320.30	217.00	JT3D-3B	4				35	105.5	101.1	107.2	2	6,26,**	NM
MCDONNELL DOUGLAS	DC-08-55 W/BAC QN	325.00	204.70	JT3D-3B	4			15	50	103.7	101.2	108.2	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-55 W/BAC QN	325.00	240.00	JT3D-3B	4			15	35	103.7	101.2	107.9	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-61 (QNC QN)	270.00	240.00	JT3D-3B	4			15	25	98.1	103.1	106.5	2	6,26,**	SO
MCDONNELL DOUGLAS	DC-08-61 (QNC QN)	309.80	240.00	JT3D-3B	4			15	25	105.2	102.8	106.5	2	6,26,**	SO
MCDONNELL DOUGLAS	DC-08-61 QNC FLS QN	320.30	240.00	JT3D-3B	4				35	105.5	101.1	107.2	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-61 QNC FLS QN	270.00	240.00	JT3D-3B	4				35	98.6	101.5	107.2	2	6,26,**	NM
MCDONNELL DOUGLAS	DC-08-61 W/BAC QN	325.00	240.00	JT3D-3B	4			15	35	103.7	101.2	107.9	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-61F (QNC QN)	309.80	240.00	JT3D-3B	4			15	25	105.2	102.8	106.9	2	6,26,**	SO
MCDONNELL DOUGLAS	DC-08-62 (BAC B-1)	350.00	240.00	JT3D-3B	4			12	35	100.5	101.2	100.2	3	6	
MCDONNELL DOUGLAS	DC-08-62 (BAC/MGN)	348.00	240.00	JT3D-3B	4			12	35	100.5	101.2	100.7	3	6	NW
MCDONNELL DOUGLAS	DC-08-62 W/ADC QN	335.00	240.00	JT3D-3B	4			12	50	102.5	98.2	108.3	2	6,**	NM

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AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MGTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STG	NOTES	REF.
MCDONNELL DOUGLAS	DC-08-62 W/ADC QN	335.00	240.00	JT3D-7	4			12	50	101.6	98.8	108.3	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-62 W/ADC QN	350.00	250.00	JT3D-3B	4			12	50	104.3	98.1	108.3	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-62 W/ADC QN	350.00	250.00	JT3D-7	4			12	50	103.4	98.5	108.3	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-62 W/TBC QN	335.00	240.00	JT3D-3B	4			12	50	102.0	99.3	107.8	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-62 W/TBC QN	350.00	250.00	JT3D-3B	4			12	50	103.9	98.9	107.9	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-62 W/TBC QN	335.00	250.00	JT3D-7	4			12	35	101.6	101.7	106.4	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-62 W/TBC QN	355.00	275.00	JT3D-7	4			12	33	102.7	100.7	107.6	2	6,**	SW
MCDONNELL DOUGLAS	DC-08-63 (BAC B-1)	355.00	275.00	JT3D-7	4			12	35	98.9	101.4	103.0	3	6	CE
MCDONNELL DOUGLAS	DC-08-63 (BAC)	353.00	275.00	JT3D-7	4			12	50	98.9	99.0	107.6	2	6,**	NW
MCDONNELL DOUGLAS	DC-08-63 (BAC/MGN)	353.00	240.00	JT3D-7	4			12	35	98.9	101.4	102.0	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-63 (BAC/MGN)	353.00	275.00	JT3D-7	4			12	35	98.9	101.4	103.0	3	6	NM
MCDONNELL DOUGLAS	DC-08-63 W/ADC QN	355.00	245.00	JT3D-3B	4			12	50	104.8	99.2	108.3	2	6,**	SW
MCDONNELL DOUGLAS	DC-08-63 W/ADC QN	355.00	245.00	JT3D-7	4			12	50	104.1	98.4	108.3	2	6,**	NM

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AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STG	NOTES	REF.
MCDONNELL DOUGLAS	DC-08-63 W/ADC QN	355.00	275.00	JT3D-3B	4			12	50	104.8	98.1	108.5	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-63 W/ADC QN	355.00	275.00	JT3D-7	4			12	50	104.1	98.4	108.4	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-63 W/THC QN	335.00	240.00	JT3D-3B	4			12	50	101.7	99.1	107.8	2	6,**	SW
MCDONNELL DOUGLAS	DC-08-63 W/THC QN	350.00	250.00	JT3D-3B	4			12	50	103.9	98.9	107.9	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-63 W/THC QN	335.00	250.00	JT3D-7	4			12	35	100.7	101.8	106.5	2	6,**	SW
MCDONNELL DOUGLAS	DC-08-63 W/THC QN	355.00	275.00	JT3D-7	4			12	35	103.8	101.3	107.3	2	6,**	NM
MCDONNELL DOUGLAS	DC-08-71	325.00	240.00	CFM-56-2C5	4	22.00				94.3	92.9	98.3	3	*	NM
MCDONNELL DOUGLAS	DC-08-71	325.00	240.00	CFM56-2-C1	4	22.00	6.0	15	50	94.3	92.9	98.3	3	*	D-1
MCDONNELL DOUGLAS	DC-08-71	328.00	258.00	CFM56-2-C1	4	22.00	6.0	15	50	96.5	92.9	96.6	3	*	D-1
MCDONNELL DOUGLAS	DC-08-72	335.00	240.00	CFM56-2-C1	4	22.00	6.0	12	50	94.4	92.9	98.1	3	*	D-1
MCDONNELL DOUGLAS	DC-08-72	350.00	250.00	CFM56-2-C1	4	22.00	6.0	12	50	95.2	92.8	98.2	3	*	D-1
MCDONNELL DOUGLAS	DC-08-73	355.00	250.00	CFM56-2-C1	4	22.00	6.0	12	50	95.7	92.8	98.3	3	*	D-1
MCDONNELL DOUGLAS	DC-08-73	355.00	275.00	CFM56-2-C1	4	22.00	6.0	12	50	95.7	92.8	98.5	3	*	D-1

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UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 10000	LW 10000	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STG	NOTES	REF.
MCDONNELL DOUGLAS	DC-08F-54 (QNC QN)	306.00	207.00	JT3D-3B	4			15	25	105.2	102.8	105.0	2	6,**	SO
MCDONNELL DOUGLAS	DC-08F-54 (QNC QN)	309.00	207.00	JT3D-3B	4			15	25	105.2	102.8	104.6	2	6,26,**	SO
MCDONNELL DOUGLAS	DC-08F-54 (QNC QN)	306.00	217.00	JT3D-3B	4			15	25	105.2	102.8	105.6	2	6,**	SO
MCDONNELL DOUGLAS	DC-08F-54 (QNC QN)	309.00	240.00	JT3D-3B	4			15	25	105.2	102.8	106.5	2	6,26,**	SO
MCDONNELL DOUGLAS	DC-08F-54 QNC PLS QN	315.00	217.00	JT3D-3B	4				35	105.2	101.1	107.3	2	6,**	NM
MCDONNELL DOUGLAS	DC-08F-54 QNC PLS QN	315.00	217.00	JT3D-3B	4				35	104.9	101.2	107.2	2	6,26,**	NM
MCDONNELL DOUGLAS	DC-08F-54 QNC PLS QN	315.00	240.00	JT3D-3B	4				35	104.9	101.2	107.4	2	6,26,**	NM
MCDONNELL DOUGLAS	DC-08F-55 (QNC QN)	309.00	240.00	JT3D-3B	4			15	25	105.2	102.8	106.5	2	6,26,**	SO
MCDONNELL DOUGLAS	DC-08F-55 QNC PLS QN	317.00	240.00	JT3D-3B	4				35	105.2	101.1	107.4	2	6,26,**	NM
MCDONNELL DOUGLAS	DC-09-10	90.70	81.70	JT8D-7	2	14.00	1.1	10	50	91.4	100.8	103.1	2	24	D-5
MCDONNELL DOUGLAS	DC-09-10	90.70	81.70	JT8D-7/-7A	2	14.00	1.1	10	50	91.4	101.4	100.4	2	1	D-1
MCDONNELL DOUGLAS	DC-09-10 (ABS)	90.70	81.70	JT8D-7/7A/7B	2			10	40	87.2	96.4	95.0	3	6	CE
MCDONNELL DOUGLAS	DC-09-30	98.00	93.40	JT8D-15	2	15.50	1.0	0	50	91.2	101.1	98.4	2	1	D-1

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UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
MCDONNELL DOUGLAS	DC-09-30	103.00	95.30	JT8D-7	2	14.00		0	50	95.3	99.3	103.5	2	16,24	D-5
MCDONNELL DOUGLAS	DC-09-30	103.00	98.10	JT8D-17	2	16.00	1.0	0	50	92.7	103.5	101.1	2	1	D-1
MCDONNELL DOUGLAS	DC-09-30	108.00	98.10	JT8D-17	2	16.00	1.0	0	50	94.2	103.7	101.1	2	1	D-1
MCDONNELL DOUGLAS	DC-09-30	108.00	99.00	JT8D-7A	2	14.00	1.1	0	50	95.1	97.3	97.3	2	1	D-1
MCDONNELL DOUGLAS	DC-09-30	103.00	99.00	JT8D-9	2	14.50	1.0	0	50	94.3	99.0	99.0	2	1	D-1
MCDONNELL DOUGLAS	DC-09-30	108.00	99.00	JT8D-9	2	14.50	1.0	0	50	96.4	100.3	103.7	2	24	D-5
MCDONNELL DOUGLAS	DC-09-30	110.00	101.00	JT8D-7	2	14.00		0	50	97.5	99.0	104.3	2	16,24	D-5
MCDONNELL DOUGLAS	DC-09-30	110.00	101.00	JT8D-7	2	14.00	1.1	0	50	95.9	97.1	97.3	2	1	D-1
MCDONNELL DOUGLAS	DC-09-30	120.00	101.00	JT8D-9	2	14.50	1.0	0	50	97.0	100.3	104.3	2	24	D-5
MCDONNELL DOUGLAS	DC-09-30	114.00	102.00	JT8D-15	2	15.50	1.0	0	50	95.8	100.5	99.0	2	1	D-1
MCDONNELL DOUGLAS	DC-09-30	114.00	102.00	JT8D-9	2	14.50	1.0	0	50	97.1	99.0	99.4	2	1	D-1
MCDONNELL DOUGLAS	DC-09-30 (ABS)	103.00	99.00	JT8D-9	2			0	40	89.7	96.0	96.0	3	6	HM
MCDONNELL DOUGLAS	DC-09-30 (ABS)	105.00	101.00	JT8D-9	2			0	40	90.3	96.7	96.1	3	6	HM

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UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
MCDONNELL DOUGLAS	DC-09-34	110.00	101.00	JT8D-9	2	14.50	1.0	0	50	96.1	98.8	99.1	2	1	D-1
MCDONNELL DOUGLAS	DC-09-34	121.00	110.00	JT8D-15	2	15.50	1.0	0	50	97.0	102.1	102.4	2	1	D-1
MCDONNELL DOUGLAS	DC-09-34	121.00	110.00	JT8D-17	2	16.00	1.0	0	50	98.0	102.6	101.9	2	1	D-1
MCDONNELL DOUGLAS	DC-09-40	114.00	102.00	JT8D-11	2	15.00	1.0	0	50	96.2	99.5	99.4	2	1	D-1
MCDONNELL DOUGLAS	DC-09-40	114.00	102.00	JT8D-15	2	15.50	1.0	0	50	95.8	100.5	99.4	2	1	D-1
MCDONNELL DOUGLAS	DC-09-50	115.00	104.00	JT8D-17	2	16.00	1.0	0	50	96.4	103.4	101.6	2	1	D-1
MCDONNELL DOUGLAS	DC-09-50	115.00	110.00	JT8D-15	2	15.50	1.0	0	50	96.1	102.6	101.9	2	1	D-1
MCDONNELL DOUGLAS	DC-09-50	121.00	110.00	JT8D-15	2	15.50	1.0	0	50	97.8	102.2	101.9	2	1	D-1
MCDONNELL DOUGLAS	DC-09-50	121.00	110.00	JT8D-17	2	16.00	1.0	0	50	98.1	103.2	101.9	2	1	D-1
MCDONNELL DOUGLAS	DC-10-10	410.00	347.80	CF6-6D	3	39.30	5.7	24	50	97.4	97.0	104.9	3	*	D-1
MCDONNELL DOUGLAS	DC-10-10	410.00	347.00	CF6-6K	3	39.30	5.9	24	50	96.8	96.3	103.3	3	*	D-2
MCDONNELL DOUGLAS	DC-10-10	430.00	347.00	CF6-6K2	3	40.90	5.9	22	50	97.4	96.5	103.3	3	*	D-2
MCDONNELL DOUGLAS	DC-10-10	455.00	363.50	CF6-6D	3	39.30	5.7	0	50	101.8	96.0	105.5	3	*	D-1

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MGTOW 1000#	LW 1000#	ENGINE DATA: MODEL	NO.	THRUST 1000#	BPR	FLAPS: TO	AP	NOISE LEVEL (EPNL): TAKE-OFF	SIDE-LINE	APPR.	STG	NOTES	REF.
MCDONNELL DOUGLAS	DC-10-10	430.00	363.50	CF6-6D1	3	40.30	5.8	11	50	98.1	97.0	105.5	3	*	D-1
MCDONNELL DOUGLAS	DC-10-10	455.00	363.50	CF6-6D1	3	40.30	5.8	4	50	100.2	96.6	105.5	3	*	D-1
MCDONNELL DOUGLAS	DC-10-10	455.00	363.50	CF6-6D1A	3	40.90	5.8	4	50	100.2	96.6	105.5	3	*	D-1
MCDONNELL DOUGLAS	DC-10-10	430.00	363.50	CF6-6D1A	3	40.90	5.8	11	50	98.1	97.0	105.5	3	*	D-1
MCDONNELL DOUGLAS	DC-10-10	455.00	363.50	CF6-6K	3	39.30	5.9	0	50	100.9	95.5	103.0	3	*	D-2
MCDONNELL DOUGLAS	DC-10-10	455.00	363.50	CF6-6K2	3	40.90	5.9	4	50	99.3	96.1	103.0	3	*	D-2
MCDONNELL DOUGLAS	DC-10-15	455.00	363.50	CF6-50C2-F	3	45.60	4.6	5	50	93.8	95.6	103.1	3		D-5
MCDONNELL DOUGLAS	DC-10-30	555.00	403.00	CF6-50A	3			5	50	101.8	101.3	106.3	2	*	NM
MCDONNELL DOUGLAS	DC-10-30	555.00	403.00	CF6-50C/E	3	50.40	4.3	10	50	101.6	97.5	106.3	3		D-6
MCDONNELL DOUGLAS	DC-10-30	572.00	403.00	CF6-50C1	3	51.80	4.2	10	50	102.1	98.3	106.3	3		D-6
MCDONNELL DOUGLAS	DC-10-30	555.00	403.00	CF6-50C2	3	51.80	4.3	5	50	96.8	97.8	105.0	3		D-3
MCDONNELL DOUGLAS	DC-10-30	555.00	403.00	CF6-50C2-B	3	53.20	4.3	5	50	96.1	98.4	105.0	3		D-3
MCDONNELL DOUGLAS	DC-10-30	555.00	403.00	CF6-50C2-R	3	50.40	4.4	10	50	97.5	97.2	105.0	3		D-5

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MGTOW 1000#	LW 1000#	ENGINE DATA: MODEL	NO.	THRUST 1000#	BPR	FLAPS: TO	AP	NOISE LEVEL (EPNL): TAKE-OFF	SIDE-LINE	APPR.	STG	NOTES	REF.
MCDONNELL DOUGLAS	DC-10-30	565.00	411.00	CF6-50A	3			5	50	102.7	101.4	106.6	2	*	NM
MCDONNELL DOUGLAS	DC-10-30	572.00	411.00	CF6-50C/E	3	50.40	4.3	10	50	102.3	97.5	106.6	3		D-6
MCDONNELL DOUGLAS	DC-10-30	590.00	411.00	CF6-50C1	3	51.80	4.2	20	50	103.0	98.0	106.6	3		D-6
MCDONNELL DOUGLAS	DC-10-30	590.00	411.00	CF6-50C2	3	51.80	4.3	15	50	99.0	97.9	105.3	3		D-3
MCDONNELL DOUGLAS	DC-10-30	590.00	411.00	CF6-50C2-B	3	53.20	4.3	15	50	98.7	98.5	105.3	3		D-3
MCDONNELL DOUGLAS	DC-10-30	572.00	421.00	CF6-50C2-R	3	50.40	4.4	10	50	98.4	97.3	105.8	3		D-5
MCDONNELL DOUGLAS	DC-10-30	555.00	424.00	CF6-50C2	3	51.80	4.3	5	50	96.8	97.8	106.0	3	15	D-3
MCDONNELL DOUGLAS	DC-10-30	555.00	424.00	CF6-50C2-B	3	53.20	4.3	5	50	96.1	98.4	106.0	3	15	D-3
MCDONNELL DOUGLAS	DC-10-30	572.00	424.00	CF6-50C2-B	3	53.20	4.3	10	50	97.4	98.5	106.0	3	15	D-3
MCDONNELL DOUGLAS	DC-10-30	590.00	436.00	CF6-50C2	3	51.80	4.3	15	50	99.0	97.7	106.4	3	15	D-3
MCDONNELL DOUGLAS	DC-10-40	530.00	403.00	JT9D-20D	3	44.50	5.0	10	50	100.8	95.2	105.7	3	*	D-1
MCDONNELL DOUGLAS	DC-10-40	555.00	403.00	JT9D-59A	3	51.70	4.9	10	50	101.4	98.0	106.4	3	*	D-1
MCDONNELL DOUGLAS	MD-11	602.50	430.00	CF6-80C2	3	61.50	5.3	10	50	92.8	96.3	103.6	3		D-6

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MGTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
MCDONNELL DOUGLAS	MD-11	602.50	430.00	PW4460	3	60.00	5.0	10	50	94.1	96.1	103.5	3		D-6
MCDONNELL DOUGLAS	MD-11	618.00	471.50	CF6-80C2	3	61.50	5.3	10	50	93.9	96.3	104.3	3		D-6
MCDONNELL DOUGLAS	MD-11	618.00	471.50	PW4460	3	60.00	5.0	10	50	95.2	96.2	104.0	3		D-6
MCDONNELL DOUGLAS	MD-80	140.00	128.00	JT8D-209	2	19.25	1.8	0	40	88.9	94.7	92.8	3	10	D-4
MCDONNELL DOUGLAS	MD-80	140.00	128.00	JT8D-219	2	21.70	1.7	0	40	86.7	97.3	92.8	3	10	D-4
MCDONNELL DOUGLAS	MD-80	149.50	130.00	JT8D-209	2	19.25	1.8	0	40	92.2	94.5	92.9	3	10	D-4
MCDONNELL DOUGLAS	MD-80	149.50	130.00	JT8D-217	2	20.85	1.8	0	40	89.7	95.8	92.9	3	10	D-4
MCDONNELL DOUGLAS	MD-80	142.00	130.00	JT8D-217	2	20.85	1.8	0	40	88.2	96.2	92.9	3	10	D-4
MCDONNELL DOUGLAS	MD-80	149.50	130.00	JT8D-219	2	21.70	1.7	0	40	88.6	97.2	92.9	3	10	D-4
MCDONNELL DOUGLAS	MD-80	160.00	150.00	JT8D-217A	2	20.85	1.8	2	40	92.8	95.9	93.7	3	* 10	D-4
MCDONNELL DOUGLAS	MD-80	160.00	150.00	JT8D-217C	2	20.85	1.7	2	40	91.5	96.3	93.7	3	10	D-4
MCDONNELL DOUGLAS	MD-80	160.00	150.00	JT8D-219	2	21.70	1.7	2	40	90.8	97.2	93.7	3	10	D-4
MCDONNELL DOUGLAS	MD-87	125.00	120.00	JT8D-217A	2	20.85	1.8	0	40	86.3	96.4	92.9	3	10	NW

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MGTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	FLAPS AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
MCDONNELL DOUGLAS	MD-87	125.00	120.00	JT8D-217C	2	20.85	1.7	0	40	86.1	96.5	92.9	3	10	D-4
MCDONNELL DOUGLAS	MD-87	140.00	128.00	JT8D-219	2	21.70	1.7	0	40	86.5	97.1	93.3	3	10	D-4
MCDONNELL DOUGLAS	MD-87	149.50	130.00	JT8D-217A	2	20.85	1.8	1	40	89.7	95.9	93.3	3	10	D-4
MCDONNELL DOUGLAS	MD-87	149.50	130.00	JT8D-217C	2	20.85	1.7	1	40	89.2	96.2	93.3	3	10	D-4
MCDONNELL DOUGLAS	MD-87	149.50	130.00	JT8D-219	2	21.70	1.7	1	40	88.5	97.1	93.3	3	10	D-4
MITSUBISHI	MU-300 (DIAMOND I)	14.10	13.20	JT15D-4	2	2.50		10	30	86.3	88.0	85.8	3	*	CR
MITSUBISHI	MU-300 (DIAMOND I)	15.50	13.20	JT15D-4D	2			0	30	81.2	88.4	85.8	3		SW
MITSUBISHI	MU-300-10 (DIAM. II)	15.70	14.22	JT15D-5	2	2.00		10	30	88.6	93.7	91.4	3	*	SW
SABRELINER	SABRELINER 40	17.50	14.00	JT12A-8	2	3.30		0	25	89.7	100.4	97.5	2		SA-1
SABRELINER	SABRELINER 60	20.20	17.50	JT12A-8	2	3.30		0	25	94.5	100.1	98.4	2		SA-1
SABRELINER	SABRELINER 60	20.20		JT12A-8	2	3.30			24	95.0	100.3	98.5	2	*	A-1
SABRELINER	SABRELINER 60A/60SC	22.70	20.60	JT12A-8	2	3.30		0		94.4	100.0	102.2	2		SA-1
SABRELINER	SABRELINER 65	24.00	21.00	TFE731-3R	2	3.70	2.8			86.0	93.0	90.6	3	*	CR

APPENDIX 1
AIRCRAFT NOISE DATA FOR UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
SABRELINER	SABRELINER 65	22.70	21.00	TFE731-3R	2	3.70	2.0	0	36	82.3	93.1	90.6	3	*	SA-1
SABRELINER	SABRELINER 75A	23.00		CF700-2D-2	2	4.30	2.0	15	25	90.7	91.3	100.2	2	*	A-1
SABRELINER	SABRELINER 80	23.30	22.00	CF700-2D-2	2	4.32	2.0			90.7	91.3	100.2	2	*	CR
SABRELINER	SABRELINER 80A/80SC	25.50	22.00	CF700-2D-2	2	4.30	2.0	0		91.2	91.4	101.1	2	*	SA-1

APPENDIX 1 NOTES

1 ENGINES EQUIPPED WITH P-36 ACOUSTICAL TREATMENT (MCDONNELL DOUGLAS AIRCRAFT)
2 QUIET NACELLES AND FAN CASE DOUBLE ACOUSTIC TREATMENT (BOEING AIRCRAFT)
3 FAN CASE DOUBLE ACOUSTIC TREATMENT (BOEING AIRCRAFT)
4 AT TOGW OF 445K OR LESS AND LANDING WEIGHTS OF 400K OR LESS, THE CENTER LANDING GEAR RETRACTED.
5 DIRECT LIFT CONTROL USED ON APPROACH.
6 ENGINE ACOUSTIC TREATMENT INSTALLED PER APPROPRIATE STC
10 DC-9-80 NORMAL TAKEOFF POWER
12 EQUIPPED WITH STANDARD HUSH KIT
13 EQUIPPED WITH LEARAVIA ENGINE SUPPRESSOR NOZZLE (GATES LEARJET)
14 EQUIPPED WITH LEARAVIA WITH ECR 936 (GATES LEARJET)
15 REVISED FORWARD CENTER OF GRAVITY ON APPROACH
16 DATA ALSO APPLIES TO JT8D-7A AND JT8D-7B ENGINES
17 DATA ALSO APPLIES TO JT8D-9A
18 DATA ALSO APPLIES TO JT8D-15A
19 DATA ALSO APPLIES TO JT8D-17A
20 DATA ALSO APPLIES TO JT8D-17AR
21 DATA ALSO APPLIES TO JT3D-3B DERATED TO JT3D-1 THRUST
22 INCREASED TAKEOFF THRUST RATING
23 EQUIPPED WITH JT8D-217C OUTBOARD ENGINES
24 EQUIPPED WITH FAN DUCT ACOUSTIC TREATMENT (MCDONNELL DOUGLAS)
25 EQUIPPED WITH THRUST REVERSERS
26 EQUIPPED WITH 4% LEADING EDGE EXTENSION
27 EQUIPPED WITH ROHR AERONAUTICAL CORP.NACELLE
28 EQUIPPED WITH BOEING NACELLE
29 EQUIPPED WITH -100 "CH" NACELLE.
30 EQUIPPED WITH -200 "CH" NACELLE.
31 EQUIPPED WITH MODIFICATIONS 2450 (SHORT NOZZLE), 1305, AND 1373.
32 EQUIPPED WITH JT8D-219 OUTBOARD ENGINES.
33 DATA ALSO APPLIES TO TFE731-3R-1H
34 EQUIPPED WITH MODIFICATION M0330
* FULL POWER TAKEOFF
** 650 METER SIDELINE

APPENDIX 1 REFERENCES

A-1	ADVISORY CIRCULAR 36-1B 12/5/77
AA	ACOUSTICAL ANALYSIS ASSOCIATES
EA	EASTERN AIRLINES
B-1	BOEING
BA	BRITISH AEROSPACE
CE	CENTRAL REGION
CR	CERTIFICATION REPORT/FLIGHT MANUAL
D-1	MCDONNELL DOUGLAS 2/24/83
D-2	MCDONNELL DOUGLAS 9/5/85
D-3	MCDONNELL DOUGLAS 9/24/85
D-5	MCDONNELL DOUGLAS 2/26/90
D-6	MCDONNELL DOUGLAS 5/8/91
EU	EUROPEAN REGION
FK	FOKKER
GA-1	LEARJET
GU	GULFSTREAM
IA	ISRAEL AIRCRAFT INDUSTRIES
L-1	LOCKHEED
NM	NORTHWEST MOUNTAIN REGION
SA	SABRELINER
SO	SOUTHERN REGION
SW	SOUTHWEST REGION

EQUATIONS FOR THE CALCULATION OF NOISE CERTIFICATION LIMITS
AT TAKEOFF, SIDELINE, AND APPROACH

STAGE 2

	TAKEOFF LIMITS (EPNdB)	SIDELINE LIMITS (EPNdB)	APPROACH LIMITS (EPNdB)
UP TO AND INCLUDING 75,000 LBS.	93	102	102
OVER 75,000 LBS. TO 600,000 LBS.	$93+5\left[\frac{\log\frac{W}{75,000}}{\log 2}\right]$	$102+2\left[\frac{\log\frac{W}{75,000}}{\log 2}\right]$	$102+2\left[\frac{\log\frac{W}{75,000}}{\log 2}\right]$
OVER 600,000 LBS.	108	108	108

EQUATIONS FOR THE CALCULATION OF NOISE CERTIFICATION LIMITS AT TAKEOFF

STAGE 3-TAKEOFF
(EPNdB)

4 ENGINE OR MORE
(EPNdB)

UP TO AND INCLUDING 44,673 LBS.	89
OVER 44,673 LBS. TO 850,000 LBS.	$89+4\left\{\frac{\log\frac{W}{44,673}}{\log 2}\right\}$
OVER 850,000 LBS.	106

3 ENGINE

UP TO AND INCLUDING 63,177 LBS.	89
OVER 63,177 TO 850,000 LBS.	$89+4\left\{\frac{\log\frac{W}{63,177}}{\log 2}\right\}$
OVER 850,000 LBS.	104

2 ENGINE OR LESS

UP TO AND INCLUDING 106,250 LBS.	89
OVER 106,250 TO 850,000 LBS.	$89+4\left\{\frac{\log\frac{W}{106,250}}{\log 2}\right\}$
OVER 850,000 LBS.	101

EQUATIONS FOR THE CALCULATION OF NOISE CERTIFICATION LIMITS AT SIDELINE AND APPROACH

STAGE 3-SIDELINE
(EPNdB)

UP TO AND INCLUDING 77,200 LBS.	94
OVER 77,200 LBS. TO 882,000 LBS.	$94+2.56\left\{\frac{\log\frac{W}{77,200}}{\log 2}\right\}$
OVER 882,000 LBS.	103

STAGE 3-APPROACH
(EPNdB)

UP TO AND INCLUDING 77,200 LBS.	98
OVER 77,200 TO 617,300 LBS.	$98+2.33\left\{\frac{\log\frac{W}{77,200}}{\log 2}\right\}$
OVER 617,300 LBS.	105

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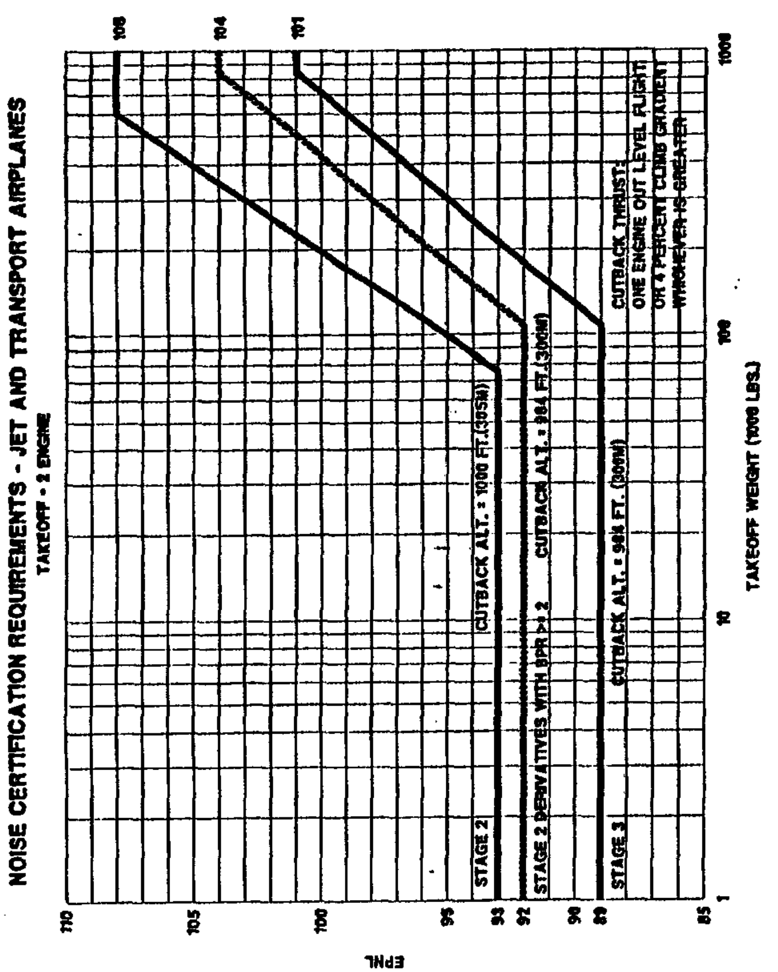
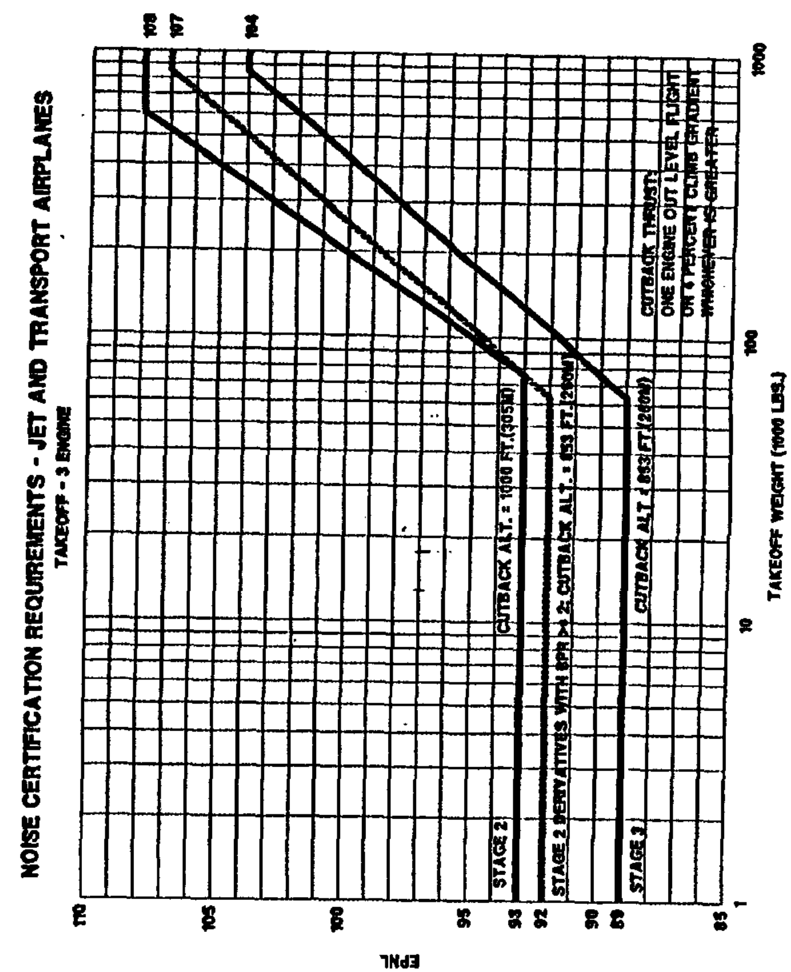
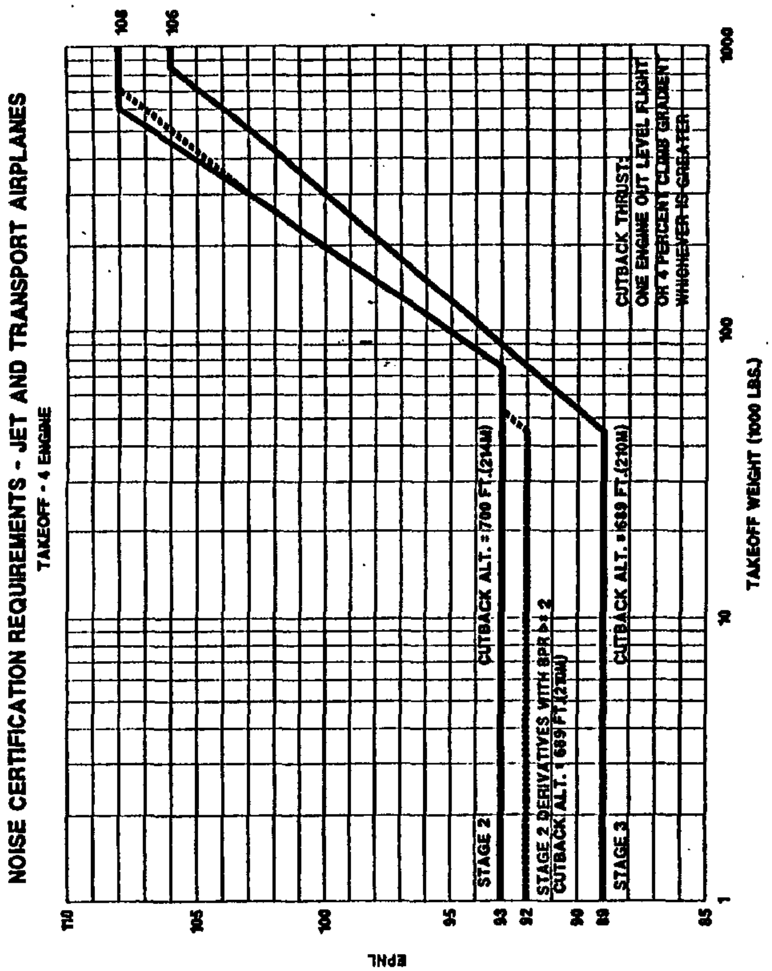
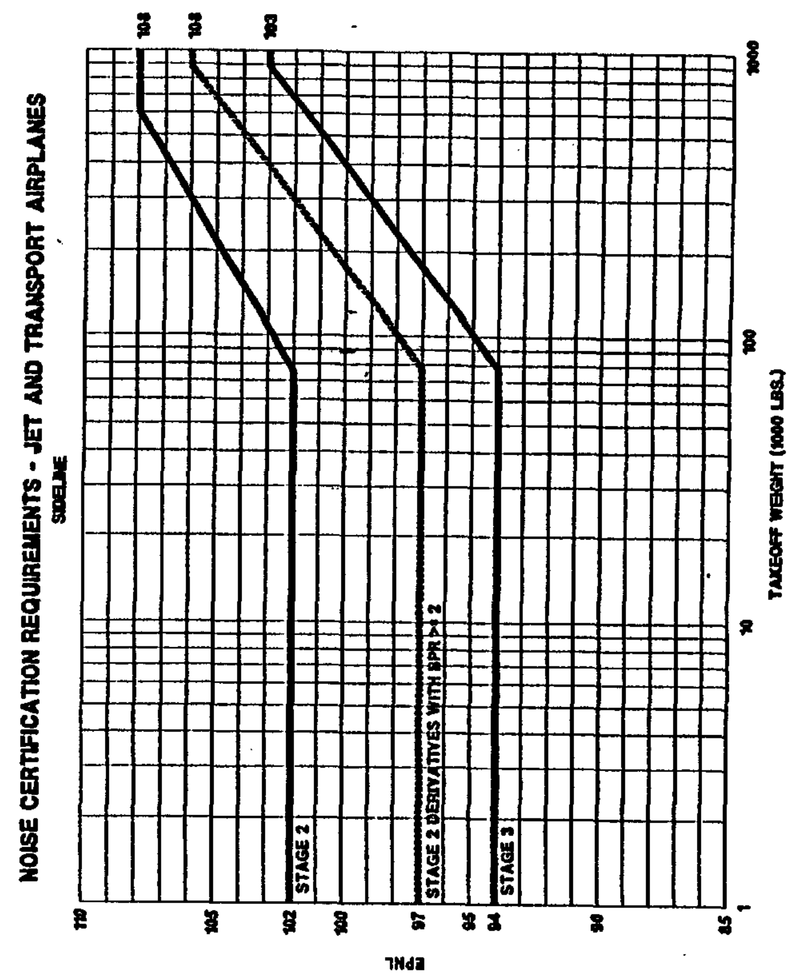

NOISE CERTIFICATION REQUIREMENTS - JET AND TRANSPORT AIRPLANES
TAKEOFF - 2 ENGINE
108
104
101
CUTBACK ALT. = 1000 FT.(305M)
STAGE 2
STAGE 2 DERIVATIVES WITH BPR >= 2
CUTBACK ALT. = 984 FT.(300M)
CUTBACK ALT. = 984 FT. (300M)
STAGE 3
CUTBACK THRUST:
ONE ENGINE OUT LEVEL FLIGHT
OR 4 PERCENT CLIMB GRADIENT
WHICHEVER IS GREATER
110
105
100
95
93
92
90
89
85
EPNL
1
10
100
1000
TAKEOFF WEIGHT (1000 LBS.)

213

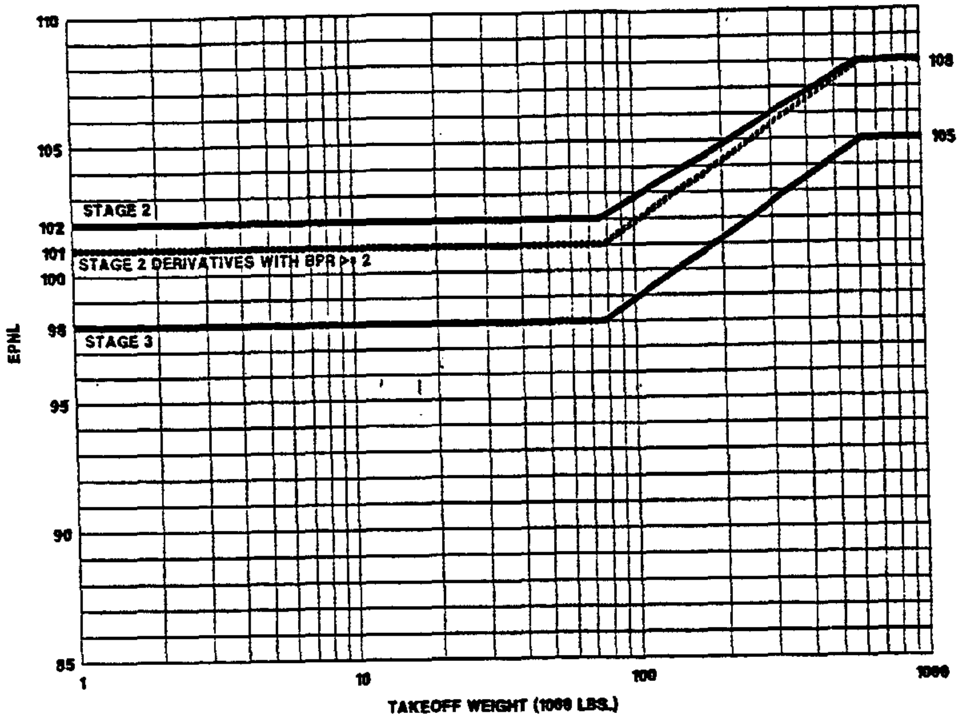

NOISE CERTIFICATION REQUIREMENTS - JET AND TRANSPORT AIRPLANES
TAKEOFF - 3 ENGINE
108
107
104
CUTBACK ALT. = 1000 FT.(305M)
STAGE 2
STAGE 2 DERIVATIVES WITH BPR >= 2; CUTBACK ALT. = 853 FT.(260M)
CUTBACK ALT. = 853 FT.(260M)
STAGE 3
CUTBACK THRUST:
ONE ENGINE OUT LEVEL FLIGHT
OR 4 PERCENT CLIMB GRADIENT
WHICHEVER IS GREATER
110
105
100
95
93
92
90
89
85
EPNL
1
10
100
1000
TAKEOFF WEIGHT (1000 LBS.)


NOISE CERTIFICATION REQUIREMENTS - JET AND TRANSPORT AIRPLANES
TAKEOFF - 4 ENGINE
CUTBACK THRUST:
ONE ENGINE OUT LEVEL FLIGHT
OR 4 PERCENT CLIMB GRADIENT
WHICHEVER IS GREATER
CUTBACK ALT. =700 FT.(214M)
STAGE 2
STAGE 2 DERIVATIVES WITH BPR >= 2
CUTBACK ALT. 1689 FT.(210M)
CUTBACK ALT. =689 FT.(210M)
STAGE 3
TAKEOFF WEIGHT (1000 LBS.)
EPNL


NOISE CERTIFICATION REQUIREMENTS - JET AND TRANSPORT AIRPLANES
SIDELINE
STAGE 2
STAGE 2 DERIVATIVES WITH BPR >= 2
STAGE 3
TAKEOFF WEIGHT (1000 LBS.)
EPNL

NOISE CERTIFICATION REQUIREMENTS - JET AND TRANSPORT AIRPLANES

APPROACH



APPENDIX 2
AIRCRAFT NOISE DATA FOR
FOREIGN CERTIFICATED TURBOJET POWERED AIRCRAFT

AIRCRAFT MANUFACTURER AND TYPE	MGTOW TO / LW (1000)	ENGINE DATA: NUMBER / MODEL	THRUST (1000)	BPR	FLAPS TO	FLAPS APPR.	NOISE LEVEL (EPNL) SIDE-LINE 450M	SIDE-LINE 650M	ALT. FEET	TAKEOFF	APPR. 2000m	CHAPTER	NOTES	REFERENCE
AEROSPATIALE CARAVELLE 10-B1R	114.5 / 109.0	2 / JT8D-7	14.0	1.1	5	35		98.2		92.3	105.1	2		I-3
AEROSPATIALE CARAVELLE 10-B1R	119.0 / 109.0	2 / JT8D-7	14.0	1.1	5	35		98.1		93.7	105.1	2		I-3
AEROSPATIALE CARAVELLE 10-B3	119.6 / 109.0	2 / JT8D-7	14.0	1.1	5	45		97.7		94.4	106.2	2		I-3
AEROSPATIALE CARAVELLE 10-B3	125.6 / 109.0	2 / JT8D-9	14.2	1.1	5	45		98.2		95.7	106.2	2		I-3
AEROSPATIALE CARAVELLE 11R	114.5 / 109.0	2 / JT8D-7	14.0	1.1	5	35		97.9		92.3	105.1	2		I-3
AEROSPATIALE CARAVELLE 12	119.0 / 109.0	2 / JT8D-9	14.2	1.1	5	45		98.4		94.0	105.9	2		I-3
AEROSPATIALE CARAVELLE 12	123.4 / 109.0	2 / JT8D-9	14.2	1.1	5	45		98.3		95.3	105.9	3		I-3
AEROSPATIALE CARAVELLE 12	127.0 / 109.0	2 / JT8D-9	14.2	1.1	5	45		98.2		96.6	105.9	2		I-3
AIRBUS A300B2	302.0 / 269.0	2 / CF6-50C2R	50.4	4.3	0	25	97.4			90.0	102.9	3		I-6

APPENDIX 2
AIRCRAFT NOISE DATA FOR
FOREIGN CERTIFICATED TURBOJET POWERED AIRCRAFT

AIRCRAFT MANUFACTURER AND TYPE	MGTOW LB 1000S	ENGINE DATA NUMBER MODEL	THRUST 1000S	BPR	FLAPS TO	FLAPS APPR.	NOISE LEVEL (EPNL) SIDE-LINE 450M	SIDE-LINE 650M	ALT. TEST	TAKEOFF	APPR. 2000M	CHAPTER	NOTES	REFERENCE
AIRBUS A300B1	302.1 269.0	2 CF6-50A	48.4	4.6		25		90.7		87.9	101.1	2		I-3
AIRBUS A300B2 K3C	313.1 286.7	2 CF6-50C	50.4	4.3		25		92.6		87.0	101.7	2		I-3
AIRBUS A300B2-1A	302.1 281.1	2 CF6-50A	48.3	4.6		25		90.7		87.9	101.1	2		I-3
AIRBUS A300B2-1C	291.0 269.0	2 CF6-50C	50.4	4.3	0	25	97.5			89.9	102.9	3		I-6
AIRBUS A300B2-1C	313.0 286.7	2 CF6-50C	50.4	4.3	0	25	97.4			91.0	103.1	3		I-6
AIRBUS A300B2-202	313.0 287.0	2 CF6-50C1	51.7	4.6	0	25	97.3	93.5		89.3	102.0	3		I-1,I-3
AIRBUS A300B2-320	330.0 293.3	2 JT9D-59A	50.4	4.9	8	15	98.5			90.3	100.5	3		I-3
AIRBUS A300B4-102	347.3 294.8	2 CF6-50C1	51.7	4.6		25		93.3		90.1	101.9	2		I-3
AIRBUS A300B4-120	313.1 286.6	2 JT9D-59A			0	25	98.0			90.0	102.9	3		EU

APPENDIX 2
AIRCRAFT NOISE DATA FOR
FOREIGN CERTIFICATED TURBOJET POWERED AIRCRAFT

AIRCRAFT MANUFACTURER AND TYPE	MGTOW LB 1000S	ENGINE DATA NUMBER MODEL	THRUST 1000S	BPR	FLAPS TO	FLAPS APPR.	NOISE LEVEL (EPNL) SIDE-LINE 450M	SIDE-LINE 650M	ALT. TEST	TAKEOFF	APPR. 2000M	CHAPTER	NOTES	REFERENCE
AIRBUS A300B4-120	347.2 295.4	2 JT9D-59A			0	25	97.7			92.2	103.2	3	2	EU
AIRBUS A300B4-120	363.8 295.4	2 JT9D-59A			0	25	97.6			93.5	103.2	3	2	EU
AIRBUS A300B4-120	363.8 299.8	2 JT9D-59A			0	25	97.5			93.6	102.3	3		EU
AIRBUS A300B4-203	302.0 275.6	2 CF650.C2			0	25	98.3			89.9	102.4	3		EU
AIRBUS A300B4-203	363.0 299.8	2 CF650.C2			0	25	97.9			93.9	102.9	3		EU
AIRBUS A300B4-2C	330.8 293.3	2 CF6-50C	50.4	4.3		25		92.4		89.0	101.9	2		I-3
AIRBUS A300B4-2C	337.4 293.3	2 CF6-50C	50.4	4.3		25		92.6		89.6	101.9	2		I-3
AIRBUS A300B4-2C	347.3 293.3	2 CF6-50C	50.4	4.3		25		92.4		90.5	101.9	2		I-3
AIRBUS A300B4-620	330.7 280.8	2 JT9D-7R4H1	56.0	5.	0	40	99.4	0.0		89.3	100.7	3		I-6

APPENDIX 2
AIRCRAFT NOISE DATA FOR
FOREIGN CERTIFICATED TURBOJET POWERED AIRCRAFT

AIRCRAFT MANUFACTURER AND TYPE	MTOW LB 1000	ENGINE DATA: NUMBER / MODEL	ENGINE DATA: THRUST 1000	ENGINE DATA: BPR	FLAPS: TO	FLAPS: APPR.	NOISE LEVEL (EPNL): SIDE-LINE 450M	NOISE LEVEL (EPNL): SIDE-LINE 650M	NOISE LEVEL (EPNL): ALT. FEET	NOISE LEVEL (EPNL): TAKEOFF	NOISE LEVEL (EPNL): APPR. 2000M	CHAPTER	NOTES	REFERENCE
AIRBUS A300B4-620	385.8 / 319.7	2 / JT9D-7R4H1	56.0	5.	0	40	98.9	0.0		93.0	101.0	3		I-6
AIRBUS A300B4-622-R	330.7 / 290.8	2 / PW4158	57.8	4.7	0	40	98.0	0.0		88.0	101.3	3		I-6
AIRBUS A300B4-622-R	385.8 / 319.7	2 / PW4158	57.8	4.7	0	40	97.6	0.0		93.1	101.9	3		I-6
AIRBUS A300B42C-13	302.0 / 286.6	2 / CF6-50C2R	50.6	4.3	0	25	96.9	0.0		89.8	102.4	3		I-6
AIRBUS A300B42C-13	347.2 / 299.8	2 / CF6-50C2R	50.4	4.3	0	25	96.7	0.0		93.2	102.4	3		I-6
AIRBUS A310-203	275.6 / 261.3	2 / CF6-80A3	50.0	6.6	0	40	97.1	0.0		87.5	99.7	3		I-6
AIRBUS A310-203	305.6 / 267.9	2 / CF6-80A3	50.0	6.0	0	40	96.8	0.0		90.2	99.9	3		I-6
AIRBUS A310-222	275.6 / 261.3	2 / JT9D-7R4	50.0	5.	0	40	95.6			86.3	100.6	3		I-6
AIRBUS A310-222	305.6 / 267.9	2 / JT9D-7R4	50.0	5.	0	40	95.4	0.0		89.7	100.6	3		I-6

APPENDIX 2
AIRCRAFT NOISE DATA FOR
FOREIGN CERTIFICATED TURBOJET POWERED AIRCRAFT

AIRCRAFT MANUFACTURER AND TYPE	MTOW LB 1000	ENGINE DATA: NUMBER / MODEL	ENGINE DATA: THRUST 1000	ENGINE DATA: BPR	FLAPS: TO	FLAPS: APPR.	NOISE LEVEL (EPNL): SIDE-LINE 450M	NOISE LEVEL (EPNL): SIDE-LINE 650M	NOISE LEVEL (EPNL): ALT. FEET	NOISE LEVEL (EPNL): TAKEOFF	NOISE LEVEL (EPNL): APPR. 2000M	CHAPTER	NOTES	REFERENCE
AIRBUS A320-111	132.3 / 130.1	2 / CFM56-5A1	25.0	6.	10	35	94.8			82.1	96.3	3		I-4
AIRBUS A320-111	160.8 / 147.7	2 / CFM56-5A1	25.0	6.	10	35	94.3			89.8	96.7	3		I-6
ANTONOV AN-124	864.2 / 727.5	4 / D-18T					100.6			109.9	108.2	2		I-5
BAe 1-11 475	92.0 / 84.0	2 / SPEY 512-14DW	12.6	0.7	6	45		102.2	2230	93.0	100.3	2	1	I-4
BAe 1-11 500	99.7 / 87.0	2 / SPEY 512-14DW	13.6	0.7	6	45		101.6	1870	95.3	100.0	2	1	I-4
BAe 1-11 500E	104.5 / 87.0	2 / SPEY 512-14DW	12.6	0.7	6	45		101.0	1640	97.0	100.0	2	1	I-4
BAe 1-11 510	92.5 / 86.0	2 / SPEY 512-14E	12.0	0.7	8	45		101.7	2130	93.3	101.7	2	1	I-1,I-3
BAe 146-100-20	82.3 / 73.3	4 / ALF502R-3	6.7	5.9	18	33	90.9		1700	83.1	95.2	3		I-4
BAe 146-200-01	89.5 / 79.5	4 / ALF502-3	7.0	5.7	18	33	97.3		1290	84.9	95.6	3		I-4

APPENDIX 2
AIRCRAFT NOISE DATA FOR
FOREIGN CERTIFICATED TURBOJET POWERED AIRCRAFT

AIRCRAFT MANUFACTURER AND TYPE	MTOW LW 1000#	ENGINE DATA NUMBER MODEL	THRUST 1000#	BPR	FLAPS TO	APPR.	NOISE LEVEL (EPNL) SIDE-LINE 450M	SIDE-LINE 650M	ALT. FEET	TAKEOFF	APPR. 2000M	CHAPTER	NOTES	REFERENCE
BAe CONCORDE	400.0 245.0	4 OLYMPUS 610	38.5					112.0		119.5	117.0			I-2
BAe HS 125-1	20.0 18.1	2 VIPER 520	3.0	0.	0	45		97.3	2090	91.1	103.6	2		I-4
BAe HS 125-1B	21.2 19.5	2 VIPER 521	3.2	0.	0	45		98.4	2210	91.6	104.0	2		I-4
BAe HS 125-1B/522	21.2 19.5	2 VIPER 522	3.3	0.	0	45		100.0	2610	89.8	104.3	2		I-4
BAe HS 125-1B/R522	23.2 19.6	2 VIPER 522	3.3	0.	0	45		100.0	2450	90.5	104.4	2		I-4
BAe HS 125-3B	21.7 20.0	2 VIPER 522	3.3	0.	0	45		100.0	2490	90.6	104.4	2		I-4
BAe HS 125-3B/RA	22.8 20.0	2 VIPER 522	3.3	0.	0	45		100.0	2315	91.5	104.5	2		I-4
BAe HS 125-400B	23.3 20.0	2 VIPER 522	3.3	0.	0	45		100.0	2230	92.0	104.5	2		I-4
BAe HS 125-403B	23.6 20.0	2 VIPER 522	3.3	0.	0	45		100.0	2180	92.4	104.5	2		I-4

APPENDIX 2
AIRCRAFT NOISE DATA FOR
FOREIGN CERTIFICATED TURBOJET POWERED AIRCRAFT

AIRCRAFT MANUFACTURER AND TYPE	MTOW LW 1000#	ENGINE DATA NUMBER MODEL	THRUST 1000#	BPR	FLAPS TO	APPR.	NOISE LEVEL (EPNL) SIDE-LINE 450M	SIDE-LINE 650M	ALT. FEET	TAKEOFF	APPR. 2000M	CHAPTER	NOTES	REFERENCE
BAe HS 125-600B	25.5 23.0	2 VIPER 601-22	3.7	0.	0	45	99.2	97.2	1960	88.7	102.7	2	1	I-4
BAe HS 125-600B	25.5 22.0	2 VIPER 601-22	3.7	0.	0	45		101.1	2040	93.4	101.9	2		I-4
BAe HS 125-600F	25.5 22.0	2 TFE 731-3-1H	3.7	2.7	0	45	89.3		2150	88.0	96.0	3		I-4
BAe HS 125-700B	25.5 22.0	2 TFE 731-3-1H	3.7	2.7	0	45	89.3		2150	88.0	96.0	3		I-4
DASSAULT BREGUET FALCON 20	28.7 27.3	2 CF700-2D-2	4.3	2.	10	40	92.0	90.0	2600	90.0	103.0	2	*	I-1
DASSAULT BREGUET FALCON 20G	30.4 28.0	2 ATF3-6-2C	5.1	2.9	10	40	89.7			82.7	95.8	3	*	I-3
DASSAULT BREGUET FALCON 20G	32.0 27.6	2 ATF3-6-2C	5.1	2.9	10	40	89.6			85.0	95.8	3	*	I-3
DASSAULT BREGUET MERCURE 100A	120.2 110.9	2 JT8D-15	15.5	0.99	5	25	102.6	100.0		93.0	103.7	2		I-1
DASSAULT BREGUET MERCURE 100B	125.0 115.0	2 JT8D-15	15.5	1.	5	25		99.9		94.1	103.0	2		I-3

APPENDIX 2
AIRCRAFT NOISE DATA FOR
FOREIGN CERTIFICATED TURBOJET POWERED AIRCRAFT

AIRCRAFT MANUFACTURER AND TYPE	MGTOW	LW 1000#	ENGINE DATA: NUMBER	ENGINE DATA: MODEL	THRUST 1000#	BPR	FLAPS: TO	FLAPS: APPR.	NOISE LEVEL (EPNdB): SIDE-LINE 450M	SIDE-LINE 650M	ALT. [illegible]	TAKEOFF	APPR. 2000M	CHAPTER	NOTES	REFERENCE
FOKKER 614	44.1	44.1	2	M45H	6.9	3.1		35		89.6		90.5	99.0	2		I-1
FOKKER F28 MK2000	65.0	59.0	2	RB183MK555-15	41.0	1.	6	42	99.5			90.0	101.8	2		NR
ILYUSHIN IL-62M	363.8	231.5	4	D-30KU	44.0	2.46	30	30	103.7	100.5		106.9	105.0	2		I-5
ILYUSHIN IL-62M	369.3	235.9	4	D-30KU	24.3	2.4	30	30	99.1			102.5	102.6	3	1	I-5
ILYUSHIN IL-76T(TD)	374.8	334.8	4	D-30KP	26.5	2.30	30	30		102.7		103.1	108.9	2		I-5
ILYUSHIN IL-86	463.0	385.8	4	NK-86	28.7	1.3	30	40		104.2		107.4	105.1	2		I-5
TUPOLEV TU-134	99.2	88.2	2	D-30-I	15.0	1.	10	38		101.9		92.9	101.4	2		I-5
TUPOLEV TU-134A-3/B-3	104.9	94.8	2	D-30-III	15.3	0.84	10	38		102.5		95.5	101.3	2		I-5
TUPOLEV TU-134A-3/B-3	108.0	94.8	2	D-30-III	15.3	0.84	10	30		102.5		96.7	101.3	2		I-5

APPENDIX 2
AIRCRAFT NOISE DATA FOR
FOREIGN CERTIFICATED TURBOJET POWERED AIRCRAFT

AIRCRAFT MANUFACTURER AND TYPE	MGTOW	LW 1000#	ENGINE DATA: NUMBER	ENGINE DATA: MODEL	THRUST 1000#	BPR	FLAPS: TO	FLAPS: APPR.	NOISE LEVEL (EPNdB): SIDE-LINE 450M	SIDE-LINE 650M	ALT. [illegible]	TAKEOFF	APPR. 2000M	CHAPTER	NOTES	REFERENCE
TUPOLEV TU-134A/B	103.6	94.0	2	D-30-II	15.0	1.	10	38		101.9		95.3	102.1	2		I-5
TUPOLEV TU-154	211.6	172.0	3	NK-8-2U	23.2	1.	28	45		97.8		100.1	106.0	2		I-5
TUPOLEV TU-154	216.2	172.0	3	NK-8-2U	23.2	1.	28	45		97.8		100.1	106.0	2		I-5
TUPOLEV TU-154M	220.5	176.4	3	D-30KU-154	24.3	2.4	15	45	99.5			92.3	102.0	3	1	I-5
TUPOLEV TU-154M	220.5	176.6	3	D-30KU-154	24.3	2.4	28	45		90.0		94.2	102.5	2		I-5
YAKOLEV YAK-40	35.3	32.4	3	AI-25	3.3	2.	20	35		85.3		88.7	99.3	2		I-5
YAKOLEV YAK-42	119.0	110.2	3	D-36	14.3	6.	20	45		93.6		93.0	102.6	2		I-5
YAKOLEV YAK-42	124.6	111.3	3	D-36	14.3	6.	20	45	92.0			90.9	99.6	3	1	I-5

APPENDIX 2 REFERENCES

EU	EUROPEAN REGION
I-1	FRANCE ICAO CAN 6 DATA 3/78
I-2	UNITED KINGDOM ICAO CAN 6 RIP 21 3/4/79
I-3	ICAO CAN WG #0# UPDATE 4/81
I-4	BRITISH AEROSPACE
I-5	USER
I-6	DERC
NM	NORTHWEST MOUNTAIN REGION

APPENDIX 2 NOTES

*	FULL POWER TAKEOFF
1	EQUIPPED WITH STANDARD HUSH KIT
2	EQUIPPED WITH MODIFICATIONS 3305 AND 3373

APPENDIX 3
STAGE 3
TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	ENGINE MODEL	MTOW (1000)	MLW (1000)	NOISE LEVELS EPNdB TAKEOFF	SIDELINE	APPROACH	NOTES
BOEING	B-727-100 (FED. EX.)	JT8D-7(A)(B)	169.5	142.5	94.4	96.9	97.9	6,20
BOEING	B-727-100 (FED. EX.)	JT8D-7/A/B	160.0	137.5	92.8	96.4	97.8	6,20
BOEING	B-727-100 (FED. EX.)	JT8D-9/A	169.5	142.0	94.0	97.3	98.0	6,27
BOEING	B-727-200 (FED. EX.)	JT8D-7/A/B	177.6	154.5	96.9	96.0	99.1	6,27
BOEING	B-727-200 (FED. EX.)	JT8D-7B(A)(B)	172.6	150.0	95.7	96.8	98.9	6,27
BOEING	B-727-200 (FED. EX.)	JT8D-7B(A)(B)	172.6	150.0	96.0	97.4	99.0	6,20
BOEING	B-727-200 (FED. EX.)	JT8D-9/A	169.5	150.0	96.1	97.8	100.2	6,27
BOEING	B-727-200RE(VALSAN)	JT8D-15/217C	190.5	140.0	91.8	99.3	98.6	6,23
BOEING	B-727-200RE(VALSAN)	JT8D-17/217C	190.6	150.0	92.2	99.5	99.0	6,22
BOEING	B-727-200RE(VALSAN)	JT8D-17A/217C	203.1	164.0	94.6	97.6	90.3	6,23
BOEING	B-727-200RE(VALSAN)	JT8D-17A/217C	209.5	159.0	94.8	99.6	99.0	6,23
BOEING	B-737-300	CFM56-3-B1	124.5	114.0	84.4	90.4	99.9	
BOEING	B-737-300	CFM56-3-B1	139.9	115.8	87.8	89.9	100.0	
BOEING	B-737-300	CFM56-3B-2	124.5	114.0	82.8	93.2	99.9	
BOEING	B-737-300	CFM56-3B-2	139.5	118.0	85.7	91.9	100.0	
BOEING	B-737-400	CFM56-3-B1	130.5	121.0	87.2	88.0	100.2	
BOEING	B-737-400	CFM56-3-B1	142.5	121.0	88.9	89.6	100.2	
BOEING	B-737-400	CFM56-3B-2	130.5	121.0	85.7	92.1	100.2	
BOEING	B-737-400	CFM56-3B-2	150.0	124.0	87.7	91.7	100.2	
BOEING	B-737-400	CFM56-3C-1	130.5	121.0	85.0	93.2	100.2	

APPENDIX 3
STAGE 3
TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	ENGINE MODEL	MTOW 1000#	MLW 1000#	NOISE LEVELS EPNdB TAKEOFF	SIDELINE	APPROACH	NOTES
BOEING	B-737-400	CFM56-3C-1	150.0	124.0	87.1	93.1	100.2	
BOEING	B-737-500	CFM56-3-B1	115.5	103.0	83.7	90.0	99.4	
BOEING	B-737-500	CFM56-3-B1	139.0	110.0	87.3	90.0	99.0	
BOEING	B-737-500	CFM56-3-B1(R)	115.5	103.0	83.4	89.9	99.4	
BOEING	B-737-500	CFM56-3-B1(R)	132.0	110.0	87.7	88.9	99.8	
BOEING	B-747-100	JT9D-3A	710.0	400.0	105.4	102.1	104.6	29
BOEING	B-747-100	JT9D-3A	710.0	540.0	105.4	102.1	104.6	29
BOEING	B-747-100	JT9D-7	734.0	540.0	105.1	102.7	104.1	29
BOEING	B-747-100	JT9D-7	734.0	423.0	105.1	102.7	104.6	29
BOEING	B-747-200	JT9D-7A	734.0	460.0	106.3	102.6	105.3	29
BOEING	B-747-200	JT9D-7A	734.0	630.0	106.3	102.6	105.5	29
BOEING	B-747-200	JT9D-7F	750.0	400.0	104.5	103.5	104.5	29
BOEING	B-747-100	JT9D-7F	750.0	520.0	104.5	103.5	104.5	29
BOEING	B-747-200	CF6-50E	775.0	585.0	100.7	101.1	105.9	
BOEING	B-747-200	CF6-50E	820.0	630.0	102.5	100.9	107.0	
BOEING	B-747-200	CF6-50E2	820.0	630.0	102.1	101.7	106.6	
BOEING	B-747-200	CF6-50E2	833.0	630.0	102.6	101.7	106.5	
BOEING	B-747-200	JT9D-3A	710.0	630.0	104.6	100.8	105.7	30
BOEING	B-747-200	JT9D-3A	710.0	520.0	104.4	100.8	106.9	30
BOEING	B-747-200	JT9D-7	734.0	630.0	106.2	101.3	105.2	30

APPENDIX 3
STAGE 3
TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	ENGINE MODEL	MTOW 1000#	MLW 1000#	NOISE LEVELS EPNdB TAKEOFF	SIDELINE	APPROACH	NOTES
AEROSPATIALE	SN601 CORVETTE	JT15D-4	13.9	12.4	88.4	85.4	89.5	*
AEROSPATIALE	SN601 CORVETTE	JT15D-4	14.6	13.2	76.0	81.0	90.0	
AIRBUS	A300B2-203	CF6-50-C2	313.1	286.6	91.1	97.9	103.1	
AIRBUS	A300B4-103	CF6-50-C2	347.2	293.4	93.0	97.7	103.0	
AIRBUS	A300B4-203	CF6-50-C2	363.7	299.8	94.0	96.9	102.6	31
AIRBUS	A300B4-203	CF6-80C2	313.0	286.6	90.5	97.3	102.4	31
AIRBUS	A300B4-605R	CF6-80-C2-A5	375.1	308.0	93.3	98.9	99.0	
AIRBUS	A300B4-622R	PW-4158	330.0	275.0	88.0	98.3	101.3	
AIRBUS	A300B4-622R	PW-4158	385.8	306.9	93.1	97.9	101.0	
AIRBUS	A310-221	JT9D-7R4D1	303.6	267.9	90.5	94.8	100.6	
AIRBUS	A310-304	CF6-80C2A2	275.6	261.3	85.7	96.8	98.5	
AIRBUS	A310-304	CF6-80C2A2	352.7	266.6	92.9	96.1	98.0	
AIRBUS	A310-324	PW-4152	330.7	271.2	90.6	97.2	100.2	
AIRBUS	A320-211	CFM56-5A1	149.9	142.2	85.3	94.4	96.4	
AIRBUS	A320-211	CFM56-5A1	162.0	142.2	87.8	94.3	96.4	
AIRBUS	A320-231	V2500.A1	149.9	142.2	84.6	93.0	96.6	
AIRBUS	A320-231	V2500.A1	162.0	142.2	86.6	92.0	96.6	
BAe	125-1000	PW305	31.0	25.0	81.0	85.0	91.8	
BAe	125-800	TFE731-5R-1H	27.4	23.4	80.9	87.2	98.5	
BAe	125-800A	TFE731-5R-1H	27.4	23.4	80.9	89.6	96.3	25

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STAGE 3
TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	ENGINE MODEL	MTOW 1000#	MLW 1000#	NOISE LEVELS EPNdB TAKEOFF	SIDELINE	APPROACH	NOTES
BAe	146-100A	ALF502R-3	76.0	72.3	88.7	87.3	95.1	
BAe	146-100A	ALF502R-3A	76.0	72.3	79.0	88.0	94.9	
BAe	146-100A	ALF502R-3A	82.3	73.3	82.3	87.6	95.2	
BAe	146-100A	ALF502R-5	82.3	73.3	82.3	87.6	95.2	
BAe	146-100A	ALF502R-5	84.0	77.5	81.0	87.7	95.6	
BAe	146-200A	ALF502R-3	89.5	77.5	85.9	86.6	95.6	
BAe	146-200A	ALF502R-3A	89.5	77.5	86.9	87.3	95.6	
BAe	146-200A	ALF502R-5	89.5	77.5	86.9	87.3	95.6	
BAe	146-200A	ALF502R-5	93.0	81.0	89.2	87.3	95.0	
BAe	146-300A	ALF 502R-5	95.0	83.0	86.0	87.0	96.0	
BAe	146-300A	ALF502R-5	97.5	84.5	86.5	86.7	85.6	
BAe	C-29A	TFE731-5R-1H	28.0	23.4	81.4	87.3	95.8	
BAe	HS 125-1A	TFE731-3-1H	21.2	19.6	83.4	90.1	96.0	
BAe	HS 125-1A	TFE731-3-1H	21.7	19.6	84.2	90.0	94.0	
BAe	HS 125-3A	TFE731-3-1H	21.7	20.0	84.2	90.0	96.3	
BAe	HS 125-3A/RA	TFE731-3-1H	23.6	20.0	85.9	89.0	95.7	
BAe	HS 125-400A	TFE731-3-1H	23.6	20.0	85.5	89.0	95.7	
BAe	HS 125-600A	TFE731-3-1H	25.5	22.0	88.0	89.2	96.3	
BAe	HS 125-700A	TFE731-3-1H	25.5	22.0	88.0	89.2	96.3	33
BEECH	BEECHJET 400	JT15D-5	15.8	14.3	88.6	93.7	91.6	*

APPENDIX 3
STAGE 3
TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	ENGINE MODEL	MTOW 1000#	MLW 1000#	NOISE LEVELS EPNdB TAKEOFF	SIDELINE	APPROACH	NOTES
BOEING	B-747-200	JT9D-7	734.0	540.0	104.2	101.3	106.7	30
BOEING	B-747-200	JT9D-70A	820.0	630.0	101.3	98.8	106.0	
BOEING	B-747-200	JT9D-7A	734.0	630.0	103.5	101.2	105.0	30
BOEING	B-747-200	JT9D-7A	734.0	564.0	103.5	101.2	106.9	30
BOEING	B-747-200	JT9D-7F	750.0	630.0	103.5	102.0	106.0	30
BOEING	B-747-200	JT9D-7F	750.0	520.0	103.5	102.0	106.9	30
BOEING	B-747-200	JT9D-7J	778.0	475.0	103.6	102.0	105.9	30
BOEING	B-747-200	JT9D-7J	778.0	630.0	103.0	103.0	104.0	30
BOEING	B-747-200	JT9D-7Q	853.0	630.0	103.2	103.5	104.4	
BOEING	B-747-200	JT9D-7Q	833.0	600.0	103.2	103.5	106.6	
BOEING	B-747-200	RB.211-524C2	833.0	585.0	106.5	99.7	107.0	*
BOEING	B-747-300	RB.211-524D4	833.0	630.0	103.9	99.7	106.9	
BOEING	B-747-300	CF6-50E2	800.0	630.0	102.6	102.0	106.5	
BOEING	B-747-300	CF6-80C2B1	600.0	564.0	99.8	99.1	102.5	
BOEING	B-747-300	CF6-80C2B1	833.0	646.0	99.0	98.2	103.2	
BOEING	B-747-300	JT9D-7R4G2	785.0	630.0	100.1	101.5	106.4	
BOEING	B-747-300	JT9D-7R4G2	833.0	630.0	102.4	101.3	106.6	
BOEING	B-747-400	CF6-80C2	870.0	652.0	99.7	98.3	101.4	
BOEING	B-747-400	CF6-80C2B1F	600.0	564.0	89.6	99.1	101.7	
BOEING	B-747-400	CF6-80C2B1F	870.0	652.9	99.7	98.3	103.8	

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STAGE 3
TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	ENGINE MODEL	MTOW 1000#	MLW 1000#	NOISE LEVELS EPNdB TAKEOFF	SIDELINE	APPROACH	NOTES
BOEING	B-747-400	PW 4056	870.0	652.0	101.5	99.7	104.7	
BOEING	B-747-400	PW4056	600.0	564.0	89.5	100.7	103.2	
BOEING	B-747-400	RB.211-524G	600.0	564.0	90.3	98.9	102.4	
BOEING	B-747-400	RB.211-524G	870.0	652.0	100.0	98.1	103.0	
BOEING	B-747-400	RB.211-524H	600.0	564.0	89.7	89.7	103.4	
BOEING	B-747-400	RB.211-524H	870.0	652.0	99.3	98.8	103.0	
BOEING	B-747-SP	JT9D-7A	660.0	450.0	98.6	101.3	102.5	
BOEING	B-747-SP	JT9D-7A	701.0	465.0	102.0	101.1	102.9	
BOEING	B-747-SP	JT9D-7F	660.0	475.0	98.7	102.3	103.0	
BOEING	B-747-SP	JT9D-7J	696.0	475.0	99.0	103.5	103.0	
BOEING	B-747-SP	JT9D-7J	705.0	450.0	100.1	103.3	103.2	
BOEING	B-747-SP	JT9D-7J	702.0	475.0	100.1	103.3	103.0	
BOEING	B-747-SP	RB.211-524B2	696.0	450.0	99.5	99.0	103.2	
BOEING	B-747-SP	RB.211-524D4	762.0	610.0	99.2	99.0	107.0	
BOEING	B-747-SR	CF6-45A2	571.0	564.0	98.4	93.2	105.4	
BOEING	B-747-SR	JT9D-7A	610.0	564.0	101.0	101.6	106.9	*
BOEING	B-757-200	PW 2037	220.0	198.0	84.2	84.0	97.7	
BOEING	B-757-200	PW 2037	255.5	210.0	91.4	93.7	98.1	
BOEING	B-757-200	PW 2046	220.0	198.0	84.6	94.9	97.7	
BOEING	B-757-200	PW 2040	255.5	210.0	89.7	94.2	98.1	

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STAGE 3
TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	ENGINE MODEL	MTOW 1000#	MLW 1000#	NOISE LEVELS EPNdB TAKEOFF	SIDELINE	APPROACH	NOTES
BOEING	B-757-200	RB.211-535-E4	220.0	198.0	82.2	93.3	95.0	
BOEING	B-757-200	RB.211-535-E4	255.5	210.0	86.0	93.0	95.2	
BOEING	B-757-200	RB.211-535C	220.0	198.0	85.5	96.0	100.3	
BOEING	B-757-200	RB.211-535C	240.0	210.0	88.1	93.0	99.6	
BOEING	B-757-200	RB.211-535E4-B	220.0	198.0	81.3	94.4	95.0	
BOEING	B-757-200	RB.211-535E4-B	255.5	210.0	85.7	94.3	95.2	
BOEING	B-767-200	CF6-80A	279.9	257.0	86.9	95.5	101.4	
BOEING	B-767-200	CF6-80A	360.0	300.0	92.0	96.0	101.7	
BOEING	B-767-200	CF6-80A2	279.9	257.0	84.2	97.2	101.6	
BOEING	B-767-200	CF6-80A2	360.0	300.0	91.7	96.5	101.7	
BOEING	B-767-200	CF6-80C2-B2	300.0	270.0	85.2	96.1	95.7	
BOEING	B-767-200	CF6-80C2-B2	351.0	300.0	89.8	93.7	96.4	
BOEING	B-767-200	CF6-80C2-B4	351.0	270.0	87.7	95.3	95.7	
BOEING	B-767-200	CF6-80C2-B4	387.0	300.0	88.6	95.0	96.0	
BOEING	B-767-200	JT9D-7R4D(A)	282.0	257.0	87.7	93.7	101.0	
BOEING	B-767-200	JT9D-7R4D(A)	351.0	300.0	95.1	95.2	102.7	
BOEING	B-767-200	JT9D-7R4D(B)	282.0	257.0	88.4	93.9	101.9	
BOEING	B-767-200	JT9D-7R4D(B)	360.0	300.0	96.2	95.3	102.6	
BOEING	B-767-200	JT9D-7R4E	282.0	257.0	87.5	96.0	101.9	
BOEING	B-767-200	JT9D-7R4E	360.0	300.0	95.4	96.2	102.6	

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STAGE 3
TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	ENGINE MODEL	MTOW 1000#	MLW 1000#	NOISE LEVELS EPNdB TAKEOFF	SIDELINE	APPROACH	NOTES
BOEING	B-767-200	PW 4056	400.0	300.0	93.7	95.5	98.6	
BOEING	B-767-200	PW4052	335.0	270.0	89.4	95.0	97.8	
BOEING	B-767-200	PW4052	351.0	285.0	90.9	94.9	98.2	
BOEING	B-767-200	PW4056	340.0	270.0	88.5	96.0	97.8	
BOEING	B-767-300	CF6-80A	300.0	280.0	87.5	95.2	101.7	
BOEING	B-767-300	CF6-80A	351.0	320.0	92.0	94.9	101.7	
BOEING	B-767-300	CF6-80A2	300.0	280.0	86.7	96.9	101.7	
BOEING	B-767-300	CF6-80A2	351.0	320.0	91.2	96.5	101.7	
BOEING	B-767-300	CF6-80C2-B4	300.0	280.0	90.2	95.3	96.5	
BOEING	B-767-300	CF6-80C2-B4	407.0	320.0	92.1	95.2	98.4	
BOEING	B-767-300	CF6-80C2-B6	300.0	280.0	89.2	96.4	96.5	
BOEING	B-767-300	CF6-80C2-B6	407.0	320.0	91.1	96.3	98.4	
BOEING	B-767-300	CF6-80C2B2	280.7	280.0	83.1	94.3	96.9	
BOEING	B-767-300	CF6-80C2B6F	300.0	280.0	89.1	96.1	96.6	
BOEING	B-767-300	CF6-80C2B6F	407.0	320.0	90.9	96.0	98.5	
BOEING	B-767-300	JT9D-7R4D(B)	300.0	280.0	91.0	95.7	102.3	
BOEING	B-767-300	JT9D-7R4D(B)	351.0	320.0	95.7	95.6	103.0	
BOEING	B-767-300	JT9D-7R4E	300.0	280.0	90.0	96.5	102.3	
BOEING	B-767-300	JT9D-7R4E	351.0	320.0	95.0	96.2	103.0	
BOEING	B-767-300	PW 4056	300.0	280.0	92.0	96.0	98.8	

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STAGE 3
TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	ENGINE MODEL	MTOW 1000#	MLW 1000#	NOISE LEVELS EPNdB TAKEOFF	SIDELINE	APPROACH	NOTES
BOEING	B-767-300	PW 4056	407.0	320.0	94.2	95.7	100.2	
BOEING	B-767-300	PW 4060	407.0	320.0	93.2	97.0	100.2	
BOEING	B-767-300	PW4060	300.0	280.0	91.2	97.2	98.0	
BOEING	B-767-300	RB.211-524G	340.0	280.0	89.4	96.3	98.5	
BOEING	B-767-300	RB.211-524G	407.0	320.0	93.8	96.0	99.8	
BOEING	B-767-300	RB.211-524H	340.0	280.0	88.7	95.2	98.5	
BOEING	B-767-300	RB.211-524H	407.0	320.0	92.9	96.0	99.0	
CANADAIR	CL-600	ALF-502	36.0	33.0	81.6	89.3	91.2	*
CANADAIR	CL-601 CHALLENGER	CF34-1A	42.1	36.0	79.4	84.9	89.4	*
CESSNA	500 CITATION	JT15D-1	10.3	9.8	76.4	86.1	87.7	*
CESSNA	500/501 CITATION I	JT15D-1/-1A	11.8	11.3	78.0	86.2	87.9	*
CESSNA	550 CITATION II	JT15D-4	13.3	12.7	80.1	86.7	90.5	*
CESSNA	550 CITATION II	JT15D-4	14.1	13.5	71.6	86.4	90.5	
CESSNA	551 CITATION II	JT15D-4	12.8	12.0	80.1	86.7	90.5	*
CESSNA	552	JT15D-5	15.5	14.3	89.3	91.7	88.5	*
CESSNA	560 CITATION V	JT15D-5A	15.9	15.2	83.7	94.7	88.8	
CESSNA	560 CITATION V	JT15D-5A	16.3	15.2	84.6	94.6	88.9	
CESSNA	650 CITATION III	TFE731-3B-100B	21.0	17.0	84.9	92.5	92.0	
CESSNA	650 CITATION III	TFE731-3B-100S	22.0	20.0	88.1	92.6	93.0	22
CESSNA	S550 CITATION S/II	JT15D-4B	14.7	14.0	87.9	91.6	85.1	*

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STAGE 3
TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	ENGINE MODEL	MTOW 1000#	MLW 1000#	NOISE LEVELS EPNdB TAKEOFF	SIDELINE	APPROACH	NOTES
CESSNA	S550 CITATION S/II	JT15D-4B	15.1	14.4	80.0	91.3	86.3	
DASSAULT BREGUET	FALCON 10	TFE731-3	18.3	17.2	82.9	86.4	93.3	
DASSAULT BREGUET	FALCON 10	TFE731-2-1C	19.3	17.6	81.4	86.2	95.6	
DASSAULT BREGUET	FALCON 20-C5/D5/E5	TFE-731-5AR-1C	29.1	27.0	80.3	90.7	90.7	30
DASSAULT BREGUET	FALCON 20-C5/D5/E5	TFE731-5AR-2C	29.1	27.0	82.9	88.6	90.7	
DASSAULT BREGUET	FALCON 20-F5	TFE-731-5AR-1C	29.1	27.0	79.3	90.9	90.0	30
DASSAULT BREGUET	FALCON 20-F5	TFE731-5AR-2C	29.1	27.0	81.0	88.6	90.0	
DASSAULT BREGUET	FALCON 20-G	ATF3-6-2C	32.0	27.6	87.9	89.3	95.9	
DASSAULT BREGUET	FALCON 200 MYSTERE	ATF3-6-4C	32.0	27.6	83.9	89.0	93.9	
DASSAULT BREGUET	FALCON 200 MYSTERE	ATF3-6A-4C	32.0	28.5	83.9	89.0	94.2	
DASSAULT BREGUET	FALCON 50	TFE731-2	38.8	35.7	84.3	91.4	97.6	
DASSAULT BREGUET	FALCON 50	TFE731-3-1C	40.8	35.7	84.6	91.9	97.1	
DASSAULT BREGUET	FALCON 900	TFE731-5AR-1C	45.5	42.0	81.9	89.5	91.7	
DASSAULT BREGUET	FALCON 900B	TFE731-5BR-1C	46.5	42.0	89.7	91.3	91.7	
FOKKER	F100	TAY MK650-15	98.0	88.0	81.0	91.7	93.0	
GULFSTREAM	G-IV	TAY 611-8	73.2	58.5	78.9	87.3	91.0	
GULFSTREAM	G-IV GULFSTREAM	TAY 610-8	71.7	58.5	78.0	86.5	91.0	
ISRAEL AIRCRAFT	1124 WESTWIND	TFE731-3-1G	22.9	19.0	81.2	88.4	93.0	
ISRAEL AIRCRAFT	1124A WESTWIND 2	TFE731-3-1G	23.5	18.0	85.4	88.7	92.0	*
ISRAEL AIRCRAFT	1125 ASTRA	TFE731-3A-200G	23.5	20.7	83.3	89.8	89.0	

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STAGE 3
TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	ENGINE MODEL	MTOW 1000#	MLW 1000#	NOISE LEVELS EPNdB TAKEOFF	SIDELINE	APPROACH	NOTES
ISRAEL AIRCRAFT	1125 ASTRA	TFE731-3A-200G	24.7	20.7	86.1	89.7	89.0	
LEARJET	31	TFE731-2-3B	15.5	15.3	79.6	87.2	93.6	
LEARJET	31	TFE731-2-3B	16.5	15.3	81.0	87.0	92.6	*
LEARJET	35/36	TFE731-2-2B	17.0	14.3	84.0	86.9	92.2	*
LEARJET	35/36	TFE731-2-2B	18.0	14.3	84.5	87.9	92.2	*
LEARJET	35A	TFE731-2-2B	18.0	14.3	83.6	87.4	91.3	*
LEARJET	35A/36A	TFE731-2-2B	18.0	14.3	78.7	87.4	91.3	
LEARJET	35A/36A	TFE731-2-2B	18.3	15.3	79.3	86.7	91.6	
LEARJET	36A	TFE731-2-2B	18.3	15.3	83.9	87.8	91.6	*
LEARJET	55	TFE731-3A-2B	19.5	17.0	84.2	90.9	90.6	*
LEARJET	55	TFE731-3A-2B	22.0	17.0	85.9	90.7	90.6	*
LEARJET	55B	TFE731-3A-2B	21.5	18.0	86.3	90.7	93.0	
LEARJET	55C	TFE731-3AR-2B	21.0	18.0	86.2	91.0	93.6	*
LEARJET	55C	TFE731-3AR-2B	21.5	18.0	86.7	90.9	92.6	*
LEARJET	M55C	TFE731-3AR-3B	21.0	17.0	86.7	91.5	92.4	*
LEARJET	M55C	TFE731-3AR-3B	21.5	17.0	87.0	91.6	92.4	*
LOCKHEED	L-1011	RB.211-22B	430.0	356.0	95.9	95.1	102.0	5 *
LOCKHEED	L-1011-1	RB.211-22B	430.0	358.0	96.0	95.0	102.0	5 *
LOCKHEED	L-1011-100	RB.211-22B	466.0	368.0	98.5	94.9	102.0	5 *
LOCKHEED	L-1011-200	RB.211-524B	466.0	368.0	98.3	97.9	101.6	5 *

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STAGE 3
TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	ENGINE MODEL	MTOW 1000#	MLW 1000#	NOISE LEVELS EPNdB TAKEOFF	SIDELINE	APPROACH	NOTES
LOCKHEED	L-1011-500	RB.211-524B	496.0	368.0	98.6	97.0	101.5	5 *
LOCKHEED	L-1011-500	RB.211-524B2	496.0	368.0	97.4	96.7	100.3	5 *
LOCKHEED	L-1011-500	RB.211-524B3	504.0	368.0	98.0	96.9	100.2	5 *
LOCKHEED	L-1011-500	RB.211-524B4	510.0	368.0	99.3	96.4	102.0	*
LOCKHEED	L1011-385-1-14/15	RB.211-22B	474.0	368.0	98.6	96.1	102.8	
LOCKHEED	L1011-385-1-14/15	RB.211-524B4	466.0	368.0	97.9	95.9	103.3	*
MCDONNELL DOUGLAS	DC-08-62 (BAC R-1)	JT3D-3B	350.0	240.0	100.5	101.2	100.2	6
MCDONNELL DOUGLAS	DC-08-62 (BAC/HGH)	JT3D-3B	348.0	240.0	100.5	101.2	100.7	6
MCDONNELL DOUGLAS	DC-08-63 (BAC R-1)	JT3D-7	355.0	275.0	98.9	101.4	103.0	6
MCDONNELL DOUGLAS	DC-08-63 (BAC/HGH)	JT3D-7	353.0	275.0	98.9	101.4	103.0	6
MCDONNELL DOUGLAS	DC-08-71	CFM-56-2C5	335.0	240.0	94.3	92.9	98.3	*
MCDONNELL DOUGLAS	DC-08-71	CFM56-2-C1	325.0	240.0	94.3	92.9	98.3	*
MCDONNELL DOUGLAS	DC-08-71	CFM56-2-C1	328.0	258.0	94.5	92.9	98.6	*
MCDONNELL DOUGLAS	DC-08-72	CFM56-2-C1	335.0	240.0	94.4	92.9	98.1	*
MCDONNELL DOUGLAS	DC-08-72	CFM56-2-C1	350.0	258.0	95.2	92.0	98.2	*
MCDONNELL DOUGLAS	DC-08-73	CFM56-2-C1	355.0	258.0	95.7	92.8	98.3	*
MCDONNELL DOUGLAS	DC-08-73	CFM56-2-C1	355.0	275.0	95.7	92.8	98.5	*
MCDONNELL DOUGLAS	DC-09-10 (ABS)	JT8D-7/7A/7B	90.7	81.7	87.2	96.4	95.0	6
MCDONNELL DOUGLAS	DC-09-30 (ABS)	JT8D-9	103.0	99.0	89.7	96.0	96.0	6
MCDONNELL DOUGLAS	DC-09-30 (ABS)	JT8D-9	105.0	101.0	90.3	96.7	96.3	6

APPENDIX 3
STAGE 3
TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	ENGINE MODEL	MTOW 1000#	MLW 1000#	NOISE LEVELS EPNdB TAKEOFF	SIDELINE	APPROACH	NOTES
MCDONNELL DOUGLAS	DC-10-10	CF6-6D	410.0	347.0	97.4	97.0	104.0	*
MCDONNELL DOUGLAS	DC-10-10	CF6-6D	455.0	363.5	101.8	96.0	105.5	*
MCDONNELL DOUGLAS	DC-10-10	CF6-6D1	430.0	363.5	98.1	97.0	105.5	*
MCDONNELL DOUGLAS	DC-10-10	CF6-6D1	455.0	363.5	100.2	96.6	105.5	*
MCDONNELL DOUGLAS	DC-10-10	CF6-6D1A	430.0	363.5	98.1	97.0	105.5	*
MCDONNELL DOUGLAS	DC-10-10	CF6-6D1A	455.0	363.0	100.2	96.4	105.5	*
MCDONNELL DOUGLAS	DC-10-10	CF6-6K	410.0	347.0	96.0	96.3	103.3	*
MCDONNELL DOUGLAS	DC-10-10	CF6-6K	455.0	363.5	100.9	95.5	103.8	*
MCDONNELL DOUGLAS	DC-10-10	CF6-6K2	430.0	347.0	97.4	96.5	103.3	*
MCDONNELL DOUGLAS	DC-10-10	CF6-6K2	455.0	363.5	99.3	96.3	103.0	*
MCDONNELL DOUGLAS	DC-10-15	CF6-50C2-F	455.0	363.5	93.0	95.0	103.1	
MCDONNELL DOUGLAS	DC-10-30	CF6-50C/R	555.0	405.0	101.6	97.5	106.3	
MCDONNELL DOUGLAS	DC-10-30	CF6-50C/H	572.0	411.0	102.3	97.8	106.6	
MCDONNELL DOUGLAS	DC-10-30	CF6-50C1	573.0	403.0	102.3	98.3	106.3	
MCDONNELL DOUGLAS	DC-10-30	CF6-50C1	590.0	411.0	103.0	98.0	106.6	
MCDONNELL DOUGLAS	DC-10-30	CF6-50C2	555.0	403.0	96.0	97.0	105.0	
MCDONNELL DOUGLAS	DC-10-30	CF6-50C2	555.0	428.0	96.0	97.0	106.0	15
MCDONNELL DOUGLAS	DC-10-30	CF6-50C2	590.0	411.0	99.0	97.9	105.3	
MCDONNELL DOUGLAS	DC-10-30	CF6-50C2	590.0	436.0	99.0	97.7	106.4	15
MCDONNELL DOUGLAS	DC-10-30	CF6-50C2-B	555.0	403.0	96.1	98.4	105.0	

APPENDIX 3
STAGE 3
TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	ENGINE MODEL	MTOW 1000#	MLW 1000#	NOISE LEVELS EPNdB TAKEOFF	SIDELINE	APPROACH	NOTES
MCDONNELL DOUGLAS	DC-10-30	CF6-50C2-B	555.0	424.0	96.1	98.4	106.0	15
MCDONNELL DOUGLAS	DC-10-30	CF6-50C2-B	572.0	424.0	97.4	98.5	106.0	15
MCDONNELL DOUGLAS	DC-10-30	CF6-50C2-B	590.0	411.0	98.7	98.5	105.3	
MCDONNELL DOUGLAS	DC-10-30	CF6-50C2-R	555.0	403.0	97.5	97.2	105.0	
MCDONNELL DOUGLAS	DC-10-30	CF6-50C2-R	572.0	421.0	98.4	97.3	105.0	
MCDONNELL DOUGLAS	DC-10-40	JT9D-20D	530.0	403.0	100.0	95.2	105.7	*
MCDONNELL DOUGLAS	DC-10-40	JT9D-59A	555.0	403.0	101.4	98.0	106.4	*
MCDONNELL DOUGLAS	MD-11	CF6-80C2	602.5	430.0	92.8	96.3	103.6	
MCDONNELL DOUGLAS	MD-11	CF6-80C2	618.0	471.5	93.9	96.3	104.3	
MCDONNELL DOUGLAS	MD-11	PW4460	602.5	430.0	94.1	96.1	103.5	
MCDONNELL DOUGLAS	MD-11	PW4460	618.0	471.5	95.2	96.1	104.0	
MCDONNELL DOUGLAS	MD-80	JT8D-209	140.0	128.0	88.9	96.7	92.8	10
MCDONNELL DOUGLAS	MD-80	JT8D-209	149.0	130.0	91.1	96.5	92.9	10
MCDONNELL DOUGLAS	MD-80	JT8D-217	142.0	130.0	88.2	96.1	92.9	10
MCDONNELL DOUGLAS	MD-80	JT8D-217	149.5	130.0	89.7	95.0	92.9	10
MCDONNELL DOUGLAS	MD-88	JT8D-217A	160.0	150.0	92.0	95.9	93.7	* 10
MCDONNELL DOUGLAS	MD-89	JT8D-217C	149.0	150.0	91.8	96.3	93.7	10
MCDONNELL DOUGLAS	MD-80	JT8D-219	140.0	128.0	96.7	97.3	92.8	10
MCDONNELL DOUGLAS	MD-80	JT8D-219	149.5	130.0	88.6	97.1	92.9	10
MCDONNELL DOUGLAS	MD-80	JT8D-219	160.0	150.0	90.0	97.2	93.7	10

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STD	NOTES	REF.
BOEING	B-727-200 (FED. EX.)	172.60	150.00	JT8D-7B(A)(B)	3			5	30	96.0	97.4	99.0	3	6,28	AA
BOEING	B-727-200 (FED. EX.)	172.60	150.00	JT8D-7B(A)(B)	3			5	30	95.7	96.5	98.9	3	6,27	NN
BOEING	B-727-200 (FED. EX.)	169.50	150.00	JT8D-9/A	3			5	30	94.1	97.8	100.2	3	6,27	AA
BOEING	B-727-200 (FED. EX.)	177.60	154.50	JT8D-7/A/B	3			5	30	96.9	96.0	99.1	3	6,27	AA
BOEING	B-727-200RE(VALSAN)	190.50	160.00	JT8D-15/217C	3				30	91.5	99.3	98.8	3	6,23	NN
BOEING	B-727-200RE(VALSAN)	190.50	159.00	JT8D-17/217C	3				30	92.2	99.5	99.0	3	6,23	NN
BOEING	B-727-200RE(VALSAN)	209.50	159.00	JT8D-17A/217C	3				30	94.5	99.6	99.0	3	6,23	NN
BOEING	B-727-200RE(VALSAN)	203.10	164.00	JT8D-17A/217C	3				30	94.6	97.6	99.3	3	6,23	NN
BOEING	B-737-200 ADV.	128.10	79.10	JT8D-17QN	2	16.00	1.0	1	40	97.0	104.1	102.8	2	2,19	B-1
BOEING	B-737-200 ADV.	128.10	88.00	JT8D-15QN	2	15.50	1.0	1	40	97.7	102.4	103.8	2	2,18	B-1
BOEING	B-737-200 ADV.	115.50	95.30	JT8D-17QN	2	16.00		1	40	93.6	104.4	104.5	2	2,19	B-1
BOEING	B-737-200 ADV.	115.50	101.00	JT8D-15QN	2	15.50	1.0	1	40	94.4	103.1	105.0	2	2,18	B-1
BOEING	B-737-200 ADV.	115.50	103.00	JT8D-9QN	2	14.50		1	40	95.3	100.6	105.1	2	2,17	B-1

APPENDIX 1
AIRCRAFT NOISE DATA FOR
UNITED STATES CERTIFICATED TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	MTOW 1000#	LW 1000#	ENGINE DATA MODEL	NO.	THRUST 1000#	BPR	FLAPS TO	AP	NOISE LEVEL (EPNL) TAKE-OFF	SIDE-LINE	APPR.	STG	NOTES	REF.
BOEING	B-737-200 ADV.	122.50	105.00	JT8D-9QN	2	14.50		1	40	96.9	99.9	105.3	2	2,17	B-1
BOEING	B-737-200 NON-ADV.	108.50	95.00	JT8D-7QN	2	14.00	1.1	1	40	92.1	101.7	102.1	2	2,16	A-1 B-1
BOEING	B-737-200 NON-ADV.	109.00	95.00	JT8D-9QN	2	14.50	1.0	1	40	93.2	100.7	104.8	2	2,17	A-1 B-1
BOEING	B-737-200 NON-ADV.	109.00	98.00	JT8D-7QN	2	14.00	1.1	1	40	94.7	101.3	102.1	2	2,16	B-1
BOEING	B-737-200 NON-ADV.	117.00	101.70	JT8D-9QN	2	14.50	1.0	1	40	95.5	100.3	105.3	2	2,17	A-1 B-1
BOEING	B-737-300	124.50	114.00	CFM56-3-B1	2	20.00	5.0	1	40	84.4	90.4	99.9	3		B-1
BOEING	B-737-300	124.50	114.00	CFM56-3B-2	2	22.00	4.9	1	40	82.8	92.2	99.9	3		B-1
BOEING	B-737-300	139.50	115.80	CFM56-3-B1	2	20.00	5.0	1	40	87.5	89.9	100.8	3		B-1
BOEING	B-737-300	139.50	115.80	CFM56-3B-2	2	22.00	4.9	1	40	85.7	91.9	100.0	3		B-1
BOEING	B-737-400	138.50	121.00	CFM56-3-B1	2	20.00	5.0	5	40	87.2	90.0	100.2	3		B-1
BOEING	B-737-400	142.50	121.00	CFM56-3-B1	2	20.00	5.0	5	40	88.9	89.6	100.2	3		B-1
BOEING	B-737-400	138.50	121.00	CFM56-3B-2	2	22.00	4.9	5	40	85.7	92.1	100.2	3		B-1
BOEING	B-737-400	138.50	121.00	CFM56-3C-1	2	23.50	4.9	5	40	85.0	93.2	100.2	3		B-1

APPENDIX 3
STAGE 3
TURBOJET POWERED AIRCRAFT

MANUFACTURER	MODEL	ENGINE MODEL	MTOW 1000$	MLW 1000#	NOISE LEVELS EPNdB TAKEOFF	SIDELINE	APPROACH	NOTES
MCDONNELL DOUGLAS	MD-87	JT8D-217A	125.0	128.0	86.3	96.4	92.9	10
MCDONNELL DOUGLAS	MD-87	JT8D-217A	149.5	130.0	89.7	95.9	93.3	10
MCDONNELL DOUGLAS	MD-87	JT8D-217C	128.0	128.0	86.1	96.5	92.9	10
MCDONNELL DOUGLAS	MD-87	JT8D-217C	149.5	130.0	89.2	96.2	93.3	10
MCDONNELL DOUGLAS	MD-87	JT8D-219	140.0	128.0	86.5	97.1	93.3	10
MCDONNELL DOUGLAS	MD-87	JT8D-219	149.5	130.0	88.5	97.1	93.3	10
MITSUBISHI	MU-300 (DIAMOND I)	JT15D-4	14.1	13.2	86.3	88.0	85.0	*
MITSUBISHI	MU-300 (DIAMOND I)	JT15D-4D	15.5	13.2	81.2	88.4	85.0	
MITSUBISHI	MU-300-10 (DIAM. II)	JT15D-5	15.0	14.3	80.4	93.7	91.4	*
SABRELINER	SABRELINER 65	TFE731-3R	22.7	21.0	82.3	93.1	90.6	*
SABRELINER	SABRELINER 65	TFE731-3R	24.0	21.0	84.0	93.0	88.6	*

APPENDIX 4

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

TAKEOFF

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
BOEING	B-747-200	767.00	JT9D-3A	10	110.0	* **
BOEING	B-747-200	800.00	JT9D-7F	10	109.7	* **
BOEING	B-747-200	812.00	JT9D-7FW/-7J	10	109.7	* **
BOEING	B-747-100	734.00	JT9D-3A	10	109.4	* **
BOEING	B-747-200	805.00	JT9D-7FW	10	109.4	* **
BOEING	B-747-200	785.00	JT9D-7A	10	109.3	* **
BOEING	B-747-200	800.00	JT9D-7J	10	109.3	* **
BOEING	B-747-200	775.00	JT9D-3AWET	10	109.1	* **
BOEING	B-747-200	778.00	JT9D-7	10	108.8	* **
BOEING	B-747-200	785.00	JT9D-7WET	10	108.7	* **
BOEING	B-747-100	750.00	JT9D-7A	10	107.8	* **
BOEING	B-747-100	750.00	JT9D-7F	10	107.7	* **
BOEING	B-747-100	750.00	JT9D-7FW	10	107.6	* **
BOEING	B-747-100	750.00	JT9D-7WET	10	107.4	* **
BOEING	B-747-200	833.00	RB.211-524C2	10	106.5	*
BOEING	B-707-300B ADV/C SHN	322.30	JT3D-1-3B(3C)	14	105.5	6,21,**
BOEING	B-747-200	820.00	RB.211-524B/B2	10	105.5	**
BOEING	B-747-300	820.00	RB.211-524B2	10	105.5	**
MCDONNELL DOUGLAS	DC-8-55 QNC PLS QN	328.30	JT3D-3B		105.5	6,26,**
MCDONNELL DOUGLAS	DC-8-61 QNC PLS QN	328.30	JT3D-3B		105.5	6,**
MCDONNELL DOUGLAS	DC-8-33 QNC PLS QN	318.00	JTD3D-3B		105.3	6,26,**
MCDONNELL DOUGLAS	DC-8-33 (QNC QN)	308.00	JT3D	15	105.2	6,**
MCDONNELL DOUGLAS	DC-8-55 (QNC QN)	309.00	JT3D-3B	15	105.2	6,26,**
MCDONNELL DOUGLAS	DC-8-61 (QNC QN)	309.00	JT3D-3B	15	105.2	6,26,**
MCDONNELL DOUGLAS	DC-8-61F (QNC QN)	309.00	JT3D-3B	15	105.1	6,26,**

APPENDIX 4

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

TAKEOFF

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
MCDONNELL DOUGLAS	DC-8F-54 (QNC QN)	309.00	JT3D-3B	15	105.2	6,26,**
MCDONNELL DOUGLAS	DC-8F-54 QNC PLS QN	315.00	JT3D-3B		105.2	6,**
MCDONNELL DOUGLAS	DC-8F-55 (QNC QN)	309.00	JT3D-3B	15	105.2	6,26,**
MCDONNELL DOUGLAS	DC-8F-55 QNC PLS QN	317.00	JT3D-3B		105.2	6,26,**
BOEING	B-747-100	734.00	JT9D-7	10	105.1	39
MCDONNELL DOUGLAS	DC-8-53 (QNC QN)	315.00	JT3D-3B		104.9	6,**
MCDONNELL DOUGLAS	DC-8-63 W/ADC QN	355.00	JT3D-3B	12	104.8	6,**
BOEING	B-707-300B ADV/C SHN	330.00	JT3D-7		104.7	6,**
BOEING	B-707-300B ADV/C SHN	321.00	JT3D-3B		104.5	6,**
BOEING	B-747-100	750.00	RB.211-524C2	10	104.5	* **
BOEING	B-707-300B ADV/C QNC	335.00	JT3D-3B		104.4	6,**
MCDONNELL DOUGLAS	DC-8-62 W/ADC QN	350.00	JT3D-3B	12	104.3	6,**
MCDONNELL DOUGLAS	DC-8-63 W/ADC QN	355.00	JT3D-7	12	104.1	6,**
BOEING	B-747-300	833.00	RB.211-524D4	10	103.9	
BOEING	B-747-300	833.00	RB.211-524D4	10	103.9	**
MCDONNELL DOUGLAS	DC-8-62 W/TNC QN	350.00	JT3D-3B	12	103.9	6,**
MCDONNELL DOUGLAS	DC-8-63 W/TNC QN	350.00	JT3D-3B	12	103.9	6,**
BOEING	B-707-100B (QNC)	258.00	JT3D-3B		103.8	6,**
MCDONNELL DOUGLAS	DC-8-63 W/TNC QN	355.00	JT3D-7	12	103.8	6,**
MCDONNELL DOUGLAS	DC-8-53 (QNC QN)	300.00	JT3D-3B	15	103.7	6,26,**
MCDONNELL DOUGLAS	DC-8-55 W/BAC QN	325.00	JT3D-3B	15	103.7	6,**
MCDONNELL DOUGLAS	DC-8-65 W/BAC QN	335.00	JT3D-3B	15	103.7	6,**
BOEING	B-707-120B (SHANNON)	258.00	JT3D-1		103.5	21,**
BOEING	B-707-100B (QNC)	241.30	JT3D-1		103.4	6,**
MCDONNELL DOUGLAS	DC-8-62 W/ADC QN	350.00	JT3D-7	12	103.4	6,**

APPENDIX 4

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

TAKEOFF

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
BOEING	B-707-138B (SHANNON)	258.00	JT3D-1		103.2	21,**
MCDONNELL DOUGLAS	DC-10-30	590.00	CF6-50C1	10	103.0	
MCDONNELL DOUGLAS	DC-8-52 QNC PLS QN	300.00	JT3D-3B		102.8	6,20,**
MCDONNELL DOUGLAS	DC-8-62 W/TNC QN	355.00	JT3D-7	12	102.7	6,**
MCDONNELL DOUGLAS	DC-10-30	565.00	CF6-50A	5	102.7	*
BOEING	B-747-200	833.00	CF6-50E2	10	102.6	
BOEING	B-747-200	820.00	CF6-50E	10	102.5	
BOEING	B-727-200	208.00	JT8D-17RQN	5	102.4	2,20
BOEING	B-747-200	833.00	JT9D-7R4G2	10	102.4	**
BOEING	B-747-300	833.00	JT9D-7R4G2	10	102.4	
BOEING	B-720B (QNC)	234.00	JT3D-1		102.3	6,**
MCDONNELL DOUGLAS	DC-8-53 W/BAC QN	315.00	JT3D-3B	15	102.3	6,**
MCDONNELL DOUGLAS	DC-8-54 W/BAC QN	315.00	JT3D-3B	15	102.3	6,**
MCDONNELL DOUGLAS	DC-10-30	572.00	CF6-50C/H	10	102.3	
BOEING	B-727-200	203.10	JT8D-17QN	5	102.0	2,19
BOEING	B-747-SP	701.00	JT9D-7A	10	102.0	
MCDONNELL DOUGLAS	DC-8-51 QNC PLS QN	276.00	JT3D-1		101.9	6,**
BOEING	B-747-SR	610.00	JT9D-7A	10	101.8	*
MCDONNELL DOUGLAS	DC-10-10	455.00	CF6-6D	8	101.8	*
BOEING	B-747-300	800.00	CF6-50E2	10	101.6	
BOEING	B-727-200	184.80	JT8D-9QN	15	101.5	2,17
BOEING	B-747-400	870.00	PW 4056	10	101.5	
MCDONNELL DOUGLAS	DC-10-40	555.00	JT9D-59A	10	101.4	*
MCDONNELL DOUGLAS	DC-8-51 (QNC QN)	286.00	JT3D-3B	15	101.3	6,26,**
BOEING	B-747-200	820.00	JT9D-70A	10	101.1	

APPENDIX 4

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

TAKEOFF

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
BOEING	B-747-400	870.00	RB.211-524G	10	100.9	
MCDONNELL DOUGLAS	DC-8-52 W/BAC QN	305.00	JT3D-3B	15	100.8	6,**
MCDONNELL DOUGLAS	DC-10-10	455.00	CF6-6K	8	100.8	*
MCDONNELL DOUGLAS	DC-10-40	530.00	JT9D-20D	10	100.8	*
BOEING	B-727-200	170.00	JT8D-9FCD	5	100.7	3,17
MCDONNELL DOUGLAS	DC-8-51 QNC PLS QN	286.00	JT3D-3B		100.7	6,26,**
MCDONNELL DOUGLAS	DC-8-62 (BAC R-1)	350.00	JT3D-3B	12	100.5	6
MCDONNELL DOUGLAS	DC-8-62 (BAC/MOM)	340.00	JT3D-3B	12	100.5	6
BOEING	B-747-300	820.00	JT9D-70A	10	100.2	**
MCDONNELL DOUGLAS	DC-10-10	455.00	CF6-6D1	4	100.2	*
MCDONNELL DOUGLAS	DC-10-10	455.00	CF6-6D1A	4	100.2	*
BOEING	B-747-SP	702.00	JT9D-7J	10	100.1	
BOEING	B-727-200	172.50	JT8D-7QN	15	100.0	2,16
BOEING	B-727-200	190.50	JT8D-15QN	5	100.0	2,18
BOEING	B-727-200	177.60	JT8D-7FCD	5	99.8	3,16
BOEING	B-747-400	870.00	CF6-80C2		99.7	
BOEING	B-747-400	870.00	CF6-80C2B1F	10	99.7	
BOEING	B-747-400	870.00	RB.211-524H	10	99.5	
BOEING	B-747-SP	696.00	RB.211-524B2	10	99.5	
MCDONNELL DOUGLAS	DC-8-51 W/BAC QN	276.00	JT3D-1		99.5	6,**
BOEING	B-720B (QNC)	234.00	JT3D-3B		99.3	6,**
LOCKHEED	L-1011-500	510.00	RB.211-524B4	10	99.3	*
MCDONNELL DOUGLAS	DC-10-10	455.00	CF6-6K2	4	99.3	*
BOEING	B-747-SP	702.00	RB.211-524D4	10	99.2	
BOEING	B-747-300	833.00	CF6-80C2B1	10	99.0	

APPENDIX 4

AIRCRAFT NOISE CERTIFICATION LEVELS IN
DESCENDING EPNdB FOR U.S. CERTIFICATED
TURBOJET POWERED AIRCRAFT

TAKEOFF

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
MCDONNELL DOUGLAS	DC-10-30	590.00	CF6-50C2	15	99.0	
BOEING	B-720B (SHANNON)	234.00	JT3D-1		98.9	6,**
MCDONNELL DOUGLAS	DC-08-63 (BAC R-1)	355.00	JT3D-7	12	98.9	6
MCDONNELL DOUGLAS	DC-08-63 (BAC)	353.00	JT3D-7	12	98.8	6,**
MCDONNELL DOUGLAS	DC-08-63 (BAC/NGM)	353.00	JT3D-7	12	98.9	6
BOEING	B-747-SP	660.00	JT9D-7F	10	98.7	
MCDONNELL DOUGLAS	DC-10-30	590.00	CF6-50C2-R	15	98.7	
LOCKHEED	L1011-385-1-14/15	474.00	RB.211-22B	4	98.6	
BOEING	B-727-100	169.50	JT8D-1FCD	5	98.5	3
LOCKHEED	L-1011-100	466.00	RB.211-22B	10	98.5	5 *
BOEING	B-747-SR	571.00	CF6-45A2	10	98.4	
LOCKHEED	L-1011-500	496.00	RB.211-524B	14	98.4	5 *
MCDONNELL DOUGLAS	DC-08-51 W/BAC ON	286.00	JT3D-3B		98.4	6,**
MCDONNELL DOUGLAS	DC-10-30	572.00	CF6-50C2-R	10	98.4	
BOEING	B-727-100	169.50	JT8D-9FCD	5	98.3	3,17
LOCKHEED	L-1011-200	466.00	RB.211-524B	10	98.1	5 *
MCDONNELL DOUGLAS	DC-09-50	121.00	JT8D-17	0	98.1	1
LOCKHEED	L-1011-500	504.00	RB.211-524B3	22	98.0	5 *
MCDONNELL DOUGLAS	DC-09-36	121.00	JT8D-17	0	98.0	1
BOEING	B-727-100	169.50	JT8D-7FCD	5	97.9	3,16
LOCKHEED	L1011-385-1-14/15	466.00	RB.211-524B4	10	97.9	*
MCDONNELL DOUGLAS	DC-09-34	121.00	JT8D-15	0	97.8	1
MCDONNELL DOUGLAS	DC-09-50	121.00	JT8D-15	0	97.8	1
BOEING	B-737-200 ADV.	120.10	JT8D-15QN	1	97.7	2,10
BOEING	B-720B (SHANNON)	234.00	JT3D-3B		97.3	6,**

APPENDIX 4

AIRCRAFT NOISE CERTIFICATION LEVELS IN
DESCENDING EPNdB FOR U.S. CERTIFICATED
TURBOJET POWERED AIRCRAFT

TAKEOFF

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
MCDONNELL DOUGLAS	DC-09-30	116.00	JT8D-9	0	97.1	1
BOEING	B-737-200 ADV.	128.10	JT8D-17QN	1	97.0	2,19
BOEING	B-727-200 (FED. EX.)	177.60	JT8D-7/A/B	5	96.9	6,27
BOEING	B-737-200 ADV.	132.50	JT8D-9QN	1	96.9	2,17
MCDONNELL DOUGLAS	DC-09-40	114.00	JT8D-11	0	96.8	1
BOEING	B-767-200	360.00	JT9D-7R4D(B)	1	96.2	
MCDONNELL DOUGLAS	DC-09-34	110.00	JT8D-9	0	96.1	1
LOCKHEED	L-1011-1	430.00	RB.211-22B	10	96.0	5 *
LOCKHEED	L-1011	430.00	RB.211-22B	14	95.9	5 *
MCDONNELL DOUGLAS	DC-09-30	110.00	JT8D-7	0	95.9	1
MCDONNELL DOUGLAS	DC-09-30	114.00	JT8D-15	0	95.8	1
MCDONNELL DOUGLAS	DC-09-40	114.00	JT8D-15	0	95.8	1
BAe	1-11 400	89.50	SPEY511-14/14W	0	95.7	12
BOEING	B-727-200 (FED. EX.)	172.60	JT8D-7B(A)(B)	5	95.7	6,27
BOEING	B-767-300	351.00	JT9D-7R4D(B)	5	95.7	
MCDONNELL DOUGLAS	DC-08-73	355.00	CFM56-2-C1	12	95.7	*
BOEING	B-737-200 NON-ADV.	117.00	JT8D-9QN	1	95.5	2,17
BOEING	B-767-200	360.00	JT9D-7R4E	1	95.4	
MCDONNELL DOUGLAS	DC-08-72	350.00	CFM56-2-C1	12	95.2	*
MCDONNELL DOUGLAS	MD-11	610.00	PW4460	10	95.2	
BOEING	B-767-200	331.00	JT9D-7R4D(A)	1	95.1	
MCDONNELL DOUGLAS	DC-09-30	108.00	JT8D-7A	0	95.1	1
BOEING	B-767-300	351.00	JT9D-7R4E	5	95.0	
SABRELINER	SABRELINER 60	20.30	JT12A-8		95.0	*
BOEING	B-737-200 NON-ADV.	109.00	JT8D-7QN	1	94.7	2,16

APPENDIX 4

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

TAKEOFF

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
BOEING	B-727-200RE(VALSAN)	209.50	JT8D-17A/217C		94.9	6,23
MCDONNELL DOUGLAS	DC-8-71	328.00	CFM56-2-C1	18	94.8	*
SABRELINER	SABRELINER 40	20.20	JT12A-8	0	94.8	
BOEING	B-727-100 (FED. EX.)	169.50	JT8D-7(A)(B)	5	94.6	6,20
SABRELINER	SABRELINER 60A/60SC	22.70	JT12A-8	0	94.4	
MCDONNELL DOUGLAS	DC-8-73	325.00	CFM-56-2C5		94.3	*
MCDONNELL DOUGLAS	DC-9-30	108.00	JT8D-17	0	94.3	1
BOEING	B-767-300	407.00	PW 4056	5	94.2	
BOEING	B-727-200 (FED. EX.)	169.50	JT8D-9/A	5	94.1	6,27
AIRBUS	A300B4-203	363.70	CF6-50-C2	0	94.0	21
BOEING	B-727-100 (FED. EX.)	169.50	JT8D-9/A	5	94.0	6,27
LEARJET	25G	15.00	CJ610-6	20	94.0	13
LEARJET	25D	15.00	CJ610-6	20	94.0	14
MCDONNELL DOUGLAS	MD-11	610.00	CF6-80C2	10	93.9	
BOEING	B-767-300	407.00	RB.211-524G	5	93.8	
MCDONNELL DOUGLAS	DC-10-15	455.00	CF6-50C2-F	5	93.8	
BOEING	B-767-200	400.00	PW 4056	2	93.7	
AIRBUS	A300B4-103	347.20	CF6-50-C2	16	93.6	
LEARJET	25	15.00	CJ610-6	10	93.5	
LEARJET	25B/C/D/F ER Dee Hwd	16.20	CJ610-6/8A	10	93.3	
BAe	1-11 200	80.00	SPEY 506-14	3	93.3	12
BOEING	B-767-300	407.00	PW 4060	5	93.2	
AIRBUS	A300B4-622R	365.00	PW-4158	0	93.1	
LOCKHEED	1329-25 (AIRESEARCH)	44.50	TFE731-3		93.1	* **
AIRBUS	A310-304	352.74	CF6-80C2A2	0	92.9	

APPENDIX 4

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

TAKEOFF

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
BOEING	B-767-300	407.00	RB.211-524H	5	92.9	
FOKKER	F28 MK6000	73.00	SPEY MK555-15P	6	92.9	
BOEING	B-767-200	360.00	CF6-80A	1	92.8	
LOCKHEED	1329-23 (AIRESEARCH)	43.06	TFE731-3-1E	20	92.7	* **
BOEING	B-727-100 (FED. EX.)	160.00	JT8D-7/A/B	5	92.5	6,20
GULFSTREAM	G-II GULFSTREAM	65.50	SPEY 511-8	10	92.5	12
BAe	HS 125-600A	25.50	VIPER 601-22	0	92.3	12
BOEING	B-727-200RE(VALSAN)	190.50	JT8D-17/217C		92.2	6,23
BOEING	B-767-300	407.00	CF6-80C2-B4	5	92.1	
BOEING	B-767-300	351.00	CF6-80A	5	92.0	
MCDONNELL DOUGLAS	MD-80	140.00	JT8D-217A	2	92.0	* 10
FOKKER	F28 MK4000	73.00	SPEY MK555-15H	6	91.9	
LEARJET	24D	13.50	CJ610-6	20	91.8	14
LEARJET	24/24D	13.50	CJ610-6	20	91.8	13
BOEING	B-767-200	360.00	CF6-80A2	1	91.7	
BOEING	B-727-200RE(VALSAN)	190.50	JT8D-15/217C		91.5	6,23
MCDONNELL DOUGLAS	MD-80	140.00	JT8D-217C	2	91.5	10
BOEING	B-757-200	255.50	PW 2037	5	91.4	
MCDONNELL DOUGLAS	DC-09-10	90.70	JT8D-7	10	91.4	24
MCDONNELL DOUGLAS	DC-09-10	90.70	JT8D-7/-7A	10	91.4	1
BOEING	B-767-300	351.00	CF6-80A2	5	91.2	
BOEING	B-767-300	380.00	PW4060	5	91.2	
SABRELINER	SABRELINER 80A/80SC	35.50	CF700-2D-2	0	91.2	*
AIRBUS	A300B2-203	313.10	CF6-50-C2	16	91.1	
AIRBUS	A300B4-605R	375.10	CF6-80-C2-A5		91.1	

APPENDIX 6

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

TAKEOFF

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
BOEING	B-767-300	407.00	CF6-80C2-B6	5	91.1	
GULFSTREAM	G-IIB/G-III	69.70	SPEY 511-8	10	91.1	12
MCDONNELL DOUGLAS	MD-88	149.50	JT8D-209	0	91.1	10
FOKKER	F28 MK3000	71.00	SPEY MK555-15H	6	91.0	
LEARJET	25/25B/C Raisb MK II	15.00	CJ610	10	91.0	
BOEING	B-767-200	351.00	PW4052	1	90.9	
BOEING	B-767-300	407.00	CF6-80C2B6F	5	90.9	
LEARJET	25D/25F	15.00	CJ610-6/8A	8	90.9	
MCDONNELL DOUGLAS	MD-80	160.00	JT8D-219	2	90.8	10
SABRELINER	SABRELINER 75A	23.00	CF700-2D-2	15	90.7	*
SABRELINER	SABRELINER 80	23.30	CF700-2D-2		90.7	*
AIRBUS	A310-324	330.69	PW-4152	15	90.6	
BOEING	B-767-200	387.00	CF6-80C2-B4	1	90.6	
AIRBUS	A300B4-203	313.05	CF6-50C2	0	90.5	31
AIRBUS	A310-221	305.60	JT9D-7R4D1	15	90.5	
MCDONNELL DOUGLAS	DC-09-30 (ABS)	105.00	JT8D-9	0	90.3	6
DASSAULT BREGUET	FALCON 20- /D/E	28.70	CF700-2D-2	15	90.0	
DASSAULT BREGUET	FALCON 20-F	28.66	CF700-2D-2	10	90.0	
FOKKER	F28 MK1000	65.00	SPEY MK555-15	6	90.0	
FOKKER	F28 MK2000	65.00	SPEY MK555-15	6	90.0	*
BOEING	B-757-200	255.50	PW 2040	5	89.7	
MCDONNELL DOUGLAS	MD-88	149.50	JT8D-217	0	89.7	10
MCDONNELL DOUGLAS	MD-87	149.50	JT8D-217A	1	89.7	10
BOEING	B-747-400	800.00	PW4056	10	89.5	
BOEING	B-767-200	351.00	CF6-80C2-B2	1	89.5	

APPENDIX 6

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

TAKEOFF

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
CESSNA	552	16.50	JT15D-5	20	89.3	*
MCDONNELL DOUGLAS	MD-87	149.50	JT8D-217C	1	89.2	10
LEARJET	24 Raisbeck MK II	13.00	CJ610-1/-6	10	89.0	
BOEING	B-737-400	142.50	CFM56-3-B1	5	88.9	
BEECH	BEECHJET 400	15.78	JT15D-5	10	88.6	*
MITSUBISHI	MU-300-10 (DIAM. II)	15.78	JT15D-5	10	88.6	*
BOEING	B-767-200	300.00	PW4056	1	88.5	
MCDONNELL DOUGLAS	MD-87	140.50	JT8D-219	1	88.5	10
BOEING	B-757-200	240.00	RB.211-535C	5	88.1	
BAe	HS 125-800A	25.50	TFE731-5-1H	0	88.0	
BAe	HS 125-700A	25.50	TFE731-3-1H	0	88.0	33
LEARJET	23 Raisbeck MK II	12.50	CJ610-1/-6	10	88.0	
AIRBUS	A320-211	162.00	CFM56-5A1		87.9	
BOEING	B-737-400	150.00	CFM56-3B-2	5	87.7	
BOEING	B-737-500	132.00	CFM56-3-B1(R)	5	87.7	
LEARJET	24B/D Raisbeck MK II	13.50	CJ610	10	87.6	
BOEING	B-737-300	139.50	CFM56-3-B1	1	87.5	
DASSAULT BREGUET	FALCON 20-G	32.00	ATF3-6-2C	10	87.5	
BOEING	B-737-500	133.00	CFM56-3-B1	5	87.3	
MCDONNELL DOUGLAS	DC-09-10 (ABS)	90.70	JT8D-7/7A/7B	10	87.2	6
BOEING	B-737-400	150.00	CFM56-3C-1	5	87.1	
LEARJET	28/29	15.00	CJ610-8A	0	87.0	
LEARJET	55C	21.50	TFE731-3AR-2B	20	87.0	*
BOEING	B-757-200	255.50	RB.211-535-E4	5	86.8	
LEARJET	55C	21.50	TFE731-3AR-2B	20	86.7	*

APPENDIX 4

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

TAKEOFF

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
AIRBUS	A320-231	162.00	V2500.A1		86.6	
BAe	146-300A	97.50	ALF502R-5	10	86.5	
LEARJET	55B	21.50	TFE731-3A-2B	20	86.3	
MITSUBISHI	MU-300 (DIAMOND I)	14.10	JT15D-4	10	86.3	*
BAe	146-300A	95.00	ALF 502R-5	10	86.0	
BAe	146-200A	89.50	ALF502R-3	10	85.9	
LEARJET	24F	13.50	CJ610-6	0	85.8	
BOEING	B-737-300	139.50	CFM56-3B-2	1	85.7	
BOEING	B-757-200	255.50	RB.211-535E4-B	5	85.7	
BAe	HS 125-3A/RA	23.60	TFE731-3-1H	0	85.5	
BAe	HS 125-400A	23.60	TFE731-3-1H	0	85.5	
LEARJET	55	21.00	TFE731-3A-2B	8	85.5	*
ISRAEL AIRCRAFT	1124A WESTWIND 2	23.50	TFE731-3-1G	20	85.4	*
BAe	146-200A	93.00	ALF502R-5	18	85.2	
BAe	146-200A	89.50	ALF502R-3A	18	84.9	
DASSAULT BREGUET	FALCON 50	40.78	TFE731-3-1C	20	84.8	
CESSNA	560 CITATION V	16.30	JT15D-5A	7	84.6	
LEARJET	35/36	18.00	TFE731-2-2B	20	84.5	*
DASSAULT BREGUET	FALCON 50	38.80	TFE731-2	20	84.3	
LEARJET	24E	12.90	CJ610-6	6	84.3	
BAe	HS 125-1A	22.70	TFE731-3-1H	0	84.2	
BAe	HS 125-3A	21.70	TFE731-3-1H	0	84.2	
ISRAEL AIRCRAFT	1125 ASTRA	24.70	TFE731-3A-200G	12	84.1	
SABRELINER	SABRELINER 65	24.00	TFE731-3R		84.0	*
DASSAULT BREGUET	FALCON 200 MYSTERE	32.00	ATF3-6-4C	5	83.9	

APPENDIX 4

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

TAKEOFF

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
DASSAULT BREGUET	FALCON 200 MYSTERE	32.00	ATF3-6A-4C	5	83.9	
LEARJET	36A	18.30	TFE731-2-2B	20	83.8	*
LEARJET	24F-A	13.50	CJ610-6	6	83.6	
LEARJET	35A	18.00	TFE731-2-2B	8	83.6	*
BOEING	B-767-300	[illegible].70	CF6-80C2B2	5	83.1	
DASSAULT BREGUET	FALCON 10	18.30	TFE731-2	15	82.9	
DASSAULT BREGUET	FALCON 20-C5/D5/E5	29.10	TFE731-5AR-2C	15	82.9	
BAe	146-100A	82.25	ALF502R-3A	30	82.3	
DASSAULT BREGUET	FALCON 900	45.50	TFE731-5AR-1C	20	81.9	
BAe	125-1000	31.00	PW305	0	81.8	
BAe	146-100A	84.00	ALF502R-5	18	81.8	
DASSAULT BREGUET	FALCON 20-F5	29.30	TFE731-5AR-2C	10	81.8	
FOKKER	F100	98.00	TAY MK650-15	0	81.8	
CANADAIR	CL-600	36.00	ALF-502	20	81.6	*
DASSAULT BREGUET	FALCON 10	19.30	TFE731-2-1C	15	81.6	
BAe	C-29A	28.00	TFE731-5R-1H	0	81.4	
ISRAEL AIRCRAFT	1124 WESTWIND	23.00	TFE731-3-1G	20	81.2	
MITSUBISHI	MU-300 (DIAMOND I)	15.50	JT15D-4D	0	81.2	
LEARJET	31	16.50	TFE731-2-3B	8	81.0	*
BAe	125-800	27.40	TFE731-5R-1H	0	80.9	
BAe	125-800A	27.40	TFE731-5R-1H	0	80.9	25
BAe	146-100A	76.00	ALF502R-3	10	80.7	
DASSAULT BREGUET	FALCON 900B	46.50	TFE731-5BR-1C	20	80.7	
DASSAULT BREGUET	FALCON 20-C5/D5/E5	29.10	TFE-731-5AR-1C	15	80.3	34
CESSNA	550 CITATION II	13.30	JT15D-4	15	80.1	*

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APPENDIX 4

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

TAKEOFF

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
CESSNA	551 CITATION II	12.50	JT15D-4	15	80.1	*
CESSNA	650 CITATION III	22.00	TFE731-3B-100S	7	80.1	22
CESSNA	S550 CITATION S/II	15.10	JT15D-4B	7	80.0	
CANADAIR	CL-601 CHALLENGER	43.10	CF34-1A	20	79.4	*
DASSAULT BREGUET	FALCON 20-F5	29.10	TFE-731-5AR-1C	10	79.3	30
LEARJET	35A/36A	18.30	TFE731-2-2B	8	79.2	
GULFSTREAM	G-IV GULFSTREAM	71.70	TAY 610-8	20	79.0	
CESSNA	500/501 CITATION I	11.80	JT15D-1/-1A	15	78.0	*
GULFSTREAM	G-IV	73.20	TAY 611-8	10	76.8	
CESSNA	500 CITATION	10.30	JT15D-1	15	76.4	*
AEROSPATIALE	SN601 CORVETTE	14.60	JT15D-4	15	74.0	
CESSNA	550 CITATION II	14.10	JT15D-4	0	71.6	

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APPENDIX 5

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

*****APPROACH*****

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
MCDONNELL DOUGLAS	DC-8-63 W/ADC QN	355.00	JT3D-3B	50	108.3	6,**
MCDONNELL DOUGLAS	DC-8-63 W/ADC QN	355.00	JT3D-7	50	108.3	6,**
BOEING	B-707-300B ADV/C SHN	330.00	JT3D-7	35	108.3	6,**
MCDONNELL DOUGLAS	DC-8-62 W/ADC QN	350.00	JT3D-3B	50	108.3	6,**
MCDONNELL DOUGLAS	DC-8-62 W/ADC QN	350.00	JT3D-7	50	108.3	6,**
MCDONNELL DOUGLAS	DC-8-63 W/ADC QN	355.00	JT3D-3B	50	108.3	6,**
MCDONNELL DOUGLAS	DC-8-63 W/ADC QN	355.00	JT3D-7	50	108.3	6,**
BOEING	B-707-300B ADV/C SHN	321.00	JT3D-3B	25	108.2	6,**
MCDONNELL DOUGLAS	DC-8-55 W/BAC QN	325.00	JT3D-3B	50	108.2	6,**
MCDONNELL DOUGLAS	DC-8-53 W/BAC QN	315.00	JT3D-3B	50	108.1	6,**
MCDONNELL DOUGLAS	DC-8-52 W/BAC QN	305.00	JT3D-3B	50	108.0	6,**
BOEING	B-707-300B ADV/C QNC	335.00	JT3D-3B	35	107.9	6,**
MCDONNELL DOUGLAS	DC-8-61 W/BAC QN	335.00	JT3D-3B	35	107.8	6,**
MCDONNELL DOUGLAS	DC-8-62 W/TNC QN	350.00	JT3D-3B	50	107.9	6,**
MCDONNELL DOUGLAS	DC-8-63 W/TNC QN	350.00	JT3D-3B	50	107.9	6,**
BOEING	B-747-200	800.00	JT9D-7F	30	107.8	* **
BOEING	B-747-200	800.00	JT9D-7J	30	107.8	* **
BOEING	B-747-200	803.00	JT9D-7FW	30	107.8	* **
MCDONNELL DOUGLAS	DC-8-51 W/BAC QN	276.00	JT3D-1	50	107.8	6,**
MCDONNELL DOUGLAS	DC-8-51 W/BAC QN	286.00	JT3D-3B	50	107.8	6,**
MCDONNELL DOUGLAS	DC-8-62 W/TNC QN	355.00	JT3D-7	25	107.6	6,**
MCDONNELL DOUGLAS	DC-8-63 (BAC)	353.00	JT3D-7	50	107.6	6,**
BOEING	B-747-100	750.00	JT9D-7F	30	107.4	* **
BOEING	B-747-100	750.00	JT9D-7FW	30	107.4	* **
BOEING	B-747-200	612.00	JT9D-7FW/-7J	30	107.4	* **

APPENDIX 5

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

*****APPROACH*****

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
MCDONNELL DOUGLAS	DC-8F-55 QNC PLS QN	317.00	JT3D-3B	35	107.4	6,26,**
BOEING	B-747-200	785.00	JT9D-7A	30	107.3	* **
BOEING	B-747-200	785.00	JT9D-7WET	30	107.3	* **
BOEING	B-747-200	820.00	RB.211-524B/B3	30	107.3	**
BOEING	B-747-300	820.00	RB.211-524B2	30	107.3	**
MCDONNELL DOUGLAS	DC-8-63 W/TNC QN	355.00	JT3D-7	35	107.3	6,**
MCDONNELL DOUGLAS	DC-8F-54 QNC PLS QN	315.00	JT3D-3B	35	107.3	6,**
BOEING	B-747-300	734.00	JT9D-3A	30	107.2	* **
MCDONNELL DOUGLAS	DC-8-55 QNC PLS QN	320.30	JT3D-3B	35	107.2	6,26,**
MCDONNELL DOUGLAS	DC-8-61 QNC PLS QN	320.30	JT3D-3B	35	107.2	6,**
MCDONNELL DOUGLAS	DC-8-51 QNC PLS QN	276.00	JT3D-1	35	107.2	6,**
MCDONNELL DOUGLAS	DC-8-51 QNC PLS QN	286.00	JT3D-3B	35	107.1	6,26,**
MCDONNELL DOUGLAS	DC-8-53 (QNC QN)	319.00	JT3D-3B	35	107.1	6,**
MCDONNELL DOUGLAS	DC-8-53 QNC PLS QN	310.00	JTD3D-3B	35	107.1	6,26,**
BOEING	B-747-200	820.00	CF6-50E	30	107.0	
BOEING	B-747-200	833.00	RB.211-524C2	30	107.0	*
BOEING	B-747-SP	702.00	RB.211-524D4	30	107.0	
MCDONNELL DOUGLAS	DC-8-52 QNC PLS QN	300.00	JT3D-3B	35	107.0	6,26,**
BOEING	B-747-100	750.00	JT9D-7A	30	106.9	* **
BOEING	B-747-100	750.00	JT9D-7WET	30	106.9	* **
BOEING	B-747-SR	610.00	JT9D-7A	30	106.9	*
MCDONNELL DOUGLAS	DC-8-61F (QNC QN)	309.00	JT3D-3B	25	106.9	6,26,**
BOEING	B-747-200	770.00	JT9D-7	30	106.7	* **
BOEING	B-747-200	773.00	JT9D-3AWET	30	106.7	* **
BOEING	B-747-200	833.00	JT9D-7Q	30	106.6	

APPENDIX 5

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

APPROACH

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
BOEING	B-747-200	833.00	JT9D-7R4G2	30	106.6	**
BOEING	B-747-300	833.00	JT9D-7R4G2	30	106.6	
MCDONNELL DOUGLAS	DC-10-30	565.00	CF6-50A	50	106.4	*
MCDONNELL DOUGLAS	DC-10-30	572.00	CF6-50C/H	50	106.4	
MCDONNELL DOUGLAS	DC-10-30	590.00	CF6-50C1	50	106.4	
BOEING	B-747-100	750.00	RB.211-524C2	30	106.3	* **
BOEING	B-747-200	767.00	JT9D-3A	30	106.3	* **
BOEING	B-747-200	833.00	CF6-50E2	30	106.3	
BOEING	B-747-200	800.00	CF6-50E2	30	106.3	
MCDONNELL DOUGLAS	DC-8-61 (QNC QN)	309.00	JT3D-3B	25	106.3	6,26,**
MCDONNELL DOUGLAS	DC-8F-54 (QNC QN)	309.00	JT3D-3B	25	106.3	6,26,**
MCDONNELL DOUGLAS	DC-8F-55 (QNC QN)	309.00	JT3D-3B	25	106.3	6,26,**
MCDONNELL DOUGLAS	DC-10-40	555.00	JT9D-59A	50	106.0	*
BOEING	B-727-200	177.60	JT8D-7FCD	40	106.0	3,16
BOEING	B-747-200	820.00	JT9D-70A	30	106.0	
BOEING	B-727-100	169.50	JT8D-9FCD	40	105.9	3,17
BOEING	B-727-200	170.00	JT8D-9FCD	30	105.8	3,17
MCDONNELL DOUGLAS	DC-10-30	572.00	CF6-50C2-B	50	105.8	
BOEING	B-707-300B ADV/C SHN	322.30	JT3D-1-3B(3C)	25	105.7	6,21,**
MCDONNELL DOUGLAS	DC-10-40	530.00	JT9D-20D	50	105.7	*
MCDONNELL DOUGLAS	DC-10-10	455.00	CF6-6D	50	105.5	*
MCDONNELL DOUGLAS	DC-10-10	455.00	CF6-6D1	50	105.5	*
MCDONNELL DOUGLAS	DC-10-10	455.00	CF6-6D1A	50	105.5	*
BOEING	B-747-SR	571.00	CF6-45A2	30	105.4	
BOEING	B-707-120B (SHANNON)	258.00	JT3D-1	30	105.3	21,**

APPENDIX 5

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

APPROACH

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
BOEING	B-707-138B (SHANNON)	258.00	JT3D-1	30	105.3	21,**
BOEING	B-737-200 ADV.	123.50	JT8D-9QN	40	105.3	2,17
BOEING	B-737-200 NON-ADV.	117.00	JT8D-9QN	40	105.3	2,17
BOEING	B-747-300	820.00	JT9D-70A	30	105.3	**
MCDONNELL DOUGLAS	DC-10-30	590.00	CF6-50C2	50	105.3	
MCDONNELL DOUGLAS	DC-10-30	590.00	CF6-50C2-B	50	105.2	
BOEING	B-747-300	833.00	CF6-80C2B1	30	105.2	
MCDONNELL DOUGLAS	DC-8-55 (QNC QN)	309.00	JT3D-3B	25	105.2	6,26,**
MCDONNELL DOUGLAS	DC-8-54 W/RAC QN	315.00	JT3D-3B	33	105.1	6,**
MCDONNELL DOUGLAS	DC-8-33 (QNC QN)	306.00	JT3D	35	105.0	6,**
BOEING	B-727-200	172.50	JT8D-7QN	40	104.9	2,16
BOEING	B-747-200	833.00	RB.211-524D4	30	104.9	
BOEING	B-747-200	833.00	RB.211-524D4	30	104.9	**
BOEING	B-720B (SHANNON)	234.00	JT3D-1	30	104.7	6,**
BOEING	B-720B (SHANNON)	234.00	JT3D-3B	30	104.7	6,**
BOEING	B-747-400	870.00	PW 4056	30	104.7	
BOEING	B-747-100	734.00	JT9D-7	30	104.6	29
MCDONNELL DOUGLAS	DC-8-51 (QNC QN)	286.00	JT3D-3B	25	104.6	6,26,**
BOEING	B-727-200	203.10	JT8D-17QN	40	104.5	2,19
BOEING	B-727-100	169.50	JT8D-1FCD	40	104.3	3
BOEING	B-727-100	169.50	JT8D-7FCD	40	104.3	3,16
MCDONNELL DOUGLAS	DC-8-53 (QNC QN)	300.00	JT3D-3B	25	104.3	6,26,**
MCDONNELL DOUGLAS	MD-11	610.00	CF6-80C2	50	104.2	
MCDONNELL DOUGLAS	MD-11	610.00	PW4460	50	104.0	
BOEING	B-737-200 ADV.	128.10	JT8D-15QN	40	103.8	2,18

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AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

APPROACH

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
BOEING	B-747-400	870.00	CF6-80C2B1F	30	103.0	
BOEING	B-747-400	870.00	RB.211-524G	30	103.0	
BOEING	B-747-400	870.00	RB.211-524H	30	103.0	
BOEING	B-747-SP	660.00	JT9D-7F	30	103.0	
MCDONNELL DOUGLAS	DC-10-10	455.00	CF6-6K	50	103.0	*
MCDONNELL DOUGLAS	DC-10-10	455.00	CF6-6K2	50	103.0	*
LOCKHEED	L1011-385-1-14/15	466.00	RB.211-524B4	42	103.3	*
BOEING	B-727-200	184.80	JT8D-9QN	40	103.2	2,17
BOEING	B-727-200	190.50	JT8D-15QN	40	103.2	2,18
BOEING	B-727-200	208.00	JT8D-17RQN	40	103.2	2,20
BOEING	B-747-SP	696.00	RB.211-524B2	30	103.2	
BOEING	B-747-SP	702.00	JT9D-7J	30	103.2	
AIRBUS	A300B2-203	313.10	CF6-50-C2	25	103.1	
BOEING	B-747-400	600.00	PW4056	30	103.1	
MCDONNELL DOUGLAS	DC-09-10	90.70	JT8D-7	50	103.1	24
MCDONNELL DOUGLAS	DC-10-15	455.00	CF6-50C2-F	50	103.1	
AIRBUS	A300B4-103	347.20	CF6-50-C2	25	103.0	
BOEING	B-767-300	351.00	JT9D-7R4D(B)	30	103.0	
BOEING	B-767-300	351.00	JT9D-7R4E	30	103.0	
DASSAULT BREGUET	FALCON 20- /D/E	28.70	CF700-2D-2	40	103.0	
DASSAULT BREGUET	FALCON 20-F	28.66	CF700-2D-2	40	103.0	
MCDONNELL DOUGLAS	DC-08-63 (BAC R-1)	355.00	JT3D-7	35	103.0	6
MCDONNELL DOUGLAS	DC-08-63 (BAC/HGM)	353.00	JT3D-7	35	103.0	6
BAe	HS 125-600A	25.50	VIPER 601-22	45	102.9	12
BOEING	B-747-SP	703.00	JT9D-7A	30	102.9	

APPENDIX 5

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

APPROACH

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
BOEING	B-707-300B (QNC)	341.20	JT3D-1	30	102.8	6,**
BOEING	B-707-300B (QNC)	258.00	JT3D-3B	30	102.8	6,**
BOEING	B-737-200 ADV.	128.10	JT8D-17QN	40	102.8	2,19
LOCKHEED	L-1011	430.00	RB.211-22B	42	102.8	5 *
LOCKHEED	L-1011-1	430.00	RB.211-22B	42	102.8	5 *
LOCKHEED	L-1011-100	466.00	RB.211-22B	42	102.8	5 *
LOCKHEED	L1011-385-1-14/15	474.00	RB.211-22B	42	102.8	
BOEING	B-767-200	351.00	JT9D-7R4D(A)	30	102.7	
LEARJET	25D	15.00	CJ610-6	40	102.7	16
BOEING	B-767-200	360.00	JT9D-7R4D(B)	30	102.6	
BOEING	B-767-200	360.00	JT9D-7R4E	30	102.6	
AIRBUS	A300B4-203	313.05	CF6-50C2	25	102.4	31
AIRBUS	A300B4-203	363.70	CF6-50-C2	25	102.4	31
SABRELINER	SABRELINER 60A/60SC	23.70	JT12A-8		102.2	
BOEING	B-737-200 NON-ADV.	109.00	JT8D-7QN	40	102.1	2,16
LOCKHEED	L-1011-500	510.00	RB.211-524B4	33	102.0	*
AIRBUS	A300B4-622R	365.00	PW-4158	40	101.9	
MCDONNELL DOUGLAS	DC-09-34	121.00	JT8D-17	50	101.9	1
MCDONNELL DOUGLAS	DC-09-50	121.00	JT8D-15	50	101.9	1
MCDONNELL DOUGLAS	DC-09-50	121.00	JT8D-17	50	101.9	1
FOKKER	F28 MK3000	65.00	SPEY MK555-15	42	101.8	*
BOEING	B-767-200	360.00	CF6-80A	30	101.7	
BOEING	B-767-200	360.00	CF6-80A2	30	101.7	
BOEING	B-767-300	351.00	CF6-80A	30	101.7	
BOEING	B-767-300	351.00	CF6-80A2	30	101.7	

APPENDIX 5

AIRCRAFT NOISE CERTIFICATION LEVELS IN
DESCENDING EPNdB FOR U.S. CERTIFICATED
TURBOJET POWERED AIRCRAFT

APPROACH

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
LEARJET	24D	13.50	CJ610-6	40	101.7	14
LEARJET	28/29	15.00	CJ610-8A	40	101.7	
BOEING	B-720B (QNC)	234.00	JT3D-1	30	101.6	6,**
BOEING	B-720B (QNC)	234.00	JT3D-3B	30	101.6	6,**
LOCKHEED	L-1011-500	496.00	RB.211-524B	33	101.5	5 *
BOEING	B-747-400	870.00	CF6-80C2	25	101.4	
FOKKER	F28 MK4000	73.00	SPEY MK555-15P	42	101.4	
LOCKHEED	L-1011-200	466.00	RB.211-524B	33	101.4	5 *
MCDONNELL DOUGLAS	DC-09-34	121.00	JT8D-15	50	101.4	1
FOKKER	F28 MK1000	65.00	SPEY MK555-15	42	101.2	
MCDONNELL DOUGLAS	DC-09-30	108.00	JT8D-17	50	101.1	1
SABRELINER	SABRELINER 80A/80SC	25.50	CF700-2D-2		101.1	*
LEARJET	25C	15.00	CJ610-6	40	100.8	13
LEARJET	24/24D	13.50	CJ610-6	40	100.7	13
MCDONNELL DOUGLAS	DC-08-62 (BAC/MSN)	340.00	JT3D-3B	35	100.7	6
AIRBUS	A310-221	305.60	JT9D-7R4D1	40	100.6	
MCDONNELL DOUGLAS	DC-09-10	90.70	JT8D-7/-7A	50	100.4	1
AIRBUS	A310-324	330.69	PW-4152	40	100.2	
BOEING	B-727-200 (FED. EX.)	169.50	JT8D-9/A	30	100.2	6,27
BOEING	B-737-400	142.50	CFM56-3-B1	40	100.2	
BOEING	B-737-400	150.00	CFM56-3B-2	40	100.2	
BOEING	B-737-400	150.00	CFM56-3C-1	40	100.2	
BOEING	B-767-300	407.00	PW 4056	30	100.2	
BOEING	B-767-300	407.00	PW 4060	30	100.2	
LOCKHEED	L-1011-500	504.00	RB.211-524B3	33	100.2	5 *

APPENDIX 5

AIRCRAFT NOISE CERTIFICATION LEVELS IN
DESCENDING EPNdB FOR U.S. CERTIFICATED
TURBOJET POWERED AIRCRAFT

APPROACH

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
MCDONNELL DOUGLAS	DC-08-62 (BAC R-1)	350.00	JT3D-3B	35	100.2	6
SABRELINER	SABRELINER 75A	23.00	CF700-2D-2	30	100.2	*
SABRELINER	SABRELINER 80	23.30	CF700-2D-2		100.2	*
BOEING	B-737-300	139.50	CFM56-3-B1	40	100.0	
BOEING	B-737-300	139.50	CFM56-3B-2	40	100.0	
BAe	1-11 400	89.50	SPEY511-14/14W	45	99.9	12
AIRBUS	A300B4-605R	375.30	CF6-80-C2-A5	40	99.8	
BOEING	B-737-500	133.00	CFM56-3-B1(R)	40	99.8	
BOEING	B-737-500	130.00	CFM56-3-B1	40	99.8	
BOEING	B-767-300	407.00	RB.211-524G	30	99.8	
BOEING	B-767-300	407.00	RB.211-524H	30	99.6	
BOEING	B-757-200	240.00	RB.211-535C	25	99.6	
FOKKER	F28 MK3000	73.00	SPEY MK555-15H	42	99.4	
FOKKER	F28 MK4000	73.00	SPEY MK555-15H	42	99.4	
MCDONNELL DOUGLAS	DC-09-30	110.00	JT8D-9	50	99.4	1
MCDONNELL DOUGLAS	DC-09-40	114.00	JT8D-11	50	99.4	1
MCDONNELL DOUGLAS	DC-09-40	114.00	JT8D-15	50	99.4	1
BOEING	B-727-200 (FED. EX.)	177.60	JT8D-7/A/B	30	99.2	6,27
MCDONNELL DOUGLAS	DC-09-34	110.00	JT8D-9	50	99.1	1
BOEING	B-727-200RE(VALSAN)	190.50	JT8D-17/217C	30	99.0	6,23
BOEING	B-727-200RE(VALSAN)	209.50	JT8D-17A/217C	30	99.0	6,23
LEARJET	35	16.00	CJ610-6	40	99.0	
LEARJET	25/25D/C Raisb MK 33	15.00	CJ610	40	99.0	
LEARJET	25B/C/D/F ER Dee Hwd	16.30	CJ610-6/8A	40	99.0	
MCDONNELL DOUGLAS	DC-09-30	114.00	JT8D-15	50	99.0	1

APPENDIX 5

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

APPROACH

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
BOEING	B-727-200 (FED. EX.)	172.00	JT8D-7B(A)(B)	30	98.9	6,27
AIRBUS	A310-308	352.74	CF6-80C2A2	40	98.8	
BOEING	B-727-100 (FED. EX.)	169.50	JT8D-9/A	30	98.8	6,27
BOEING	B-727-200RE(VALSAN)	190.50	JT8D-15/217C	30	98.8	6,23
BOEING	B-767-300	380.00	PW4060	30	98.8	
BOEING	B-767-200	400.00	PW 4056	30	98.6	
MCDONNELL DOUGLAS	DC-08-71	325.00	CFM56-2-C1	50	98.6	*
BOEING	B-767-300	407.00	CF6-80C2B6F	30	98.5	
SABRELINER	SABRELINER 60	20.20	JT12A-8	24	98.5	*
BOEING	B-767-300	407.00	CF6-80C2-B4	30	98.4	
BOEING	B-767-300	407.00	CF6-80C2-B6	30	98.4	
GULFSTREAM	G-II GULFSTREAM	65.50	SPEY 511-8	39	98.4	12
SABRELINER	SABRELINER 40	20.20	JT12A-8	25	98.4	
MCDONNELL DOUGLAS	DC-08-71	325.00	CFM-56-2C5		98.3	*
MCDONNELL DOUGLAS	DC-08-73	355.00	CFM56-2-C1	50	98.3	*
BOEING	B-767-200	351.00	PW4052	30	98.3	
MCDONNELL DOUGLAS	DC-08-72	350.00	CFM56-2-C1	50	98.2	*
BOEING	B-757-200	255.50	PW 2037	30	98.1	
BOEING	B-757-200	255.50	PW 2040	30	98.1	
LEARJET	23 Raisbeck MK II	12.50	CJ610-1/-6		98.0	
LEARJET	24 Raisbeck MK II	13.00	CJ610-1/-6		98.0	
LEARJET	24B/D Raisbeck MK II	13.50	CJ610	40	98.0	
BOEING	B-727-100 (FED. EX.)	169.50	JT8D-7(A)(B)	30	97.9	6,28
BAe	1-11 200	80.00	SPEY 506-14	45	97.8	12
BOEING	B-727-100 (FED. EX.)	160.00	JT8D-7/A/B	30	97.8	6,28

APPENDIX 5

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

APPROACH

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES #
BOEING	B-767-300	340.00	PW4056	30	97.8	
DASSAULT BREGUET	FALCON 50	38.80	TFE731-3	48	97.4	
GULFSTREAM	G-1159/G-II	69.70	SPEY 511-8	39	97.3	12
MCDONNELL DOUGLAS	DC-09-30	108.00	JT8D-7A	50	97.3	1
MCDONNELL DOUGLAS	DC-09-30	110.00	JT8D-7	50	97.3	1
DASSAULT BREGUET	FALCON 50	40.78	TFE731-3-1C	48	97.1	
LOCKHEED	1329-23 (AIRESEARCH)	43.00	TFE731-3-1E	50	96.9	* **
LOCKHEED	1329-25 (AIRESEARCH)	44.50	TFE731-3		96.9	* **
AIRBUS	A320-231	162.00	V2500.A1	40	96.6	
BAe	125-800	27.40	TFE731-5R-1H	45	96.5	
BAe	125-800A	27.40	TFE731-5R-1H	45	96.5	35
BOEING	B-767-300	280.70	CF6-80C2B2	20	96.4	
AIRBUS	A320-211	162.00	CFM56-5A1	35	96.4	
BOEING	B-767-300	351.00	CF6-80C2-B2	30	96.4	
BOEING	B-767-200	387.00	CF6-80C2-B4	30	96.4	
BAe	HS 125-3A	21.70	TFE731-3-1H	45	96.3	
BAe	HS 125-600A	25.50	TFE731-3-1H	45	96.3	
BAe	HS 125-700A	25.50	TFE731-3-1H	45	96.3	33
MCDONNELL DOUGLAS	DC-09-30 (ABS)	105.00	JT8D-9	40	96.1	6
BAe	146-300A	95.00	ALF 502R-5	33	96.0	
BAe	HS 125-1A	21.70	TFE731-3-1H	45	96.0	
DASSAULT BREGUET	FALCON 20-G	32.00	ATF3-6-2C	40	95.8	
BAe	146-200A	93.00	ALF502R-5	33	95.8	
BAe	C-29A	28.00	TFE731-5R-1H	45	95.8	
BAe	HS 125-3A/RA	23.60	TFE731-3-1H	45	95.7	

APPENDIX 5

AIRCRAFT NOISE CERTIFICATION LEVELS IN
DESCENDING EPNdB FOR U.S. CERTIFICATED
TURBOJET POWERED AIRCRAFT

APPROACH

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
BAe	HS 125-800A	23.60	TFE731-5-1H	45	95.7	
BAe	146-100A	84.00	ALF502R-5	33	95.6	
BAe	146-200A	89.50	ALF502R-3	33	95.6	
BAe	146-200A	89.50	ALF502R-3A	33	95.6	
BAe	146-300A	97.50	ALF502R-5	33	95.6	
DASSAULT BREGUET	FALCON 20	29.30	TFE731-5-2C	52	95.6	
DASSAULT BREGUET	FALCON 20	28.30	TFE731-2	52	95.3	
LEARJET	24E	12.90	CJ610-6	40	95.3	
LEARJET	24F	13.50	CJ610-6	40	95.3	
LEARJET	24F-A	12.90	CJ610-6	40	95.3	
BAe	146-100A	82.25	ALF502R-3A	33	95.2	
BOEING	B-757-200	255.50	RB.211-535-E4	30	95.2	
BOEING	B-757-200	255.50	RB.211-535E4-B	30	95.2	
LEARJET	25D/25F	15.00	CJ610-6/8A	40	95.2	
BAe	146-100A	76.00	ALF502R-3	33	95.1	
MCDONNELL DOUGLAS	DC-09-10 (ABS)	90.70	JT8D-7/7A/7B	40	95.0	6
DASSAULT BREGUET	FALCON 200 MYSTERE	32.00	ATF3-6A-4C	40	94.2	
DASSAULT BREGUET	FALCON 200 MYSTERE	32.00	ATF3-6-4C	40	93.9	
CESSNA	650 CITATION III	22.00	TFE731-3B-100S	37	93.8	32
MCDONNELL DOUGLAS	MD-80	160.00	JT8D-217A	40	93.7	* 10
MCDONNELL DOUGLAS	MD-80	160.00	JT8D-217C	40	93.7	10
MCDONNELL DOUGLAS	MD-80	160.00	JT8D-219	40	93.7	10
MCDONNELL DOUGLAS	MD-87	149.50	JT8D-217A	40	93.3	10
MCDONNELL DOUGLAS	MD-87	149.50	JT8D-217C	40	93.3	10
MCDONNELL DOUGLAS	MD-87	149.50	JT8D-219	40	93.3	10

APPENDIX 5

AIRCRAFT NOISE CERTIFICATION LEVELS IN
DESCENDING EPNdB FOR U.S. CERTIFICATED
TURBOJET POWERED AIRCRAFT

APPROACH

MANUFACTURER	MODEL	MTOW 1000#	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
FOKKER	F100	98.00	TAY MK650-15	42	93.0	
ISRAEL AIRCRAFT	1124 WESTWIND	22.90	TFE731-3-1G	40	93.0	
MCDONNELL DOUGLAS	MD-88	149.50	JT8D-209	40	92.9	10
MCDONNELL DOUGLAS	MD-88	149.50	JT8D-217	40	92.9	10
ISRAEL AIRCRAFT	1124A WESTWIND 2	23.50	TFE731-3-1G	40	92.8	*
LEARJET	31	16.50	TFE731-2-3B	40	92.6	*
LEARJET	55C	21.50	TFE731-3AR-2B	40	92.4	*
LEARJET	M55C	21.50	TFE731-3AR-2B	40	92.4	*
LEARJET	35/36	18.00	TFE731-2-2B	40	92.2	*
DASSAULT BREGUET	FALCON 900	45.50	TFE731-5AR-1C	40	91.7	
DASSAULT BREGUET	FALCON 900B	46.50	TFE731-5BR-1C	40	91.7	
BAe	125-1000	31.00	PW305	25	91.6	
BEECH	BEECHJET 400	15.70	JT15D-5	30	91.6	*
LEARJET	35A/36A	18.30	TFE731-2-2B	40	91.6	
LEARJET	36A	18.30	TFE731-2-2B	40	91.4	*
MITSUBISHI	MU-300-10 (DIAM. II)	15.70	JT15D-5	30	91.4	*
LEARJET	35A	18.00	TFE731-2-2B	40	91.3	*
CANADAIR	CL-600	36.00	ALF-502	43	91.2	*
GULFSTREAM	G-IV	73.20	TAY 611-8	39	91.0	
GULFSTREAM	G-IV GULFSTREAM	71.70	TAY 610-8	39	91.0	
LEARJET	55B	21.50	TFE731-3A-2B	40	91.0	
DASSAULT BREGUET	FALCON 20-C5/D5/E5	29.10	TFE-731-5AR-2C	40	90.7	36
DASSAULT BREGUET	FALCON 20-C5/D5/E5	29.10	TFE731-5AR-2C	40	90.7	
LEARJET	55	21.00	TFE731-3A-2B	40	90.6	*
SABRELINER	SABRELINER 65	24.00	TFE731-3R		90.6	*

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APPENDIX 5

AIRCRAFT NOISE CERTIFICATION LEVELS IN DESCENDING EPNdB FOR U.S. CERTIFICATED TURBOJET POWERED AIRCRAFT

APPROACH

MANUFACTURER	MODEL	MTOW 1000S	ENGINE MODEL	FLAPS	NOISE LEVELS (EPNdB)	NOTES
CESSNA	550 CITATION II	13.30	JT15D-4	40	90.5	*
CESSNA	550 CITATION II	16.10	JT15D-4	40	90.5	
CESSNA	551 CITATION II	12.50	JT15D-4	40	90.5	*
AEROSPATIALE	SN601 CORVETTE	14.60	JT15D-4	35	90.0	
DASSAULT BREGUET	FALCON 20-F5	29.10	TFE-731-5AR-1C	40	90.0	34
DASSAULT BREGUET	FALCON 20-F5	29.10	TFE731-5AR-2C	40	90.0	
ISRAEL AIRCRAFT	1125 ASTRA	21.70	TFE731-3A-200G	40	89.0	
CANADAIR	CL-601 CHALLENGER	43.10	CF34-1A	45	89.4	*
CESSNA	560 CITATION V	16.30	JT15D-5A	35	88.9	
CESSNA	552	15.50	JT15D-5	35	88.5	*
CESSNA	500/501 CITATION I	11.00	JT15D-1/-1A	40	87.9	*
CESSNA	500 CITATION	10.30	JT15D-1	40	87.7	*
CESSNA	S550 CITATION S/II	15.10	JT15D-4B	35	86.2	
MITSUBISHI	MU-300 (DIAMOND I)	14.10	JT15D-4	30	85.0	*
MITSUBISHI	MU-300 (DIAMOND I)	15.50	JT15D-4D	30	85.0	

APPENDIX 6
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN AIRCRAFT IN THE TRANSPORT CATEGORY

AIRCRAFT MAKE, MODEL	MTOW IN 1000#	ENGINE MAKE, MODEL	ENGINE NO.	SHP RPM	PROPELLER MAKE, MODEL	DIAM (IN)	BLADES	PITCH	FLAPS TAKEOFF APPR.	FORWARD SPEED (KTS) TO REF APP REF	NOISE LEVELS EPNdB SIDE-LINE	TAKE-OFF	APPR.	STAGE	REF. NOTES
ATR 42-200	34.7 34.2	PRATT&WHITNEY 120	2	1800 1200	HAMILTON STD 14SF-1	156	4	V	15 30		83.0	82.1	96.8	3	HK
ATR 42-300	35.3 34.2	PRATT&WHITNEY 120	2	1800 1200	HAMILTON STD 14SF-1	156	4	V	15 30		83.0	82.6	96.8	3	HK
BAe 748-2A	44.5 43.0	ROLLS-ROYCE DART 532-2	2	2470 1394	DOWTY ROTOL CR212/4-30-4/22	144	4	V	15 28	122.2 107.9	96.8	92.5	103.8	2	BA
BAe 748-2B	46.0 43.0	ROLLS ROYCE DART 535-2	2	2470 1394	DOWTY ROTOL CR212/4-30-4/22	144	4	V	15 28	120.2 107.9	96.8	92.5	103.4	2	BA
BAe 748-2B	46.0 43.0	ROLLS ROYCE DART 536-2	2	2470 1394	DOWTY ROTOL CR212/4-30-4/22	144	4	V	8 28	131.8 107.5	93.3	88.7	92.8	3	BA 1
BAe ATP	50.5 49.0	PRATT&WHITNEY PW124A	2	2160 1200	HAMILTON STD. 6/5500/F	165	6	V	7 22	133.3 122.6	82.1	80.7	96.5	3	BA
BAe ATP	50.5 49.0	PRATT&WHITNEY PW126A	2	 1200	HAMILTON STD. 6/5500/F.1	165	6	V	7 15		82.7	79.5	97.9	3	EU
CASA C-212-CB	14.3 13.8	AIRESEARCH TPE 331-5-251C	2	750 1591	HARTZELL HC-B4TN-5CL/LT10282H	107	4	V	10 20	125. 120.	84.0	87.3	91.2	3	EU *
CASA C-212-CC	17.0 16.4	AIRESEARCH TPE 331-10-501C	2	900 1591	HARTZELL HC-B4MN-5AL	110	4	V	10 15	112. 107.	85.1	85.9	90.9	3	EU *
CASA CN-235	31.8 31.3	GENERAL ELECTRIC CT7-7A	2		HAMILTON STD. 14RF-21	130	4		8 23		86.5	84.5	87.0	3	HK *
CONVAIR 580 (Aeroprod.)	58.2 52.0	ALLISON 501-D13H	2	3460 1020	AEROPRODUCTS A6441FN-606A	162	4	V	10 28		91.1	87.4	98.3	3	HK

APPENDIX 6
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN AIRCRAFT IN THE TRANSPORT CATEGORY

AIRCRAFT MAKE, MODEL	MTOW IN 1000#	ENGINE MAKE, MODEL	ENGINE NO.	SHP RPM	PROPELLER MAKE, MODEL	DIAM (IN)	BLADES	PITCH	FLAPS TAKEOFF APPR.	FORWARD SPEED (KTS) TO REF APP REF	NOISE LEVELS EPNdB SIDE-LINE	TAKE-OFF	APPR.	STAGE	REF. NOTES
DEHAVILLAND DHC-7-101	43.0 41.0	PRATT&WHITNEY PT6A-50	4	1017 1210	HAMILTON STD. 24PF-305	135	4	V	25 25	95.1 102.1	83.3	80.1	91.6	3	HK *
DEHAVILLAND DHC-7-103	44.0 42.0	PRATT&WHITNEY PT6A-50	4	1120 1210	HAMILTON STD. 24PF-305	135	4	V	25 25	95.9 103.3	84.0	80.5	91.4	3	HK *
DEHAVILLAND DHC-8	33.0 32.4	PRATT&WHITNEY PW 120	2	1800	HAMILTON STD. 14SF-1	156	4	V	15 35		86.2	80.7	95.1	3	CR
DEHAVILLAND DHC-8-300	41.1 40.0	PRATT&WHITNEY PW123	2	 1200	HAMILTON STD. 14SF-15	156	4	V	5 15		87.4	86.3	98.9	3	HK
EMBRAER EMB-120	21.2 21.2	PRATT&WHITNEY PW 115	2	1500	HAMILTON STD. 14RF-9	126	4	V	15 25	110. 110.	81.6	76.6	92.5	3	BD
EMBRAER EMB-120	25.4 26.0	PRATT&WHITNEY PW118	2		HAMILTON STD. 14RF-9	126	4	V	15 25		83.5	81.2	92.3	3	 *
FOKKER 50	45.9 41.0	PRATT&WHITNEY 125B	2					V	0 26		85.0	81.0	96.8	3	HK
FOKKER F27 MK500	45.0 43.5	ROLLS ROYCE DART 7/MK535-7	2		DOWTY ROTOL R193-4-30-4	138	4	V	0 40	127.9 109.	90.1	86.9	94.3	3	HK 1
FOKKER F27 MK500	45.0 43.5	ROLLS ROYCE DART 7/MK535-7R	2		DOWTY ROTOL R193-4-30-4	138	4	V	0 40	127.9 109.	89.8	87.4	94.3	3	HK 1
FOKKER F27 MK500	45.0 42.0	ROLLS ROYCE DART 7/MK535-7R	2		DOWTY ROTOL R193-4-30-4	138	4	V	0 40	127.9 107.	92.2	90.6	100.3	2	HK
FOKKER F27 MK500	45.9 43.5	ROLLS ROYCE DART 7/MK551-7R	2		DOWTY ROTOL R193-4-30-4	138	4	V	0 40	129. 109.	89.0	87.6	94.3	3	HK 1

APPENDIX 6
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN
AIRCRAFT IN THE TRANSPORT CATEGORY

AIRCRAFT MAKE,MODEL	MTOW LB 1000#	ENGINE MAKE,MODEL	ENGINE NO.	SHP RPM	PROPELLER MAKE,MODEL	DIAM (IN)	BLADES	PITCH	FLAPS TAKEOFF APPR.	FORWARD SPEED (KTS) TO REF APP REF	NOISE LEVELS EPNdB SIDE-LINE	NOISE LEVELS EPNdB TAKE-OFF	NOISE LEVELS EPNdB APPR.	STAGE	REF. NOTES
FOKKER F27 MK500/600	45.0 41.0	ROLLS ROYCE DART 7/MK552-7R	2	2307	DOWTY ROTOL R193-4-30-4	138	4	V	0 40		89.8	87.4	94.1	3	NN 1
FOKKER F27 MK500/600	45.9 43.5	ROLLS ROYCE DART 7/MK552-7R	2	2307	DOWTY ROTOL R193-4-30-4	138	4	V	0 40		89.8	87.6	94.3	3	NN 1
FOKKER F27 MK600	45.0 42.0	ROLLS ROYCE DART7 MK532-7R	2		DOWTY ROTOL R193-4-30-4	138	4	V	0 40	127.9 107.	92.2	90.6	100.3	2	NN
LOCKHEED L382G	155.0 135.0	ALLISON 501-D22A	4	4050 1020	HAMILTON STD. 54H60	162	4	V	18 35	147. 141.4	96.7	94.8	98.1	3	A-1 * **
MCDONNELL DOUG DC3C (BTC STC)	28.8 28.8	PRATT&WHITNEY PT6A-67R	2		HARTZELL HC-B5MA-3/M11276	115	5	V	0 45		84.4	82.4	91.9	3	NN
SAAB 340B	28.5 28.0	GENERAL ELECTRIC CT7-9B	2	 1384	DOWTY ROTOL R375/4-123-F/21	132	4	V	15 20		85.9	78.0	91.6	3	EU
SAAB 340B	28.5 28.0	GENERAL ELECTRIC CT7-9B	2	 1384	HAMILTON STD. 14RF-19	132	4	V	15 20		86.1	77.7	90.1	3	EU
SAAB 340B	28.5 28.0	GENERAL ELECTRIC CT7-9B	2	 1384	DOWTY ROTOL R354/4-123-F/13/20	132	4	V	15 20		85.9	78.0	91.6	3	EU
SAAB SF340A	28.0 27.2	GENERAL ELECTRIC CT7-5A2	2	 1384	DOWTY ROTOL R354/4-123-F/13/20	132	4	V	15 20		85.8	78.2	84.4	3	EU
SAAB SF340A	28.0 27.2	GENERAL ELECTRIC CT7-5A2	2	 1384	DOWTY ROTOL R375/4-123-F/21	132	4	V	15 20		85.8	78.2	84.4	3	EU
SAAB FAIRCHILD 340	27.0 26.5	GENERAL ELECTRIC CT7-5A	2	1210	DOWTY ROTOL R320/4-123-F/1	126	4	V	15 35		87.6	79.3	89.6	3	CR

APPENDIX 6
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN
AIRCRAFT IN THE TRANSPORT CATEGORY

AIRCRAFT MAKE,MODEL	MTOW LB 1000#	ENGINE MAKE,MODEL	ENGINE NO.	SHP RPM	PROPELLER MAKE,MODEL	DIAM (IN)	BLADES	PITCH	FLAPS TAKEOFF APPR.	FORWARD SPEED (KTS) TO REF APP REF	NOISE LEVELS EPNdB SIDE-LINE	NOISE LEVELS EPNdB TAKE-OFF	NOISE LEVELS EPNdB APPR.	STAGE	REF. NOTES
SAAB FAIRCHILD 340	27.0 26.5	GENERAL ELECTRIC CT7-7E	2	1210	DOWTY ROTOL R320/4-123-F/1	126	4	V	15 35		87.4	79.5	89.6	3	CR
SAAB-SCANIA 340A W/APU	27.3 26.5	GENERAL ELECTRIC CT7-5A2	2	1735	DOWTY ROTOL R354/4-123-F13	132	4	V	 35		86.2	77.5	86.3	3	CE
SHORT BROS. SD3-30	22.0 21.6	PRATT&WHITNEY PT6A-45	2	1120 1675	HARTZELL HC-35MP-3A/M10282B-6	111	5	V	8 35	107. 102.	83.9	88.5	92.8	3	CR *
SHORT BROS. SD3-60	26.0 25.7	PRATT&WHITNEY PT6A-65R	2	1327	HARTZELL HC-B5MP-3C/M10876X	111	5	V	5 30		82.7	84.4	89.9	3	CR **
SHORT BROS. SD3-60-300	27.1 25.7	PRATT&WHITNEY PT6A-67R	2	 1700	HARTZELL HC-A6A-3/A1046E	108	6	V	15 15		82.7	80.0	94.3	3	NN

APPENDIX 6 REFERENCES

A-1	ADVISORY CIRCULAR 36-1B 12/5/77
BA	BRITISH AEROSPACE
CR	CERTIFICATION REPORT
EU	EUROPEAN REGION
NE	NEW ENGLAND REGION
NM	NORTHWEST MOUNTAIN REGION
SO	SOUTHERN REGION

APPENDIX 6 NOTES

1 EQUIPPED WITH STANDARD HUSHKIT
* FULL THRUST TAKEOFF
** 650 METER SIDELINE
SEE APPENDIX 1 FOR CHARTS AND EQUATIONS FOR THE CALCULATION OF NOISE CERTIFICATION LIMITS

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APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE, MODEL	MTOW LB 1000#	ENGINE MAKE, MODEL	ENGINE NO.	ENGINE SHP RPM EXH	PROPELLER MAKE, MODEL	PROPELLER DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE LEVELS dBA NOISE MEAS.	NOISE LEVELS dBA PERF CORR	NOISE LEVELS dBA CORR. LEVEL	NOTES	REF.
AEROTECH/AUS. N22S NOMAD SEARCHM.	9.1	ALLISON 250-B17E	2		HARTZELL HC-A3VF-7B/V10133N-11	91 2071	3			78.0	-2.1	75.9		HK
ANDERSON GREEN WOOD 51	3.2 3.2	AVCO LYCOMING O-540-A4D5	1	250 2575 3	HARTZELL HC-E2YR-1B/8465-7R	77 2575	2	V	167	75.2	-1.5	73.7		SW
BAe JETSTREAM 31	14.6 14.6	AIRESEARCH TPE331-10U-501H	2	900	DOWTY ROTOL R333/4-82-F/12	106 1591	4	V	239	74.4	-3.5	70.9	1	BA
BAe JETSTREAM 31	15.2 14.6	GARRETT TPE331-10UF/UR513H	2	940	DOWTY ROTOL R333/4-82-F/12	106 1591	4	V	239	74.1	-2.4	71.7	1	BA
BAe JETSTREAM 3201	16.2 15.6	GARRETT TPE331-12UA(R)701H	2	1020 41730	DOWTY ROTOL R333/4-82-F/12	106 1591	4	V	250	76.2	-3.2	73.0		BA
BEECH (200) SUPER KING AIR	12.5 12.5	PRATT&WHITNEY PT6A-41	2	847 2000 1	HARTZELL HC-B3TN-3G/T10178HB-3R	98 2000	3	V	251	82.8	-3.6	79.2		CE
BEECH 1900/1900C AIRLINER	16.6 16.1	PRATT&WHITNEY PT6A-65B	2	1100 1700 2	HARTZELL HCB4MP-3A/M10877K	110 1700	4	V		80.5	3.0	77.4	1	CE
BEECH 2000 STARSHIP	14.4	PRATT & WHITNEY XPT6A-67	2	1200 1700	McCAULEY D-L104DSZ-0	104 1700	5	V	250	84.3	-5.5	79.3		CE
BEECH 58/58A BARON	5.5 5.4	TCM IO-550-C	2	300 2700	McCAULEY 3AF32C512/82-NEA-5	77	3	V		80.7	-3.3	77.4		B-1

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AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE, MODEL	MTOW LB 1000#	ENGINE MAKE, MODEL	ENGINE NO.	ENGINE SHP RPM EXH	PROPELLER MAKE, MODEL	PROPELLER DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE LEVELS dBA NOISE MEAS.	NOISE LEVELS dBA PERF CORR	NOISE LEVELS dBA CORR. LEVEL	NOTES	REF.
BEECH A36 BONANZA	3.6 3.6	TELEDYNE IO-520-B	1	260 2700 5	McCAULEY 3A32C760/82 NB-2	80 2700	3	V	175	78.8	-0.6	78.2		G-3
BEECH A36 BONANZA	3.6 3.6	TELEDYNE IO-520-H	1	220 2550 5	McCAULEY 2A36C23/84B-0	84 2550	2	V	173	78.0	-0.6	77.4		CE
BEECH A36 BONANZA	3.7 3.7	TCM IO-550-B	1	300 2700	McCAULEY 3A32C406/82NDB-2	80	3	V		78.2	-1.6	76.7		B-1
BEECH A36TC BONANZA	3.7 3.7	TELEDYNE TSIO-520-U	1	300 2700 5	McCAULEY 3A32C760/82 NB-2	80 2700	3	V	169	79.5	-0.3	79.2		CE
BEECH B100 KING AIR	11.8 11.2	AIRESEARCH TPE331-6-252B	2	715 2000 1	HARTZELL HC-B4TN-5C/T10173FB-12-1/2	90 2000	4	V	230	80.2	-2.9	77.3		CE
BEECH B200 SUPER KING AIR	12.5 12.5	PRATT&WHITNEY PT6A-41	2	845 2000 1	HARTZELL HC-B3TN-3G/T10178HB-3R	99 1996	3	V	251	82.8	-3.6	79.2		CE
BEECH B200/B200C SUPER KING AIR	12.5 12.5	PRATT&WHITNEY PT6A-42	2	850 2000 1	HARTZELL HC-B3TN-3G/T10178HB-3R	98 2000	3	V	251	82.8	-3.6	79.2		CE
BEECH B200/B200C SUPER KING AIR	12.5 12.5	PRATT&WHITNEY PT6A-42	2	850 2000 2	McCAULEY 3GFR34C702/100LA-2	98 2000	3	V	255	79.3	-3.9	75.4		CE
BEECH B200/B200C/C12F KING AIR	12.5 12.5	PRATT&WHITNEY PT6A-42	2	850 2000	McCAULEY 4HFR34C754/94LA-0	94	4	V		80.7	-3.9	76.8		B-1

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AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE, MODEL	MTOW IN 1000#	ENGINE MAKE, MODEL	NO.	SHP RPM EXH	PROPELLER MAKE, MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
BEECH B200CT SUPER KING AIR	12.5 12.5	PRATT&WHITNEY PT6A-42	2	845 2000 1	HARTZELL HC-B3TN-3G/T10178HB-3R	99 1996	3	V	251	82.8	-3.3	79.5		CE
BEECH B200T/B200CT KING AIR	12.5 12.5	PRATT&WHITNEY PT6A-42	2	850 2000	MCCAULEY 4HFR34C754/94LA-0	94	4	V		80.7	-3.8	76.8		B-1
BEECH B200T/B200CT SUPER KING AIR	12.5 12.5	PRATT&WHITNEY PT6A-42	2	850 2000 1	MCCAULEY 3GFR34C702/100LA-8	98 2000	3		255	79.3	-3.8	75.5		CE
BEECH B300 SUPER KING AIR	15.0	PRATT&WHITNEY PT6A-60A	2	1050 1700 2	HARTZELL HC-B4MP-3/M10476K	105 1700	4			75.9	-3.8	72.1	1	CE
BEECH B36TC BONANZA	3.9 3.9	TELEDYNE TSIO-520-U	1	293 2700	MCCAULEY 82NDA-6	78 2700	3	V	177	78.7	0.5	79.2		G-3
BEECH B55 BARON	5.1 5.1	TELEDYNE IO-470-L	2	221 2550 2	HARTZELL PHC-C3YF-2/FC7663-2R	76 2550	3	V	177	77.7	-3.0	74.7		CE
BEECH E55 BARON	5.1 5.1	TELEDYNE IO-470-L	2	223 2550 2	HARTZELL BHC-C2YF-2CH/FC8465-6	78 2550	2	V	178	81.0	-3.0	78.0		CE
BEECH B58 BARON	5.4 5.4	TELEDYNE IO-520-C	2	254 2550 2	HARTZELL BHC-J2YF-2C/FC8475-6	78 2550	2	V	192	82.0	-3.1	78.9		CE,G-3
BEECH B58 BARON	5.4 5.4	TELEDYNE IO-520-C	2	256 2650 2	HARTZELL PHC-J3YF-2/FC7663-OR	76 2630	3	V	195	81.9	-3.1	78.8		CE,G-3

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE, MODEL	MTOW IN 1000#	ENGINE MAKE, MODEL	NO.	SHP RPM EXH	PROPELLER MAKE, MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
BEECH B50	5.5 5.4	TCM IO-550-C4B	2	300 2700	HARTZELL FC-7063Q	2700	4	V	196	78.5	-3.1	75.4		CE
BEECH B58P PRESS. BARON	6.1 6.1	TELEDYNE TSIO-520-L	2	301 2600 2	HARTZELL PHC-J3YF-2/FC7663-OR	78 2600	3	V	193	80.6	-1.5	79.1		A-1, G-3
BEECH B58P BARON	6.2 6.2	CONTINENTAL TSIO-520-WB	2	294 2600 4	HARTZELL PHC-J3YF-2UF/FC7663-8R	78 2600	3	V	197	78.2	-2.1	76.1		CE
BEECH B58TC TURBO BARON	6.1 6.1	TELEDYNE TSIO-520-WB	2	294 2600 4	HARTZELL PHC-J3YF-2UF/FC7663-8R	78 2600	3	V	197	78.2	-2.1	76.1		CE
BEECH B58TC TURBO BARON	6.2 6.2	CONTINENTAL TSIO-520-L	2	301 2600 2	HARTZELL PHC-J3Y-2F/FC7663-0R	78 2600	3	V	193	80.6	-1.5	79.1		CE,G-3
BEECH B60 DUKE	6.8 6.8	LYCOMING TIO-541-E1C4	2	296 2750 2	HARTZELL HC-F3YR-2UF/FC7479B-2R	74 2750	3	V	178	82.1	-2.5	79.6		G-3
BEECH B65-90 TAURUS	9.0 8.6	PRATT&WHITNEY PT6A-135	2	700 1900 4	HARTZELL HC-B3TN-2(B)/T10173B-8	93 1900	3	V	233	76.2	-5.8	70.4		SW
BEECH B76 DUCHESS	3.9 3.9	LYCOMING O-360-A1G6D	2	165 2700 2	HARTZELL HC-M2YR-2CLUF/FC7666A	76 2700	2	V	160	80.2	-1.5	78.7		CE
BEECH B76 DUCHESS	4.0	LYCOMING O-360-A1G6D	2	165 2700 1	HARTZELL HC-M2YR-2CLUF/FC7666A	76 2700	2	V	160	79.5	-2.3	77.2		I-1,G-3

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW LB 1000#	ENGINE MAKE,MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
BEECH 77 SKIPPER	1.7 1.7	LYCOMING O-235-L2C	1	115 2700 8	SENSENICH 72CKS12-0-52	72 2700	2	F	104	65.1	-1.3	63.8		CE
BEECH 95-C55	5.3 5.3	TCM IO-550-C	2	300 2700 2	HARTZELL PC-7063Q	74 2700	4	V	196	78.5	-3.1	75.4		CE
BEECH C23 SUNDOWNER	2.5 2.5	LYCOMING O-360-A4J	1	163 2700 3	SENSENICH 76EM8S5-0-60	76 2700	2	F	117	73.3	0.0	73.3		CE
BEECH C24R SIERRA	2.8 2.8	LYCOMING O-360-A1B6	1	202 2700 2	HARTZELL HC-M2YR-1BF/FC7666A-2R	76 2700	2	V	137	73.0	-1.3	71.7		B-1,CE
BEECH C90 KING AIR C90	9.7 9.2	PRATT&WHITNEY PT6A-21	2	550 2200	HARTZELL HC-B3TN-3B/T10173B-8	93 2200	3	V	231	78.7	-4.4	74.3		G-3
BEECH C90A KING AIR	10.1	PRATT&WHITNEY PT6A-21		550 2200 4	HARTZELL HC-B3TN-2(B)	93 2200	3		231	78.7	-4.4	74.3		CE
BEECH C99 AIRLINER	11.3 11.3	PRATT&WHITNEY PT6A-34	2	715 2200	HARTZELL HC-B3TN-3/T10173B-8	93 2200	3	V	241	79.3	-3.4	75.9		CE
BEECH D55	5.3 5.3	TCM IO-550-C	2	300 2700 2	HARTZELL PC-7063Q	74 2700	4	V	196	78.5	-3.4	75.0		CE
BEECH E55	5.3 5.3	TCM IO-550-C	2	300 2700 V	HARTZELL PC-7063Q	74 2700	4	V		78.5	-3.4	75.0		CE

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AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW LB 1000#	ENGINE MAKE,MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
BEECH E55	5.3 5.3	TCM IO-550-C	2	300 2700 2	HARTZELL PC-7063Q	74 2700	4	V		78.5	-3.4	75.0		CE
BEECH E55	5.3 5.3	TCM IO-550-C	2	300 2700 V	HARTZELL PC-7063Q	74 2700	4	V		78.5	-3.4	75.0		CE
BEECH E55 BARON	5.3 5.3	TELEDYNE IO-520-C	2	256 2650 2	HARTZELL PHC-J3Y-2F/FC7663-2R	76 2650	3	V	195	81.9	-3.2	78.7		CE
BEECH E55 BARON	5.3 5.3	TELEDYNE IO-520-C	2	254 2550 2	HARTZELL BHC-C2YF-2C/FC8475-6	78 2550	2	V	191	82.0	-3.2	78.8		CE
BEECH E90 KING AIR E90	10.1 9.7	PRATT&WHITNEY PT6A-28	2	550 2200	HARTZELL HC-B3TN-3B/T10173B-8	93 2200	3	V	231	79.0	-4.0	75.0		G-3
BEECH F33 A/C BONANZA	3.4 3.4	TELEDYNE IO-520-B	1	260 2700 5	MCCAULEY 3A32C76/82NB-2	80 2700	3	V	175	78.3	-1.4	76.9		CE,G-3
BEECH F33 A/C BONANZA	3.4 3.4	TELEDYNE IO-520-BA	1	220 2550 5	MCCAULEY 2A36C23/84 B-0	84 2550	2	V	173	78.1	-1.5	76.6		CE
BEECH F90 SUPER KING AIR 90	10.9 10.9	PRATT&WHITNEY PT6A-135	2	754 1900 I	HARTZELL HC-B4TN-3B/T10173FB-10.5	92 1900	4	V	248	77.9	-5.0	72.9		CE
BEECH V35B BONANZA	3.4 3.4	TELEDYNE IO-520-B	1	260 2700 5	MCCAULEY 3A32C76/82 NB-2	80 2700	3	V	175	78.8	-2.0	76.8		CE,G-3

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW IN 1000#	ENGINE MAKE,MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	P/F/V	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
BEECH V35B BONANZA	3.4 3.4	TELEDYNE IO-520-BA	1	228 2550 5	MCCAULEY 2A36C23/84B-0	84 2550	2	V	173	78.1	-1.5	76.6		CE
BELLANCA 17-30A VIKING	3.2 3.2	CONTINENTAL IO-520-K	1	225 2550 0	MCCAULEY D2A34C401/90DFA-12	78 2550	3	F	129	79.4	-1.9	77.5		GL
BELLANCA 7ECA CITABRIA	1.6 1.6	LYCOMING O-235-K2C	1	115 2700 2	SENSENICH 74DM6S8-1-56	72 2700	2	F		71.5	-2.7	68.8		GL
BELLANCA 7GCAA CITABRIA	1.6 1.6	LYCOMING O-320-A2B/-A2D	1	150 2700 2	SENSENICH 74DM6S8-1-56	73 2800	2	F		71.5	-4.7	66.8		GL
BELLANCA 7GCBC CITABRIA	1.6 1.6	LYCOMING O-320-A2B/A2D	1	150 2700 2	SENSENICH 74DM6S8-1-56	73 2700	2	F	117	71.5	-4.6	66.9		GL
BELLANCA 7GCBC SEAPLANE CITABRIA	1.8 1.8	LYCOMING O-320	1	150 2700 2	MCCAULEY 1A175GM/8040	89 2500	2	F	89	68.4	1.9	70.3		GL
BELLANCA 8GCBC SCOUT	2.2 2.2	LYCOMING O-360-C1A/-C1E	1	180 2700 2	HARTZELL HC-C2YR-1BF/F7666A	76 2550	2	F		76.3	-3.4	72.9		GL
BELLANCA 8GCBC SCOUT	2.2 2.2	LYCOMING O-360-C2A/-C2E	1	149 2700 2	MCCAULEY 1A200/HFA	80 2550	2	F	113	76.3	-3.5	72.8		GL
BELLANCA 8KCAB DECATHLON	1.8 1.8	LYCOMING AEIO-320-E1B	1	150 2700 2	HARTZELL HC-C2YL-4F/FC7663-4	72 2800	2	V		72.2	-2.2	70.0		GL

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW IN 1000#	ENGINE MAKE,MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	P/F/V	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
BELLANCA 8KCAB DECATHLON	1.8 1.8	LYCOMING AEIO-320-E2B	1	150 2700 2	SENSENICH 74DM6S8-0	74 2800	2	F		72.2	-3.0	69.2		GL
BELLANCA 8KCAB DECATHLON	1.8 1.8	LYCOMING AEIO-360-H1A	1	180 2700 2	HARTZELL HC-C2YR-4CF/FC7666A-2	74 2900	2	V	122	72.2	-5.0	67.2		GL
CESSNA 152 MODEL 152	1.7 1.7	LYCOMING O-235-L2C	1	110 2550 0	MCCAULEY 1A102/TCM6958	69 2550	2	F	101	65.8	-1.0	64.8		S-1
CESSNA 152/A152 MODEL 152	1.7 1.7	LYCOMING O-235-L2C	1	110 2550 0	MCCAULEY 1A103/TCM6958	69 2550	2	F	104	66.7	-0.4	66.3		CE,S-1
CESSNA 172N (LAND) SKYHAWK	2.3 2.3	LYCOMING O-320-H2AD	1	160 2700 0	MCCAULEY 1C160/DTM 7557	75 2700	2	F	115	74.3	-0.5	73.8		CE,S-1
CESSNA 172N (SEA) SKYHAWK	2.2 2.2	LYCOMING O-320-H2AD	1	160 2700 0	MCCAULEY 1A175/ETM8042	80 2700	2	F	91	73.6	-1.4	72.2		CE,S-1
CESSNA 172P SKYHAWK	2.4	LYCOMING O-320-D2J	1	160 2700 0	MCCAULEY 1C160/DTM7557	75 2700	2	F	115	74.3	-0.5	73.8		G-3
CESSNA 172RG SKYHAWK RG	2.7 2.7	LYCOMING O-360-F1A6	1	180 2700 0	MCCAULEY B2D34C220/90VLA-3.5	76 2700	2	V	136	73.4	0.5	73.9		CE,S-1
CESSNA 177B CARDINAL	2.5 2.5	LYCOMING IO-360-A1F6D	1	180 2700 0	MCCAULEY B2D34C211/82PCA-6	76 2700	2	V	124	72.0	-0.3	71.7		CE,S-1

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN
SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW IN 1000#	ENGINE MAKE,MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	P/T DTCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
CESSNA 177RG CARDINAL RG	2.8 2.8	LYCOMING IO-360-A1B6D	1	200 2700 8	MCCAULEY B2D34C207/78TCA-0	78 2700	2	V	139	76.3	-0.7	75.6		CE,S-1
CESSNA 180K (AMPHIB) SKYWAGON	3.0 3.0	TCM O-470-U	1	230 2400 8	MCCAULEY C2A34C204/90DCA-2	88 2400	2	V	123	74.0	-2.2	71.8		CE,G-2,S-1
CESSNA 180K (LAND) SKYWAGON	2.8 2.8	TCM O-470-U	1	230 2400 8	MCCAULEY C2A34C204/90DCB-8	90 2400	2	V	140	73.0	-3.0	70.0		CE,G-2,S-1
CESSNA 182Q SKYLANE	3.0 3.0	TCM O-470-U	1	230 2400 8	MCCAULEY D2A34C203/90DCA-8	82 2400	2	V	138	72.0	-2.9	69.1		CE,G-2,S-1
CESSNA 182R SKYLANE	3.1	TCM O-470-V	1	230 2400 8	MCCAULEY D2A34C203/90DCA-8	82 2400	2	V	139	72.0	-2.9	69.1		G-3
CESSNA 207A SKYWAGON	3.8 3.8	TCM IO-520-F	1	285 2700 8	MCCAULEY D3A32C404/80VA-0	80 2700	3	V	139	79.0	0.8	79.8		CE,S-1
CESSNA 207A STATIONAIR	3.8 3.8	TCM IO-520-F	1	285 2700 8	MCCAULEY D3A32C90/82NC-2	80 2700	3	V	138	77.8	-0.1	77.7		A-1,S-1
CESSNA 208 CARAVAN I	7.3 7.3	PRATT&WHITNEY PT6A-114		600 1900 2	HARTZELL HC-B3MN-3	100 1900	3	V	159	72.8	-1.1	71.7		CE
CESSNA 208 CARAVAN I	8.0 7.8	PRATT&WHITNEY PT6A-114		600 1900 2	HARTZELL HC-B3MN-3	100 1900	3	V	159	72.8	0.7	73.5		CE

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN
SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW IN 1000#	ENGINE MAKE,MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	P/T DTCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
CESSNA 208A CARAVAN I	8.0 7.8	PRATT&WHITNEY PT6A-114		600 1900 2	HARTZELL HC-B3MN-3	100 1900	3	V	159	72.8	0.7	73.5		CE
CESSNA 208B CARAVAN I	8.8 8.5	PRATT&WHITNEY PT6A-114		600 1900 2	HARTZELL HC-B3MN-3	100 1900	3	V	159	72.8	2.3	75.1		CE
CESSNA 210M CENTURION	3.8 3.8	TCM IO-520-L-3A	1	285 2700 8	MCCAULEY D3A34C404/80VA-0	80 2700	3	V	163	79.6	0.3	79.9		G-3
CESSNA 210N CENTURION	3.8 3.8	TCM IO-520-L-3A	1	285 2700 8	MCCAULEY D3A34C404/80VA-0	80 2700	3	V	163	79.6	0.0	79.6		CE,G-2
CESSNA 210R CENTURION	3.8 3.8	TCM IO-520-L	1	285 2700 8	MCCAULEY D3A34C404/80VA-0	80 2700	3	V	163	79.6	-0.6	79.0		CE
CESSNA 310R	5.5 5.4	TCM IO-520-M	2	285 2700 8	MCCAULEY 3AF32C87/82NC-5.5	77 2700	3	V	184	82.0	-2.9	79.1		G-1,S-1
CESSNA 335	6.0 6.0	TCM TSIO-520-EB	2	300 2700 4	MCCAULEY 3AF32C87/82NC-5.5	77 2700	3	V	182	79.6	-1.5	78.1		G-1,S-1
CESSNA 337H SKYMASTER	4.6 4.4	TCM TSIO-360-C	2	195 2600 8	MCCAULEY D2AF34C307/L78CHA-2 (R)	76 2600	2	V	149	78.6	1.3	79.9		CE,S-1
CESSNA 337H SKYMASTER	4.6 4.4	TCM TSIO-360-C	2	195 2600 8	MCCAULEY D2AF34C310/90DHA-12 (F)	78 2600	2	V	149	78.6	1.3	79.9		CE,S-1

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN
SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW LW 1000#	ENGINE MAKE,MODEL	NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
CESSNA 340A	6.0 6.0	TCM TSIO-520-N	2	310 2700 4	MCCAULEY 3AF32C93/82NC-5.5	76 2700	3	V	200	82.0	-5.5	76.5		G-1,S-1
CESSNA 340A	6.0 6.0	TCM TSIO-520-N	2	310 2700 3	MCCAULEY 3AF32C93/82NC-5.5	77 2700	3	V	195	83.4	-3.7	79.7		S-1
CESSNA 402B BUSINESS LINER	6.8 6.8	TCM TSIO-520-E	2	300 2700 3	MCCAULEY 3AF32C87N/82NC-5.5	76 2700	3	V	181	81.6	-2.8	78.8		S-1
CESSNA 402C BUSINESS LINER	6.8 6.8	TCM TSIO-520-GB	2	325 2700 4	MCCAULEY 3AF32C92N/82NC-6.5	76 2700	3	V	182	80.8	-2.2	78.6		S-1
CESSNA 402C BUSINESS LINER	6.8 6.8	TCM TSIO-520-VB	2	310 2600 4	MCCAULEY 3AF32C93/82NC-5.5	77 2600	3	V	190	77.2	-2.1	75.1		CE,S-1
CESSNA 404 TITAN	8.4 8.1	PRATT&WHITNEY PT6A-34	2	550 2000 4	HARTZELL HCB3TN-3B/T10173-8R	93 2000	3	V		81.1	-5.0	76.1		SW
CESSNA 404 TITAN	8.4 8.1	TCM GTSIO-520-M	2	375 3350 4	MCCAULEY 3FF32C501/90UNB-0	90 3350	3	V	185	81.6	-2.7	78.9		G-1,S-1
CESSNA 406 CARAVAN II	9.4 9.4	PRATT&WHITNEY PT6A-112	2	500 1900 1	MCCAULEY 3GFR34C701/93KB-0	93 1900	3	V	213	75.0	-3.0	72.0		CE
CESSNA 414A CHANCELLOR	6.8 6.8	TCM TSIO-520-N	2	298 2600 4	MCCAULEY 3AF32C93/82NC-5.5	77 2600	3	V	181	79.1	-2.5	76.6		G-1,S-1

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN
SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW LW 1000#	ENGINE MAKE,MODEL	NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
CESSNA 421C GOLDEN EAGLE	7.4 7.2	TCM GTSIO-520-L	2	375 3350 4	MCCAULEY 3FF32C501/90UNB-0	90 3350	3	V	196	80.3	-3.6	76.7		G-1,S-1
CESSNA 425 CONQUEST I	8.2 8.0	PRATT&WHITNEY PT6A-112	2	450 1900 4	MCCAULEY 3GFR34C701/93KB-0	93 1900	3	V	210	75.7	-4.3	71.4		CE
CESSNA 425 CONQUEST I	8.2 8.0	PRATT&WHITNEY PT6A-112	2	450 1900 4	HARTZELL HC-B3TN-3C/T10178B-8R	93 1900	3	V	210	75.7	-4.3	71.4		G-1,S-1
CESSNA 425 CONQUEST I	8.6 8.0	PRATT&WHITNEY PT6A-112	2	450 1900 4	HARTZELL HC-B3TN-3C/T10178B-8R	93 1900	3	V	210	75.7	-3.4	72.3		CE
CESSNA 441 CONQUEST II	9.9 9.4	AIRESEARCH TPE331-8-401S	2	636 1990 4	HARTZELL HC-B3TN-5E/T10178-11	90 1990	3	V	210	78.0	-4.0	74.0		G-2,S-1
CESSNA 441 CONQUEST II	9.9 9.4	AIRESEARCH TPE331-8-401S	2	636 1990 4	MCCAULEY 3GFR34C601/93JA	90 1990	3	V	210	78.0	-4.0	74.0		CE
CESSNA A185F (AMPHIB) SKYWAGON	3.3 3.1	TCM IO-520-D	1	285 2700 8	MCCAULEY D3A34C403/80VA-0	80 2700	3	V	126	78.9	-1.2	77.7		CE
CESSNA A185F (FLOAT) SKYWAGON	3.3 3.3	TCM IO-520-D-24	1	285 2700 8	MCCAULEY D3A32C90/82NC-2	88 2700	3	V	126	78.9	-1.0	77.9		CE,G-2
CESSNA A185F (LAND) SKYWAGON	3.3 3.3	TCM IO-520-D	1	285 2700 8	MCCAULEY D3A34C403/80VA-0	80 2700	3	V	142	78.9	-2.0	77.9		CE,G-2,S-1

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW LW 1000#	ENGINE MAKE,MODEL	ENGINE NO.	ENGINE SHP RPM EXH	PROPELLER MAKE,MODEL	PROPELLER DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE LEVELS dBA NOISE MEAS.	NOISE LEVELS dBA PERF CORR	NOISE LEVELS dBA CORR. LEVEL	NOTES	REF.
CESSNA A188B AG TRUCK	3.3 3.3	TCM IO-520-D	1	260 2700 8	MCCAULEY D3A32C408/82NDA-2	80 2700	3	V	117	77.3	-1.5	75.8		CE
CESSNA P210N CENTURION(PRESS	4.0 3.8	TCM TSIO-520-P	1	285 2600 4	MCCAULEY D3A34C402/90DFA-10	80 2600	3	V	174	77.1	0.9	78.0		CE,G-2
CESSNA P210N ADVANCED SPIRIT 750	4.0	PRATTWHITNEY PT6A-135	1	450 2	HARTZELL HC-B3TN-3C/T10282K-25-5Q	77 1900	3	V	233	68.7	-2.0	66.8		EH
CESSNA P210R PRESS CENTURION	4.1 4.1	TCM TSIO-520-CE	1	325 2700 4	McCAULEY D3A36C410/80VNB-0	80 2700	3	V	174	80.2	-0.8	79.4		CE
CESSNA P337H PRESS SKYMASTER	4.7 4.4	TCM TSIO-360-C	2	200 2600 4	MCCAULEY D2AF34C305/L78CBA-2 (R)	76 2600	2	V	178	80.8	-1.1	79.7		CE,S-1
CESSNA P337H PRESS.SKYMASTER	4.7 4.4	TCM TSIO-360-C	2	200 2600 4	MCCAULEY D2AF34C308/90DEA-12 (F)	78 2600	2	V	178	80.8	-1.1	79.7		CE,G-2
CESSNA R172K (LAND) HAWK XP	2.5 2.5	TCM IO-360-K	1	195 2600 8	MCCAULEY 2A34C203/90DCA-14	76 2600	2	V	127	74.7	-0.6	74.1		CE,G-2,S-1
CESSNA R172K (SEA) HAWK XP	2.5 2.5	TCM IO-360-K	1	195 2600 8	MCCAULEY 2A34C203/90DCA-10	80 2600	2	V	113	76.4	-1.4	75.0		CE,S-1
CESSNA R182 SKYLANE RG	3.1 3.1	LYCOMING O-540-J3C5D	1	235 2400 8	MCCAULEY B2D34C214/90DHB-8	82 2400	2	V	146	72.7	-2.0	70.7		CE,S-1

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW LW 1000#	ENGINE MAKE,MODEL	ENGINE NO.	ENGINE SHP RPM EXH	PROPELLER MAKE,MODEL	PROPELLER DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE LEVELS dBA NOISE MEAS.	NOISE LEVELS dBA PERF CORR	NOISE LEVELS dBA CORR. LEVEL	NOTES	REF.
CESSNA R182 SKYLANE RG	3.1 3.1	LYCOMING O-540-J3C5D	1	235 2400 8	MCCAULEY B3D32C407/82NDA-3	79 2400	3	V	152	70.3	-2.0	68.3		G-1,S-1
CESSNA T182 TURBO SKYLANE	3.1 3.1	LYCOMING O-540-L3C5D	1	235 2400 4	MCCAULEY B2D34C219/90DHB-8	82 2400	2	V	140	73.2	-0.7	72.5		G-1,S-1
CESSNA T182 TURBO SKYLANE	3.1 3.1	LYCOMING O-540-L3C5D	1	235 2400 4	MCCAULEY B3D32C407/82NDA-3	79 2400	3	V	161	69.5	-0.7	68.8		G-1,S-1
CESSNA T207A TURBOSTATIONAIR	3.8 3.8	TCM TSIO-520-G-1A	1	285 2600 4	MCCAULEY 3A32C401/90DFA-10	80 2600	3	V	140	77.9	-1.6	76.3		CE,G-2,S-1
CESSNA T210N TURBO CENTURION	3.8 3.8	TCM TSIO-520-R-4A	1	285 2600 4	MCCAULEY D3A34C-102/90DFA-10	80 2600	3	V	172	77.4	-1.6	75.8		G-3
CESSNA T210N TURBO CENTURION	4.0 3.8	TCM TSIO-520-R	1	285 2600 4	MCCAULEY D3A34C402/90DFA-10	80 2600	3	V	172	77.4	0.0	77.4		CE,G-2
CESSNA T210R TURBO CENTURION	4.1 4.1	TCM TSIO-520-CE	1	325 2700 4	McCAULEY D3A36C410/80VNB-0	80 2700	3	V	174	80.2	-0.8	79.4		CE
CESSNA T303 CRUSADER	5.2 5.0	TCM TSIO-520-AE	2	250 2400 4	MCCAULEY 3AF32C506/82NDB-8	74 2400	3	V	176	76.5	-2.2	74.3		CE
CESSNA T310R TURBO 310R	5.5 5.4	TCM TSIO-520-BB	2	285 2700 4	MCCAULEY 3AF32C87/82NC-4	78 2700	3	V	185	80.9	-3.2	77.7		G-1,S-1

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN
SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW LB 1000#	ENGINE MAKE,MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE LEVELS dBA NOISE MEAS.	PERF CORR.	CORR. LEVEL	NOTES	REF.
CESSNA T337H TURBO SKYMASTER	4.6 4.4	TCM TSIO-360-H	2	195 2600 4	MCCAULEY D2AF34C308/90UMA-12 (F)	78 2600	2	V	165	79.4	-1.0	78.4		CE,S-1
CESSNA T337H TURBO SKYMASTER	4.6 4.4	TCM TSIO-360-H	2	195 2600 4	MCCAULEY D2AF34C305/L78CHA-2 (R)	76 2600	2	V	165	79.4	-1.0	78.4		CE,G-2,S-1
CESSNA TR182 TURBOSKYLANE RG	3.1 3.1	LYCOMING O-540-L3C5D	1	235 2400 4	MCCAULEY B2D34C217/90DHB-8	82 2400	2	V	143	73.8	-1.2	72.6		CE,G-2,S-1
CESSNA TR182 TURBOSKYLANE RG	3.1 3.1	LYCOMING O-540-L3C5D	1	235 2400 4	MCCAULEY B3D32C407/82NDA-3	79 2400	3	V	155	70.6	-1.2	69.4		G-1,S-1
CESSNA TU206G TURBOSTATIONAIR	3.6 3.6	TCM TSIO-520-M	1	285 2600 4	MCCAULEY D3A34C402/90DFA-10	80 2600	3	V	145	78.5	-3.1	75.4		CE,S-1
CESSNA TU206G (AMPHIB) TURBOSTATIONAIR	3.6 3.6	TCM TSIO-520-M	1	285 2600 4	MCCAULEY D3A34C402/90DFA-10	80 2600	3	V	125	78.0	1.2	79.2		CE,S-1
CESSNA U206G STATIONAIR	3.6 3.6	TCM IO-520-F	1	285 2700 8	MCCAULEY D3A34C404/80VA-0	80 2700	3	V	137	77.9	-0.4	77.5		CE,S-1
CESSNA U206G (LAND) STATIONAIR	3.6 3.6	TCM IO-520-F-9	1	285 2700 8	MCCAULEY D3A34C404/80VA-0	80 2700	3	V	144	79.8	-0.4	79.4		CE
CESSNA U206G(SEAPLANE) STATIONAIR	3.5 3.5	TCM IO-520-F	1	285 2700 8	MCCAULEY D3A34C404/80VA-0	80 2700	3	V	132	80.2	-0.8	79.4		G-1

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN
SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW LB 1000#	ENGINE MAKE,MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE LEVELS dBA NOISE MEAS.	PERF CORR.	CORR. LEVEL	NOTES	REF.
CLASSIC AIRCRAFT WACO F5 CLASSIC WACO	2.7 2.7	JACOBS R-755B2M		245 2050	SENSENICH W96JA72	96 2050	2	F	120	75.1	-2.3	72.8		CE
CLASSIC AIRCRAFT WACO F5 CLASSIC WACO	2.8 2.8	JACOBS R-755B2M		275 2200	SENSENICH W90T6JA72	90 2200	2	F	124	76.3	-0.7	75.6		CE
CURTISS-WRIGHT TRAVEL AIR 4000	2.5 2.5	LYCOMING R-680E3B	1	225 2050 2	HAMILTON STD 2D20/6135A	102 2050	2	F	130	75.2	-1.6	75.6		GL
DEHAVILLAND DHC-3 W/SAR STC	8.0	PRATTWHITNEY PT6A-135/135A	1	1900	HARTZELL HC-B3TN-3C/T10282	102	3	V		76.3	-0.3	76.0		SR
DORNIER 228-100	12.5 12.5	GARRETT TPE331-5-252D	2	715	HARTZELL HC-B4TN-5ML/LT	106	4					71.5		SR
EMBRAER EMB-110 BANDEIRANTE	12.5 12.0	PRATTWHITNEY PT6A-34	2	750 2200	HARTZELL HC-B3TN-3C/T10178H-8R	93 2002	3	V	217	78.7	-1.4	77.3		SO
FAIRCHILD SA226-T(B) MERLIN IIIB	12.5 12.5	AIRESEARCH TPE331-10U-501G	2	900 4173 4	HARTZELL HC-B4TN-5KL/LT10282NB+2.5	106 1591	4	V	275	77.4	-4.6	72.8		SW
FAIRCHILD SA226TC METRO II	12.5 12.5	AIRESEARCH TPE331-3UW-303G	2	632 1920 4	HARTZELL HCB3 TN-5/T10282HB	102 1920	3	V	239	83.6	-3.8	79.8		SW
FAIRCHILD SA227-AC METRO III	12.5 12.5	AIRESEARCH TPE331-11U-601G	2	1000 4173 4	DOWTY ROTOL (C)R321/4-82-F/8	106 1591	4	V	250	76.7	-4.8	71.9		SW

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE, MODEL	MTOW LB 1000#	ENGINE MAKE, MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE, MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
FAIRCHILD SA227-AC METRO III	14.0 14.0	AIRESEARCH TPE331-11U-601G	2	1000 4173 4	DOWTY ROTOL (C)R321/4-82-F/8	106 1591	4	V	250	76.7	-2.2	74.5	1	SW
FAIRCHILD SA227-AC	14.5	GARRETT TPE331-11	2	1000	DOWTY-ROTOL R321/4-82-F/8	106 1591	4	F		76.7	-1.9	74.8	1	NM
FAIRCHILD SA227-AC	16.0	GARRETT TPE331-11	2	1000	DOWTY-ROTOL R321/4-82-F/8	106 1591	4	F		76.7	0.0	77.7	1	NM
FAIRCHILD SA227-AT MERLIN IVC	12.5 12.5	AIRESEARCH TPE331-11U-601G	2	1000 4173 4	DOWTY ROTOL (C)R321/4-82-F/8	106 1591	4	V	250	76.7	-4.8	71.9		SW
FAIRCHILD SA227-AT MERLIN IVC	14.0 14.0	AIRESEARCH TPE331-11U-601G	2	1000 4173 4	DOWTY ROTOL (C)R321/4-82-F/8	106 1591	4	V	250	76.7	-2.2	74.5	1	SW
FAIRCHILD SA227-TT MERLIN IIIC	12.5 12.5	AIRESEARCH TPE331-10U-503G	2	900 4173 4	DOWTY ROTOL (C)R324/4-82-F/9	106 1591	4	V	275	77.4	-4.6	72.8		SW
FAIRCHILD SA227-TT MERLIN IIIC	13.2 13.2	AIRESEARCH TPE331-10U-503G	2	900 4173 4	DOWTY ROTOL (C)R324/4-82-F/9	106 1591	4	V	275	77.4	-4.1	73.3	1	SW
FUJI HEAVY IND. 700	6.8 6.6	LYCOMING TIO-540-R2AD	2	340 2500 4	HARTZELL HC-E3YR-2ATF/FC8468-5R	79 2500	3	V	190	80.8	-3.2	77.6		NM
FUJI HEAVY IND. 710	8.3 8.3	LYCOMING TIGO-541-D1B	2	450 2133 4	HARTZELL HC-C3YR-2LUF/FJC-9684-3R	93 2133	3		202	82.7	-3.3	79.4		NM

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE, MODEL	MTOW LB 1000#	ENGINE MAKE, MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE, MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
GRUMMAN G-44/SCAN 30	5.5	LYCOMING TIO/LTIO-540-J2BD	2		HARTZELL HC-C3YR-2UF/HC-C3YR-2LUF	87	3	V		82.8	-3.2	79.6		AA
GULFSTREAM 112B COMMANDER	2.8 2.8	AVCO LYCOMING IO-360-C1D6	1	200 2700 3	HARTZELL HC-E2YR-1BF/F8467-7R	77 2700	2	V	133	75.1	-0.5	74.6		SW
GULFSTREAM 112TC COMMANDER	2.8 2.8	AVCO LYCOMING TO-360-C1A6	1	210 2575 4	HARTZELL HC-E2YR-1BF/F8467-7R	77 2575	2	V	145	76.1	-1.3	74.8		SW
GULFSTREAM 112TCA COMMANDER	3.0 3.0	AVCO LYCOMING TO-360-C1A6	1	210 2575 4	HARTZELL HC-E2YR-1BF/F8467-7R	77 2575	2	V	145	76.1	-1.3	74.8		SW
GULFSTREAM 114 COMMANDER	3.1 3.1	AVCO LYCOMING IO-540-T4A5D	1	260 2700 3	HARTZELL HC-C2YR-1BF/F8467-7R	77 2700	2	V	150	79.7	-1.2	78.5		SW
GULFSTREAM 114A COMMANDER	3.3 3.1	AVCO LYCOMING IO-540-T4B5D	1	260 2700 3	MCCAULEY B3D36C405/90DFA-13	77 2700	3	V	150	79.7	-1.2	78.5		SW
GULFSTREAM 690 TURBOCOMMANDER	10.3 9.6	AIRESEARCH TPE331-5-251K	2	700 1591 4	HARTZELL HC-B3TN-5FL/LT10282H+4	106 1591	3	V	243	76.4	-5.0	71.4		G-3
GULFSTREAM 690A TURBOCOMMANDER	10.3 9.6	AIRESEARCH TPE331-5-251K	2	700 1591 4	HARTZELL HC-B3TN-5FL/LT10282H+4	106 1591	3	V	243	76.4	-5.0	71.4		G-3
GULFSTREAM 690B TURBOCOMMANDER	10.3 9.7	AIRESEARCH TPE331-5-251K	2	700 1591 4	HARTZELL HC-B3TN-5FL/LT10282H+4	106 1591	3	V	243	76.4	-5.0	71.4		G-3

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN
SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW LB (1000#)	ENGINE MAKE,MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
GULFSTREAM 690C 840	10.3 9.7	AIRESEARCH TPE331-5-254K	2	700 1591 4	DOWTY ROTOL (C)R306/3-82-F/7(C)VF2926	106 1591	3	V	243	76.4	-5.0	71.4		G-3
GULFSTREAM 690D (900)	10.7 10.6	AIRESEARCH TPE331-5-254K	2	737 2730 4	DOWTY ROTOL (C)R306/3-82-F/7(C)VF2926	106 1591	3	V	245	76.4	-5.0	71.4		SW
GULFSTREAM 695 (980)	10.3 9.7	AIRESEARCH TPE331-10-501K	2	700 1591 4	DOWTY ROTOL (C)R306/3-82-F/7(C)VF2926	106 1591	3	V	243	76.4	-5.0	71.4		G-3
GULFSTREAM 695A (1000)	11.2 10.6	AIRESEARCH TPE331-10-501K	2	700 1591 4	DOWTY ROTOL (C)R306/3-82-F/7(C)VF2926	106 1591	3	V	252	71.8	0.0	71.8		G-3
GULFSTREAM 700 COMMANDER	6.9 6.6	AVCO LYCOMING TIO-540-R2AD	2	340 2500 4	HARTZELL HC-E3YR-2AFT/FC8468SR	79 2500	3	V	175	77.8	-2.4	75.4		SW
GULFSTREAM AA-1B T-CAT	1.5 1.5	LYCOMING O-235-C2C	1	108 2600 7	MCCAULEY SCM1A105/7154	71 2600	2	F	109	66.7	1.1	67.8		SO
GULFSTREAM AA-1B T-CAT	1.5 1.5	LYCOMING O-235-C2C	1	108 2600 7	MCCAULEY SCM1A105/7157	71 2600	2	F	109	66.3	0.6	66.9		SO
GULFSTREAM AA-1C T-CAT	1.6 1.6	LYCOMING O-235-L2C	1	115 2700 7	SENSENICH 72CK-0-56	71 2700	2	F	111	68.3	0.5	68.8		SO
GULFSTREAM GA-7 COUGAR	3.8 3.8	LYCOMING O-320-D1D	2	160 2700	HARTZELL F2YL-2VFFC7663D-3	73 2700	2	V	160	74.2	-2.2	72.0		SO

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN
SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW LB (1000#)	ENGINE MAKE,MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
MAULE M-5-180C/-180TC	2.3 2.3	LYCOMING O-360-C1F	1	175 2700 3	HARTZELL HC-C2YR-1BF/F7666A	76 2700	2	V		72.3	0.0	72.3		SO
MAULE M-5-200	2.3 2.3	LYCOMING IO-360-J1A6D	1	198 2600 3	HARTZELL HC-E2YR-1BF/F8468A-6R	77 2600	2	V	135	73.3	0.0	73.3		SO
MAULE M-5-210TC LUNAR ROCKET	2.3 2.3	LYCOMING IO-360-C1A-6D	1	210 2575	HARTZELL HC-E2YR-1BF/F8467-7R	74 2575	2	V		74.6	-1.0	73.6		SO
MAULE M-5-235	2.8 2.8	LYCOMING O-540-J1A5D	1	235 2400 3	HARTZELL HC-C2YR-1BF/F8468A-3R	81 2400	2	V	140	74.7	0.9	75.6		SO
MAULE M-5-235C LUNAR ROCKET	2.3 2.3	LYCOMING O-540-J1A5D/-W1A5D	1	235 2400	HARTZELL HC-C2YR-1BF/F8468A-6R	78	2	V		72.6	-5.0	67.6		SO,A-1
MAULE M-6-180	2.3 2.3	LYCOMING O-360-C1F	1	175 2600 3	HARTZELL HC-C2YR-1BF/F7666A	76 2600	2	V	90	70.9	0.9	71.8		SO
MAULE M-6-235	2.3 2.3	LYCOMING O-540-J1A5D/-W1A5D	1	235 2400	HARTZELL HC-E2YR-1BF/F8468A-6R	78 2400	2	V		72.6	-5.0	67.6		SO
MAULE M-6-235	2.5 2.3	LYCOMING O-540-J1A5D	1		HARTZELL HC-C2YR-1BF/F8468A-3R	81 2700	2	V	223			71.3		CE
MAULE M-7-235		LYCOMING O-540-J1A5D	1	2400 3	HARTZELL HC-C2YR-1BF/F8468A-3R	81 2400	2		117	74.7	-2.5	72.2		CE

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE, MODEL	MTOW LB 1000#	ENGINE MAKE, MODEL	NO.	SHP RPM EXH	PROPELLER MAKE, MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
MAULE M-7-235		LYCOMING O-540-J1A5D	1	235 2400 3	HARTZELL HC-C2YR-1BF/F8468A-6R	78 2400	2		137	72.6	-0.3	72.3		CE
MITSUBISHI MU-2B-40	10.5 10.0	AIRESEARCH TPE331-10-501	2	665 4173 4	HARTZELL HC-B4TN-5DL/LT10282BB-5.3R	98 1591	4	V	250	77.4	-2.9	74.8		SW
MITSUBISHI MU-2B-60	11.6 11.6	AIRESEARCH TPE331-10-501M	2	715 4273 4	HARTZELL HC-B4TN-5DL/LT10282BB-5.3R	98 1591	4	V	250	77.7	-1.4	76.5		SW
MOONEY M20J 201	2.7 2.7	LYCOMING IO-360-A3B6D	1	192 2700	MCCAULEY B2D34C212/78CDA-4	74 2700	2	V	178	75.3	-1.3	74.0		SW
MOONEY M20L MOONEYPFM	2.9 2.9	PORSCHE PFM3200N03		7	HARTZELL BHC-J2YF-1C/B7421	74	3	V				76.6		SW
MOONEY AIRCRAFT M20K MOONEY 231	2.9 2.9	TELEDYNE TSIO-360-GB1	1	210 2700 4	MCCAULEY 2A34C216/90DHB-16E	74 2700	2	V	198	76.6	-1.1	75.4		SW
PARTENAVIA P68-TC	4.4 4.6	AVCO LYCOMING TO-360-C1A6D	2		HARTZELL HC-C2YK-2CUF	76 2575	2	V				75.4		EU
PIPER PA-18-150 SUPER CUB	1.8 1.8	LYCOMING O-320-A2B	1	150 2700 7	SENSENICH M74DM6-0-56	74 2700	2	F	120	69.0	-3.1	65.9		EA,P-1
PIPER PA-23-250 AZTEC F	5.2 4.9	LYCOMING IO-540-C4B5	2	250 2575 6	HARTZELL HC-E2YR-2B465-7R	77 2575	2	V	178	76.8	-1.1	75.7		EA,P-1

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE, MODEL	MTOW LB 1000#	ENGINE MAKE, MODEL	NO.	SHP RPM EXH	PROPELLER MAKE, MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
PIPER PA-23T-250 AZTEC F	5.2 4.9	LYCOMING TIO-540-C1A	2	250 2575 4	HARTZELL HC-E2YR-2B465-7R	77 2575	2	V	178	77.0	-0.8	76.2		EA,P-1
PIPER PA-28-161 WARRIOR II	2.3 2.3	LYCOMING O-320-D3G	1	160 2700 5	SENSENICH 74DM6-0-60	74 2700	2	F	115	71.4	0.6	72.0		SO,P-1
PIPER PA-28-181 ARCHER II	2.5 2.5	LYCOMING O-360-A4M	1	180 2700 5	SENSENICH 76EM8S5-062	76 2700	2	F	129	73.4	0.5	73.9		SO,P-1
PIPER PA-28-236 DAKOTA	3.0 3.0	LYCOMING O-540-J3A5D	1	235 2400 5	HARTZELL HC-F2YR-1F/F8468A-4R	80 2400	2	V	140	72.5	0.4	72.9		SO,P-1
PIPER PA-28R-200 ARROW II	2.7 2.7	LYCOMING IO-360-C1C	1	200 2700	SENSENICH	74 2700	2	V	184	75.5	0.0	75.5		SO
PIPER PA-28R-201T TURBO ARROWII	2.9 2.9	LYCOMING TSIO-360-FB	1	200 2575 2	HARTZELL PHC-C3YF-1F/7663-2R	76 2575	2	V	144	69.1	0.5	69.6		SO
PIPER PA-28RT-201 ARROW IV	2.8 2.8	LYCOMING IO-360-C1C6	1	200 2700 5	MCCAULEY B2D34213/90DHA-16	74 2700	2	V	130	74.4	1.1	75.5		SO,P-1
PIPER PA-28RT-201T TURBO ARROW IV	2.9 2.9	CONTINENTAL TSIO-360-F	1	200 2575 2	HARTZELL BHC-C2YF-1F/F8459A-8R	76 2575	2	V	146	69.1	0.3	69.4		SO,P-1
PIPER PA-28RT-201T TURBO ARROW IV	2.9 2.9	CONTINENTAL TSIO-360F	1	200 2575 4	HARTZELL PHC-C3YF-1F/F7663-2R	76 2575	3	V	146	72.5	0.3	72.8		SO,P-1

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW LW 1000#	ENGINE MAKE,MODEL	NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
PIPER PA-31 NAVAJO	6.5 6.5	LYCOMING TIO-540-2AC	2	275 2400 4	HARTZELL HC-E3YR-2ATF FC8468-6R	80 2400	3	V	186	77.0	-1.6	75.4		P-1
PIPER PA-31-325 NAVAJO C/R	6.5 6.5	LYCOMING TIO-540-F2BD	2	275 2400 4	HARTZELL HC-E3YR-2ATF FC8468-6R	80 2400	3	V		78.0	-1.1	76.9		P-1
PIPER PA-31-350 CHIEFTAIN	7.0 7.0	LYCOMING TIO-540-J2BD	2	315 2400 4	HARTZELL HC-E3YR-2ATF FC8468-6R	80 2400	3	V	175	78.0	0.9	78.9		P-1
PIPER PA-31P COMANCHERO	7.8 7.8	PRATT&WHITNEY PT6A-135	2	620 3810 4	HARTZELL HC-B3TN-3C/T10178-8R	93 1900	3	V	215	76.5	-5.0	71.5		SN
PIPER PA-31T CHEYENNE II	9.0 9.0	PRATT&WHITNEY PT6A-28	2	620 3810 4	HARTZELL HC-B3TN-3B/T-10173B-8	93 2000	3	V	231	79.2	-5.0	74.2		EA
PIPER PA-31T-62 CHEYENNE II	9.0 9.0	PRATT&WHITNEY PT6A-28	2	620 3810 4	HARTZELL HC-B3TN-3B	93 2000	3	V	231	78.2	-4.0	74.2		SO
PIPER PA-31T1 CHEYENNE II	8.7 8.7	PRATT&WHITNEY PT6A-11	2	455 3810 4	HARTZELL HC-B3TN-3B/T-10173B-8	93 2000	3	V	206	76.6	-1.6	75.0		EA,P-1
PIPER PA-31T2 CHEYENNE II XL	9.5	PRATT&WHITNEY PT6A-135	2	620 3810 4	HARTZELL HC-B3TN-3B/T-10173B-8	93 1900	3	V	231	79.2	-2.1	77.1		P-1
PIPER PA-31T3 T-1040	9.0	PRATT&WHITNEY PT6A-11	2	455 3810 1	HARTZELL HC-B3TN-3B/T-10173K-8R	93 2200	3	V	214	76.6	-1.0	75.6		NE

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW LW 1000#	ENGINE MAKE,MODEL	NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
PIPER PA-32-300 CHEROKEE SIX	3.4 3.4	LYCOMING IO-540-K1A5	1	300 2700	HARTZELL HC-C2YR-1( )F/F8475D-4	80 2700	2	V		80.5	-1.2	79.3		SO,A-1
PIPER PA-32-301 SARATOGA	3.6 3.6	LYCOMING IO-540-K1G5	1	300 2700 5	HARTZELL HC-C3YR-1( )F/F7663R-0	78 2700	3	V	152	78.1	-0.6	77.5		P-1
PIPER PA-32-301 SARATOGA	3.6 3.6	LYCOMING IO-540-K1G5D	1	294 2600 5	HARTZELL HC-C2YR-1( )F/F8475D-4	80 2600	2	V	152	77.3	-0.6	76.7		P-1
PIPER PA-32-301T TURBO SARATOGA	3.6 3.6	LYCOMING TIO-540-S1AD	1	300 2700 4	HARTZELL HC-E3YR-1( )F/F7673DR	78 2700	3	V	150	76.1	-1.3	74.8		P-1
PIPER PA-32-301T TURBO SARATOGA	3.6 3.6	LYCOMING TIO-540-S1AD	1	294 2575 4	HARTZELL HC-E2YR-1( )F/F8477-4	80 2575	2	V	150	75.7	-1.3	74.4		P-1
PIPER PA-32R-301 SARATOGA SP	3.6 3.6	LYCOMING IO-540-K1G5D	1	294 2600 5	HARTZELL HC-C2YR-1( )F/F8475D-4	80 2600	2	V	152	77.3	0.3	77.6		P-1
PIPER PA-32R-301 SARATOGA SP	3.6 3.6	LYCOMING IO-540-K1G5D	1	300 2700 5	HARTZELL HC-C3YR-1( )F/F7663R-0	78 2700	3	V	152	78.1	0.3	78.4		P-1
PIPER PA-32R-301T TURBO SARATOGA	3.6 3.6	LYCOMING TIO-540-S1AD	1	294 2575 4	HARTZELL HC-E2YR-1( )F/F8477-4	80 2575	2	V	150	75.7	0.4	76.1		P-1
PIPER PA-32RT-300 TURBO LANCE II	3.6 3.6	LYCOMING IO-540-S1AD	1	300 2700	HARTZELL HC-E2YR-1BF/F8477-4	80 2400	2	V		75.4	0.0	75.4		SO

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN
SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW LB 1000#	ENGINE MAKE,MODEL	NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE LEVELS dBA NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
PIPER PA-34-200T SENECA II	4.6 4.3	LYCOMING TSIO-360-E	2	200 2575 4	HARTZELL FC8459-8R/FJC8459-8R	76 2575	2	V	170	75.7	-2.2	73.5		SO
PIPER PA-34-200T SENECA II	4.6 4.3	TELEDYNE TSIO-360-E/EB	2	200 2575 4	MCCAULEY 80HA-4/L80HA-4	76 2575	3	V	169	78.6	-2.2	76.4		SO
PIPER PA-34-220T SENECA III	4.7 4.5	CONTINENTAL TSIO-360-KB	2	200 2600 4	HARTZELL BHC-C2YF-2CKUF/FCC8459-8R	76 2600	2	V	176	74.2	-2.8	71.4		SO,P-1
PIPER PA-34-220T SENECA III	4.7 4.5	CONTINENTAL TSIO-360-KB	2	200 2600 4	MCCAULEY 3AF32C508/82NFA-6	76 2600	3	V	169	77.0	-2.8	74.2		SO,P-1
PIPER PA-38-112 TOMAHAWK	1.7 1.7	LYCOMING O-235-L2C	1	112 2600 5	SENSENICH 72CK-0-56	72 2600	2	F	105	67.8	0.0	67.8		P-1
PIPER PA-42 CHEYENNE III	11.2 10.2	PRATT+WHITNEY PT6A-41	2	720 2000 4	HARTZELL HC-B3TN-3B/T10173AB-6Q	95 2000	3	V	230	80.3	-3.5	76.8		P-1
PIPER PA-42-1000 CHEYENNE IV	12.1 11.1	GARRETT TPE331-14A-801Y	2	1000 1540 4	DOWTY ROTOL R339/4-123-F/8RH R341/4----LR	106 1540	4	V		75.1	-5.0	70.1		CE
PIPER PA-44-180 SEMINOLE	3.8 3.8	LYCOMING O-360-E1D	2	180 2700 2	HARTZELL HC-C3YR-2EUF/FC-7663-5R	73 2700	3	V	168	77.2	-2.5	74.7		P-1
PIPER PA-44-180T TURBO SEMINOLE	3.9 3.8	LYCOMING TO-360-E1A6D	2	180 2575 4	HARTZELL HC-C3YR-2EUF FC-7663-5R	73 2575	3	V	162	74.7	-2.3	72.4		P-1

APPENDIX
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN
SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW LB 1000#	ENGINE MAKE,MODEL	NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE LEVELS dBA NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
PIPER PA-44-180T TURBO SEMINOLE	3.9 3.8	LYCOMING TO-360-E1A6D	2	180 2575 4	HARTZELL HC-C2YR-2CUF FC7666A-2R	74 2575	2	V	162	73.8	-2.3	71.5		P-1
PIPER PA-46-310P MALIBU	3.9	CONTINENTAL TSIO-520-BE		310 2600 4	HARTZELL BHC-C2YF-1BF/F8052	80	2	V	174	74.5	0.0	74.5		SO
PIPER PA-60-700P AEROSTAR	6.3	LYCOMING TIO-540-U2A	2	350 2500 4	HARTZELL HC-C3YR-2UF/FC7451	76 2500	3	V	217	80.8	-1.9	78.9		SO
PIPER PA-600A AEROSTAR	5.5 5.5	LYCOMING IO-540-K1J5	2	284 2520	HARTZELL HC-C3YR-2UF FC-8486-10Q	[illegible] 2520	3	V		82.4	-2.4	80.0		P-1
PIPER PA-601P AEROSTAR 601P	6.0 6.0	LYCOMING IO-540-S1A5/-P1A5	2	290 2575	HARTZELL HC-C3YR-2/C8468-8R	78	2	V		81.5	-1.7	79.8		SO
PIPER PA-602P AEROSTAR PRESS.	6.0 6.0	LYCOMING IO-540-AA1A5	2	290 2425 4	HARTZELL HC-3YR-2UF/FC8468-8R	78 2425	3	V	208	81.9	-2.6	79.3		P-1
SIAI MARCHETTI F-260C	2.4 2.4	AVCO LYCOMING AEIO-540-D4A5	1		HARTZELL HC-C2YK-1BF	76 2700		V				73.2		EU
SIAI MARCHETTI SF 600 CANGURO	7.5 7.5	ALLISON 250-B17C	2		HARTZELL HC-B3TF-7A/T10173-11R	90 2030	3	V				74.3		EU
SIAI-MARCHETTI SF260 TURBO PROP	2.6 2.6	ALLISON 250-B17D		320 4	HARTZELL HC-B3TF-7A	76 2030	3		187	77.8	-5.0	72.8		CE

APPENDIX 7
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES
(FAR PART 36, APPENDIX F)

AIRCRAFT MAKE,MODEL	MTOW LB (1000)	ENGINE MAKE,MODEL	NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE LEVELS dBA NOISE MEAS.	PERF CORR.	CORR. LEVEL	NOTES	REF.
SOCATA TB 10 TOBAGO	2.5 2.4	LYCOMING O-360-A1-AD	1	180 2700	HARTZELL HC-C2YK-1BF/F 7666A2	74 2700	2	V	123			70.7		EU
SOCATA TB 20 TRINIDAD	3.1 2.9	LYCOMING IO-540-C4D5D	1	250 2575	HARTZELL HC-C2YK-1BF/F 8477-4	80 2575	2	V	95			74.0		EU
SOCATA TB 21 TRINIDAD TC	3.1 2.9	LYCOMING IO-540-AB1AD	1	310 2575	HARTZELL HC-C2YK-1BF/F 8477-4	80 2575	2	V	95			75.4		EU
SOCATA TB 9 CLUB	2.3 2.3	LYCOMING O-320-D2A	1	160 2700	SENSENICH 74 DM 658-0-54	74 2700	2	F	135			72.2		EU
TAYLORCRAFT BC-12D	1.2 1.2	AVCO LYCOMING IO-360-E2A	1	118 2500 3	HENDRICKSON H73-A50	71 2500	2	F	105	72.6	-5.0	67.6		SW
TAYLORCRAFT F-19	1.5 1.5	CONTINENTAL O-200-A	1	100 2750 5	MCCAULEY 1A105/SCM6950	69 2750	2	F		69.1	-0.7	68.4		GL
TAYLORCRAFT F-21	1.5 1.5	LYCOMING O-235-L2C	1	112 2600 5	SENSENICH 72CK-0-56	71 2600	2	F	96	69.0	-0.2	68.8		GL
TRIDENT TR-1	3.8 3.8	TELEDYNE TIARA 6-285-C1	1	232 4000 7	HARTZELL HC-E3YP-3LF/FL-C9684-12	84 4000	3	V	122	78.2	-1.0	77.2		EA

APPENDIX 7 REFERENCES

A-1 : ADVISORY CIRCULAR 36-1B 12/5/77
AA : ACOUSTICAL ANALYSIS ASSOCIATES
B-1 : BEECH
BA : BRITISH AEROSPACE
CE : CENTRAL REGION
EA : EASTERN REGION
G-1 : GAMA DATA 2/27/81 (ADDITIONAL DATA)
G-2 : GAMA DATA 2/27/81 (CORRECTIONS)
G-3 : GAMA DATA 8/15/81
GL : GREAT LAKES REGION
NE : NEW ENGLAND REGION
NM : NORTHWEST MOUNTAIN REGION
P-1 : PIPER DATA 6/31/81
S-1 : CESSNA DATA
SO : SOUTHERN REGION
SW : SOUTHWEST REGION

APPENDIX 7 NOTES

1 MAXIMUM TAKEOFF WEIGHT GREATER THAN 12,500 LBS. - AIRCRAFT CERTIFICATED TO FAR PART 41 OR FAR PART 23 COMMUTER CATEGORY

EXHAUST CONFIGURATIONS (RECIPROCATING ENGINES)

1 STUB PIPES
2 SMALL COLLECTOR, SHORT EXHAUST PIPE
3 BAFFLES IN COLLECTOR AND/OR CONES IN EXHAUST PIPE
4 TURBINE OR TURBOCHARGER
5 HEAT MUFF
6 COLLECTOR WRAPAROUND MANIFOLD STRAIGHT PIPE
7 MANIFOLD MUFFLER
8 RESONATOR MUFFLER

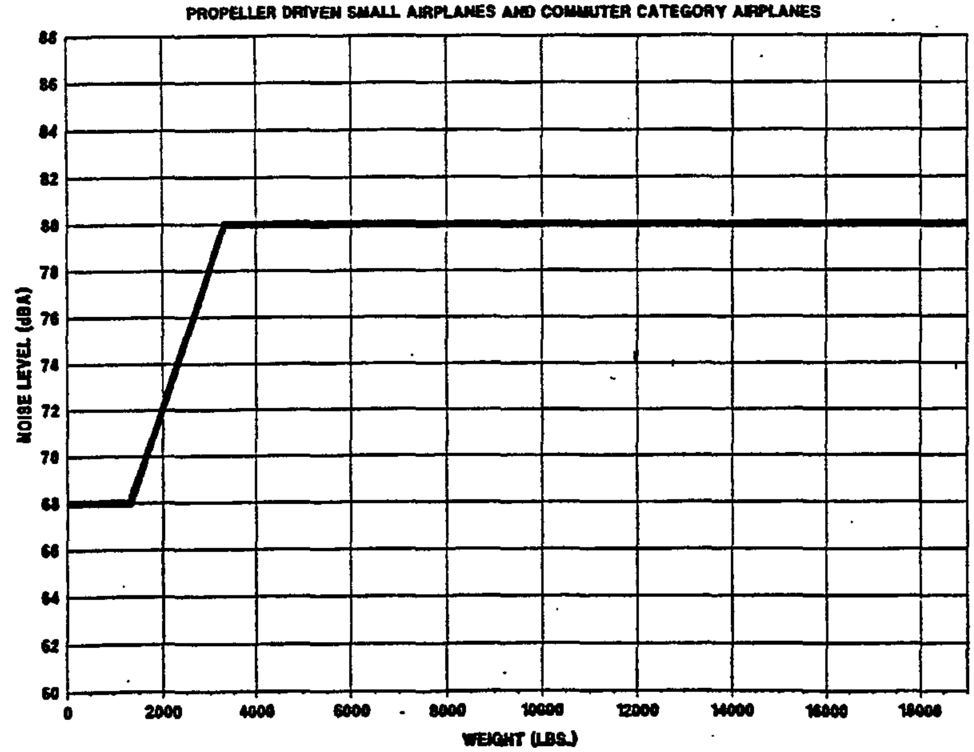
EQUATIONS FOR THE CALCULATION OF NOISE CERTIFICATION LIMITS FOR PROPELLER DRIVEN SMALL AIRPLANES AND COMMUTER CATEGORY AIRPLANES

Application for Type Certification on or After January 1, 1975

UP TO AND INCLUDING 1,320 LBS.	68 dB(A)
OVER 1,320 LBS. UP TO AND INCLUDING 3,300 LBS.	dB(A) limit = 68 +(W-1320)/165
OVER 3,300 LBS.	80 dB(A)

W = TAKEOFF GROSS WEIGHT IN POUNDS

NOISE CERTIFICATION REQUIREMENTS - FAR PART 36, APPENDIX F
PROPELLER DRIVEN SMALL AIRPLANES AND COMMUTER CATEGORY AIRPLANES



APPENDIX 8
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES AND COMMUTER CATEGORY AIRPLANES
(FAR PART 36, APPENDIX G)

AIRCRAFT MAKE	AIRCRAFT MODEL	MTOW LB 1000S	ENGINE MAKE, MODEL	ENGINE NO	SHP RPM	PROPELLER MAKE, MODEL	DIAM (IN) RPM	BLADES	FIX/VAR PITCH	NOISE LEVEL dBA	NOTES	REFERENCE
CESSNA	208/208A CARAVAN	8.0 / 8.0	PRATT & WHITNEY PT6A-114	1	600	MCCAULEY 3GFR34C703-X/Z-106GA-C	106.0 / 1900	3	V	81.6		CE
CESSNA	208B CARAVAN	8.8 / 8.0	PRATT & WHITNEY PT6A-114	1	600	MCCAULEY 3GFR34C703-X/Z-106GA-C	106.0 / 1900	3	V	84.2		CE
CESSNA	208B CARAVAN	8.8 / 8.8	PRATT & WHITNEY PT6A-114A	1	675	MCCAULEY 3GFR34C703-X/Z-106GA-C	106.0 / 1900	3	V	82.7		CE
CESSNA	208B CARAVAN	8.8 / 8.8	PRATT & WHITNEY PT6A-114A	1	675	HARTZELL HCBCN03/M10083	100.0 / 1900	3	V	80.1		CE
CESSNA	TU206G(WIPAIRE)	3.8	CONTINENTAL TCM TSIO-520M	1		MCCAULEY D3A34C402/90DFA-10	80.0 / 2700	3	V	82.0		CE
CESSNA	U206F(WIPAIRE)	3.8 / 3.8	CONTINENTAL TCM IO-550-F	1		MCCAULEY D3A34C402/90DFA-10	80.0 / 2700	3	V	84.3		CE
CESSNA	U206G(WIPAIRE)	3.8 / 3.8	CONTINENTAL TCM IO-550-F	1		MCCAULEY D3A34C402/90DFA-10	80.0 / 2700	3	V	84.3		CE
DORNIER COMP.	SEASTAR CD 2 SEASTAR	10.1 / 9.9	PRATT & WHITNEY PT6A-135A	2		MCCAULEY 4HFR34C760/4HFR34C761	94.5 / 1900	4	V	78.5		EU
FAIRCHILD	SA227-DC METRO 23	16.5 / 15.7	GARRETT TPE331-12UA/AR701G	2		MCCAULEY 4HFR34C652X/X-L106LA-0	106.0 / 1591	4	V	80.9		SW
GYROFLUG-INGENIEUR	SC 01 B-160	1.6 / 1.6	LYCOMING O-320 D1A	1	153 / 2500	MT-PROPELLER MTV-6-C/LD 152-07	60.3 / 2500	3	V	72.0		AA
MOONEY	M20M	3.4 / 3.4	LYCOMING TIO-540-AF1A	1	270 / 2575	MCCAULEY B3D32C417/G82NHA07	75.0 / 2575	2	V	74.0		SW

APPENDIX 8
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED PROPELLER DRIVEN SMALL AIRPLANES AND COMMUTER CATEGORY AIRPLANES
(FAR PART 36, APPENDIX G)

AIRCRAFT MAKE	AIRCRAFT MODEL	MTOW LB 1000S	ENGINE MAKE, MODEL	ENGINE NO	SHP RPM	PROPELLER MAKE, MODEL	DIAM (IN) RPM	BLADES	FIX/VAR PITCH	NOISE LEVEL dBA	NOTES	REFERENCE
PIAGGIO	P. 180 AVANTI	10.8 / 10.8	PRATT & WHITNEY PT6A-66	2		HARTZELL [illegible]	85.0 / 2000	5	V	81.9		ID

APPENDIX 8 REFERENCES

AA	:	ACOUSTICAL ANALYSIS ASSOCIATES
CE	:	CENTRAL REGION
EU	:	EUROPEAN REGION
SW	:	SOUTHWEST REGION

EQUATIONS FOR THE CALCULATION OF NOISE CERTIFICATION LIMITS FOR PROPELLER DRIVEN SMALL AIRPLANES AND COMMUTER CATEGORY AIRPLANES

	FAR Part 36, Appendix G Noise Limit (dBA)
UP TO AND INCLUDING 1,320 LBS.	73
OVER 1,320 LBS. TO 3,300 LBS.	73 +(W-1320)/165
OVER 3,300 LBS.	85

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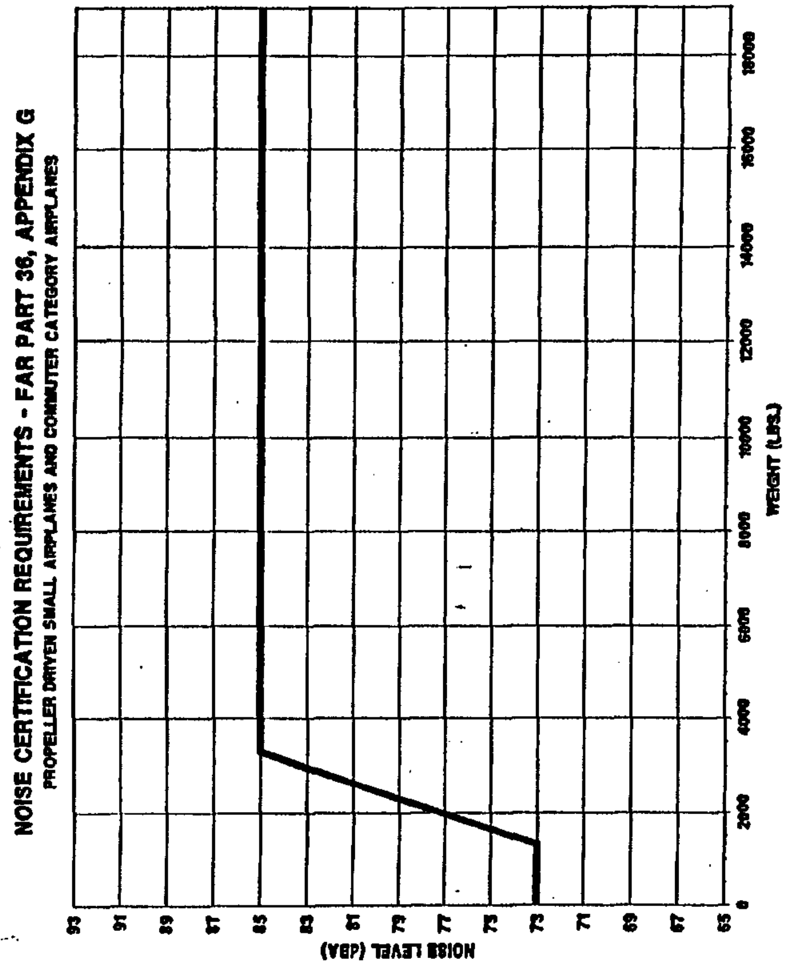

NOISE CERTIFICATION REQUIREMENTS - FAR PART 36, APPENDIX G
PROPELLER DRIVEN SMALL AIRPLANES AND COMMUTER CATEGORY AIRPLANES
NOISE LEVEL (dBA)
93
91
89
87
85
83
81
79
77
75
73
71
69
67
65
WEIGHT (LBS.)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000

213

APPENDIX 9
AIRCRAFT NOISE DATA FOR FOREIGN CERTIFICATED PROPELLER DRIVEN SMALL AIRCRAFT

AIRCRAFT MAKE / MODEL / POPULAR NAME	MTOW LB (1000)	ENGINE MAKE, MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE, MODEL	DIAM (IN) RPM	BLADES	FIX/VAR PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
A. SCHLEICHER ASK 16	1.6	LIMBACH L2000-EB-1	1	74	HOFFMANN HO-V62R/L160T	63 2700	2	V	86	60.	-1.3	58.7		I-0
AIRCONCEPT VONI-10	0.7	LIMBACH SL-1700-EA	1	59	HOFFMANN HO-11-150B65L	59 3100	2	F	62	64.1	-1.3	62.8		I-0
AKA-FLIEG STUTTGART FS-28 AVISPA	2.0	LYCOMING IO-360-B17	1	181	HOFFMANN HO-V-132K-X/LD210	78 2200	2	V	114	72.1	-1.6	70.6		I-0
ALPLA-WERKE AVO-68R	1.5	LIMBACH SL-1700-EI	1	59	HOFFMANN HO-11-150B75L	59 3025	2	F	78	62.8	1.8	64.6		I-0
ALPLA-WERKE AVO-68S	1.5	LIMBACH SL-1700-EI	1	59	HOFFMANN HO-11-150B-75L	59 3125	2	F	82	64.1	1.8	65.9		I-0
BEECH B76 DUCHESS	4.0	LYCOMING O-360-A1G6D	2	165 2700 1	HARTZELL HC-M2YR-2CLUF/FC7666A	76 2700	2	V	160	79.5	-2.3	77.2		I-1,G-3
BEECH (EXCALIBUR) 65-880 QUEEN AIR	8.8 8.8	LYCOMING IO-720-A1B	2	2400	HARTZELL HC-A3VK-2/V8433N-2R	2400	3	V	115	77.0	-0.7	76.3		I-6
BRITTEN-NORMAN BN2-A-6	6.3	LYCOMING O-540-	2	256	HARTZELL HC-C2YK-2CF/FC8477A-4	79 2650	2	V	139	82.3	-3.7	78.6		I-0
BUCKER (UNBAU) BU 131	1.5	LYCOMING AIO-320-C1B	1	153	HOFFMANN HO-23 A-180 125	74 2600	2	F	89	69.6	-6.2	64.6		I-0

APPENDIX 9
AIRCRAFT NOISE DATA FOR FOREIGN CERTIFICATED PROPELLER DRIVEN SMALL AIRCRAFT

AIRCRAFT MAKE / MODEL / POPULAR NAME	MTOW LB (1000)	ENGINE MAKE, MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE, MODEL	DIAM (IN) RPM	BLADES	FIX/VAR PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
CASA 1.131E S2000	1.6	ENMASA TIGRE G-IV-B	1	118	ENMASA BC 212.111	83 2070	2	F	116	67.		67.		I-0
CASA 1.131E S2000	1.6	LYCOMING AEIO-360-B2F	1	170	HOFFMANN HO-27 HM-180D	78 2500	2	F	105	71.4	-5.	66.4		I-0
CASA SPANIER 1.131-E	1.6	TIGER ENMASA G-IV-A2	1	99	ENMASA BC-212-111	83 1850	2	F	96	71.4	-1.8	69.6		I-0
DEHAVILLAND DH6-300	12.6 12.35	PRATT+WHITNEY PT6A-27	2	620 2112	HARTZELL HC-B3TN-3D	102 2112	3	V	167	82.3	-4.9	77.4		I-4
DORNIER 228-101	13.1	GARRETT TPE331-5-252D	2		HARTZELL HC-B4TN-5NL/LT10574	107	4					75.3		I-0
DORNIER 228-201	13.1	GARRETT TPE331-5-252D	2		HARTZELL HC-B4TN-5NL/LT10574	107	4					75.3		I-0
DORNIER DO-28-D	9.6	PRATT+WHITNEY PT-6A-110	2	399	HARTZELL HC-B-3TN-3D	100 1900	3	V	147	70.8	-5.	65.8		I-0
FOKKER F-149D	2.6	AVCO LYCOMING GO-480-B1A6	1	260	HARTZELL HC-A3V20-1B/V8433SP	85 1926	3	V	136	68.8	-0.1	68.7		I-0
FUJI HEAVY IND. FA-200-180	2.5	LYCOMING IO-360-B1B	1	180	MCCAULEY B2D34-C53/74E-0	74 2670	2	V	110	73.1	0.5	73.6		I-0

APPENDIX 9
AIRCRAFT NOISE DATA FOR FOREIGN CERTIFICATED PROPELLER DRIVEN
SMALL AIRCRAFT

AIRCRAFT MAKE MODEL POPULAR NAME	MTOW LB 1000S	ENGINE MAKE, MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE, MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
GREAT LAKES 2T-1A-2	1.8	LYCOMING AEIO-360-B1G6	1	177	HARTZELL HC-C2YK-4BF	74 2700	2	V	91	74.4	-5.	69.4		I-0
GULFSTREAM AMERICAN AA-1A TRAINER	1.5	LYCOMING O-235-C2C	1	108 2500	MC CAULEY SCM1A105/7154	71 2500	2	F	105	68.3	0.3	68.6		I-5
GULFSTREAM AMERICAN AA-5A CHEETAH	2.2	LYCOMING O-320-E2G	1	150 2680	MC CAULEY 1C172/BTM7359	73 2680	2	F	113	73.3	-0.6	72.7		I-5
LEICHTFLUG-TECHNIK LFU-205	2.7	LYCOMING IO-360-A1C	1	197	HARTZELL HC-C2YK-1B/F7666A-2	74 2680	2	V	147	72.9	0.1	73.		I-0
LET KUNOVICE BLANIK-L-13M	1.3	VW VW 1500-FR	1	50	HOFFMANN HO-11-130B-100D	51 3600	2	F	83	59.5		59.5		I-0
MBB BO-208 JUNIOR	1.4	CONTINENTAL O-200-A	1	99	MCCAULY 1A-100MCM-6955	69 2700	2	F	106	67.3		67.3		I-0
MBB BO-208 JUNIOR	1.4	CONTINENTAL O-200-A	1	69	MCCAULY 1A-100MCM-6950	69 2750	2	F	105	66.9		66.9		I-0
MBB BO-208 JUNIOR	1.4	CONTINENTAL O-200-A	1	99	MCCAULY 1A-100MCM-6758	67 2750	2	F	110	67.5	-1.	66.5		I-0
MBB BO-209 MONSUN	1.8	LYCOMING O-320-E1F	1	147	HARTZELL HC-C2YL-1B/7663A-6 'Pa	76 2700	2	V	120	70.7	-1.6	69.1		I-0

APPENDIX 9
AIRCRAFT NOISE DATA FOR FOREIGN CERTIFICATED PROPELLER DRIVEN
SMALL AIRCRAFT

AIRCRAFT MAKE MODEL POPULAR NAME	MTOW LB 1000S	ENGINE MAKE, MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE, MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
MBB BO-209 MONSUN	1.8	LYCOMING IO-320-D1A	1	157	HARTZELL HC-C2YL-1B/7663-5P	76 2700	2	V	127	70.8	-3.2	67.6		I-0
MBB BO-209-FP MONSUN	1.8	LYCOMING O-320-E2F	1	147	MCCAULY 1C-172MGM70-5-66	70 2680	2	F	126	70.6	-0.9	69.7		I-0
MBB SIAT 223	2.3	LYCOMING IO-360-C1D6	1	197	HARTZELL HC-C2YK-1BF	76 2700	2	V	111	72.8		72.8		I-0
MORANE SAULNIER MS-885	1.9	CONTINENTAL O-300-A	1	145	MCCAULY 1C-172MDM-7652	76 2400	2	F	96	71.3	-0.3	70.3		I-0
MORAVAN CSSR ZLIN 43	3.0	MORAVAN M337A	1	160	AVIA-PRAHA V500A	79 2600	2	V	104	71.7	1.4	73.1		I-0
MUDRY CAARP CAP 10	1.8	LYCOMING IO 360 B2F	1	241 2700	HOFFMANN HO 29 HM 00170	71 2700	2	F		67.		67.		I-1
PARTENAVIA P 68 B VICTOR	4.3	LYCOMING IO-360-A1B6	2	200 2700	HARTZELL HC-C2YK-2CF/FC7666A-4	72 2600	2	V		79.6	-5.	74.6		I-0
PILATUS BRITTEN BN 2A-2 ISLANDER	6.3	LYCOMING IO-540-K1B5	2	300 2500 6	HARTZELL HC-C2YK-2CF/FC8477A-4	80 2500	2	V	147	80.7	-5.	75.7		I-5
PILATUS BRITTEN BN-2T [illegible] ISLANDER	6.6	ALLISON 250-B17C	2	320 3	HARTZELL HC-C3YF-5/FC8475-4	80 2030	3	V	146	72.3	-4.1	68.2		I-5

APPENDIX 9
AIRCRAFT NOISE DATA FOR FOREIGN CERTIFICATED PROPELLER DRIVEN SMALL AIRCRAFT

AIRCRAFT MAKE MODEL POPULAR NAME	MTOW LB 10000	ENGINE MAKE,MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
PILATUS BRITTEN BN2A MKIII-2 TRISLANDER	9.5	LYCOMING O-540-EAC5	3	260 2500 4	HARTZELL HC-C2YK-CUF/FC8477A-6	78 2500	2	V	151	79.4	-2.	77.4		I-5
PILATUS BRITTEN BN2A MKIII-2 TRISLANDER	9.5	LYCOMING O-540-EAC5	3	260 2500 4	HARTZELL HC-2CYK-2CUF/FC8477A-4	80 2500	2	V	152	80.	-2.	78.		I-5
PILATUS BRITTEN BN2A MK. III-3 TRISLANDER	10.0	LYCOMING O-540-E4C5	3	260 2500 4	HARTZELL HC-C2YK-2CUF/FC8477A-6	78 2500	2	V	151	79.4	-0.9	78.5		I-5
PILATUS BRITTEN BN2A MKIII-3 TRISLANDER	10.0	LYCOMING O-540-EAC5	3	260 2500 4	HARTZELL HC-C2YK-2MF/FC8477A-4	80 2500	2	V	152	80.	-0.9	79.1		I-5
PILATUS BRITTEN BN2A-2 ISLANDER	6.3	LYCOMING IO-540-K1B5	2	300 2500 4	HARTZELL HC-C2YK-2CF/FC8477A-6	78 2500	2	V	146	77.9	-5.	72.9		I-5
PILATUS BRITTEN BN2A-21 TRISLANDER	6.6	LYCOMING IO-540-K1B5	2	300 2500 4	HARTZELL HC-C2YK-2CF/FC8477-6	78 2500	2	V		77.9	-4.	73.9		I-5
PILATUS BRITTEN BN2A-21 TRISLANDER	6.6	LYCOMING IO-540-K1B5	2	300 2500 4	HARTZELL HC-C2YK-2CF/FC8477A-4	80 2500	2	V	147	80.7	-4.	76.7		I-5
PILATUS-PORTER PC-6C1-H2/PC-6T	4.8	AIRESEARCH TPE331-1-100	1	576	HARTZELL HC-B3TN-5C/T10178C/-CH	102 2000	3	V	102	74.6	-5.	69.6		I-8
PIPER PA-20-150	2.2	LYCOMING O-320-E2A	1	2700	SENSENICH M74-DM-58	74 2700	2	F	103	70.6	0.9	71.5		I-5

APPENDIX 9
AIRCRAFT NOISE DATA FOR FOREIGN CERTIFICATED PROPELLER DRIVEN SMALL AIRCRAFT

AIRCRAFT MAKE MODEL POPULAR NAME	MTOW LB 10000	ENGINE MAKE,MODEL	ENGINE NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
POLISH PZL-104 WILGA	2.9 2.87	PZL-FRANKLIN AI-14R	2	260 2050 2	US 122	104 1620	2	V	93	72.3	-3.8	68.5		I-2
POLISH PZL-104 W/ T-05 WILGA	2.9 2.87	PZL-FRANKLIN AI-14R	2	260 2050 5	US 122	104 1620	2	V	92	65.4	-3.8	61.6		I-2
POLISH PZL-110 KOLIBER	2.7 1.7	PZL-FRANKLIN 4A.235 B	2	125 2050 2	US 135	70 2000	2	F		67.	2.8	69.8		I-2
REIMS AVIATION F 152 II	1.7	LYCOMING O235 L2C	1	109 2550	MCCAULEY 1A 103/TCM 6958	69 2550	2	F	120	65.7	-1.	64.7		I-2
REIMS AVIATION F 172 K	2.3	LYCOMING C 320 E2D	1	150 2700	MCCAULEY 1C 16//DTM 7357	75 2700	2	F	124	72.7	1.2	73.9		I-1
REIMS AVIATION F 172 N	2.3	LYCOMING C 320 H2AD	1	160 2700	MCCAULEY 1C 160/DTM 7557	75 2700	2	F	124	73.4	-0.1	73.3		I-1
REIMS AVIATION F 182 P	3.0	CONTINENTAL O 470 S	1	230 2600	MCCAULEY 2A 34C 66	82 2600	2	V	142	77.4	-1.4	76.		I-1
REIMS AVIATION F 182 Q	3.0 2.95	CONTINENTAL O470 U	1	230 2400	MCCAULEY 2A 34C 204	82 2400	2	V	150	72.1	-2.4	69.7		I-1
REIMS AVIATION FR 172K	2.6	CONTINENTAL IO 360 K	1	195 2600	MCCAULEY 2A 34C 203	77 2600	2	V	129	73.2	-1.1	72.1		I-1

APPENDIX 9
AIRCRAFT NOISE DATA FOR FOREIGN CERTIFICATED PROPELLER DRIVEN
SMALL AIRCRAFT

AIRCRAFT MAKE MODEL POPULAR NAME	MTOW LB 1000	ENGINE MAKE,MODEL	ENGINE NO.	SHP RPM ENG	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE LEVELS dBA NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
REIMS AVIATION FR 182	3.1	LYCOMING O540J3C5D	1	235 2400	MCCAULEY B2D 34C 214	82 2400	2	V	159	73.1	-2.5	70.6		I-1
ROBIN DR 400/120A PETIT PRINCE	2.0 1.98	LYCOMING O 235 L2A	1	118 2700	MCCAULEY 1A 135 DCM 7150	71 2700	2	F	109	68.2	2.4	70.6		I-1
ROBIN DR 400/160 CHEVALIER	2.3 2.31	LYCOMING O 320 D	1	160 2700	SENSENICH 74 DM 65264	74 2700	2	F	129	72.9	0.3	73.2		I-1
ROBIN DR 400/180 REGENT	2.4 2.43	LYCOMING O 360 A 1A	1	180 2600	SENSENICH 76EM8S5-064	76 2600	2	F	134	72.2	0.9	73.1		I-1
ROBIN DR 400/180R [illegible]	2.2 2.2	LYCOMING O-360 A3A	1	180 2700	SENSENICH 76 EM 855058	76 2700	2	F	117	74.1	-2.5	71.6		I-1
ROBIN DR400/120 PETIT PRINCE	2.0 1.98	LYCOMING O 235-L2A	1	116 2700	SENSENICH 72 CKS-6-056	72 2700	2	F	145	69.6	2.	71.6		I-1
ROBIN HR 100-285 TIARA	3.1 3.09	CONTINENTAL TIARA 6 285 B	1	285 4000	HOFFMANN [illegible]	79	3	V		74.2	-1.3	72.9		I-1
ROBIN R 2112	1.8 1.76	LYCOMING O 235 L2A	1	112 2600	SENSENICH 72 CK 56-056	72 2600	2	F	110	67.3	0.2	67.5		I-1
ROBIN R 2160 ACROBIN	1.8 1.76	LYCOMING O 320 D	1	160 2600	SENSENICH 74DM6S 5264	72 2600	2	F	132	72.4	-2.6	69.8		I-1

APPENDIX 9
AIRCRAFT NOISE DATA FOR FOREIGN CERTIFICATED PROPELLER DRIVEN
SMALL AIRCRAFT

AIRCRAFT MAKE MODEL POPULAR NAME	MTOW LB 1000	ENGINE MAKE,MODEL	ENGINE NO.	SHP RPM ENG	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE LEVELS dBA NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
SAAB FAIRCHILD MFI-15-200A	6.4	LYCOMING IO-360-A1B6	1	197	HARTZELL HC-2CYK-4BF	74 2700	2	V	120	73.8	0.7	74.5		I-8
SCHEIBE FLUGZEUGBAU SF-25C	1.3	LIMBACH SL-1700-EA	1	60	HOFFMANN HO-11-150B-75L	59 2000	2	F	82	58.3	-1.	57.3		I-8
SCHEIBE FLUGZEUGBAU SF-27 M-B	0.9	HIRTH-MOT.BAU 1712R-0R	1	20	HOFFMANN HO-02-120-50	47 4000	2	F	72	67.7	0.2	67.9		I-8
SCHEMPP-HIRTH CM	1.5	[illegible] MOT.BAU [illegible]	1	52	HOFFMANN HO-11 150B-70	62 2000	2	F	73	65.2	1.4	66.6		I-8
SCHEMPP-HIRTH NIMBUS-2M	1.3	SCHEMPP-HIRTH SM-1 (O-2820HX)	1	50	HOFFMANN HO-11 145-000	57 3000	2	F	77	63.6	1.8	65.4		I-8
SHORT BROS. SKYVAN SERIES III	12.6	AIRESEARCH TPE-331-2-201A	2	715	HARTZELL HC-B3TN-5B/T10282HB	98	3	V		81.9	-4.7	77.2		I-3
SLINGSBY T 67A	1.6	LYCOMING O-235-L2A	1	118 2800 2	HOFFMANN HO14-178-120	70 2800	2	F	109	70.9	-2.3	68.6		I-5
SOC.AERONAUT. JODEL D 140R [illegible]	2.7	LYCOMING O-360-A2A	1	177	SENSENICH 76EM8-0-60	76 2700	2	F	112	74.	0.2	74.2		I-8
SOCATA 110 ST [illegible]	1.7	LYCOMING O-235L-2A	1	110 2600	MCCAULEY 1A 103TCM 6958	69 2600	2	F	105	67.6	1.	68.6		I-1

APPENDIX 9
AIRCRAFT NOISE DATA FOR FOREIGN CERTIFICATED PROPELLER DRIVEN
SMALL AIRCRAFT

AIRCRAFT MAKE / MODEL / POPULAR NAME	MTOW LB (1000)	ENGINE MAKE,MODEL	NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
SOCATA 150 ST RALLYE	2.0	LYCOMING O 320 D2A	1	160 2700	SENSENICH M 74 DM 61	74 2700	2	F	64	73.8	-2.2	71.6		I-1
SOCATA 180 T RALLYE	2.2 2.09	LYCOMING O 360 A3A	1	180 2700	SENSENICH 76 EM8 060	76 2700	2	F	64	73.1	-0.8	72.3		I-1
SOCATA 235 E RALLYE	2.7 2.65	LYCOMING O 540 B4B5	1	235 2575	HARTZELL HCC2 YK184696	80 2575	2	V		74.3	-0.7	73.6		I-1
SOCATA 880 B RALLYE	1.7 1.7	ROLLS ROYCE O 200 A	1	100 2750	McCAULEY 1A 101 DCM/6948	67 2750	2	F		68.8		68.8		I-2
SOCATA 893 E RALLYE	2.3 2.32	LYCOMING O 360 A3A	1	185 2700	HOFFMANN HO 27 HM/186 135	73 2700	2	F		71.3		71.3		I-1
SOCATA TB 10 TOBAGO	2.3	LYCOMING O-360-A1AD	1	180 2700	HARTZELL HC-C2YK-1BF-F7666-A2	74 2700	2	V	125	72.4	-0.9	71.5		I-1
SOCATA TB 9 TAMPICO	2.3	LYCOMING O 320 D2A	1	160 2700	SENSENICH 74 DM6 61	74 2700	2	F	121	71.2	1.3	72.5		I-1
SPORTAVIA PUTZ. ELSTER B	1.5	CONTINENTAL C90-12F	1	88	HOFFMANN HO-14-183 100	72 2475	2	F	74	66.		66.		I-8
SPORTAVIA PUTZ. RF-5	1.4	LIMBACH L2100-EIX	1	71	HOFFMANN HO-VR/L-150A	59 3000	2	V	106	63.4	-1.3	62.1		I-8

APPENDIX 9
AIRCRAFT NOISE DATA FOR FOREIGN CERTIFICATED PROPELLER DRIVEN
SMALL AIRCRAFT

AIRCRAFT MAKE / MODEL / POPULAR NAME	MTOW LB (1000)	ENGINE MAKE,MODEL	NO.	SHP RPM EXH	PROPELLER MAKE,MODEL	DIAM (IN) RPM	BLADES	PITCH	TEST SPEED	NOISE MEAS.	PERF CORR	CORR. LEVEL	NOTES	REF.
SPORTAVIA PUTZ. RF6-B	2.0	LYCOMING O-320-A1B	1	150	HOFFMANN HO-23 178-145	70 2700	2	F	118	71.2	-1.1	70.1		I-8
SPORTAVIA PUTZ. RS-180	2.4	LYCOMING O-360-A3A	1	180	HOFFMANN HO-27-HM-180138	70 2500	2	F	110	66.8	-0.9	65.9		I-8
SPORTAVIA PUTZ. RS-180	2.3	LYCOMING O-360-A3A	1	180	McCAULY 1A170/FFA7563	75 2700	2	F	122	73.8		73.8		I-8
WASSMER WA 80	1.8	ROLLS ROYCE O 200 A	1	134 2700	HOFFMANN HO 14.175.113	69 2700	2	F		68.3		68.3		I-1
ZAKLADY SZYBOWCOWE SZD 45 OGAR	1.5	LIMBACH SL-1700-EC	1	59	HOFFMANN HO-11-145 B75D	57 3000	2	F	64	68.9	0.3	69.2		I-8

APPENDIX 9 REFERENCES

I-0	GERMANY 3/1/81
I-1	FRANCE 10/10/90 CAN
I-2	POLAND 1/18/92 CAN
I-3	UNITED KINGDOM 10/10/90 CAN
I-4	CANADA 10/10/90 CAN
I-5	ENGLAND 9/11/91
I-6	AUSTRALIA

EXHAUST CONFIGURATIONS (RECIPROCATING ENGINES)

1: STUB PIPES
2: SMALL COLLECTOR, SHORT EXHAUST PIPE
3: TURBINE OR TURBOCHARGER
4: COLLECTOR W/SPARGONS MANIFOLD STRAIGHT PIPE
5: MANIFOLD MUFFLER

APPENDIX 10
AIRCRAFT NOISE DATA FOR U.S. CERTIFICATED HELICOPTERS
(FAR PART 36, APPENDIX H)

HELICOPTER MAKE MODEL	MGW NGW 1000#	ENGINE NUMBER MAKE,MODEL	ROTOR MAIN NUMBER OF BLADES MAKE,MODEL	ROTOR MAIN DIA. (FT.)	ROTOR TAIL NUMBER OF BLADES MAKE, MODEL	ROTOR TAIL DIA. (FT.)	NOISE LEVEL EPNdB FLY-OVER	NOISE LEVEL EPNdB TAKE OFF	NOISE LEVEL EPNdB APPR.	STAGE	REFERENCE
AEROSPATIALE AS 350 B2	4.96	1 TURBOMECA ARRIEL 1D1	3 AEROSPATIALE 355A31.0001	35.1	2 AEROSPATIALE 355A12.0031 OR 0040	6.1	87.1	89.8	91.4	2	SW
BELL HELI TEXTRON 412	11.90 6.40	2 PRATT&WHITNEY PT6T-3B	4 BELL HELI TEXT 412-015-300-109	46.0	2 BELL HELI TEXT 212-010-750-105	8.6	92.4	93.2	95.6	2	SW
MCDONNELL DOUGLAS 500N	3.35 3.35	1 ALLISON 250-C20R/2	5 MCDONNELL DOUG 369D21102-503	27.4	N/A		88.2	85.4	87.9	2	NE
SIKORSKY S-76A SN:560WE	10.00 10.80	2 TURBOMECA ARRIEL 1S	4 SIKORSKY 76150-09000/09100	44.0	4 SIKORSKY 76101-05101-041	8.0	92.8	92.5	95.6	2	NE
SIKORSKY S-76C	11.70 11.70	2 TURBOMECA ARRIEL 1S1	4 SIKORSKY 76150-09199-41	44.0	4 SIKORSKY 76101-05501-041	8.0	93.2	94.0	97.7	2	NE

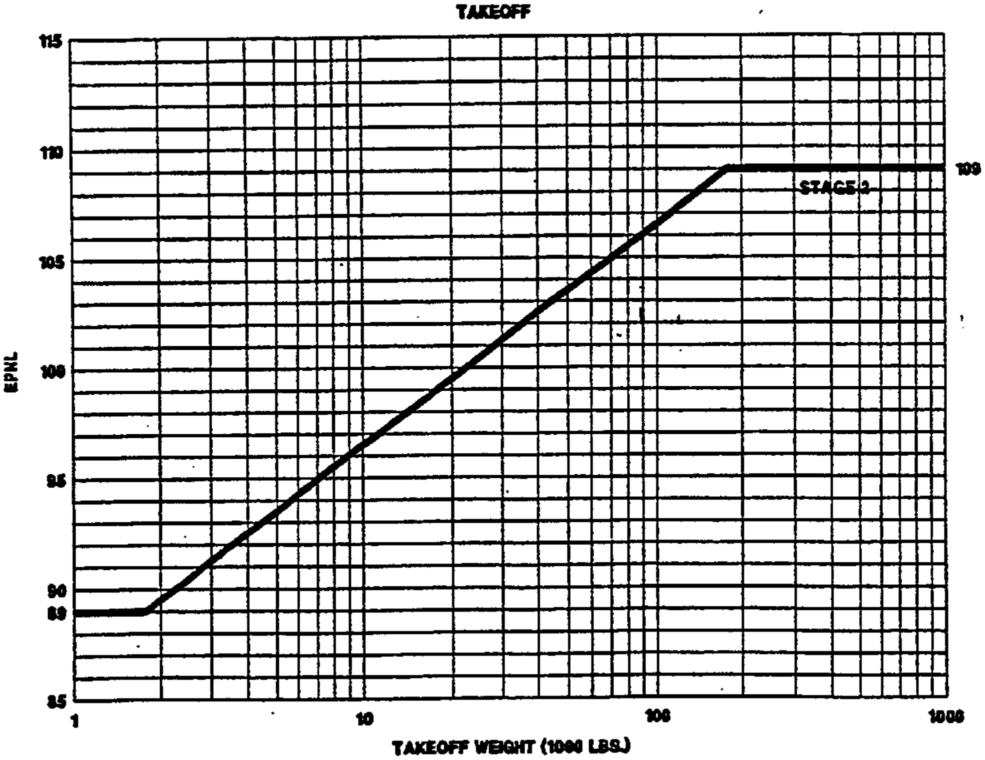
EQUATIONS FOR THE CALCULATION OF NOISE CERTIFICATION LIMITS AT TAKEOFF, SIDELINE, AND APPROACH

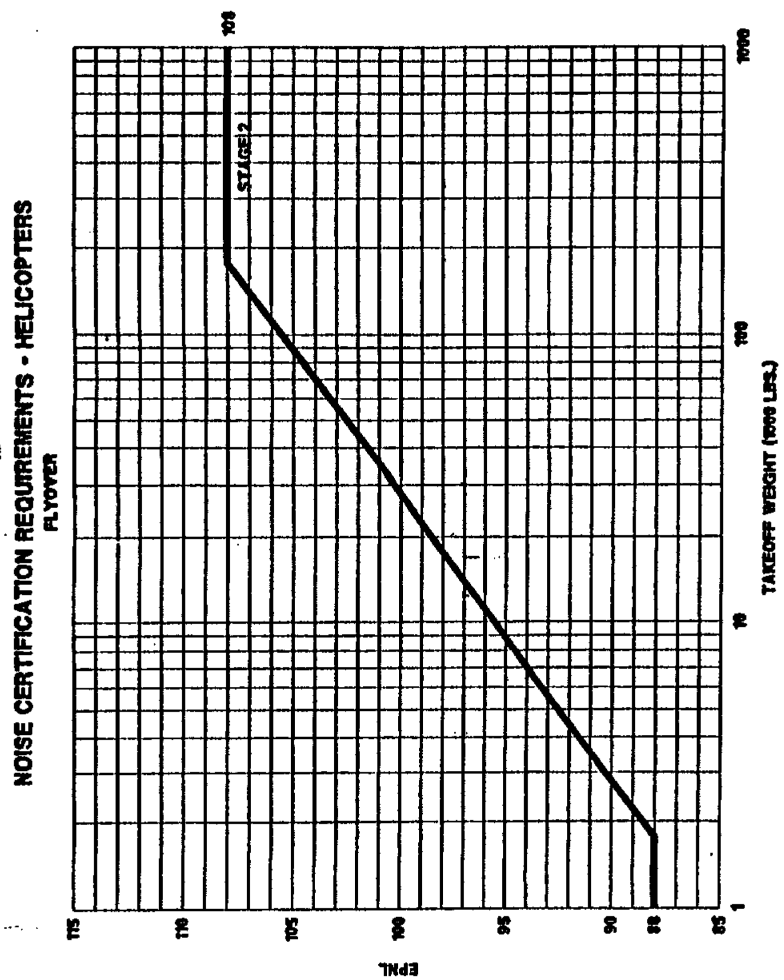
STAGE 2

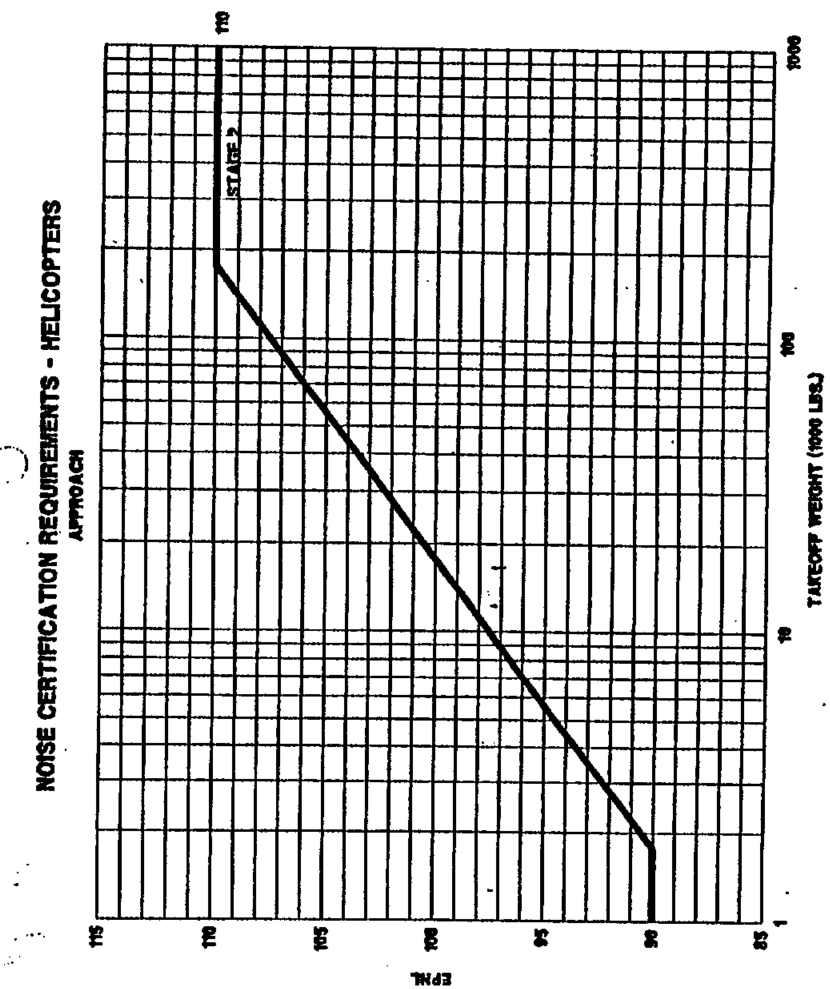
	TAKEOFF LIMITS (EPNdB)	FLYOVER LIMITS (EPNdB)	APPROACH LIMITS (EPNdB)
UP TO AND INCLUDING 1,764 LBS.	89	88	90
OVER 1,764 LBS. TO 176,370 LBS.	$89+3.01\left[\frac{\log \frac{W}{1,764}}{\log 2}\right]$	$88+3.01\left[\frac{\log \frac{W}{1,764}}{\log 2}\right]$	$90+3.01\left[\frac{\log \frac{W}{1,764}}{\log 2}\right]$
OVER 176,370 LBS.	109	108	110

NOISE CERTIFICATION REQUIREMENTS - HELICOPTERS

TAKEOFF




NOISE CERTIFICATION REQUIREMENTS - HELICOPTERS
FLYOVER
STAGE 2
108
TAKEOFF WEIGHT (1000 LBS.)
1
10
100
1000
EPNL
115
110
105
100
95
90
88
85


NOISE CERTIFICATION REQUIREMENTS - HELICOPTERS
APPROACH
STAGE 2
110
TAKEOFF WEIGHT (1000 LBS.)
1
10
100
1000
EPNL
115
110
105
100
95
90
85

APPENDIX 11

DEFINITIONS

The following definitions apply to the column headings of the appendices of Advisory Circular 36-1F:

MGW	Maximum Gross Weight
MTOW	Maximum Takeoff Weight
LW	Landing Weight
BPR	By-pass-ratio
APPR.	Approach
ALT.	The altitude in feet over the takeoff noise measurement station.
SHP	Shaft horsepower (measured during test).
RPM	Engine or propeller evolutions per minute.
EXH	Engine Exhaust configuration.

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PRELIMINARY NOISE ANALYSIS OF THE PROPOSED FAA 4 POST PLAN

NOISE MEDIATION

OPTIONS SUBCOMMITTEE

JANUARY 4, 1990

Content

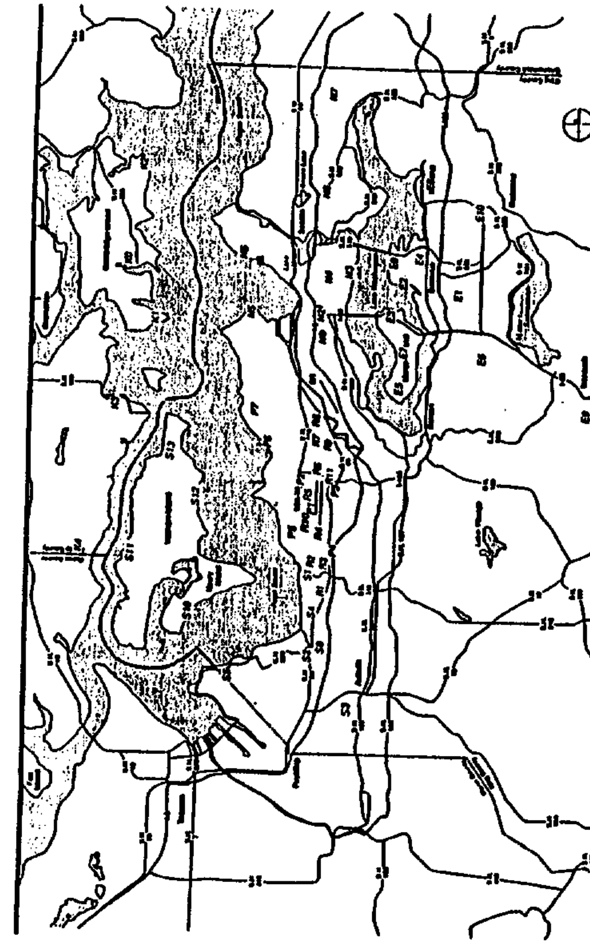
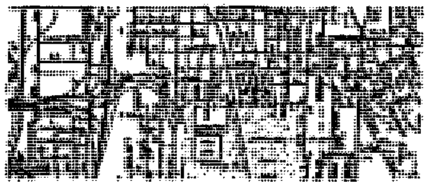


Exhibit 15
Measurement Locations

213

Location NMW/0

Site Description BEACON HILL



NOISE LEVEL DATA	LDN NOISE LEVELS Aircraft Noise Levels	Quiet Day Ambient	TIME ABOVE NOISE LEVELS Time Above dBA (Minutes) 65 dBA	60 dBA	55 dBA
CURRENT PROCEDURES					
Annual Average Day	63.0	60	1	49	130
South Flow Day (Rwy 16)	60.1		0	37	99
North Flow day (Rwy 34)	66.2		3	73	176
4-POST PROCEDURES					
Annual Average Day	63.0		1	49	130
South Flow day (Rwy 16)	59.2		0	37	104
North Flow day (Rwy 34)	66.2		3	73	176

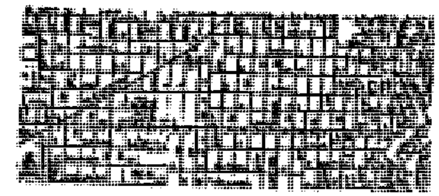
SINGLE EVENT DATA **** 737 AIRCRAFT ****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34
Energy Average SEL		84	91	
Average Peak Sound Level		70	75	

OPERATIONAL DATA ****JETS*****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34	PROPOSED 2-POST PROCEDURES South Flow D16	A16	North Flow D34	A34
Number of Aircraft	.	270	270	.	.	270	270	.

213

Location NMW 4

Site Description CAPITAL HILL



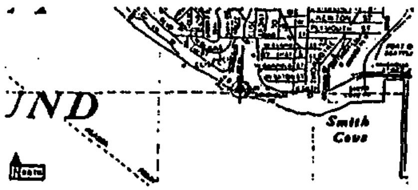
NOISE LEVEL DATA	LDN NOISE LEVELS Aircraft Noise Levels	Quiet Day Ambient	TIME ABOVE NOISE LEVELS Time Above dBA (Minutes) 65 dBA	60 dBA	55 dBA
CURRENT PROCEDURES					
Annual Average Day	54.9	50	0	16	60
South Flow Day (Rwy 16)	51.8		0	7	38
North Flow day (Rwy 34)	57.8		0	33	100
4-POST PROCEDURES					
Annual Average Day	55.2		0	20	73
South Flow Day (Rwy 16)	53.0		0	14	50
North Flow day (Rwy 34)	57.8		0	33	100

SINGLE EVENT DATA	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34
**** 737 AIRCRAFT ****				
Energy Average SEL	.	87	88	.
Average Peak Sound Level	.	69		.

OPERATIONAL DATA ****JETS*****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34	PROPOSED 4-POST PROCEDURES South Flow D16	A16	North Flow D34	A34
Number of Aircraft	.	81	148	.	.	144	181	.

Location NNW/6

Site Description MAGNOLIA/ QUEEN ANN



NOISE LEVEL DATA	LDN NOISE LEVELS Aircraft Noise Levels	Quiet Day Ambient	TIME ABOVE NOISE LEVELS Time Above dBA (Minutes) 65 dBA	60 dBA	55 dBA
CURRENT PROCEDURES					
Annual Average Day	63.1	60	0	10	42
South Flow Day (Rwy 16)	47.7		0	4	31
North Flow day (Rwy 34)	65.5		0	21	63
4-POST PROCEDURES					
Annual Average Day	61.4		0	8	31
South Flow Day (Rwy 16)	43.2		0	1	15
North Flow day (Rwy 34)	56.5		0	21	62

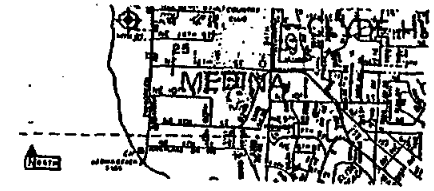
SINGLE EVENT DATA	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34
**** 737 AIRCRAFT ****				
Energy Average SEL		80	67	
Average Peak Sound Level		69	72	

OPERATIONAL DATA ****JETS*****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34	PROPOSED 4-POST PROCEDURES South Flow D16	A16	North Flow D34	A34
Number of Aircraft	-	270	90	-	-	181	90	-

213

Location E/6

Site Description MEDINA



NOISE LEVEL DATA	LDN NOISE LEVELS Aircraft Noise Levels	Quiet Day Ambient	TIME ABOVE NOISE LEVELS Time Above dBA (Minutes) 65 dBA	60 dBA	55 dBA
CURRENT PROCEDURES					
Annual Average Day	51.7	45-50	0	9	30
South Flow Day (Rwy 16)	40.1		0	1	4
North Flow day (Rwy 34)	56.1		0	25	79
4-POST PROCEDURES					
Annual Average Day	51.9		0	9	32
South Flow Day (Rwy 16)	41.6		0	1	7
North Flow day (Rwy 34)	56.1		0	25	79

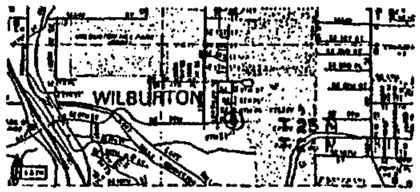
SINGLE EVENT DATA	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34
**** 737 AIRCRAFT ****				
Energy Average SEL	-	-	86	-
Average Peak Sound Level	-	-	61	-

OPERATIONAL DATA ****JETS*****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34	PROPOSED 4-POST PROCEDURES South Flow D16	A16	North Flow D34	A34
Number of Aircraft	-	-	148	-	-	-	148	-

213

Location 8/1

Site Description BELLEVUE



NOISE LEVEL DATA	LDN NOISE LEVELS Aircraft Noise Levels	Quiet Day Ambient	TIME ABOVE NOISE LEVELS Time Above dBA (Minutes) 85 dBA	65 dBA	55 dBA
CURRENT PROCEDURES					
Annual Average Day	49.0	45-50	0	4	25
South Flow Day (Rwy 16)	41.4		0	1	6
North Flow day (Rwy 34)	53.0		0	15	61
4-POST PROCEDURES					
Annual Average Day	49.5		0	6	20
South Flow Day (Rwy 16)	43.2		0	1	12
North Flow day (Rwy 34)	52.9		0	15	60

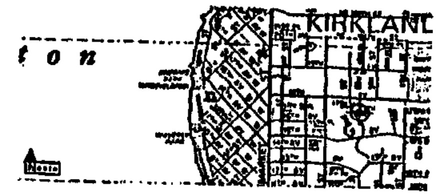
SINGLE EVENT DATA	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34
**** 727 AIRCRAFT ****				
Energy Average SEL	-	-	86	-
Average Peak Sound Level	-	-	69	-

OPERATIONAL DATA ****JETS****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34	PROPOSED 4-POST PROCEDURES South Flow D16	A16	North Flow D34	A34
Number of Aircraft	-	-	149	-	-	69	140	-

213

Location E/8

Site Description KIRKLAND



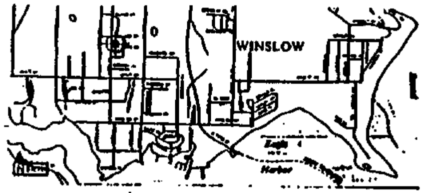
NOISE LEVEL DATA	LDN NOISE LEVELS Aircraft Noise Levels	Quiet Day Ambient	TIME ABOVE NOISE LEVELS Time Above dBA (Minutes) 85 dBA	65 dBA	55 dBA
CURRENT PROCEDURES					
Annual Average Day	42.6	46-50	0	1	12
South Flow Day (Rwy 16)	39.3		0	0	7
North Flow day (Rwy 34)	45.4		0	3	20
4-POST PROCEDURES					
Annual Average Day	43.6		0	1	15
South Flow Day (Rwy 16)	43.9		0	1	11
North Flow day (Rwy 34)	46.0		0	3	20

SINGLE EVENT DATA **** 727 AIRCRAFT ****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34
Energy Average SEL	-	68	83	-
Average Peak Sound Level	-	84	86	-

OPERATIONAL DATA ****JETS****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34	PROPOSED 4-POST PROCEDURES South Flow D16	A16	North Flow D34	A34
Number of Aircraft	-	-	6	-	-	119	3	

Location K/0

Site Description WINSLOW



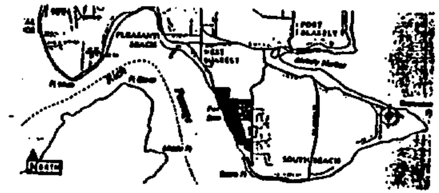
NOISE LEVEL DATA	LDN NOISE LEVELS Aircraft Noise Levels	Quiet Day Ambient	TIME ABOVE NOISE LEVELS Time Above dBA (Minutes) 75 dBA	65 dBA	55 dBA
CURRENT PROCEDURES					
Annual Average Day	51.0	40-45	0	4	14
South Flow Day (Rwy 16)	35.4		0	0	1
North Flow day (Rwy 34)	53.5		0	11	38
4-POST PROCEDURES					
Annual Average Day	51.0		0	4	14
South Flow Day (Rwy 16)	35.4		0	0	1
North Flow day (Rwy 34)	53.6		0	11	37

SINGLE EVENT DATA **** 727 AIRCRAFT ****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34
Energy Average SEL		68	87	
Average Peak Sound Level		59	73	

OPERATIONAL DATA *****JETS*****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34	PROPOSED 4-POST PROCEDURES South Flow D16	A16	North Flow D34	A34
Number of Aircraft	-	48	24	48	-	48	24	48

Location K/1

Site Description RESTORATION PT. KITSAP COUNTY



NOISE LEVEL DATA	LDN NOISE LEVELS Aircraft Noise Levels	Quiet Day Ambient	TIME ABOVE NOISE LEVELS Time Above dBA (Minutes) 75 dBA	65 dBA	55 dBA
CURRENT PROCEDURES					
Annual Average Day	49.4	40-45	0	5	25
South Flow Day (Rwy 16)	45.4		0	1	20
North Flow day (Rwy 34)	53.2		0	12	55
4-POST PROCEDURES					
Annual Average Day	49.8		0	5	20
South Flow Day (Rwy 16)	42.3		0	1	15
North Flow day (Rwy 34)	53.3		0	12	66

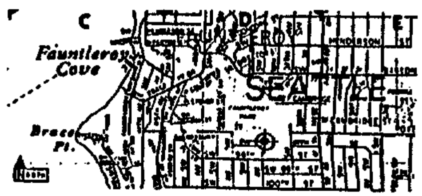
SINGLE EVENT DATA **** 727 AIRCRAFT ****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34
Energy Average SEL		73	82	
Average Peak Sound Level		59	66	

OPERATIONAL DATA *****JETS*****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34	PROPOSED 4-POST PROCEDURES South Flow D16	A16	North Flow D34	A34
Number of Aircraft	-	270	34	48	-	181	24	46

213

Location P150/7

Site Description FAUNTLEROY



NOISE LEVEL DATA	LDN NOISE LEVELS Aircraft Noise Levels	Quiet Day Ambient	TIME ABOVE NOISE LEVELS Time Above dBA (Minutes) 85 dBA	65 dBA	55 dBA
CURRENT PROCEDURES					
Annual Average Day	48.3	60	0	11	60
South Flow Day (Rwy 16)	42.3		0	3	23
North Flow day (Rwy 34)	51.9		0	25	125
4-POST PROCEDURES					
Annual Average Day	48.2		0	11	58
South Flow Day (Rwy 16)	42.1		0	3	24
North Flow day (Rwy 34)	51.7		0	25	120

SINGLE EVENT DATA	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34
**** 737 AIRCRAFT ****				
Energy Average SEL			73	
Average Peak Sound Level			58	
**** PROP ****				
Energy Average SEL		70	72	
Average Peak Sound Level		57	61	

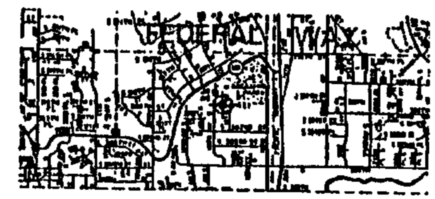
OPERATIONAL DATA *****JT8*****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34	PROPOSED 4-POST PROCEDURES South Flow D16	A16	North Flow D34	A34
Number of Aircraft	-	-	74	-	-	-	74	-

OPERATIONAL DATA ****PROPS*****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34	PROPOSED 4-POST PROCEDURES South Flow D16	A16	North Flow D34	A34
Number of Aircraft	24	122	64	10	24	61	64	5

213

Location SBW 2

Site Description FEDERAL WAY



NOISE LEVEL DATA	LDN NOISE LEVELS Aircraft Noise Levels	Quiet Day Ambient	TIME ABOVE NOISE LEVELS Time Above dBA (Minutes) 85 dBA	65 dBA	55 dBA
CURRENT PROCEDURES					
Annual Average Day	63.0	45-50	1	48	129
South Flow Day (Rwy 16)	64.8		1	55	141
North Flow day (Rwy 34)	58.8		0	30	109
4-POST PROCEDURES					
Annual Average Day	63.2		1	49	131
South Flow Day (Rwy 16)	64.8		1	50	141
North Flow day (Rwy 34)	59.5		0	34	114

SINGLE EVENT DATA	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34
**** 737 AIRCRAFT ****				
Energy Average SEL	94			84
Average Peak Sound Level	68			71

OPERATIONAL DATA *****JT8*****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34	PROPOSED 4-POST PROCEDURES South Flow D16	A16	North Flow D34	A34
Number of Aircraft	270	-	-	270	270	-	-	

Location SSW 5

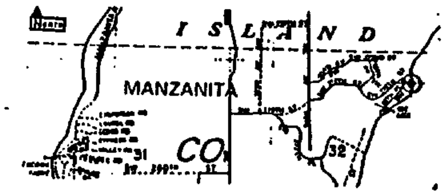
Site Description DASH POINT

NOISE LEVEL DATA	LDN NOISE LEVELS Aircraft Noise Levels	Quiet Day Ambient	TIME ABOVE NOISE LEVELS Time Above dBA (Minutes) 65 dBA	60 dBA	55 dBA
CURRENT PROCEDURES					
Annual Average Day	55.1	48-50	0	15	53
South Flow Day (Rwy 16)	56.5		0	22	76
North Flow day (Rwy 34)	42.1		0	3	14
4-POST PROCEDURES					
Annual Average Day	56.2		0	25	86
South Flow Day (Rwy 16)	57.8		0	31	98
North Flow day (Rwy 34)	43.8		0	3	20

OPERATIONAL DATA ****JETS****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34	PROPOSED 4-POST PROCEDURES South Flow D16	A16	North Flow D34	A34
Number of Aircraft	74	-	-	48	66	-	-	151

Location SSW 10

Site Description MURAY ISLAND

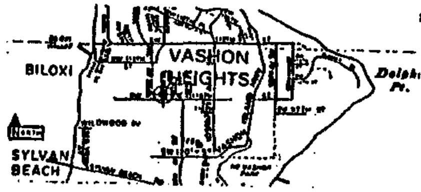


NOISE LEVEL DATA	LDN NOISE LEVELS Aircraft Noise Levels	Quiet Day Ambient	TIME ABOVE NOISE LEVELS Time Above dBA (Minutes) 65 dBA	45 dBA	50 dBA
CURRENT PROCEDURES					
Annual Average Day	51.4	40-45	0	8	43
South Flow Day (Rwy 16)	54.1		0	12	61
North Flow day (Rwy 34)	40.7		0	1	11
4-POST PROCEDURES					
Annual Average Day	47.2		0	2	25
South Flow Day (Rwy 16)	48.3		0	3	31
North Flow day (Rwy 34)	42.4		0	0	11

SINGLE EVENT DATA	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34
**** 727 AIRCRAFT ****				
Energy Average SEL	87			66
Average Peak Sound Level	73			67
Avg. Time Above 65 dBA	59			

OPERATIONAL DATA ****JETS****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34	PROPOSED 2-POST PROCEDURES South Flow D16	A16	North Flow D34	A34
Number of Aircraft	24	151	-	40	-	151	-	40

Location	SSW 13
Site Description	Vashon Island



NOISE LEVEL DATA	Aircraft Noise Levels	Quiet Day Ambient	[illegible] dBA	[illegible] dBA	[illegible] dBA
CURRENT PROCEDURES					
Annual Average Day	46.2	40-45	0	1	30
South Flow Day (Rwy 16)	43.4		0	0	32
North Flow day (Rwy 34)	47.2		0	1	49
4-POST PROCEDURES					
Annual Average Day	45.5		0	1	22
South Flow Day (Rwy 16)	43.9		0	0	21
North Flow day (Rwy 34)	47.5		0	1	32

Ldn NOISE LEVELS; TIME ABOVE NOISE LEVELS — Time Above dBA (Minutes)

SINGLE EVENT DATA **** 727 AIRCRAFT ****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34
Energy Average SEL	78	79	69	67
Average Peak Sound Level	57	63	53	50

OPERATIONAL DATA ****JETS*****	CURRENT PROCEDURES South Flow D16	A16	North Flow D34	A34	PROPOSED 4-POST PROCEDURES South Flow D16	A16	North Flow D34	A34
Number of Aircraft	34	181	74	46	·	151	74	46

INTRODUCTION

The purpose of the proposed modifications to the FAA 4 Post Plan is an attempt to combine the proposed needs of the FAA and the noise mitigation desires of the surrounding communities.

The FAA proposal has been analyzed from a noise impact and overflight annoyance standpoint. Several of the proposed modifications were developed as an attempt to remove some aircraft operations where new exposures will occur due to the 4 Post Plan. An example would be an area currently exposed to departures but not arrivals will be subject to arrival noise when the 4 Post Plan is implemented. Where possible, a modification to the FAA Plan has been developed to remove some of the departures or re-define the FAA proposed arrival route to limit the added exposure to the effected area. This "trade off" concept was applied to several FAA flight track situations. If the arrival procedures proposed by FAA in fact allow for idle-thrust approaches, those operations should be less bothersome than departures. Therefore; re-routing departure flows is very essential to a balanced noise exposure plan.

PROPOSED MODIFICATIONS TO THE FAA 4 POST PLAN

A. MODIFIED 4 POST DURING NON-PEAK PERIODS.

DESCRIPTION. This modification is designed to provide flexibility in the proposed 4 Post plan by taking advantage of lower traffic periods. When hourly landing operations are 18 or less a modified 4 post that resembles the current flow could be used. During a south flow, traffic from the southeast post could be vectored to the west side and blended into the traffic from the southwest post. Traffic from the northeast post could be vectored north of the Seattle area and blended into the traffic flow from the northwest post. Traffic could be sequenced for arrival from over the Elliott Bay area. When hourly traffic increases to the point that the proposed 4 post plan is required, aircraft could proceed from their arrival routes into the 4 Post plan with very little coordination between air traffic facilities and virtually no impact on the flight crews. This procedure would not require the Air Route Traffic Control Center to alter arrival/departure routes. Instead, inter-facility coordination could be accomplished where aircraft would be vectored from the arrival post into this modified flow into the terminal area.

GOAL. The goal of this modified 4 Post plan is to keep traffic flows generally the way they are now (i.e., Elliott Bay), yet allow FAA to transition into the 4 Post concept when capacity would be constrained if traffic flows were not changed during the heavier periods.

IMPLEMENTATION FEASIBILITY. This procedure would require the FAA to develop several interfacility agreements to completely outline the parameters required to use this procedure. Close coordination and monitoring of the hourly traffic flows and estimates of traffic increases would be essential to the success of this procedure.

BENEFIT / DIS-BENEFIT. The benefit of this procedure would be that only during heavier traffic periods would the full 4 Post plan be utilized. During the less busy periods traffic flows would be similar to the flow currently being used. Dis-benefits would include considerably more work on the part of the controllers. As traffic periods peak or decline, very timely and precise coordination is necessary to transition in or out of the modified 4 Post procedure.

B. DOWNWIND LEG EAST SIDE OF THE AIRPORT SHIFTED FURTHER EAST.

DESCRIPTION. This modification is a widening of the eastside arrival path to the airport. During heavy departure periods the west side of the path would be used. During light traffic periods the east side of the arrival path would be used. This method of reducing constant overflight situations was developed after extensive analysis of attempting to move the whole downwind leg further east than proposed by the FAA. Simply relocating the track east over the mountains causes severe constraints on departures. Departures must tunnel arrival tracks to ensure that separation between aircraft is maintained.

Tunneling is best described as follows. The arrival aircraft is descending to an assigned altitude on a predetermined track or lane when approaching the airport. Departing aircraft that will cross that arrival track must be assigned an altitude at least 1000 feet below the altitude assigned the arrival. The departure must remain at that restricted altitude until clear of the arrival track. In some situations flight tracks can be as much as five miles wide. East departures would be required to remain at low altitudes for an unacceptable distance. This proposed modification was developed to provide flexibility to flight tracks when departure operations are not impacted by arriving aircraft. Using the west side during heavy departure periods will reduce the need to keep departures at low altitude over residential areas due to the tunneling required between arrivals and departures. When departures volumes are less on the east side, arrivals would be allowed to remain further east of the residential areas at higher altitudes.

GOAL. The goal of this modification is to reduce the number of overflights and subsequent noise over high density residential areas to the east of the airport.

IMPLEMENTATION FEASIBILITY. This procedure could be implemented by ATC. Controllers could be instructed by a Facility Order when and how to use the corridor to its maximum potential.

BENEFIT / DIS-BENEFIT. The benefit is a reduction of noise and overflights in residential areas. A dis-benefit is that some opportunities to capitalize on available landing spaces may not be realized due to the aircraft being further away from the airport at high altitude. Therefore; some potential loss of capacity could be experienced.

C. USE OF INTERSTATE 5 AS AN ARRIVAL ROUTE.

DESCRIPTION. This modification is designed to define an arrival flight track to be used in visual weather conditions that keeps the aircraft over I-5 and the more commercial / industrial developments that border the freeway. This route could be used by all straight in or east side arrivals as west side arrivals utilize the Elliott Bay.

GOAL. This type of modification to the FAA 4 Post plan would reduce overflights of hi-density areas as much as possible, resulting in a lesser noise impact on the community.

IMPLEMENTATION FEASIBILITY. This modification may not be acceptable to either FAA Flight Standards or Airline Pilot Safety Groups. It would require pilots added ground tracking of I-5 in addition to all the other cockpit duties required during a landing approach.

BENEFIT / DIS-BENEFIT. The benefit of this procedure would be that during south flow good weather conditions arrivals would use the Elliott Bay I-5 corridors to the maximum extent possible resulting in less overflights in noise sensitive areas. Dis-benefits include added workload on both pilot and controller. Pilots might have difficulty in following I-5 as they must align with the runway centerline when preparing to land.

D. SHIFT SOME SOUTHBOUND DEPARTURES TO ELLIOTT BAY DURING NORTH FLOW OPERATIONS.

DESCRIPTION. This modification would shift some southbound departures to make left turns over the Elliott Bay departing on course from the west side of the airport.

GOAL. The goal is to balance the number of operations over residential areas east and west of Seattle Tacoma Airport during north flow periods.

IMPLEMENTATION FEASIBILITY. It could be implemented by ATC. Procedures to separate westside arrivals from the departures would have to be developed. This could be similar to the eastside arrival/departure procedures proposed.

BENEFIT / DIS-BENEFIT. The benefits of this modification is a more even balance of operations to the west and east of the airport. The dis-benefits are the problems of separating arrival and departure tracks west of the airport. Some increase in noise in new areas may occur because aircraft must fly back to the departure corridor.

E. SHIFT SOME STAGE II DEPARTURES TO ELLIOTT BAY DURING NORTH FLOW OPERATIONS

DESCRIPTION. During north flow operations ATC shift some Stage II departures to overfly the Duwamish Corridor and use the Puget Sound area for departure regardless of destination. This could be in terms of the time of day or destination.

GOAL. The goal of this modification is to limit the number of noisy aircraft over populated areas during the first phase of departure. Aircraft that depart out the Corridor and commence their climb over the water will be at higher altitudes by the time they overfly the more populated areas and making less noise due to their added height.

IMPLEMENTATION FEASIBILITY. This modification is feasible but possibly for a small number of operations but not totally implementable until the fleet mix has changed to include more Stage III aircraft serving the airport. However; Implementing this modification now even if only on a limited basis could become an incentive to the airlines to speed up their time table for phasing out Stage II aircraft at Seattle Tacoma Airport.

BENEFIT / DIS-BENEFIT. The benefits of this modification include reducing noise in residential areas, overflights at higher altitudes over residential areas, and a possible incentive for a quicker fleet change to Stage III aircraft. Dis-benefits are a more complex ATC system if all current Stage II aircraft were required to follow this departure procedure. Some aircraft will not depart on course as quickly as they do now, resulting in some additional flight time and fuel costs.

F. EARLY RIGHT TURNS FOR STAGE III EAST DEPARTURES

DESCRIPTION. The object of this procedure is to have the quieter aircraft who are southbound make right turns prior to Boeing Field thereby reducing the number of aircraft that proceed north and east over high density areas. This type of departure track could be developed where it normally remained to the south of Mercer Island. The other type aircraft during a north flow would use the normal departure routes north of Mercer Island.

GOAL. The goal of this modification is to reduce the number of departures over north and east portions of the community.

IMPLEMENTATION FEASIBILITY. This could be implemented by FAA after determining what minimum altitude could be used as the starting point for the turn. Involved coordination with Boeing Field would be necessary because the Seattle Departures would be operating in the Boeing Field Airport Traffic Area during the climb out.

BENEFITS / DIS-BENEFITS. The benefits include a reduction of overflights north and east of the airport which should result in less noise in those areas. Dis-benefits are numerous. Coordination with Boeing Field would be necessary prior to each departure being released. Aircraft would be overflying the Renton area at lower altitudes than normal. This type of departure track could impact the TCA plan by having air carrier aircraft at low altitude in areas that might be used by general aviation aircraft.

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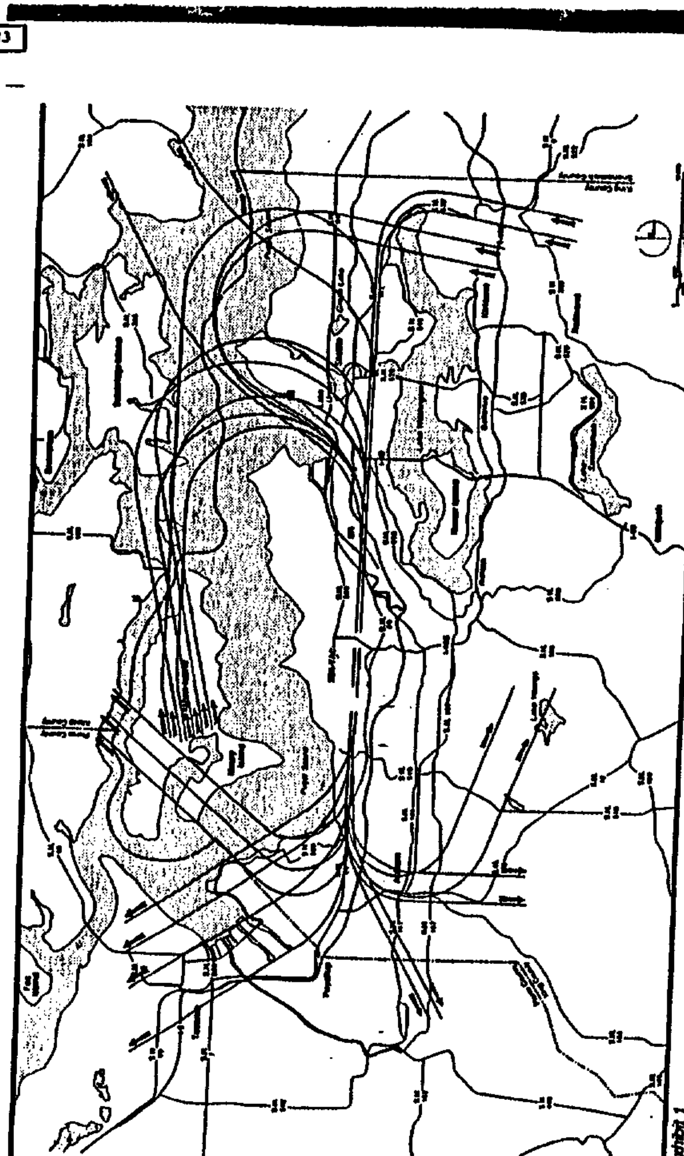

Exhibit 1
Flight Track Map - Jets (South Flow)

Current Conditions

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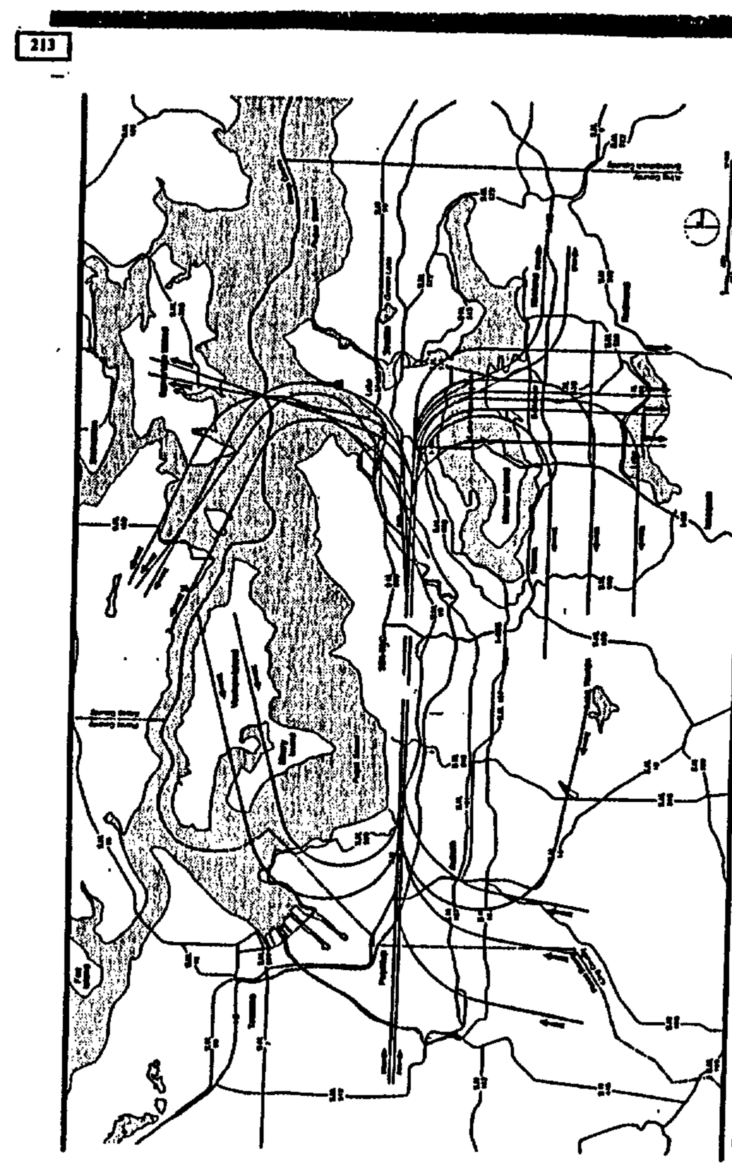

Exhibit 2
Flight Track Map - Jets (North Flow)

Current Conditions

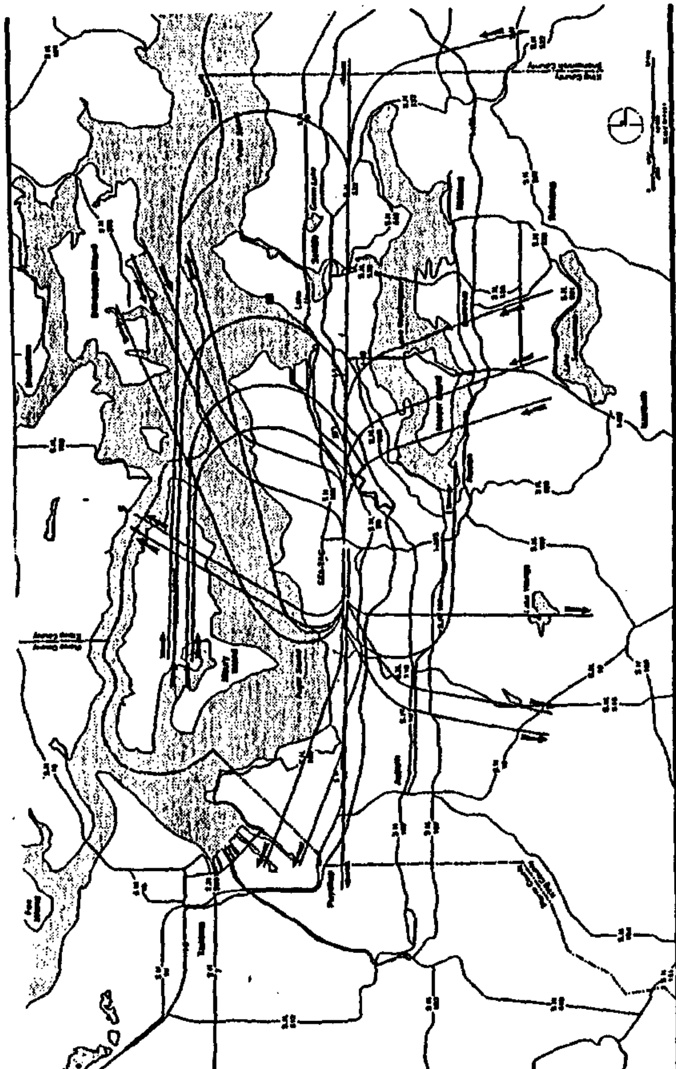

Exhibit 3
Flight Track Map - Props (South Flow)

Current Conditions

213

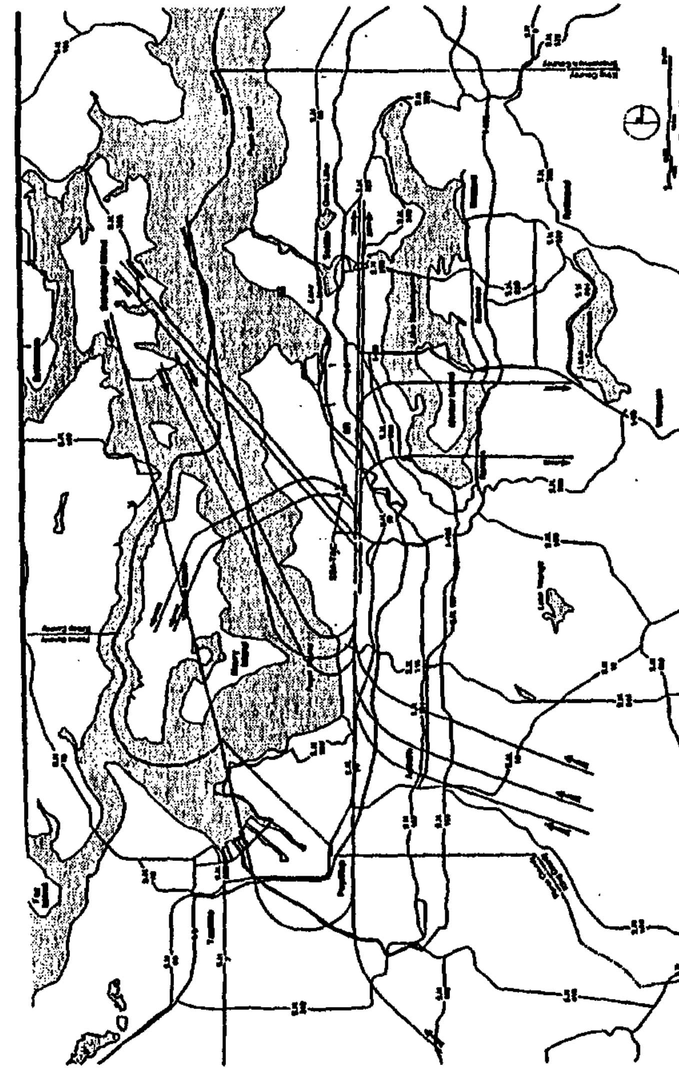

Exhibit 4
Flight Track Map - Props (North Flow)

Current Conditions

213

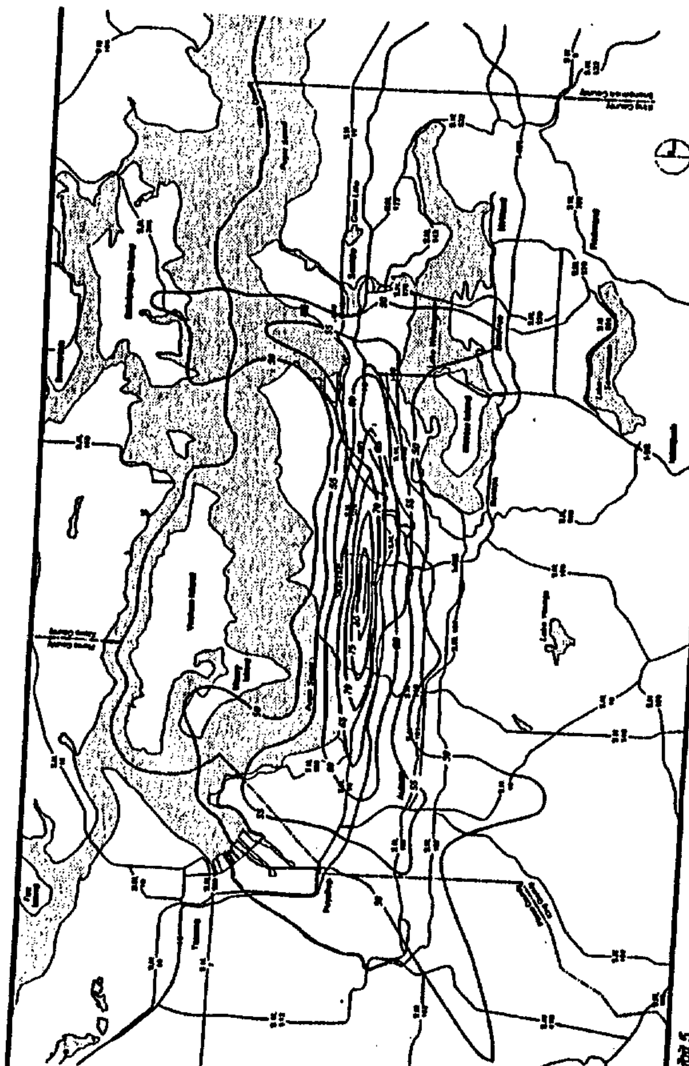

Exhibit 5
1989 Ldn Noise Contours (Annual Average)
Current Conditions

213

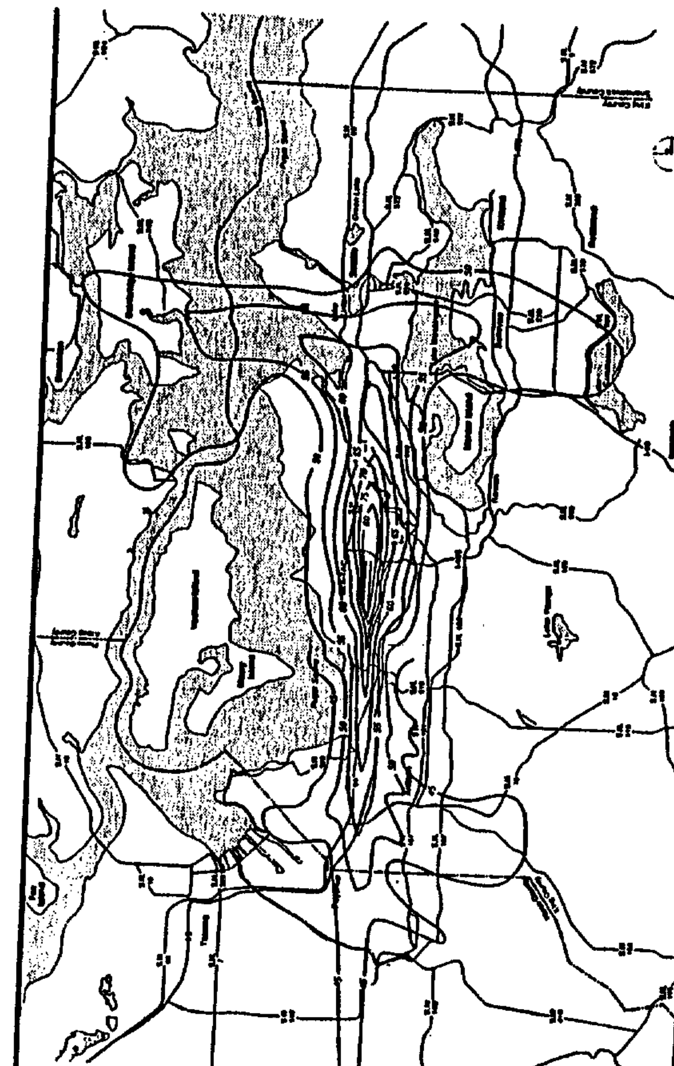

Exhibit 6
1989 Ldn Noise Contours (North Flow)
Current Conditions

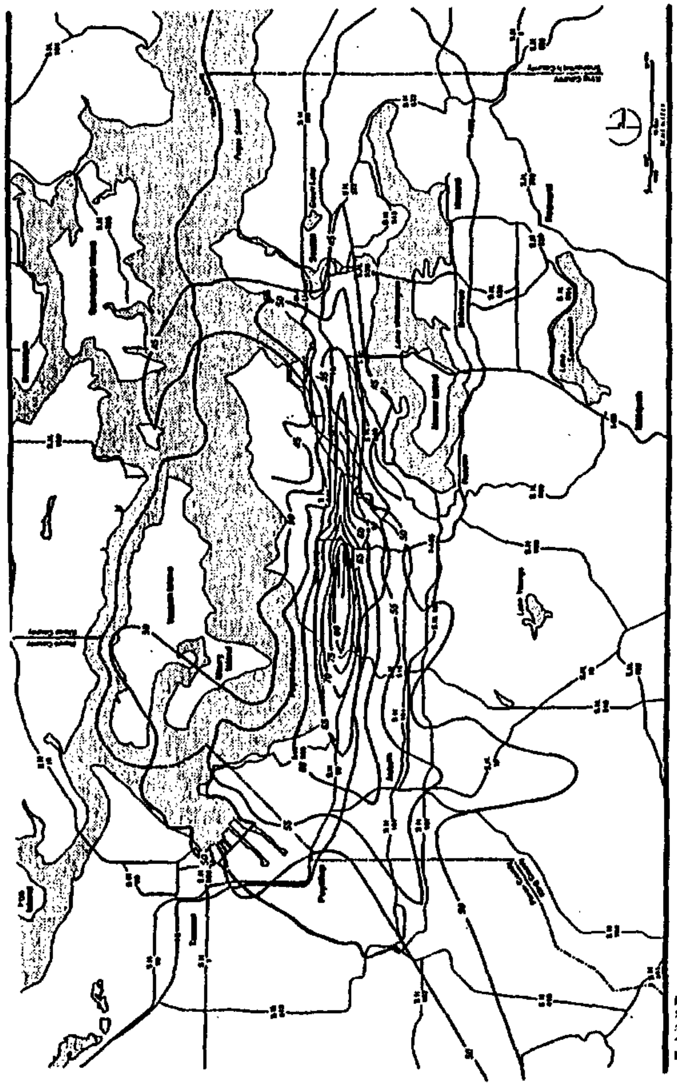

Exhibit 7
1989 Ldn Noise Contours (South Flow)
Current Conditions

213

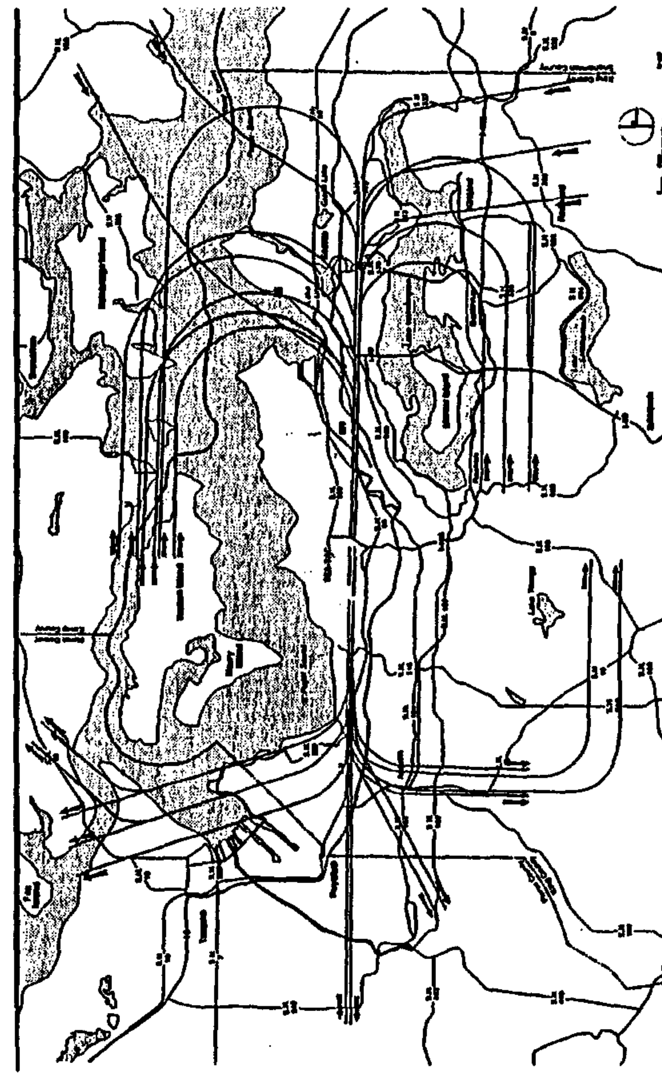

Exhibit 8
Flight Track Map - Jets (South Flow)
Proposed 4-Post Conditions

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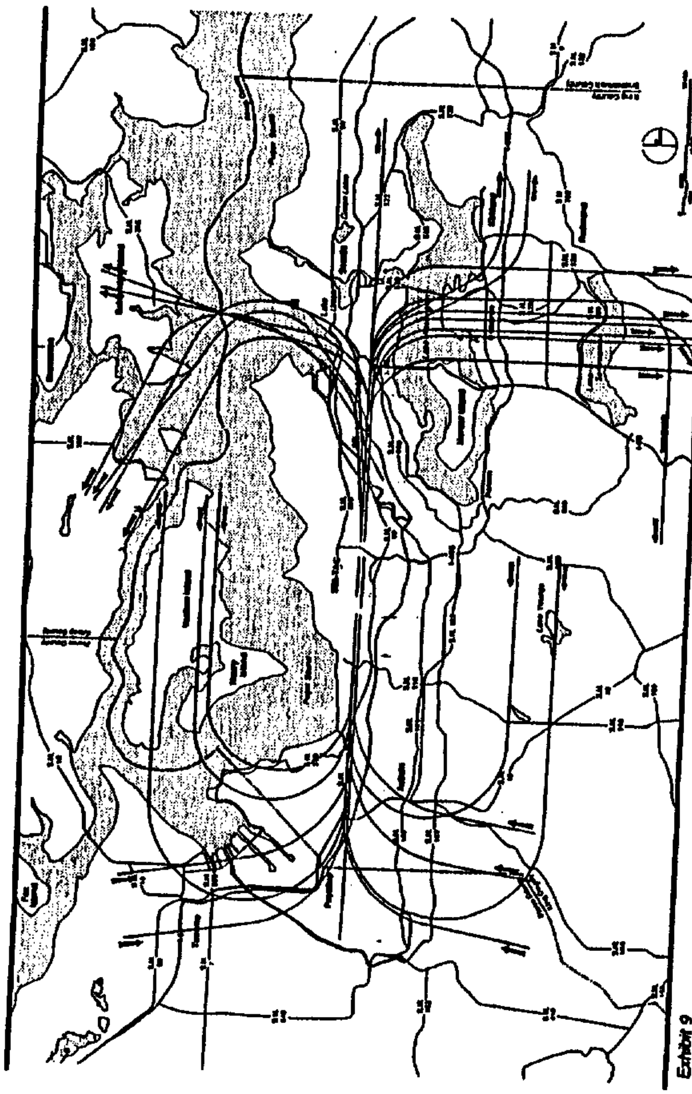

Exhibit 9
Flight Track Map - Jets (North Flow)
Proposed 4-Post Conditions

213

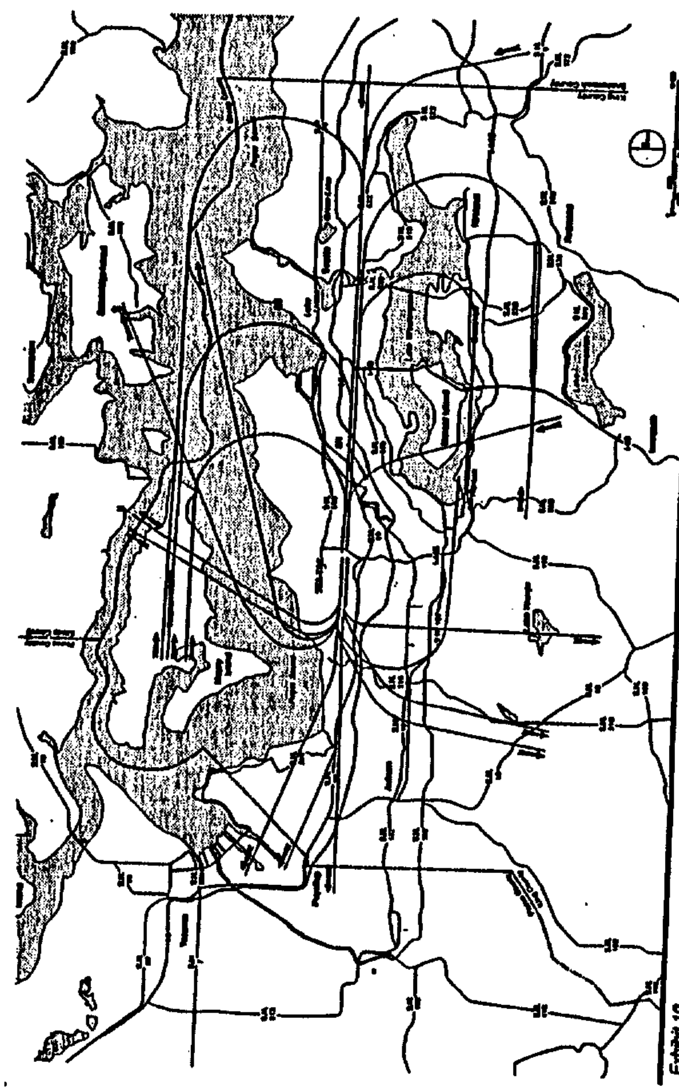

Exhibit 10
Flight Track Map - Props (South Flow)
Proposed 4-Post Conditions

213

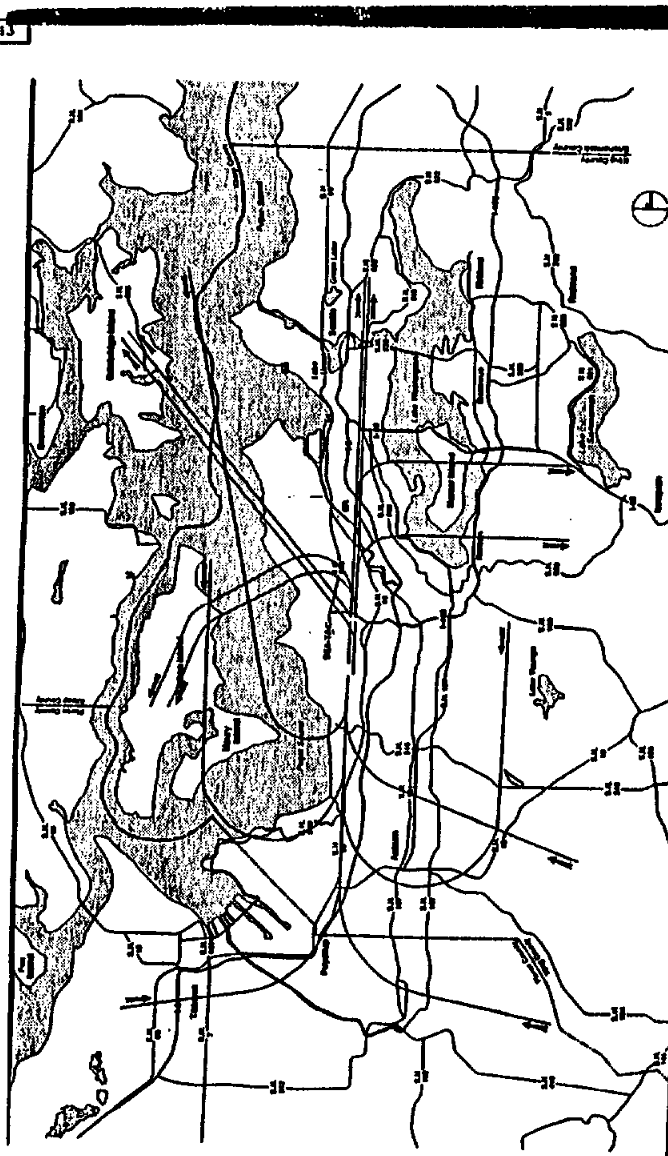

Exhibit 11
Flight Track Map - Props (North Flow)
Proposed 4-Post Conditions

213

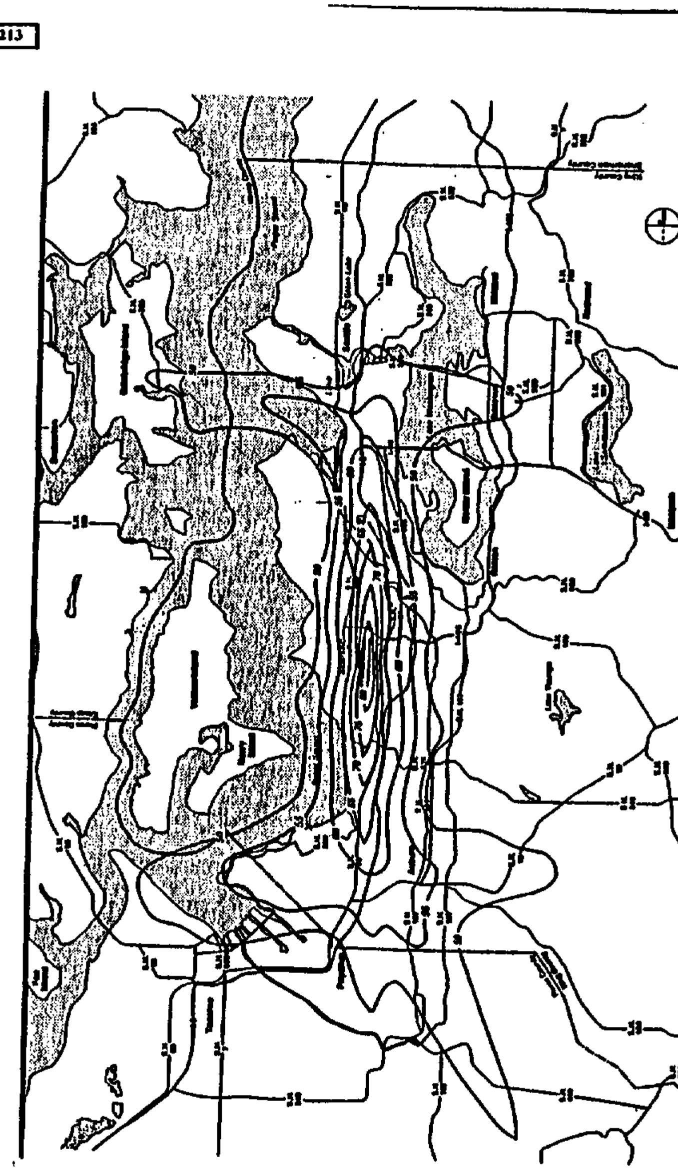

Exhibit 12
1989 Ldn Noise Contours (Annual Average)
Proposed 4-Post Conditions

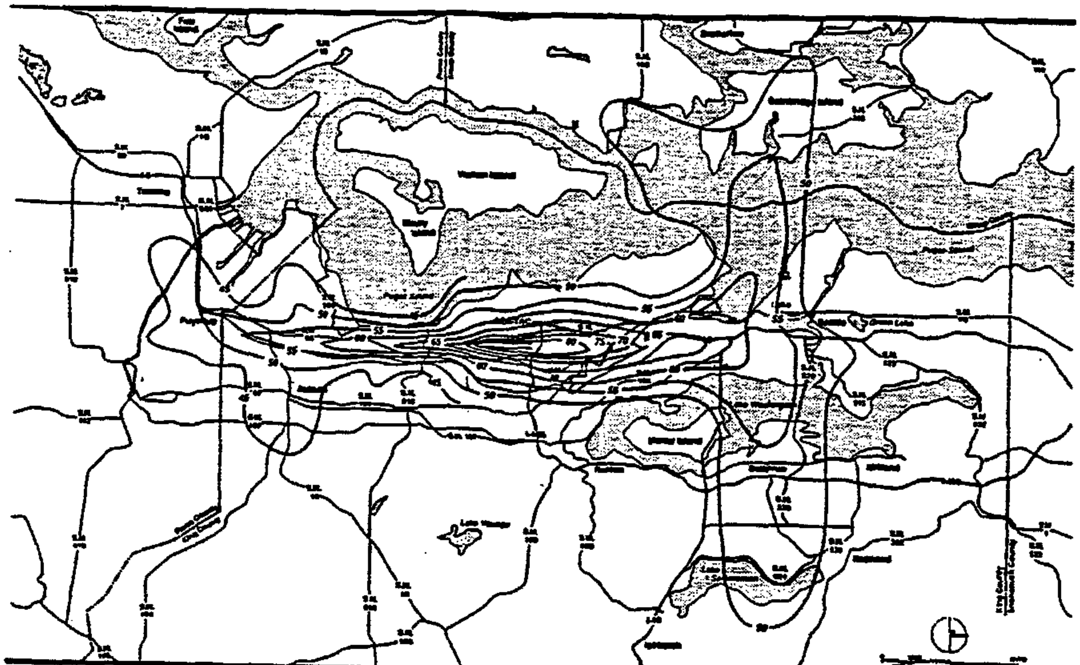

Exhibit 13
1989 Ldn Noise Contours (North Flow)

Proposed 4-Post Conditions

Exhibit 14
1989 Ldn Noise Contours (South Flow)

Proposed 4-Post Conditions

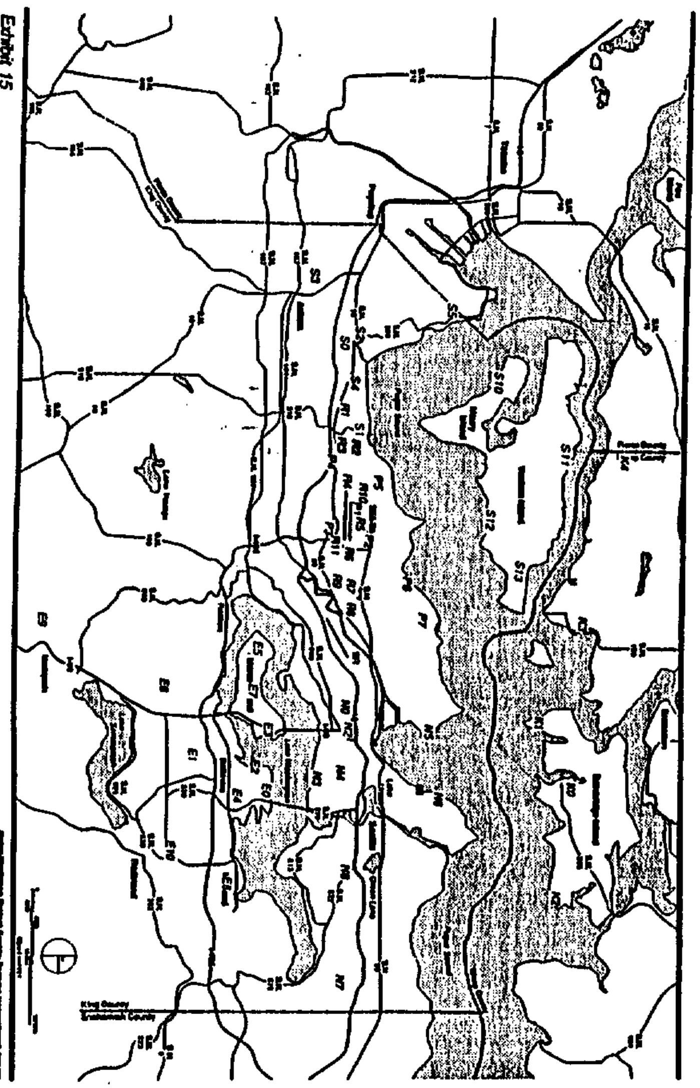

Exhibit 15
Measurement Locations

DECISION AND ORDER

The Seattle Air Traffic Control Tower (ATCT) and the Seattle Air Route Traffic Control Center (ARTCC) jointly submitted an airspace study entitled "Seattle Arrival and Departure Routes; Simulation, Analysis, Recommendations" to me on November 3, 1989 for consideration. That study detailed problems regarding arrival capacity at Seattle-Tacoma International Airport (Sea-Tac) and safety and efficiency concerns created by congestion in the airspace controlled by both the Seattle ARTCC and the Seattle ATCT. It identified various procedural alternatives for solving these problems and recommended specific changes in existing air traffic procedures.

On December 22, 1989, the Northwest Mountain Region (the Region) issued a Draft Environmental Assessment of the proposed changes and announced its intention to hold a public hearing on January 24, 1990 and to accept public comments on that document. The Final Environmental Assessment, which contains the transcript of the public hearing and the written comments received, was presented to me and signed on March 27, 1990. After consideration of the information contained in the Final Environmental Assessment, I made a Finding of No Significant Impact on March 31, 1990.

At present, the route structure in the airspace over and east of the Cascade Mountains which serves the Sea-Tac Airport blends aircraft from widely dispersed points of origin and is required to change substantially each time the runway in use changes at the airport, which may occur several times in one day. This has several effects with adverse consequences which extend throughout the National Airspace System. These include:

1. When landing runways 16L and 16R, aircraft coming to Seattle from points to the southeast, such as Denver, Dallas, and Atlanta are required during their enroute descent to pass through a steady stream of Seattle departures climbing toward such destinations as Minneapolis, Chicago, Washington, and New York. At the same time, these arrivals from the Southeast are being merged into a single arrival stream of aircraft from the Northeast. Such crossing and merging of aircraft is less efficient and more difficult to accomplish at high altitude and high speed than if conducted in the latter phase of flight when aircraft are flying at lower altitudes and speeds. The type of RADAR and navigational equipment installed in the airspace within 50 miles of major airports facilitates this crossing and merging process because of its greater accuracy and more frequent information updates.

2. In periods of high demand, if weather or airport conditions improve, the present high altitude route structure and holding airspace used by the Seattle Air Route Traffic Control Center do not permit that facility to adjust the arrival rate in a timely fashion. In order to provide sufficient room for departure routes

and balance workload between control sectors, enroute holding and metering of arriving aircraft must be conducted approximately 130-150 flying miles from the airport in the existing structure. At present, it may take as much as thirty minutes to effect a substantial increase in the metered arrival rate at the airport. This can account for as many as 20 lost arrival opportunities per event.

3. Because of the fluid nature of these routes caused by the situation described above, the integration of Seattle air traffic into the national Preferred Route System has proved difficult. This causes unnecessary system complexity and controller workload by increasing the number of points of aircraft conflict for aircraft enroute to and from Seattle throughout the National Airspace System.

In addition, when adverse weather, such as low ceilings and visibilities, creates a need for instrument approaches to the airport, the arrival capacity of the airport is symmetrical. That is, approximately 36 aircraft per hour can arrive whether runways 16 or 34 are in use. Arrival delays are similar whether landings are conducted to the north or to the south. In contrast, during periods of peak demand and optimum weather conditions, south arrival rate is much lower (42/hour), than north (56/hour). Delays, when landing south, are significantly greater than when landing north. No reason for this disparity can be found in the layout of the airport; the inefficiencies are caused by the requirement of the existing procedures that turbojet aircraft landing to the south be routed through Elliott Bay, to the northwest of the airport, in a single arrival stream.

Further, the division of airspace along the Seattle Runway 16 localizer in the south flow means that in visual approach weather the East Arrival controller must route aircraft under his control through the West Controller's airspace for a significant distance to position the aircraft in Elliott Bay. By continuing this, the FAA is engaging in a practice which increases its exposure to the risk of error and cuts very close to the actions prohibited by provisions of the FAA Air Traffic Control Handbook which pertain to coordination between controllers and transfer of control of aircraft.

The problems identified above are the result of route restrictions developed in the 1970's, in particular the procedures established in 1974 for turbojets arriving and departing Sea-Tac. These procedures were not based on abating any specific measure of noise or on any coherent plan to mitigate overall airport noise or to distribute it equitably throughout the metropolitan area. Rather they most often were the result of moving overflight tracks away from particular complaining groups and/or communities. Nonetheless they were adopted as so-called "noise abatement" measures.

Each of these measures, considered individually, has caused minor operational inefficiencies which, at the time of adoption, was regarded as acceptable to the FAA. Since 1974, however, air traffic in the region has grown steadily; the number of aircraft operations handled by the Seattle ATCT rose dramatically in 1989. Airline scheduling practices following deregulation in 1978 have compounded the operational effects of these increases in aircraft operations. Yet in the intervening years, there has been virtually no change in the procedures under which turbojet aircraft arrive and depart Sea-Tac. The cumulative effect of the existing restrictions on the FAA's use of Seattle airspace has been to create serious efficiency problems and an undesirable risk of error within the air traffic system.

Attempts have been made by the TRACON and the ARTCC to alleviate these problems, but they have been unsuccessful because of the current geographical and operational constraints.

Given the infeasibility of non-procedural changes within the foreseeable future, such as alteration of airline scheduling and establishment of a new airport, and the limited success of personnel and equipment improvements to overcome the safety and efficiency problems inherent in the existing procedures, the FAA proposed action that would alter existing air traffic control procedures and routings for turbojet and turboprop aircraft so as to improve efficiency and decrease the potential for error in the handling of air traffic.

I have considered the analyses and recommendations presented in the airspace study entitled "Seattle Arrival and Departure Routes; Simulation, Analysis, Recommendations" as well as the relative environmental consequences of various operational alternatives. I recognize that while the overall amount of noise generated by Sea-Tac operations will not change, there will be a redistribution of overflight noise from certain residential areas to others. I have reviewed the transcript of the public hearing held January 24, 1990, listened to the concerns of citizens expressed at the ninety-one Noise Mediation Committee meetings and public forums I have attended during the past eighteen months, and read the written comments received by the FAA. As a consequence of public comment on this issue, I have decided that implementation of the proposed procedures should include retention of the "Elliott Bay procedures" for north flow departures during those nighttime hours when air traffic is light enough to allow for their safe use.

Given the lack of significant environmental impacts anticipated to occur from implementation of the proposed air traffic procedures and the FAA's obligation under the Federal Aviation Act to insure the safety of aircraft and the efficient utilization of the navigable airspace, I have decided to adopt the procedures set forth in the Preferred Alternative section of the Final Environmental Assessment (Proposed Changes to Air Traffic Arrival and Departure Routes at Seattle-Tacoma International Airport -- Seattle, Washington), dated March 27, 1990. Under my delegated authority, I therefore direct the Air Traffic Managers of the Seattle Tower and Seattle ARTCC to take the steps necessary to implement the procedural and operational changes detailed within the appendices of this order as soon as is feasible.

The implementation of the procedures contained in this order cancels all previous facility directives and practices regarding noise abatement. Should unforeseen operational consequences require modification of these procedures or the Sea-Tac noise mediation process sponsored by the Port of Seattle develop operationally acceptable alternatives to the routings and procedures therein, appropriate changes will be made at the earliest available opportunity.

Temple H. Johnson, Jr.
Manager, Air Traffic Division, Northwest Mountain Region

Issued in Seattle, Washington, on the 2nd day of April, 1990.

This decision, including any subsequent actions taken to implement it, is made pursuant to 49 U.S.C. 1301 et seq., and constitutes an order of the Administrator which is subject to review by the courts of appeals of the United States in accordance with the provisions of Section 1006 of the Federal Aviation Act of 1958, as amended, 49 U.S.C. 1486.

Agency Decision and Order, dated April 2, 1990

APPENDIX A

SUBJECT: Seattle Air Route Traffic Control Center (ARTCC) Actions

1. ACTION: Seattle ARTCC shall make route and sector changes needed to eliminate high altitude crossings east of Ephrata, Washington, effecting Seattle arrivals and departures. As a minimum, these changes shall include:

a. Turbojet Arrival Flows: Fixed non-runway sensitive arrival flows will be over the Olympia VORTAC, the JAKSN intersection (Seattle VORTAC 020 radial/35-mile DME fix), the RADDY intersection (Seattle VORTAC 101 radial/39-mile DME fix), and JAWBN intersection (Seattle VORTAC 307 radial/42-mile DME fix).

b. Turbojet Departure Flows: Fixed non-runway sensitive departure flows will be over the Paine VOR, the Tatoosh VORTAC, and along the Seattle VORTAC 069, 143, 158, and 227 radials.

2. EFFECTIVE DATE: All actions needed to accomplish these actions shall be completed at the earliest possible date agreed to between Seattle ARTCC and Seattle Tower and approved by the Air Traffic Division.

3. FUTURE CHANGES: Any procedural changes impacting areas addressed in this order and decision which would alter any Seattle Tower/TRACON routes and/or procedures shall be approved by the Air Traffic Division prior to implementation.

Agency Decision and Order, dated April 2, 1990

APPENDIX B

SUBJECT: Seattle Airport Traffic Control Tower (ATCT) Actions - Departure Procedures.

1. ACTION: Seattle ATCT shall establish turbojet departure flows to join Seattle ARTCC departure flows over the Paine VOR, the Tatoosh VORTAC, and along the Seattle VORTAC 069, 143, 158, and 227 radials. Departure procedures shall include, as a minimum:

a. SOUTH FLOW: Traffic permitting, turbojet aircraft departing Runways 16, shall not be turned (radar vectored) until the aircraft is at or above 3,000 feet MSL and is at least 5 nautical miles south of the airport.

b. NORTH FLOW: Traffic permitting:

1). Turbojet aircraft departing runway 34 and making a right turn east or southeast bound shall be turned off the initial departure course, only after the aircraft is at or above 4,000 feet MSL and has reached the Seattle VORTAC 8-mile DME arc.

2). Turbojet aircraft departing runway 34 and making a left turn northwest or southwest bound shall be turned off the initial departure course at Boeing Field/King County Airport and radar-vectored over Elliott Bay then to join the appropriate departure route.

3.) Retain the provisions of Seattle TRACON Order 7200.1, Chapter 2, Section 6, para. c (1) and (2), which describe the rerouting of eastbound departures through Elliott Bay during those late night hours when traffic is light enough to permit safe use.

2. EFFECTIVE DATE: All actions needed to accomplish these actions shall be completed at the earliest possible date agreed to between Seattle Tower and Seattle ARTCC and approved by the Air Traffic Division.

3. FUTURE CHANGES: Any changes in the procedures detailed above shall be approved by the Air Traffic Division prior to implementation.

Agency Decision and Order, dated April 2, 1990

APPENDIX C

SUBJECT: Seattle Airport Traffic Control Tower (ATCT) Actions - Arrival Procedures.

1. ACTION: Seattle ATCT shall implement arrival flows in accordance with procedures defined in the Preferred Alternative section of the FAA's Final Environmental Assessment (Proposed Changes to Air Traffic Arrival and Departure Routes at Seattle-Tacoma International Airport -- Seattle, Washington) dated March 27, 1990. Turbojet Arrival Flows will be from over the Olympia VORTAC, the JAKSN intersection (Seattle VORTAC 020 radial/35-mile DME fix), the RADDY intersection (Seattle VORTAC 101 radial/39-mile DME fix), and the JAWBN intersection (Seattle VORTAC 307 radial/42-mile DME fix). As a minimum, arrival procedures will include:

a. North and South Flows:

1). Arriving aircraft will be kept as high as possible consistent with optimum descent profiles and operational dictates.

2). To the extent possible, turboprop aircraft will follow the same approximate flight tracks as turbojet aircraft.

b. South Flow:

1). During visual approach conditions, when there is no conflicting traffic or sequencing demand, turbojet arrivals from the Northwest and Southwest arrival fixes will be placed on a right-base leg over Elliott Bay.

2). Turbojet arrivals from the Northeast and Southeast arrival fixes will be positioned so as to be established on the Runway 16 final approach course, no closer to the airport than State Route 520 (11.0 nautical miles north) and no lower than 5,000 feet MSL.

3). Traffic permitting, turbojet aircraft on the "Long Leg" tracks, will be turned to a downwind leg at the Seattle VORTAC 101 radial/8-mile DME fix or the 10-mile DME fix on a direct course from the Olympia VORTAC to the Seattle VORTAC, at or above 11,000 feet MSL, as appropriate.

c. North Flow: Traffic permitting, turbojet aircraft on the "Long Leg" tracks, will be turned to a downwind leg at the Seattle VORTAC 020 radial/10-mile DME fix or the Seattle VORTAC 307 radial/12-mile DME fix, at or above 11,000 feet MSL, as appropriate.

Agency Order and Decision, dated April 2, 1990

Appendix C (Arrival Procedures continued)

2. EFFECTIVE DATE: All actions needed to accomplish these actions shall be completed at the earliest possible date agreed to between Seattle Tower and Seattle ARTCC and approved by the Air Traffic Division.

3. FUTURE CHANGES: Any changes in the procedures detailed above shall be approved by the Air Traffic Division prior to implementation.

FINDING OF NO SIGNIFICANT IMPACT

The FAA has prepared a Final Environmental Assessment (FEA) of proposed changes to air traffic arrival and departure routes at Seattle-Tacoma International Airport (Sea-Tac). As a result of the potential environmental impacts of these proposed changes and the alternatives identified in the FEA, the FAA has concluded that the DNL 65 and greater noise contours associated with Sea-Tac operations would not change as a result of the implementation of the Preferred Alternative and that, under FAA standards, all locations outside of the DNL 65 contour would remain compatible with the Airport. The FAA's environmental review further concluded that no perceptible impacts on air quality, energy resources or any other environmental impact category identified in FAA Order 1050.10 would be realized from adoption of the proposed procedural changes.

Thus, after careful and thorough consideration of the facts contained in the Final Environmental Assessment dated March 27, 1990, I find that the proposed federal action is consistent with existing national environmental policies and objectives as set forth in Section 101(a) of the National Environmental Policy Act of 1969 (NEPA) and that its implementation will not significantly affect the quality of the human environment or otherwise include any condition requiring consultation pursuant to Section 102(2)(C) of NEPA.

APPROVED: [signature] Date: 3-31-90

DISAPPROVED: ________ Date: ________

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JORGEN BADER
6536 -- 29th Avenue N.E.
Seattle, Washington 98115

April 6, 1990

Editor
Seattle Times
Fairview Avenue No. and
John Street
Seattle, Washington

Dear Editor:

Your editorial, the Airport Bully, in the <u>Seattle Times</u> on April 5, 1990 was right on target.

With one exception, the Federal Aviation Administration (F.A.A.) did exactly what it had intended at the very outset without regard to citizen opinion or community viewpoints and without regard to the mediation process. The one exception was its proposed rapid east turn over Mount Baker and mid-Mercer Island; the F.A.A. backed off that proposal in early December under threat of a lawsuit by the City of Mercer Island represented by Cutler and Sheffield. Three separate instances show how the F.A.A. treated the citizenry in the mediation process.

<u>March 1990</u>: On March 27, 1990, the F.A.A. signed its "Final environmental assessment." It kept this fact secret from the public and even the mediator, Dr. James Cormick, at the Option's Committee Meeting on March 29 and the Mediation Committee meeting on March 31, 1990. The F.A.A. should have disclosed this very significant fact, because:

(a) Its "Final environmental assessment" makes a material departure from the routing plan in its "draft environmental assessment", dated December 1989. The "draft environmental assessment", page 61 a, shows 6 jets going due north or northeast over North Seattle on departure. The map is the only reference to the northbound rerouting; the text of the draft "statement" does not even mention it. The Port of Seattle's noise analysis, dated January 4, 1990, was based on the six flights in the draft "assessment" chart. The "Final environmental assessment" shows 10 flights on northbound take-off over North Seattle for January 11, 1990 --- a 2/3rds increase. When the international flights increase in June through August, 15 or more flights per day can be expected. See comment of the North East District Council on the draft environmental assessment, page 26-27, 41, and Exhibits 2-3. A northbound take-off over the central corridor of Seattle and then over North Seattle spews the most noise over the most people at the lowest elevation of any flight path the F.A.A. can trace. See chart enclosed.

(b) In January 1990, the F.A.A. had been asked to tell the mediators when the "Final environmental assessment" would be available. The two negotiators for the North/Northwest sub-caucus had asked for a copy as soon as it became available. Throughout March, the F.A.A. referred citizens who asked about the F.A.A.'s proposed rerouting to the charts it had distributed in November and to the "draft environmental assessment."

The ground rules for the mediation process, paragraphs 47 and 53, required the participants to exercise good faith and share information on matters related to mediation. Early on the mediator had explained that these sections meant keeping the other parties at the table informed about significant events.
Had the F.A.A. disclosed that it had completed its "Final environmental assessment", the citizens would have insisted on seeing it, studying its implications, and responding. It could well have influenced the course of discussions.

November 1989: On November 10,1989, the F.A.A. announced that it would put its so-called "Four Post" rerouting plan into effect on January 11,1990. From that point on, the F.A.A. refused to discuss even continuing the then current routing over Puget Sound and Elliott Bay. The F.A.A.'s action pre-empted any independent consideration of flight paths by the Port's noise and routing consultant and violated the F.A.A.'s pledge to mediate flight path changes. The F.A.A.'s pledge was a significant inducement for the citizens to participate in the mediation process. The F.A.A.'s "draft environmental assessment" is 95 % a repetition of its airspace efficiency study, dated October 18, 1989, which gave no consideration whatever to environmental and community values. See the analysis of the North East District Council submitted to the F.A.A., Exhibit 6. The "Final environmental assessment" replicates the "draft environmental assessment", except for expanding the northbound take-off over North and North East Seattle, and then appends F.A.A. commentary (strongly negative) on the letters and testimony from the community. The F.A.A. used the mediation process as a forum for promoting its rerouting plan.

October 1989: On October 19,1989, the F.A.A. adopted Tracon Order 7200.1. The new order changed the Noise Abatement Procedures, dated October 1, 1984, SEA 7110.71 D. The 1984 Noise Abatement Procedures required eastbound jets on north flow to turn east at the eight nautical mile fix, about Veteran's hospital. Paragraph 6 a (1) states:

> " Between the hours of 0600 and 2200 local time, Seattle-Tacoma eastbound departures shall be issued a restriction/SID to cross the 8 NM fix at or above 4,000 feet and, at that point, turn right to conform with established flow. ..." (emphasis supplied)

The 1989 Tracon Order, paragraph 3 a, drops the emphasized language. The 1984 Noise Abatement Procedures required jets to depart westbound at mid-channel of Elliott Bay and then fly over Puget Sound at least 1½ miles from the Seattle shoreline:

> " Route other departures, avoiding areas of dense population, westbound over the middle of Elliott Bay. After leaving Elliott Bay, the aircraft should be at least 1½ NM from the east shoreline while northbound or southbound over Puget Sound." ¶ 6 a (2) (emphasis supplied)

The 1989 Tracon Order, paragraph 3 b, simply states "route other departures westbound over Elliott Bay." The Tracon order allows departing jets to go north over the central corridor of Seattle rather than angle over Lake Washington and to fly over all of Elliott Bay and of Puget Sound.

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No environmental analysis of any kind preceded the Tracon Order. The F.A.A. announced the changes in the Tracon Order as a fiat accompli to the Mediation Committee at its October 16, 1989 meeting. An F.A.A. spokesman had appeared at a meeting of the North/Northwest Sub-Caucus on September 25, 1989 and made no mention of such a change in the offing. In fact, the spokesman told the citizens that no changes in flight paths would occur while mediation is in process. Section IV,"Improve Duwamish/Elliott Bay Corridor Noise Abatement Procedures", of the Port's Noise Abatement Package is designed to get the jets back to mid-channel and further off shore.

The Review of the F.A.A.'s "draft environmental assessment" of the North East District Council shows the standards for environmental review and public participation that the F.A.A. was required to follow. The F.A.A.'s compliance amounted to "Little to None."

Yours very truly

Jorgen Bader

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26443 SE 154th Place
Issaquah, WA 98027
August 16, 1993

Sea Tac Noise Advisory Committee
Sea Tac International Airport
P.O. Box 68727
Seattle, WA 98168

Dear SNAC:

The draft minutes of your June 24 meeting wistfully suggest that the decreasing number of complaints to the noise hotline "...could be associated with the positive effects of the Mediation Agreement."

May I suggest that the decreasing number of noise complaints could more likely be associated with the woeful irrelevance of the noise hotline, and with an increasing public disillusionment with the whole "noise abatement" public relations ploy.

For months and months well meaning citizens called the "hotline" in good faith to record offensive airplane intrusions into their lives. The Port duly noted and laboriously recorded these thousands and thousands of calls. There has been no evidence that the Port had or has any intention of using the accumulated complaints to influence where the noise occurred and continues to occur.

Increasing numbers of sadder but wiser citizens on the ground see no reason to call the Sea Tac noise hotline ever again.

If the entrenched bureaucracy of the Port interprets public disillusionment to mean success, then the citizen members of the SNAC have a formidable task to make the Port honest.

There is a classic syndrome in the life of public service regulatory entities when the public service regulator ceases to serve the citizens it was established to serve, and becomes instead servant to the industry it is supposed to regulate.

Unless I missed something when the whole noise mediation exercise was instituted, the idea was to serve the citizens on the ground who suffered the noise.

I see on the list of citizens participating on the SNAC some citizen volunteers (outnumbered, I note, by salaried staff people) for whom I have great and abiding respect. To those on SNAC who represent us folks on the ground, my profound thanks, and my encouragement to your tireless efforts to keep the Port honest, and attentive to the folks on the ground. We need the best honest help we can get.

Sincerely,

Laurene McLane

Laurene McLane

Optimum Environment
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Environmental Analysis
Air / Noise / Stormwater
Traffic / Checklists / EIS's
Permits & Engineering

October 27, 1994

TO: Expert Arbitration Panel

FROM: Errol Nelson P.E. - Noise Consultant to RCAA

RE: Single Event Aircraft Contribution to Sea-Tac Ldn Levels

In response to the Expert Panel's information request, the following data is provided. Attached are two tables and a Figure summarizing the single noise event levels that occur from departing aircraft in the southbound pattern. Also attached are examples of the noise measurements, notes on aircraft event patterns, and the chart recordings at S.248th & 13th S and S. 308th & 23rd S. that are part of the data record summarized in the report submitted to the Expert Arbitration panel on August 11, 1994.

Unlike noise patterns that occur in most areas, airport generated noise is a never ending series of discrete noise events, of variable intensity and duration. All aircraft noise events are independent of the previous, or subsequent, aircraft noise events. The example chart recordings of noise at S. 308th St & 23rd Ave S. show low average noise levels on the 50-60 dBA range punctuated by periodic aircraft events of +20 dB or more that last for a few seconds to over a minute. This noise pattern never ceases, is unpredictable and variable in both intensity and duration.

Table I: shows the number of aircraft events that comprise the Ldn noise "average" - measured at 68.3 dBA for 24 hours. This includes 359 discrete aircraft noise events with a peak sound levels (SPL) ranging from 55 to 92 dBA. Hourly aircraft events ranged from 0 to 32. This variability in intensity and duration, and random times of departure, cannot be adequately represented in a single number descriptor of the "average." A regulatory construction of reality, ('A' weighting and Ldn averaging) is not the reality that the people who live in the flight patterns are exposed to on a continuous basis.

Table II: shows peak sound levels measured at the Port's measurement Site 3 at S. 224th and 24th Ave S. Peak noise events for departures ranged from 62 to 79 dBA for propeller aircraft and 76 to 98 dBA for jet aircraft. The is almost a 20 db difference in the peak SPL's of propeller and jet aircraft departures at this location. 60 percent of the peak SPL measurements were 80 dBA or more, including the propeller aircraft component.

Figure 1: compares the peak SPL's with the duration of aircraft event noise above 70 dBA. The linear regression shows that aircraft with a peak SPL of 80 dBA maintain sound levels above 70 dBA for about 16 seconds. Aircraft with a peak SPL of 90 dBA maintain sound levels above 70 dBA for about 35 seconds. These discrete, events cannot be adequately represented by a single number "average" Ldn noise level. What the residents in the flight path are exposed to is not what the average represents, and reducing the "average" will not necessarily change the peak event characteristics and duration.

Table I

Peak SPL Noise Events - RCAA Sea-Tac Noise Study
Dec 22-23, 1992 - S.248th St and 13th Ave S.
24 hours - 100% Southbound Departures
Runway 16L and 16R

Peak dBA	Aircraft Events*	Cumulative Events	Percent Cumulative
95	0		
94	0		
93	0		
92	5	5	1
91	1	6	2
90	5	11	3
89	10	21	6
88	6	27	8
87	12	39	11
86	9	48	13
85	13	61	17
84	20	81	23
83	22	103	29
82	14	117	33
81	21	138	38
80	18	156	43
79	10	166	46
78	19	185	52
77	12	197	55
76	11	208	58
75	21	229	64
74	14	243	68
73	15	258	72
72	12	270	75
71	11	281	78
70	4	285	79
69	10	295	82
68	3	298	83
67	2	300	84
66	8	308	86
65	6	314	87
64	4	318	89
63	9	327	91
62	1	328	91
61	4	332	92
60	9	341	95
59	5	346	96
58	1	347	97
57	1	348	97
56	3	351	98
55	0	351	98
<55	3	354	99
?	5	359	100

? - Peak SPL was masked by a previous event still in progress.
* Aircraft departures were undifferentiated between jet aircraft and propoller aircraft events.

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Table II

Peak SPL Noise Events - Sea Tac Site No. 3
October 21, 1994 - S. 224th St and 24th Ave S.
4 hours - 11AM to 3PM - 100% Southbound Departures
Runway 16L and 16R

Peak dBA	Jet Events	Propeller Events	Events Total	Events Cumulative
99	-	-		
98	2	-	2	2
97	0	-	0	
96	2	-	2	4
95	0	-	0	
94	1	-	1	5
93	1	-	1	6
92	1	-	1	7
91	1	-	1	8
90	1	-	1	9
89	10	-	10	19
88	1	-	1	20
87	5	-	5	25
86	10	-	10	35
85	1	-	1	36
84	6	-	6	42
83	7	-	7	49
82	4	-	4	53
81	3	-	3	56
80	5	-	5	61
79	4	1	5	66
78	2	0	2	68
77	4	0	4	72
76	4	0	4	76
75	-	0	0	
74	-	0	0	
73	-	0	0	
72	-	2	2	78
71	-	1	1	79
70	-	3	3	82
69	-	3	3	85
68	-	3	3	88
67	-	2	2	90
66	-	2	2	92
65	-	2	2	94
64	-	1	1	95
63	-	0	0	
62	-	1	1	96
61	-	0	0	
60	-	0	0	

MEASUREMENT NOTES: 'A' Weighting - Fast Response. Wind Direction - SW Wind Speed 5-12, Gusts to 15 mph. Field Calibrated 11AM; 110.0 dBA, 3PM: 110.2 dBA. Meter: Quest 2800 Type II Integrating Impulse - NBS Calibrated on August 16, 1994.

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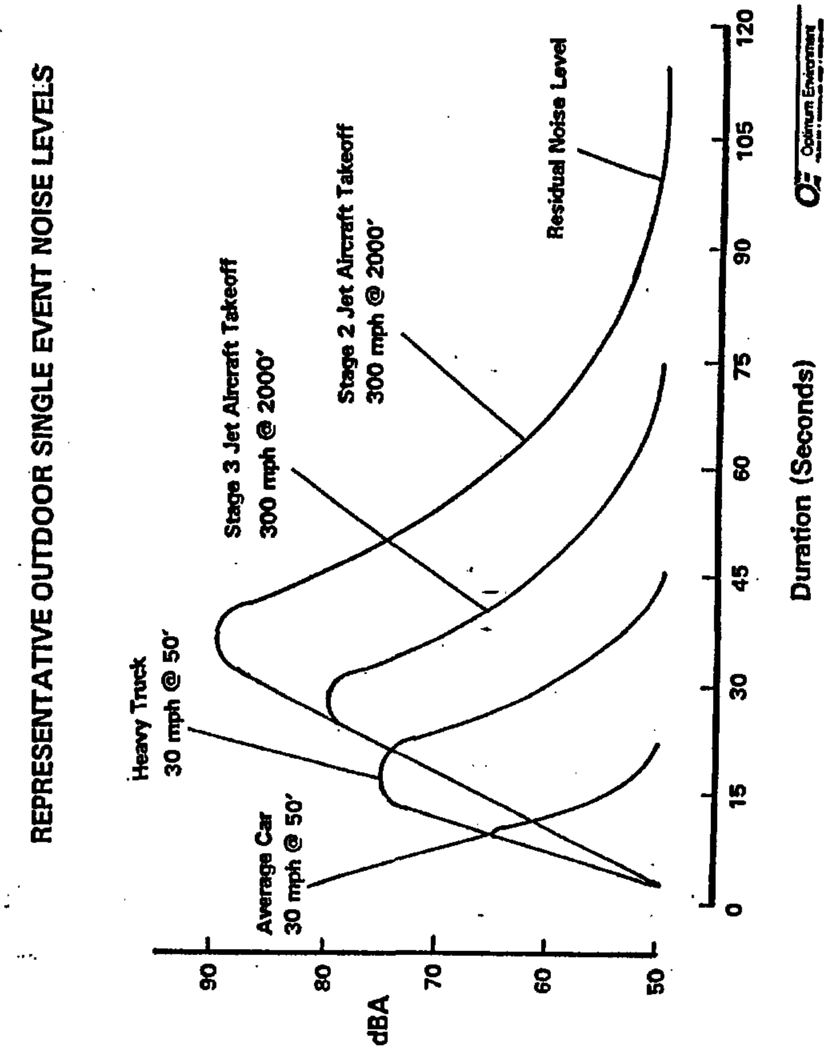
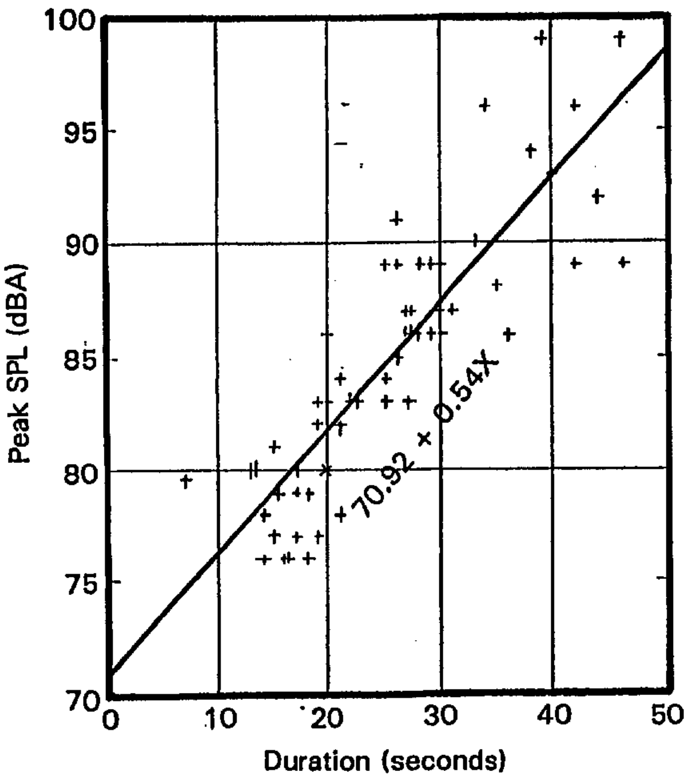


FIGURE 1

Linear Regression
Peak SPL Events vs Duration
Oct 21, 1994 - 11AM to 3PM
S. 224th St and 24th Ave S.

Regression Output:

Constant		70.92165
Std Err of Y Est		2.66045
R Squared		0.754699
No. of Observations		59
Degrees of Freedom		57
X Coefficient(s)	0.544467	
Std Err of Coef.	0.041092	



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Environmental Analysis
Air / Noise / Stormwater
Traffic / Checklists / EIS's
Permits & Engineering

August 9, 1994

TO: Expert Arbitration Panel - Puget Sound Regional Council

FROM: Errol Nelson P.E. - Noise Consultant to RCAA

RE: Attached Testimony on Noise at Aug 11, 1994 meeting.

PSRC objectives and strategies:

PSRC Resolution A-93-03 states that the proposed third Sea-Tac runway would be authorised only when several conditions are met including;

> "Noise performance objectives" should be "achieved based on independent evaluation and based on measurement of <u>real noise impacts.</u>" (underline added)

Resolution A-93-03 also includes strategies adopted as part of Vision 2020 including:

> "Vision 2020 seeks to assure that the people of this region continue to enjoy an outstanding and improving quality of life ... a healthful environment, and livable communities..."

The real, and inescapable, objective of the PSRC, and the one that must be met, is to assure Puget Sound residents a healthful environment in which to live. The best efforts of the Port of Seattle to reduce noise fall short of that objective. The REAL noise problem in the vicinity of the airport will not be abated, regardless of the measures taken. A significant number of residents live in an environment that is too noisy now and all the steps taken by the Port to reduce noise from aircraft overflights-are minimally effective over both the short and long term.

GUIDELINES FOR DETERMINING AIRPORT NOISE IMPACTS

All the discussion and conclusions in Mestre-Greve report, and other reports, say nothing about the actual impact of aircraft noise being experienced by the residents living adjacent to the airport. There is no discussion that 70+ dBA DNL noise levels are acceptable, or healthy for the average person. There have been countless noise studies on annoyance, speech and sleep interference, all with the same general conclusion; the noisier the environment the more people are adversely affected. Table 5 shows a composite DNL noise level of over 74 dDA in 1989. The best efforts at noise reduction described in the report may get that DNL down to 70 dBA by 2001. QUESTION - Would you want to live in an environment that noisy, with little hope of relief? YES or NO?

In 1974, the Environmental Protection Agency published a report "Information on Levels of Environmental Noise Requisite to Protect Public Health and Safety and Welfare with an Adequate Margin of

Safety." Its basic conclusions were that DNL noise levels less than 55 dBA were "generally acceptable" and Leq noise levels greater than 70 dBA had "unacceptable impacts on activity and hearing loss." (An Leq of 70 translates to a DNL of approximately 76 dBA). The EPA report also defined 68-72 DNL as a very noisy urban environment. Additionally, based on human response to noise, 3 dBA is the change required (increase or decrease) where humans generally notice a difference in perceived noise.

BEST NOISE IMPACTS FROM AIRCRAFT OPERATIONS

The Mestre-Greve report acknowledges that, by 2001, the 'best composite' noise reduction that can be expected from the improvements proposed in the airport noise budget is about 4 dBA, from 74 DNL to 70 DNL (Table 8). The difference will barely be noticeable to the residents and, under EPA guidelines, a very noisy urban environment will still exist in the vicinity of Sea-Tac airport. The conversion from Stage 2 to Stage 3 aircraft will be complete, and all the other recommendations to reduce noise will be fully implemented. As annual aircraft operations continue to increase, noise levels will begin to rise again, becoming a function dependent solely on total aircraft operations. The noise increase is independent of any alternative chosen for Sea-Tac use - third runway or no third runway. The noise remedy program for home insulation is, at best, a panacea, and contains has no guarantees. It may provide partial relief to some residents, but, both individually and collectively, is ineffective as a general noise control measure.

WHAT'S BEYOND 2000

It is ridiculous to assume that the best efforts by the Port of Seattle will significantly change the noise levels that are occurring now, or are predicted to occur in the future. The best present technology to reduce noise has been proposed, as described in the Mestre-Greve report. The best reduction achievable, fully implementing all the requirements, is about 4 dBA. This is barely enough to be noticeable to the average person. The environment around the airport is very noisy and will remain that way even with the proposed mitigation steps fully implemented. Finally, the noise reductions implemented will rapidly be offset by the increase in aircraft operations, and by 2005, the already noisy environment will begin to get worse again, regardless of the measures taken now.

The real problem, limiting total aircraft operations at Sea-Tac, has not been addressed, because of the vested political interest the Port has in maintaining the present airport. The only long term solution that is workable is to significantly reduce the total aircraft operations from Sea-Tac: by moving them to other airports, or eliminating them. It is the only way to reduce noise from aircraft to acceptable levels. For example: to get to the 55 dBA DNL that is considered "generally acceptable" under the EPA guidelines, a 97 percent decrease in 2001 aircraft operations is necessary, even with 100 percent Stage 3 aircraft operating.

COMMENTS ON NOISE VALIDATION METHODOLOGY (Mestre-Greve report)

The report is designed to show that the noise validation methodology is in compliance with Resolution A-93-03. However, some inconsistencies are apparent, both within and without the narrow evaluation parameters of the noise validation methodology. Inconsistencies, in addition to those mentioned above, include:

Table 5 - page 19 - Base Period Measured DNL Noise Levels:

Table 5 stipulates that the Total DNL noise levels are combination of Aircraft DNL + Community DNL noise levels, as both a composite and for individual measurement stations. The monitoring network records all noise and "contains software that distinguishes between aircraft noise...and all other sources of noise" (page 14).

Limited noise measurements by RCAA (Sea-Tac Noise Study, Optimum Environment, January 1993) indicate that Community DNL noise levels may be significantly lower than the levels described in Table 5 by the airport monitoring system. In a suburban environment, the DNL noise levels are more normally in the 55 dBA or under category. Table 5 routinely shows the Community DNL noise levels between 60 and 70 dBA. In the RCAA study, between aircraft events, chart recordings show baseline levels in the low 50 dBA range, or even the upper 40's. The remote suburban station had a DNL (including aircraft overflights) of 54 dBA. It is highly probable that the software program defines the community noise contribution at a level up to 10 dBA higher than actual DNL. If so, the community contribution could be, when compared to the Total DNL, an order of magnitude lower. This would result in a Community DNL negligible in comparison to the Total DNL, yielding therefore, the Total DNL = Aircraft DNL. This would increase existing composite noise levels from aircraft activity at Sea-Tac about 0.5 dBA to the 74.8 dBA Total DNL composite value.

Noise Contour Maps - 65, 70 and 75 DNL Contours:

The existing monitoring stations (page 16) are close in locations and cannot accurately validate the ends of the noise contours produced by the INM model. Limited data by RCAA also suggests that, based on actual data, the 65, 70 and 75 dBA contour footprints are longer than suggested by the INM model. Since there are no distant monitoring stations to verify this, the validated noise estimates at the ends of the contours are conjecture. This should be remedied by locating a monitoring station at a more distant location along the flight path.

Ground Noise Contribution:

The noise validation procedures still do not account for ground noise: aircraft taxiing and general activity throughout the airport complex. Again, the RCAA data suggests that there is a substantial contribution to overall noise levels from ground activity. This is partially reflected in the above comment on the contribution of noise from aircraft and community sources. It is highly probable that a significant portion of the community noise contribution is due to airport ground activity not included in the INM model. The airport ground noise contribution should be defined and added to the DNL noise levels as a noise contribution from airport activity.

CONCLUSIONS

- The Mestre-Greve report states that best reduction in noise achievable from Sea-Tac operations in 2001 is about 4 dBA - from 74-70 DNL.
- Based on EPA noise guidelines, 70 DNL is a very noisy urban environment and the noise impacts border on being unhealthful to the average person.
- PSRC Resolution A-93-03 "seeks to assure that the people of this region continue to enjoy an outstanding and improving quality of life.. a healthful environment, and livable communities..." The best efforts of the Port do not achieve that objective, either short term or long term.
- The only method remaining to improve the noise environment in the vicinity of Sea-Tac is to significantly reduce aircraft operations. This would not only preclude construction of a third runway, it would significantly reduce the demand on the existing facilities.

G. BOGAN & ASSOCIATES, INC.

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RCAA INPUT TO ATTACHMENT 2 TO PROCEDURAL ORDER
INFORMATION REQUESTS TO THE PUBLIC

On August 11 and 12, 1994 meetings were conducted by the Expert Arbitration Panel regarding Noise and Demand System Management issues at Sea-Tac International Airport. The Panel heard a presentation by the POS consultant concerning the method the POS proposes to use to validate whether its noise reduction performance objectives are being achieved based on measurements of real noise impacts. The Panel also received oral and written comments from various interested members of the public regarding noise issues.

The Panel deferred its decision on the question of whether the noise validation method proposed by the POS is satisfactory. Additional hearings will be conducted in early December of 1994. The Panel has determined the public may provide additional input to the Panel prior to the upcoming meetings.

Three questions were offered for public comment.

1. Summaries of any methodologically sound aviation noise data collected by local community organizations or individuals, plus specific backup documentation to support the data presented.

2. Detailed descriptions of any technical reasons why achievement of the noise reduction performance objectives of the Noise Budget and Nighttime Limitations Program would not be expected to produce significant reductions in real noise impacts on the ground.

3. Detailed descriptions of any technical reasons why the NVM proposed by the POS should not be found to be a reliable method of determining whether actual on-the-ground noise reduction performance objectives have been achieved.

After analyzing the data provided by RCAA, Optimum Environment consultant, and noise data provided by the POS, the following comments and recommendations are provided to assist in answering the questions posed by the Expert Panel.

The noise data gathered by the POS from its noise monitor system and the report generated, basically provides month and annual DNL averages for each of the eleven monitor sites. Additionally the report provides averaging data regarding the direction of traffic flow by percent, stage III operations by percent, air carrier, commercial, and total airport operations by month plus month and annual averages. Single event data (SEL) is not part of the report prepared by the POS.

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In one analysis three locations were selected, site 1, 7, and 8. These sites represent the furthest reporting stations being used by the POS in its noise gathering efforts at Sea-Tac.

From January 1990 through July 1994, the highest monthly average DNL reading for site 1 was 74.9. Site 7 was 79.2 and site 8 was 73.4. Note site 8 was inoperative from late 1991 through mid 1993 therefore site 8 data is not as reliable as sites 1 and 7.

To better understand the DNL noise values and the actual noise impact that is polluting the communities surrounding the airport one must acknowledge that DNL is a misleading value developed by averaging noise energy over a 24 hour 365 day period. Obviously any noise average number means that there are noise events that are lesser and greater than the average. The noise impact that is less than the average may not be offensive to the listener. On the other side of the equation if the average noise event is offensive to the listener, then those noise events that exceed the average can be identified as intolerable.

In an effort to understand the relationship between DNL and actual noise heard, (i.e SEL) a comparison of DNL noise at site 1 is analyzed with SEL readings for that same location. The DNL data was obtained by analysis of the POS noise monitor reports. The SEL data was obtained by actual noise recordings provided by the RCAA noise consultant, using calibrated equipment and applying accepted industry standards for noise gathering.

The highest DNL recording was during the base year. That value was reported as 74.9 for a monthly average and 73.4 for the annual average. The lowest value was recorded in late 1993. That DNL value was 68.1 for a monthly average and 69.8 for the annual average. While the 1993 DNL reflects the high percentage of Stage III aircraft operations, those values still exceed acceptable noise levels in surrounding communities.

As previously stated the current lowest average monthly DNL recorded is 68.1 (the annual is even higher at 69.8). While these measurements are better than the base year measurements; to fully understand what actual noise levels are being generated single event noise must be considered. Averaged noise levels (DNL) are not what the human ear perceives. Actual or single event is really the "noise exposure" that must be considered when evaluating noise reduction success.

Several noise monitor periods were taken by the RCAA noise consultant. The emphasis was on single event levels. The following single event exposures were recorded in the vicinity of site 1. This was a 24 hour monitor period. A total of 359 aircraft events were recorded. The loudest recording was

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92 DBA, and the lowest 55 DBA. Of the 359 aircraft recordings 11 operations or 3% were 90 DBA or higher. 145 operations or 40% were 80 DBA or higher. 129 or 36 % were 70 DBA or higher. 56 or 16 % were 60 DBA or higher, with the remaining 18 operations in the 50 DBA range. When 79 % of the recordings exceed 70 DNL, and of that 79% 43% in the potential hearing damage level, using averaging (DNL) for determining noise pollution becomes suspect.

In another analysis, a 4 hour noise monitor period was conducted in the vicinity of site 3. A total of 96 aircraft events were recorded. The loudest recording was 98 DBA and the lowest 62 DBA. Of the 96 aircraft recordings 9 operations or 10 % were 90 DBA or higher. 52 operations or 55 % were in the 80 DBA range, with over half 85 DBA or higher. 21 operations or 20 % were in the 70 DBA range. The remaining 14 or 15 % were in the 60 DBA range or higher. This noise monitoring period identified 85 % of the operations were in excess of 70 DBA. This monitor period re-enforces our position that using DNL averaging to determine noise impact on the surrounding communities is not acceptable.

In addition to the high noise levels being experienced an additional noise event should be considered when determining how noise impacts people. The time of exposure to the events must be considered. Offensive noise levels were measured lasting from 15 seconds (that event was 80 DBA) to almost 50 seconds of duration (that event was recorded at 96 DBA).

The conclusion of this analysis would support the claim that the communities surrounding the airport are being subjected to unacceptable noise levels of long and damaging duration while the POS using its measurement reporting methods could lead one to believe that the noise levels are acceptable. To carry this point to its ultimate conclusion, reducing noise to the 1996 POS goal of 72.97 ANEL and 72.2 DNL will not produce the actual noise reductions that the Panel is charged to evaluate. In all probability single event noise levels could not exceed 80 DBA if real perceived noise reductions are to be attained. The forecast reduction even though 38% in terms of total energy, will not limit noise to 80 DBA or less. Therefore, the forecast noise reductions will probably not be recognized by the citizens in impact areas.

The FAA noise model program (INM) is a planning tool but is not effective in determining what actually happened or will happen with regards to noise events. Only real time actual noise events will produce valid noise exposure levels. Noise planners do not have the liberty of evaluating real time events when developing a forecast plan. In an effort to provide the best

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guess future situation generic data must be used in the computer analysis of noise forecasts.

When a consultant develops noise contours and other noise reports using the FAA INM computer model, the majority of data is statistical information and those values have been established as the average for the given event. As an example the noise footprint for a B727 depending on what engines it is equipped with has a total noise energy level (NEL) ranging from 98.23 to 100.24. The B727 is considered the noisiest aircraft in the fleet. Even when it is modified to stage III it is still louder than other stage III aircraft. The B737 is considered one of the quietest stage III aircraft. It has an NEL range from 85.96 to 94.29. This data is taken from the Federal Air Regulation that depicts the "generic" noise generated. These noise values can vary in the real world and therefore greatly alter the true noise values.

Over the years noise studies conducted by the Federal Government and private industry repeatedly acknowledge that noise events in excess of 80 DBA are harmful to humans. The noise validation periods conducted by the RCAA noise expert concluded that more than half of the aircraft noise events were 80 DBA or louder.

As stated before, 3 POS sites were evaluated. Site 8 was deleted from total analysis due to the long period it was out of service. Of the 54 months of data reviewed, site 1 monthly DNL averages exceeded 72 DNL 28 % of the time. Site 7 exceeded 72 DNL 72 % of the time. It is reasonable to assume that if the average noise (DNL) exceeds 72 DNL the single event noise must exceed 80 DBA, which by government standards can cause physical damage.

Other data that will affect noise contours and alter the consultant's forecast is actual weather, actual aircraft weight and stage length, valid numbers of operations and the true fleet mix including engine type etc. None of these can accurately be forecast. Another very important requirement when developing noise events and values for specific locations is the actual flight track over the ground. The flight track data entered into the computer for analysis is assumed to be the correct track over ground. In reality flight tracks vary due to weather pilot technique and instrumentation variables.

The POS does not consider all of the above mentioned real values. Therefore the DNL and ANEL computations of the POS, and the POS noise validation methodology and noise reduction objectives are respectively suspect and unsatisfactory.

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Enclosures:

1. Noise monitor data from Optimum Environment dated Dec 15, 1992.
2. Noise monitor data from Optimum Environment dated Dec 22/23, 1992.
3. ~~Noise monitor data from Optimum Environment dated Oct 21, 1993.~~ NO ENCLOSURE #3
4. Noise monitor data from Optimum Environment dated Oct 21, 1994.
5. Noise data from sites 1, 7, 8 from POS dated Jan 1990 through June 1994.
6. Aircraft noise emmission data INM Version 9 Data Base VAX Computer Version current document authorized by FAA date unkn.

Enclosure #1 - 7 pages

DATA SUMMARY - SEA TAC NOISE STUDY

DATE: Tue Dec 15 & Wed Dec 16, 1992 LOCATION: Approx 100' W of (Intersection)* of S. 308th St and 23rd Ave S.

Hour	Run Time h:m:s	Leq dBA	Ln dBA	NOISE DATA Lmax dBA	Lmin dBA	Snd Exp Level	Calb'n dBA	AIRCRAFT OBSERVATIONS Dir	TO	L	TOT	WEATHER OBSERVATIONS Temp F	Wd Spd mph	Wind Dir	Sky	Comments
12-1 PM	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	110.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
1-2 PM	57:12	68.3		90.9	41.4	103.6		SB	25	0	25	39	<3	-	CLR	
2-3 PM	58:00	67.4		93.9	40.7	102.6		SB	26	0	26	39	<3	-	CLR	
3-4 PM	58:51	60.9		*105.6	44.8	96.3		SB	24	0	24	38	<3	-	CLR	
4-5 PM	58:36	60.0		78.2	46.3	95.3		NB	0	20	20	36	<3	-	CLR	
5-6 PM	58:12	62.2		79.7	50.4	97.5	110.1	NB	0	31	31	36	<3	-	CLR	
6-7 PM	58:02	61.9		78.2	42.9	97.2		NB	0	24	24	36	<3	-	CLR	
7-8 PM	59:26	62.0		77.1	52.3	97.4		NB	0	23	23	35	<3	-	CLR	
8-9 PM	1:01:14	60.6		78.2	51.6	96.1		SB	0	14	14	31	<3	-	CLR	
9-10 PM	57:27	61.5		81.6	51.2	96.8		SB	6	0	6	30	<3	-	CLR	
10-11 PM	58:19	62.9	72.9	85.3	45.6	98.2		SB	9	0	9	30	<3	-	CLR	
11-12 PM	57:08	58.6	68.6	81.2	45.2	93.8	110.1	SB	7	0	7	30	<3	-	CLR	
12-1 AM		63.7	73.7	87.5	44.8	99.3		SB	2	0	2	30	<3	-	CLR	
1-2 AM		61.4	71.4	77.8	40.3	97.0		SB	4	0	4	30	<3	-	CLR	
2-3 AM		58.0	68.0	74.0	40.8	93.6		SB	1	0	1	30	<3	-	CLR	
3-4 AM		58.5	68.5	70.4	41.6	94.1		SB	1	0	1	30	<3	-	CLR	
4-5 AM		60.3	70.3	79.4	44.5	98.1		NB	0	7	7	29	<3	-	CLR	
5-6 AM		62.0	72.0	81.9	54.4	97.6		NB	4	1	5	30	<3	-	CLR	
*12-6 AM		61.1		87.5	40.3		110.1									
6-7 AM	53:38	61.2	71.2	83.1	46.3	96.2		SB	8	0	8	30	<3	-	CLR	
7-8 AM	58:34	67.4		84.9	54.6	102.7		SB	32	0	32	32	3	-	CLR	
8-9 AM	58:45	67.4		86.8	50.4	102.7		SB	28	0	28	30	3	-	CLR	
9-10 AM	58:48	63.9		85.3	46.3	99.3		SB	15	0	15	32	<3	-	CDY	
10-11 AM	58:59	65.3		88.3	45.9	100.6		SB	18	0	18	32	<3	-	CDY	
11-12 AM	58:52	64.2		84.2	44.1	99.5		SB	14	0	14	34	<3	-	CDY	
12-1 PM	58:51	65.8		87.9	42.2	101.2	110.2	SB	22	0	22	34	<3	-	CDY	
TOTALS	17:28:54	64.2				112.9			271	120	391					
*1PM-1PM		68.3	HI	93.9	54.6											
		58.0	LOW	70.4	40.7											
	Ldn = 68.3	10.3	RNG	23.5	13.9											

*NOTES: Only 1PM-1PM values used in the data analysis. Intersection of S 308th and 23rd S is end of road at west boundary of Steel Lake park. 3-4 PM: 105.6 dB Lmax due to electrical power surge - not a noise reading. Midnight to 6 AM: Had a momentary power failure at 2:40 AM. Hourly Leq's, Lmin's and SEL's derived from chart recorder data; Lmax derived from loudest observed aircraft operation that hour:

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SEA TAC NOISE STUDY

Location: S 308th St & 23rd Ave S.
Date: Tuesday, December 15, 1992
Time: 1:00 - 2:00 PM

QUEST MODEL 2800 IMPULSE INTEGRATING SOUND LEVEL METER
DATE:______ SERIAL NO. ______ CALIBRATED: ________

"A" WEIGHTING / FAST RESPONSE

LEQ(dB)	MAX(dB)	MIN(dB)	SEL(dB)	RUN-TIME	OL-TIME
68.3	90.9	41.4	103.6	:57:12	

EXCEEDANCE LEVELS(dB)

	0	1	2	3	4	5	6	7	8	9
L00	91	83	80	78	76	75	73	72	71	70
L10	69	68	67	66	66	65	64	63	63	62
L20	62	61	61	60	60	60	59	59	59	59
L30	58	58	57	57	57	56	56	56	55	55
L40	54	54	54	53	53	53	52	52	51	51
L50	51	51	50	50	50	50	50	49	49	49
L60	48	48	48	48	48	48	48	47	47	47
L70	47	47	47	47	47	47	46	46	46	46
L80	46	46	46	45	45	45	45	45	45	45
L90	45	45	44	44	44	44	44	44	43	43

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NOISE EVENT DATA
SEA-TAC AIRCRAFT OPERATIONS

Date: 12-15-92 Hour Beginning: 1:00 pm Location: Federal Way 2246-S 308th

Temp: 29 WS: 0 WD: — Sky: Clear Rn? Sw? Fg? T/L: (SB?) NB?

Time (Min:Sec) Start	End	Plane ID Carrier	Type	L/T	Peak SPL	Comments
1:02				T	74.4	
1:04					83.4	
1:05					54.6	
1:13			(High Noise Area)		67.7	
1:19			(High Area)		63.9	
1:21			Lite Amie		55.7	
1:24					69.2	
1:27					66.2	
1:28					86.1	
1:30					(Bike)	UPS TRUCK IN/OUT
1:31					72.4	
1:34					83.1	
1:36					69.6	
1:38					71.8	
1:42					79.3	
1:43					66.1	
1:44					79.7	
1:45					86.8	
1:46					85.3	
1:49					75.9	
1:51					62.1	
1:52					90.9	
1:54					88.7	
1:55					58.7	
1:56					80.8	
1:58					77.4	
[illegible]					64.3	

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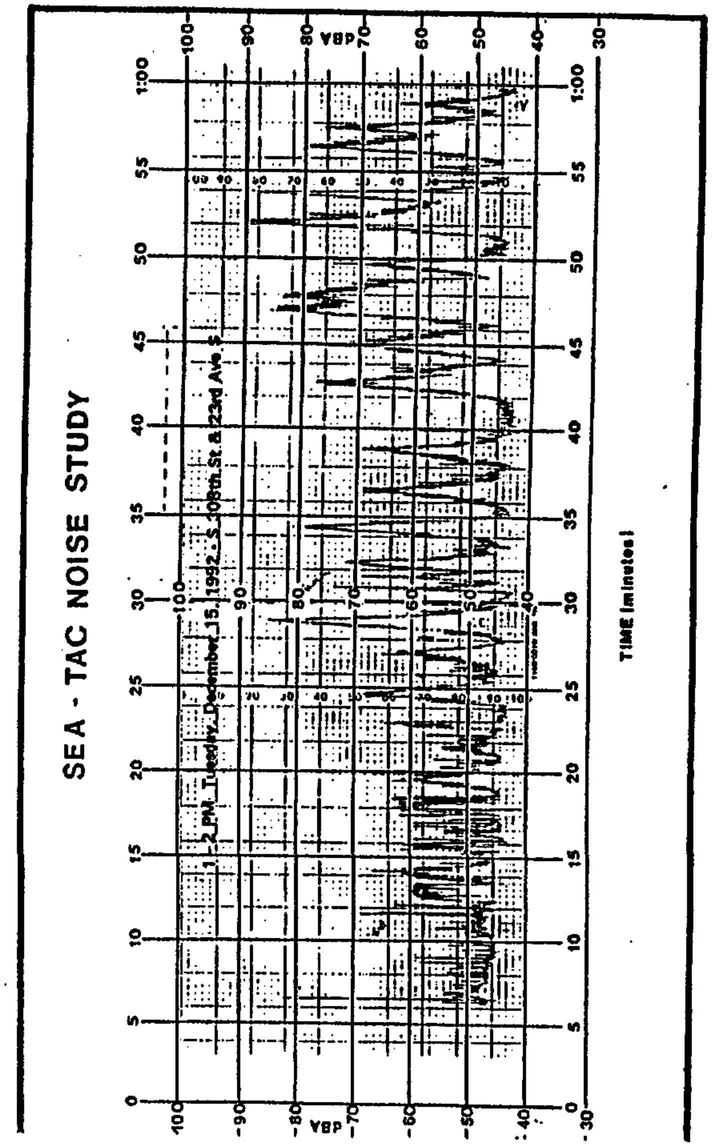

SEA TAC NOISE STUDY

Location: S 308th St & 23rd Ave S.
Date: Tuesday, December 15, 1992
Time: 10:00 - 11:00 PM

QUEST MODEL 2800 IMPULSE INTEGRATING SOUND LEVEL METER
DATE:_______ SERIAL NO. _______ CALIBRATED: __________

"A" WEIGHTING / FAST RESPONSE

LEQ(dB)	MAX(dB)	MIN(dB)	SEL(dB)	RUN-TIME	OL-TIME
62.9	85.3	45.6	98.2	:58:19	

EXCEEDANCE LEVELS(dB)

	0	1	2	3	4	5	6	7	8	9
L00	86	78	74	72	70	68	67	65	64	63
L10	62	62	61	60	59	59	58	58	57	57
L20	56	56	56	56	55	55	55	54	54	54
L30	54	54	54	54	53	53	53	53	53	53
L40	53	53	53	53	53	53	52	52	52	52
L50	52	52	52	52	51	51	51	51	51	51
L60	51	51	50	50	50	50	50	50	50	49
L70	49	49	49	49	49	49	48	48	48	48
L80	48	48	48	48	48	48	48	48	48	48
L90	48	47	47	47	47	47	47	47	47	47

NOISE EVENT DATA
SEA-TAC AIRCRAFT OPERATIONS

Date: 12·15·92 Hour Beginning: 10:00 PM Location: S 308th ... ...
Temp: 30° WS: 0 WD: 0 Sky: Clear Rn? Sw? Fg? T/L: (SB)? NB?

Time (Min:Sec) Start	End	Plane ID Carrier	Type	L/T	Peak SPL	Comments
10:02				F/o	65.8	Helicopter
10:04				T	80.4	
10:12				T	75.6	
10:17				T	60.6	
10:26				-	70.2	
10:37				T	74.1	
10:39				T	84.6	
10:42				T	85.3	
10:55				T	69.4	
10:56				T	75.9	
10:58				T	64.7	

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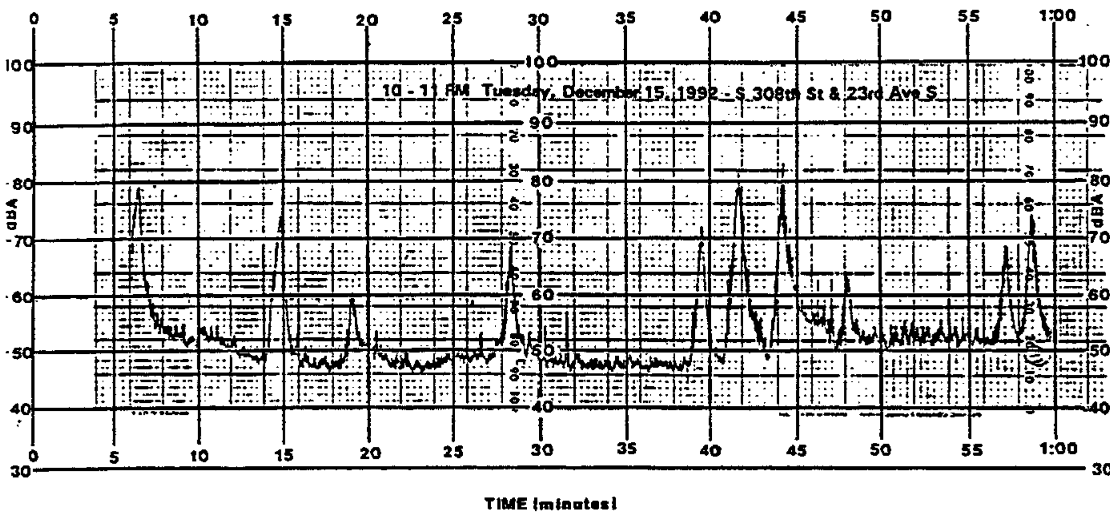
SEA - TAC NOISE STUDY



Enclosure #2 - 6 pages

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DATA SUMMARY - SEA TAC NOISE STUDY

DATE: Tue Dec 22 & Wed Dec 23 1992 LOCATION: Approx 150' S of Intersection of S. 248th St and 13th Ave S.

Hour	Run Time h:m:s	Leq dBA	Ln dBA	NOISE DATA Lmax dBA	Lmin dBA	Snd Exp Level	Calb'n dBA	AIRCRAFT OBSERVATIONS Dir	TO	L	TOT	WEATHER OBSERVATIONS Temp F	Wd Spd mph	Wind Dir	Sky	Comments
12-1 PM	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	110.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
1-2 PM	59:28	64.7		87.9	44.8	100.1		SB	26	0	26	50	5	S	OC	
2-3 PM	57:41	66.8		89.8	43.7	102.1		SB	21	0	21	50	2-5	S	OC	
3-4 PM	1:00:07	62.8		85.7	44.1	98.3		SB	18	0	18	48	6	S	OC	
4-5 PM	56:01	64.3		85.7	39.9	99.4		SB	17	0	17	48	5-7	S	OC	GUSTS TO 10 MPH
5-6 PM	58:08	63.3		86.8	40.7	98.7	110.1	SB	17	0	17	50	5	S	OC	
6-7 PM	50:24	67.6		92.9	46.8	102.3		SB	22	0	22	48	<3	S	OC	
7-8 PM	59:41	69.0		89.1	38.4	104.4		SB	24	0	24	48	5-6	S	OC	
8-9 PM	58:30	68.3		92.8	38.4	103.7		SB	17	0	17	48	<3	S	OC	
9-10 PM	57:30	63.3		86.8	36.6	98.5		SB	11	0	11	45	4-5	S	OC	
10-11 PM	57:01	61.8	71.8	89.8	35.4	97.0		SB	9	0	9	45	3-6	S	OC	
11-12 PM	57:46	58.4	68.4	82.7	35.1	93.7	110.1	SB	9	0	9	45	<3	S	OC	
12-1 AM		60.8	70.8	90.6	-			SB	3	0	3	45	<3	S	OC	
1-2 AM		59.3	69.3	83.1	-			SB	2	0	2	45	<3	S	OC	
2-3 AM		56.3	66.3	*	-			SB	0	0	0	45	<3	S	OC	
3-4 AM		55.2	65.2	*	-			SB	0	0	0	45	<3	S	OC	
4-5 AM		60.5	70.5	80.4	-			SB	1	0	1	45	<3	S	OC	
5-6 AM		58.0	68.0	87.2	-			SB	1	0	1	45	<3	S	OC	
*12-6 AM	5:57:32	58.7		105.6*	33.2	101.8	110.1	SB								
6-7 AM	55:15	64.2	74.2	88.7	41.4	99.3		SB	11	0	11	47	<3	S	P/C	
7-8 AM	58:56	69.4		89.4	41.4	104.8		SB	30	0	30	47	<3	S	P/C	
8-9 AM	58:35	68.5		92.8	42.1	103.8		SB	34	0	34	47	8-12	S	CDY	
9-10 AM	1:02:11	66.6		92.4	41.8	102.2		SB	22	0	22	47	3-5	S	CDY	
10-11 AM	56:00	65.6		87.6	39.9	100.8		SB	16	0	16	50	3-5	S	CDY	
11-12 AM	1:00:15	66.7		90.9	40.3	102.1		SB	18	0	18	50	3-5	S	CDY	
12-1 PM	57:32	64.7		90.2	41.8	99.9	110.1	SB	30	0	30	48	3-5	S	CDY	THIN CLOUDS/SUN
TOTALS	23:18:33	65.1				114.4			387	0	387					
*1PM-1PM		69.4	HI	92.9	46.8											
		55.2	LOW	82.7	33.2											
	Ldn = 68.3	14.2	RNG	10.2	13.6											

*NOTES: Only 1PM-1PM values used in the data analysis. Chart recorder failure - No chart recorder data taken during this monitoring period. Midnight to 6 AM: 105.6 dB Lmax due to electrical power surge - not a noise reading. Hourly Leq's derived from cumulative Leq read at the top of each hour; Lmax derived from loudest observed aircraft operation that hour - there were no aircraft overflights between 2 and 4 AM.; Lmin shown is the lowest for the 6 hour measurement period.

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SEA TAC NOISE STUDY

Location: S 248th St & 13th Ave S.
Date: Tuesday, December 22, 1992
Time: 1:00 - 2:00 PM

QUEST MODEL 2800 IMPULSE INTEGRATING SOUND LEVEL METER
DATE:________ SERIAL NO. ________ CALIBRATED: ____________

"A" WEIGHTING / FAST RESPONSE

LEQ(dB)	MAX(dB)	MIN(dB)	SEL(dB)	RUN-TIME	OL-TIME
64.7	87.9	44.8	100.1	:59:28	

EXCEEDANCE LEVELS(dB)

	0	1	2	3	4	5	6	7	8	9
L00	88	78	75	74	72	71	70	69	69	68
L10	67	66	66	65	65	64	63	63	62	62
L20	61	60	60	60	59	59	58	58	57	57
L30	57	57	57	56	56	56	56	56	56	56
L40	56	56	56	56	55	55	55	55	55	55
L50	55	55	54	54	54	54	54	54	54	53
L60	53	53	53	53	53	53	52	52	52	52
L70	52	51	51	51	51	51	51	51	51	51
L80	50	50	50	50	50	50	50	50	50	49
L90	49	49	49	48	48	48	48	48	47	47

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NOISE EVENT DATA
SEA-TAC AIRCRAFT OPERATIONS

Date: Dec 22,92 Hour Beginning: 1:00 P Location: S 248TH & 13TH

Temp: 50 WS: Gust 15 WD: S Sky: Overcast Rn? Sw? Fg? T/L: SB NB?

Time (Min:Sec) Start	End	Plane ID Carrier	Type	L/T	Peak SPL	Comments
1:00				T	77.4	
1:05					72.2	
1:07					80.4	
1:19					78.9	
1:22					59.8	
1:24					61.7	
1:27					83.8	
1:31					65.8	
1:32					73.7	
1:33					72.9	
1:34					78.9	
1:36					74.4	
1:37					63.2	
1:38					60.2	
1:40					87.9	
1:42					79.7	
1:45					66.9	
1:46					73.3	
1:47					78.2	
1:49					86.1	
1:50					76.7	
1:51					73.3	
1:53					81.2	
1:55					56.8	
1:58					69.9	
1:59				T	74.1	

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SEA TAC NOISE STUDY

Location: S 248th St & 13th Ave S.
Date: Tuesday, December 22, 1992
Time: 10:00 - 11:00 PM

QUEST MODEL 2800 IMPULSE INTEGRATING SOUND LEVEL METER
DATE:_______ SERIAL NO. _______ CALIBRATED: ___________

"A" WEIGHTING / FAST RESPONSE

LEQ(dB)	MAX(dB)	MIN(dB)	SEL(dB)	RUN-TIME	OL-TIME
61.8	89.8	35.4	97.0	:57:01	

EXCEEDANCE LEVELS(dB)

	0	1	2	3	4	5	6	7	8	9
L00	90	77	71	68	65	62	59	57	55	54
L10	52	50	49	48	47	47	46	45	44	44
L20	44	43	43	42	42	42	42	42	42	41
L30	41	41	41	41	41	41	41	41	41	41
L40	41	41	41	41	41	40	40	40	40	40
L50	40	40	40	40	40	40	40	40	40	40
L60	40	39	39	39	39	39	39	39	39	39
L70	39	39	39	39	39	39	39	39	39	39
L80	39	39	39	39	39	39	38	38	38	38
L90	38	38	38	38	38	38	38	37	37	37

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NOISE EVENT DATA
SEA-TAC AIRCRAFT OPERATIONS

Huntington Park

Date: 12/22/92 Hour Beginning: 10:00PM Location: 24828 9th Pl. So.
Temp: 45° WS: 3-6 WD: S Sky: Overcast Rn? Sw? Fg? (T)L: SB? NB?

Time (Min:Sec) Start	End	Plane ID Carrier	Type	L/T	Peak SPL	Comments
10:05				T	86.4	
10:20				T	89.8	Piston Aircraft
10:26				T	73.7	
10:41				T	79.7	
10:43				T	83.4	
10:46				T	71.1	
10:47				T	56.4	
10:49				T	50.1	
10:54				T	66.9	

Table I

Peak SPL Noise Events - RCAA Sea-Tac Noise Study
Dec 22-23, 1992 - S.248th St and 13th Ave S.
24 hours - 100% Southbound Departures
Runway 16L and 16R

Peak dBA	Aircraft Events*	Cumulative Events	Percent Cumulative
95	0		
94	0		
93	0		
92	5	5	1
91	1	6	2
90	5	11	3
89	10	21	6
88	6	27	8
87	12	39	11
86	9	48	13
85	13	61	17
84	20	81	23
83	22	103	29
82	14	117	33
81	21	138	38
80	18	156	43
79	10	166	46
78	19	185	52
77	12	197	55
76	11	208	58
75	21	229	64
74	14	243	68
73	15	258	72
72	12	270	75
71	11	281	78
70	4	285	79
69	10	295	82
68	3	298	83
67	2	300	84
66	8	308	86
65	6	314	87
64	4	318	89
63	9	327	91
62	1	328	91
61	4	332	92
60	9	341	95
59	5	346	96
58	1	347	97
57	1	348	97
56	3	351	98
55	0	351	98
<55	3	354	99
?	5	359	100

? - Peak SPL was masked by a previous event still in progress.
* Aircraft departures were undifferentiated between jet aircraft and propeller aircraft events.

Enclosure #4 - 1p.

Table II

Peak SPL Noise Events - Sea Tac Site No. 3
October 21, 1994 - S. 224th St and 24th Ave S.
4 hours - 11AM to 3PM - 100% Southbound Departures
Runway 16L and 16R

Peak dBA	Jet Events	Propeller Events	Events Total	Events Cumulative
99	-	-		
98	2	-	2	2
97	0	-	0	
96	2	-	2	4
95	0	-	0	
94	1	-	1	5
93	1	-	1	6
92	1	-	1	7
91	1	-	1	8
90	1	-	1	9
89	10	-	10	19
88	1	-	1	20
87	5	-	5	25
66	10	-	10	35
85	1	-	1	36
84	6	-	6	42
83	7	-	7	49
82	4	-	4	53
81	3	-	3	56
80	5	-	5	61
79	4	1	5	66
78	2	0	2	68
77	4	0	4	72
76	4	0	4	76
75	-	0	0	
74	-	0	0	
73	-	0	0	
72	-	2	2	78
71	-	1	1	79
70	-	3	3	82
69	-	3	3	85
68	-	3	3	88
67	-	2	2	90
66	-	2	2	92
65	-	2	2	94
64	-	1	1	95
63	-	0	0	
62	-	1	1	96
61	-	0	0	
60	-	0	0	

MEASUREMENT NOTES: 'A' Weighting - Fast Response. Wind Direction - SW Wind Speed 5-12, Gusts to 15 mph. Field Calibrated 11AM: 110.0 dBA, 3PM: 110.2 dBA. Meter: Quest 2800 Type II Integrating Impulse - NBS Calibrated on August 16, 1994.

Enclosure #5 - 1 p.

[illegible]

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Enclosure #6 1 p.

Table 1

Example Aircraft Single Event Noise Levels from Noise Budget

INM Aircraft	Aircraft Description	Commercial Jet Stage III	Departure 30,000 ft.	Departure 60,000 ft.	Departure 90,000 ft.	Arrival -20,000 ft.	Total NEL
			REFERENCE POINTS (NEL)				
A300	A300/CF6-50C	Yes	84.54	74.09	71.58	87.56	89.59
A310	A310/CF6-80A	Yes	83.49	74.09	70.34	87.41	89.12
707QN	B707-320B/JT3D-7QN	No	93.92	86.57	82.33	91.67	96.59
727100	B727-100/JT8D-7	No	96.42	87.06	82.55	91.97	98.23
727Q7	B727-100/JT8D-7QN	No	95.81	86.27	81.75	88.62	97.09
727D15	B727-200/JT8D-15	No	97.56	89.86	85.13	92.50	99.36
727Q15	B727-200/JT8D-15QN	No	96.94	88.89	84.38	89.28	98.35
727D17	B727-200/JT8D-17	No	97.64	89.42	85.10	89.28	98.95
727200	B727-200/JT8D-7	No	99.11	89.14	84.38	92.38	100.41
727Q9	B727-200/JT8D-9QN	No	99.41	88.61	84.15	89.26	100.24
737382	B737-300/CFM56-3B-2	Yes	78.50	70.38	67.00	84.88	85.96
737200	B737-300/CFM56-3-B1	Yes	78.67	70.28	66.13	84.88	85.98
737D17	B737/JT8D-17	No	92.77	85.04	80.86	85.45	94.29
737	B737/JT8D-9	No	90.66	82.91	78.69	86.73	93.38
737QN	B737/JT8D-9QN	No	89.95	82.12	77.95	85.16	91.88
747SP	B747SP/JT9DFL	Yes	85.89	78.36	74.10	89.62	91.46
74710Q	B747-100QN/JT9DFL	Yes	88.36	81.79	77.14	89.84	92.63
747100	B747-100/JT9DTD	No	93.73	86.02	80.64	95.09	97.86
74720B	B747-200B/JT9D-7Q	Yes	88.38	81.25	76.94	92.89	94.50
747200	B747-200/JT9DFL	Yes	89.64	83.26	78.36	90.00	93.63
757PW	B757/PW2037	Yes	76.14	67.75	63.95	84.71	85.38
757RR	B757/RR 535E	Yes	77.34	69.41	63.84	83.51	84.49
767CF6	B767-200/CF6-80A	Yes	81.15	73.97	70.12	86.96	88.31
767JT9	B767-200/JT9D-7	Yes	81.61	73.86	70.40	86.98	88.32
BAE146	BAE 146/ALF 502R-5	Yes	78.18	71.43	66.73	81.54	83.56
BEC58P	BEECH BARON 58P	–	80.95	75.04	71.89	76.89	83.44
CNA441	CESSNA CONQUEST II	–	70.71	64.42	61.90	74.20	76.27
CONCRD	CONCORDE/OLY593	–	110.95	110.19	104.61	103.82	114.50
DC1010	DC-10-10/CF6-6D	Yes	83.68	78.16	73.65	88.10	90.43
DC1030	DC-10-30/CF6-50C2	Yes	84.30	76.26	72.23	88.22	89.96
DC1040	DC-10-40/JT9D-20	Yes	84.30	76.26	73.23	88.22	89.96
DC8QN	DC-8-60/JT3D-7QN	No	94.83	87.37	83.01	91.59	97.18
DC870	DC-8-70/CFM56-2	Yes	83.94	75.74	70.86	86.69	88.71
DC910	DC-9-10/JT8D-7	No	88.38	80.48	77.12	90.18	92.77
DC9Q7	DC-9-10/JT8D-7QN	No	87.62	79.68	76.43	86.74	90.74
DC930	DC-9-30/JT8D-9	No	91.36	84.00	79.88	90.84	94.67
DC9Q9	DC-9-30/JT8D-9QN	No	90.59	83.25	79.08	87.37	93.00
DC950	DC-9-50/JT8D-17	No	94.35	86.48	82.31	88.92	96.15
DHC6	DHC-6/PT6A-27	–	76.56	70.78	68.85	85.14	85.93
DHC7	DHC-7/PT6A-50	–	71.04	64.93	60.88	80.75	81.33
DHC8	DHC-8/PW120	–	70.17	65.92	63.43	82.32	82.72
F28MK2	F28 MK2000/RB.183-2	No	90.40	82.86	78.23	88.97	93.31
F28MK4	F28 MK4000/RB.183-2P	No	87.68	79.41	74.50	88.97	91.67
LEAR25	GATES LEAR 25/CJ610	–	96.76	85.55	79.45	83.37	97.33
LEAR35	GATES LEAR 35/TFE731	–	80.90	71.50	65.79	74.40	82.36
L10115	L-1011-500/RB211-524	Yes	86.72	77.62	73.50	90.21	92.04
L1011	L-1011/RB211-22B	Yes	86.81	78.29	73.62	89.86	91.87
MD81	MD-81/JT8D-209	Yes	83.66	76.59	71.95	82.57	86.76
MD82	MD-82/JT8D-217A	Yes	84.45	77.03	72.57	82.64	87.25
MD83	MD-83/JT8D-219	Yes	85.52	77.99	73.54	85.30	88.17
SF340	SAAB 340/CT7-5	–	76.42	70.40	66.55	78.31	81.04
SD330	SHORTS SD3-30	–	78.13	72.47	69.51	79.63	82.63

NOTES: NEL Source - INM Version 9 Data Base VAX Computer Version

G. Bogan & Associates, Inc.

Aviation Consultants

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In the world of Aviation Consulting, the best way to measure a company's competence is by its track record. G. Bogan & Associates, Inc., is a highly experienced and well established consulting firm uniquely qualified to evaluate and coordinate the implementation of all types of aviation projects, ranging from initial feasibility studies to facility layout and design.

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GERALD H. BOGAN
President

EDUCATION

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Long Beach City College, Long Beach, CA

FAA TRAINING
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* Provided a wide variety of developmental, analytical and technical support for numerous aviation clients.

PROJECTS

* Feasibility analysis of joint civil/military use at MCAS El Toro, California.
* Master plan development for Jeddah Airport in Saudi Arabia.
* Preliminary master plan development and feasibility study for Schenzen International Airport in China.
* Audit of the Republic of Indonesia's civil aviation structure.
* Development of procedures, routes and other setup details compatible with airport authorities for Airspur Helicopter Service.
* Development and installation of microcomputer system in U. S. Navy and Marine Air Facilities.
* Prepared all training documentation and coordinated the installation of a microcomputer system serving six FAA air traffic control towers.
* Provide consulting on aircraft noise and related airport problems for the City of Tempe, AZ., Eagan MN., Citizen Groups in Chicago IL., Newport Beach CA., and Newark NJ.

GERALD H. BOGAN
Page two

* Analysis of air traffic control procedures, communications, and navigational aid requirements necessary for hypersonic aircraft operations for McDonald Douglas and NASA.

* IFR procedure analysis including feasibility recommendations on helicopter IFR route system for the Southern California Association of Governments.

* Airport and airspace capacity analysis for all air carrier airports in California for the California Department of Transportation.

* Analyze flight tracks and noise mitigation plans proposed by FAA and airport proprietor at Seattle-Tacoma International airport, for citizens committee involved with airport problems.

* Review airport master plan and capacity forecasts at Vancouver International Airport, B.C., for citizens involved with airport problems.

* Member of National Transportation Safety Board team investigating an air carrier/civil aircraft collision in San Louis Obispo, California.

* Provide litigation service as expert witness in air traffic control matters, airport design, obstruction evaluation, and Federal Air Regulations affecting airport safety,

* Provide aircraft noise analysis, flight track, and capacity forecasts for clients developing property adjacent to airports. Assist in obtaining required permits and approvals from the FAA for the projects.

GERALD H. BOGAN
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FEDERAL AVIATION ADMINISTRATION (Positions Held)
Chief, Los Angeles Air Route Traffic Control Center
Chief, Coast TRACON, MCAS El Toro
Supervisor, Los Angeles Tower/TRACON
Air traffic controller, Los Angeles Tower/TRACON
Military Activities Officer
Noise Abatement Officer
Plans and Program Specialist

MILITARY
U.S.A.F. Air traffic and radar controller

LICENSES
Control Tower Operator...Weather Observer
Commercial Pilots License

AWARDS
FAA Citations and Special Achievements Awards, 1967, 1968, 1976, 1980
FAA Outstanding Rating Awards, 1969, 1976
U.S. Air Force Special Achievement Medal

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STATE OF WASHINGTON
PUGET SOUND REGIONAL COUNCIL

In the Matter of:

Expert Arbitration Panel's Review of Noise and Demand/System Management Issues at Sea-Tac International Airport

ORDER ON PHASE I NOISE ISSUES

January 9, 1995

The Expert Arbitration Panel on Noise and Demand/System Management Issues (the "Panel") has carefully considered the arguments and evidence with respect to what we have termed Phase I of the Noise Issues. Written and oral submissions on these issues have been presented to us by the Port of Seattle ("POS"), the Puget Sound Regional Council ("PSRC"), the Washington State Department of Transportation ("WSDOT"), the Federal Aviation Administration ("FAA"), the Coordinating Committee and by a variety of groups and individuals representing residents of communities affected by Airport noise, including the Regional Commission on Airport Affairs ("RCAA"), the Airport Communities Coalition ("ACC"), the Airport Noise Group ("ANG") and many individuals who appeared before the Panel to offer their comments to us. On December 2, 1994, we announced our decision on the scope of the Panel's inquiry on Noise Issues and indicated that a written order was soon to follow. Thereafter, we received some additional written submissions by the POS, the RCAA, the Federal Way Chapter of the RCAA, the ACC, the ANG and Air Washington. This is the written order containing our decision on the scope of the Panel's inquiry on Noise Issues.

We have concluded that our role under PSRC Resolution A-93-03 is to determine whether the POS has scheduled, pursued and achieved a reduction in measurable, real on-the-ground noise impacts. To meet its burden under the Resolution, as we interpret it, the POS must offer us reliable evidence, based upon actual measurements of on-the-ground noise, that by 1996 there has been an objectively measurable, meaningful reduction in aircraft noise impacts in the affected communities surrounding the Airport.

Under the Resolution, it is not enough for the POS to show that it has met the goals of the Noise Budget and the Nighttime Limitations Program (or the goals of additional programs specified by the Mediated Noise Agreement). Rather, the POS must establish that through whatever means, it has reduced the impact of on-the-ground noise in a way that residents of the affected communities could appreciate. In our view, therefore, proof of compliance with the Mediated Noise Agreement is useful, but not necessarily sufficient, to establish that the noise reduction requirement of the Resolution has been met.

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We are convinced that the Resolution was intended to condition the approval of the third runway upon a showing that the noise impacts of the existing Airport have been reduced in a significant way. This means, to us, that it is not enough only to show that there has been a measurable reduction in average sound levels as determined by the Day-Night Level (DNL) metric using the existing Airport Noise Monitoring System. A measurable reduction of that sort might be so small, or have such a character, that even by objective standards, it could not be expected to make a material difference to the communities that surround the Airport. The 11 remote monitoring sites (RMS) of the existing Noise Monitoring System may also not be sufficiently representative of the locations of significant on-the-ground noise impacts generated by aircraft using the Airport.

The question we must decide is whether there has been a reduction in real noise impacts that by objective measures is significant and meaningful. We are not persuaded that the deletion of the words "reasonable, meaningful" from the description in the PSRC's Implementation Steps of the reduction in on-the-ground noise to be validated is of any consequence. We do not believe that either an "unreasonable" (i.e., unreachable or infeasible) or a "meaningless" (i.e., inappreciable or trivial) reduction in noise was contemplated by the Resolution.

The POS has not demonstrated that the Noise Validation Methodology (NVM) presented in *Noise Validation Methodology in Compliance with PSRC Resolution A-93-03* ("the NVM Report"), as it exists today, would be a valid method of determining whether the required reduction in on-the-ground noise has occurred even if it were a valid method of measuring success in meeting the ANEL goals of the Noise Budget. The Panel does, however, note several important points about the proposed NVM:

- The proposed NVM is based, as it should be, on measured, not predicted, on-the-ground sound levels.
- The proposed NVM, as it should, measures on-the-ground noise from *all* Airport noise sources, not just landing and departing domestic commercial aircraft that are subject to the noise budget.[1]
- The proposed NVM, however, depends entirely upon sound levels that have been and will be measured only at the 11 existing RMS around the Airport.
- The POS has not demonstrated that the 11 RMS will adequately reflect the levels experienced by a representative sample of the impacted population.[2]

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[1] These sources include nighttime as well as daytime flights, cargo flights, international flights, military flights and general aviation flights, plus all noises made by aircraft or auxiliary equipment while on the ground (including taxiing and ground run-up during maintenance and repair). Thus, the proposed NVM measurements include actual noise that was excluded from the Noise Budget calculations. The proposed NVM measurements would also likely include noise from aircraft operating at nearby airports.

[2] There are sites in areas where no people live, and no sites are in areas where the 1989-90 annual average DNL used in the NVM baseline calculation was below 71 dB. Sites would seem to be needed that are representative of the impacted population, not just the severely impacted population; sites are needed where the DNL are in the 55-70 dB ranges, as well as where the DNL exceeds 70 dB. Because the current Noise Monitoring System is limited to sites very close to the Airport, the average NVM DNL of 74 dB, observed at the 11 RMS, does not reflect the lower levels of noise that are experienced by most of the impacted population.

- The POS has not demonstrated that data from the 11 monitoring sites are sufficient to confirm whether the ANEL noise reductions in the Noise Budget will be achieved.[3]

- The POS has not demonstrated that the arithmetic average of a set of monitored data (as used in the NVM) will give the same target reduction as an energy summation of the same data (energy summation is used in the Noise Budget).[4]

As a result, a revised NVM will be required.

We recognize, however, that the Resolution contemplates that objective measurements of on-the-ground noise will be used. This means that the POS will not be required to conduct surveys of residents in the affected communities to ascertain their subjective perceptions of Airport noise. This is not to say that such survey results would not provide useful information to the POS and the public, and to this Panel. We also acknowledge that the Resolution does not require the POS to reduce Airport noise to "acceptable" levels, whatever they may be. Rather, the Resolution only requires that the POS achieve a significant reduction in the real noise impacts. Busy jet airports, such as Sea-Tac, are inherently noisy, and it is unrealistic to expect that nearby communities would ever find the noise impacts generated by such airports to be "acceptable."

The question therefore becomes (a) what measures of noise impacts should be used (that is, what noise "metrics" should be selected), (b) where should the measurements of noise be made, and (c) how much reduction in noise, by these measures, must be achieved, and over what time period, to satisfy the requirements of the Resolution?

We turn first to the choice of metrics. We recognize, as the POS has urged, that DNL is a valuable tool, and we intend to give significant weight to reductions in DNL that are shown by the POS. However, we have concluded that the use of the DNL metric, by itself, is inadequate to show the required reduction in noise impacts because, taken alone, as an aggregate value it does not permit us to review the intensity, duration or frequency of single noise events or to consider when, during the day or night, they occur (even though all of these attributes contribute to the measured DNL).[5] As a result, we

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[3] The ANEL includes calculation points at +60,000 and +90,000 feet from the start of take-off roll (as well as +30,000 from take-off roll and -20,000 feet from landing touchdown). However, the most distant RMS is only 29,000 feet from the start of take-off roll, and most of the 11 RMS are closer than the shortest distance in the ANEL (20,000 feet). Thus, assertions about differences among aircraft in arrival or departure noise at greater distances out from the Airport remain untested.

[4] The proposed NVM DNL goal is the arithmetic average of the annual energy-average DNL at the 11 RMS. The ANEL in the Noise Budget is the level of the sum (not the average) of the sound energies at four other points. If the NVM were to use the sum of the sound energies at the 11 RMS instead of the arithmetic average, the results will change slightly from what is currently shown in the NVM Report. While the difference would normally be of little consequence, the POS is presenting its ANEL goals with year-to-year reductions in the range of 0.2 to 0.4 dB. Also, as previously noted, the POS has not demonstrated that the reductions at the relatively close-in 11 RMS represent the reductions at more distant, yet impacted, sites.

[5] For example, a 3 dB reduction in DNL would occur if either (i) there were a 50% reduction in the noise energy generated by each aircraft using the Airport (but no change in the frequency of operations) or (ii) there were
(continued...)

encourage the POS to develop a method that supplements the use of DNL observations with various additional metrics (including sound exposure level (SEL), Time Above (TA) an appropriate sound level threshold, and unweighted sound pressure levels). The revised method should also explicitly report changes in the total number, as well as in the composition and day/night mix, of aircraft operations at the Airport. Unless the reduction in sound levels is more fully characterized than the use of only DNL allows, we will be unable to find that there has been a meaningful reduction in real on-the-ground noise impacts, as required by the Resolution.[6]

We turn next to the location of noise monitors. We have concluded that the use of measurements of on-the-ground noise from the existing Noise Monitoring System at Sea-Tac is, without more evidence, insufficient to show the required reduction in noise impacts because these measurements do not capture

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[5](...continued)
no change in the noise energy generated by each aircraft, but a 50% reduction in operations in operations at the Airport. While these two changes would be equivalent in DNL terms, the impacts on the surrounding communities would be very different.

[6] Additionally, we have concerns over the manner in which DNL is currently measured. The currently installed 11 RMS report a DNL attributable to aircraft alone as well as a DNL capturing all the noise at a site. The proposed NVM has left open the option to use either of these levels. The Panel believes that the NVM should include both the total DNL and aircraft DNL, because of the following concerns.

First, the "total DNL," by definition, captures all noise at a site. Improper placement of an RMS hydrophone (or loss of its windscreen) could cause the RMS to measure high levels of nonaircraft noise that are not truly representative of what the people are experiencing on the ground. It is possible that the total DNL in the base period could be slightly, artificially and incorrectly high. Elimination of this problem in a subsequent evaluation year could result in a different (and lower) measured level that is not due to a reduction in aircraft noise. If nothing else, the background level will appear to be artificially high, making the increase over background artificially low and making the impact of aircraft noise seem less than it is in reality. Our visits to several of the RMS gave us the clear impression that some of the "community DNL" measured by the Noise Monitoring System and shown in the NVM Report were too high. We have already expressed concern in the hearings that the hydrophone noise floors are too high for accurate measurement of the background levels, which is of particular importance when computing the nighttime contribution to DNL. We raise these issues because we note that the difference between background and aircraft levels has been cited in several studies and by the public in the hearings as one influence on annoyance.

Another concern is that placement of a monitor could result in the capture of a high level of actual nonaircraft noise. If this noise is indeed representative of the ambient noise experienced by nearby residents, it should be measured. However, the goal of the Resolution is to show a reduction in *aircraft* noise. A very high level of actual background noise would make it difficult, if not impossible, for the POS to demonstrate future reductions in aircraft noise using the "total DNL" measure. On the other hand, if the nonaircraft noise measured by an RMS is not representative of what the nearby residents hear, the "total DNL" that is reported could be higher than what the people actually experience. This could occur, for example, if the RMS is on a pole at a height that exposes it to traffic noise from which residents at ground level are shielded due to terrain features. As a result, the POS might not be able to show the full extent of the reduction that has occurred where the people live.

A final concern is that we have not been convinced that the algorithms used by the Noise Monitoring System to assign noise to the "aircraft" noise category rather than the nonaircraft or "community" noise category are sufficiently reliable. Of particular concern is noise generated while the aircraft are on the ground, such as from taxiing, reverse thrust on landings and engine run-ups of all kinds. This problem would suggest that it is more appropriate to base an evaluation on the total noise measured at the RMS.

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significant aircraft-generated on-the-ground noise beyond the immediate periphery of the Airport. We encourage the POS to expand the Noise Monitoring System so that it is capable of collecting on-the-ground noise measurements at a variety of additional locations throughout the affected communities. At a minimum, we would like to see the POS to collect on-the-ground noise measurements at six additional remote monitoring sites. These should include sites beyond the boundaries of the predicted 65 dB DNL contours (with the most recent available Noise Exposure Map input data being a reasonable guide), both farther out along major flight corridors and farther out to the east and west of the Airport.[7] As part of a revised NVM process, the POS should propose a detailed measurement plan that demonstrates a measurement sampling strategy which produces statistically acceptable representations of the annualized DNL and any other descriptors developed for the revised NVM. We feel that it is important for the POS to show us that noise impacts have been reduced where the affected population lives and where noise sensitive land uses, especially schools, are located.[8]

We turn last to the required reduction in noise impacts. This is the most difficult question. We have determined that under the Resolution, the POS has the burden of showing that whatever reduction it has achieved by 1996 is significant and meaningful in the sense that residents of the affected communities could, or should, appreciate it. It is not for us to say exactly what metrics the POS should use, or precisely how large a reduction in sound levels it must prove. Rather, the POS must show us (i) that it has articulated an appropriate standard for judging whether the reduction in noise impacts is sufficient, and (ii) that by that standard, the POS has achieved the required reduction. We do note, however, that we are not convinced that the FAA threshold for considering increases in sound levels to be significant for certain regulatory purposes (+1.5 dB increase in annual average DNL) is a satisfactory benchmark for our use in judging whether the *reduction* in real on-the-ground noise impacts achieved by the POS satisfies the requirements of the Resolution.[9]

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[7] We note that the POS' *FAR Part 150 Noise Compatibility Program Amendments of 1993* already call for evaluating the adequacy of the monitoring system. This work was to be initiated in 1994, yet we heard nothing about its progress at the hearings. We note, however, that both the POS and various representatives of the public mentioned in the hearings and in the written submittals a variety of potential new sites that warrant consideration.

[8] We also feel that it would be useful if the revised NVM included a plan for periodic, independent spot-check sound level monitoring and for more frequent visual verification of RMS condition. It would be useful if the spot checking included comparisons with the RMS data on an event-by-event-basis to determine any discrepancies in the RMS measurements of aircraft-only noise, background noise, and maximum level or SEL of events. It would also be useful if the spot-check equipment was capable of accurately measuring the minimum background noise levels at each site. Additionally, it would be desirable for the POS to file with the PSRC monthly monitoring results reports, complete with statistics on the data and annotation of all potentially spurious data. Finally, an independent review of the records of the past field visits to the RMS that could identify the extent and effect of any recorded problems, as well as an evaluation of the current sites and the RMS' condition, would also be useful.

[9] The purpose of the FAA's threshold (in areas where the DNL is already above 65 dB) is to determine when further analysis is necessary; not to deem that a significant impact has automatically occurred. A 1.5 dB DNL increase could result from an imperceptible 1.5 dB increase in the SEL of each aircraft or a very perceptible 40% increase in the number of operations. Likewise, an introduction of operations to an area previously without them could raise the DNL by 1.5 or more dB and generate substantial community reaction. A good local example of the latter was the reaction to the Four-Post Plan in areas beyond the 65 dB contour, where 3 dB increases in DNL were predicted by the POS noise consultant. The FAA threshold for further analysis is a signal to investigate the cause of the DNL increase, and to ascertain whether that *cause* has significant impact.

(continued...)

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We have also determined that 1993 is the appropriate base year for purposes of the measuring whether the reduction in noise impacts required by the Resolution has been achieved. Nothing in the Resolution speaks to noise reductions that occurred before the Resolution was enacted.[10] Thus, as we read it, the Resolution requires the POS to show that there has been a significant reduction in on-the-ground noise impacts from 1993 to 1996, when the construction of the third runway may be authorized by the PSRC.

We are not insensitive, however, to the practical problems our interpretation of the Resolution may create for the POS. Most prominently, the requirements that the POS employ additional noise metrics and monitoring stations, and that it show a reduction in noise from 1993, will inevitably require the POS to back-calculate or otherwise estimate some of the required inputs. While this may introduce some imprecision into the exercise, we have concluded that it is preferable to using only DNL data from the existing Noise Monitoring System for past years or limiting the analysis entirely to future noise reductions. The Panel believes, however, that the significance of the 1993-96 data will be best understood in the context of as much earlier data as the POS can make available to us.

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[9](...continued)

We also note that the 1992 FICON *Federal Agency Review of Selected Airport Noise Analysis Issues* submitted to us by the POS compiles a variety of other thresholds articulated by various people for various purposes. FICON suggests that "percent of people highly annoyed" (%HA) is a good indicator of environmental quality, with reference to Finegold's work and the revised Schultz curve. In the hearings, the POS noise consultant also referred to %HA citing values from the curves in the 1992 FICON review. He noted that the POS' proposed 4.4 dB reduction in average DNL by 2001 would reduce %HA by 40 or 50%. We note somewhat different values: a 50% reduction in %HA (such as from 20% to 10%) would actually require a 6 dB reduction in DNL according to the curves. The POS consultant also referred the Panel to the 1991 Fidell article (*JASA*, 89/1, pp. 221-233), which presents the "revised Schultz curve;" this curve shows that a 4.4 dB decrease in DNL would reduce the %HA by about 25%; to achieve a 50% reduction in %HA, according to the revised Schultz curve, a 9 dB decrease in DNL would be required.

We also note that A. Harris in a December 23, 1994, letter to the Panel and in his 1990 *Review of Community Responses to Changes in Noise Exposure*, submitted to us by the ACC, suggests that determination of differences in the number of impacted people represented by each study point is key to assessing the effectiveness of a change in the noise climate, coupled with changes in noise exposure and single event levels.

Further, the POS consultant noted that Fidell had reaffirmed the idea that the use of a single curve representing all transportation sources was valid. A. Suter, in her review prepared for RCAA for the hearings, disagreed, citing many recent references not addressed by Fidell or by FICON. She pointed to data that would raise the %HA for 70 dB DNL from the 20-30% range to over 70%. Also, a second Fidell article provided to us by the POS consultant (*JASA*, 89/1, pp. 234-243) showed a 5 dB "shift" in tolerance of aircraft exposure compared to nonaircraft exposure (people being less tolerant of aircraft noise, and so, more likely to be highly annoyed by a given aircraft DNL than by nonaircraft sources such as road traffic).

We believe all of these references offer insight into the significance of changes in noise exposure and DNL.

[10] It seems implausible to us the Resolution would be satisfied if a meaningful reduction in noise impacts occurred between 1989 and 1993, but noise impacts were aggravated from 1993 to 1996.

As we have said, we do not believe that it is our responsibility to specify exactly how the POS should meet its burden of showing that the required reduction in on-the-ground noise impacts has occurred. Rather, it is our role to indicate, in general terms, why the Noise Validation Method, as it has been proposed by the POS, is not adequate, and what sorts of additional considerations should be taken into account. We have attempted to do so in this Order. We leave it to the POS, and its consultants, to develop and articulate a new method of making the required showing to us.

We do not believe that we have any authority to compel the POS to adopt any particular approach to the reduction of on-the-ground noise impacts. We do feel, however, that it might be useful for the POS (in conjunction with the FAA, where appropriate) to consider a variety of measures for both noise abatement (reduction of total sound energy at the source) and noise mitigation (reduction of noise impacts). With regard to the programs that were deemed to be "responsive" in Part III.A of the Implementation Steps adopted by the Executive Board of the PSRC, we offer these comments:

- Acoustical insulation program: Based on testimony at the hearings (and subject to our reevaluation after review of the data requested in the Attachment to this order), we are concerned that the acoustical insulation program does not appear to be meeting at least one of its stated goals, which is a 5 dB reduction in A-weighted DNL in the treated houses. The POS also appears not to be meeting its design goals for each individual house for additional Noise Level Reduction after insulation. Additionally, a 5 dB reduction in overall A-weighted DNL may be too modest a goal for meaningful reduction in interior noise due to aircraft, especially in the lower frequencies.[11] Meaningful noise reduction due to sound insulation may need to address this low frequency noise. Independent, periodic and statistically supportable measurements of a representative sample of the insulated homes before and after treatment would be useful.

- Run-up noise reduction program: Based on our review of the data provided by the POS, we are concerned that the nighttime engine run-ups may regularly violate the King County Noise Ordinance, and perhaps by substantial amounts. Full POS compliance with the King County

[11] Wyle Research notes on page 2-5 of its *Guidelines for the Sound Insulation of Houses Exposed to Aircraft Noise*, provided to the Panel by the POS, "Modest improvements . . . (e.g., less than 5 dB) may not provide a noticeable improvement to the homeowner and hence are not cost effective." Further, on page 2-6, Wyle Research notes, ". . . the FAA has recognized that in order for a homeowner to perceive any improvement . . . there must be a *minimum* of 5 dB improvement in noise reduction in each room" [our emphasis]. Wyle Research also notes that interior SEL goals of 60-65 dB may also be appropriate in areas within the 65 dB exterior DNL zone.

Additionally, as the POS noise consultant indicated in the hearings, the reduction in A-weighted DNL is caused solely by a reduction in maximum A-weighted levels (and SEL) of individual aircraft. We suspect that this reduction is probably driven by a reduction in the more easily attenuated frequencies near and above 1000 Hz, with perhaps little or no reduction in the more difficult-to-reduce lower frequencies (which are heavily attenuated in the A-weighted calculation). It is these lower frequencies that seem to be the cause of much of the complaints about interior noise impacts (including window rattle). A 5 dB reduction in overall A-weighted level from an individual flyover may not be sufficient to be viewed by residents as a meaningful improvement. Even an 8-10 dB reduction in overall A-weighted level, which would typically considered as substantial, may not adequately solve the low frequency noise, vibration and rattle problems.

Finally, POS data provided to the Panel by the Pork Patrol (*Final Project Report, Summary of Test Results, AIP 3-53-0062-13*) shows many cases where the actual measured "additional sound reduction after insulation" was less than the "designed additional sound reduction".

Noise Ordinance for all run-up activities covered by the Ordinance would seem to be appropriate. In addition, whatever abatement measures the POS uses to reduce regulated run-up noise (such as a hush facility) might usefully be applied to the exempt daytime and nighttime operations as well. We would suggest that the POS demonstrate compliance with the Ordinance through measured data at appropriate measurement points in the residential areas surrounding the boundaries of the Airport. We would further suggest that independent measurements be made by trained County staff or by an independent consultant hired by the PSRC. We would encourage the POS to include in the revised NVM a plan to use measures other than mere compliance with the Ordinance and the run-up noise reduction program, such as sound level measurements and operational data, to demonstrate that meaningful reductions in ground run-up noise have occurred.

With regard to other programs or measures that were not listed in Part III.A of the Implementation Steps, we would suggest that the following be considered:

- Evaluate and, if feasible, implement alternative flight paths designed to minimize the population exposed to maximum noise levels or to redistribute the burden of maximum noise levels throughout the surrounding communities.[12]

- Consider and, if feasible, implement revised flight operating procedures to increase the angle of ascent/descent for jet aircraft at the Airport, to reduce on-the-ground noise levels along the flight paths and at the corner posts.

- Implement a high-priority program to install, by the end of CY 1996, sound insulation in all elementary and secondary schools within the 65 dB DNL contour sufficient to reduce sound levels in classrooms due to aircraft to a maximum level and duration that will eliminate speech interference.[13]

[12] We note that in Resolution A-93-03, the PSRC specifically requested "consideration by the FAA of modifying the Four-Post Plan to reduce noise impacts . . ." We also make note of the discussions in the December hearings that the FAA has invited the local communities to be involved in the process of evaluating flight path shifts. While such involvement has the potential to pit one community against another, we feel that careful examination of shifting the "posts" and perhaps narrowing the approach and departure corridors outside the posts could produce a worthwhile net benefit in noise exposure. It is clearly in the best interest of the POS, the PSRC and the citizens to pursue vigorously this option.

[13] We note, according to the 1992 FICON airport noise analysis review, that 60 dB is given as the level above which "there will be interference with speech communication." We also note that in the FAR Part 150 Amendments of 1993, the POS called for a planned pilot program on sound insulation of two churches, one private school, one convalescence home and one multi-family structure. We suggest that there is enough evidence nationwide of successful noise insulation activities that a pilot program is unnecessary and that full implementation of a public use/multi-family structure noise insulation program could begin immediately. We also believe that special emphasis should be put on schools and convalescence facilities in this program.

At a minimum, we believe that it would be very useful for the POS to complete the pilot program by mid-1995, as the POS anticipated in the Part 150 Amendments, and that a regular public use/multi-family structure insulation program could be well underway by April 1996, with a detailed schedule for completion, including documentation of which facilities are eligible, which are not (and why not), and the insulation goals.

- Further accelerate the residential sound insulation program.[14]

- Evaluate the feasibility of new technologies to reduce ground noise generated by jet engine run-ups and, if feasible, adopt new methods of doing so.

- Evaluate the feasibility of setting a cap on total nighttime operations and, if feasible, implement such a cap.

- Evaluate the feasibility of shifting nighttime operations to earlier in the evening or later in the morning and banning all operations for a core period in the middle of the night; and, if feasible, implement these measures.

- Evaluate the feasibility of setting a maximum noise limit (SEL or L_{max}) for aircraft operating during the nighttime hours, and, if feasible, implement such a limit.[15]

We recognize that in its efforts to limit and reduce the impact of aircraft-generated noise on its neighbors, the POS has been a leader within the airport industry. The POS has expressed confidence that through its innovative Noise Budget and Nighttime Limitations Program, and various other efforts, it is in fact significantly reducing the impact of on-the-ground noise. We invite the POS to show us why the community should share the POS's confidence in the significance of its on-going noise abatement and mitigation programs.[16]

The POS should submit a revised noise validation method to the PSRC, for delivery to us and for public inspection, by March 31, 1995. Any member of the Coordinating Committee or of the public who wishes to offer comments on the revised method submitted by the POS should submit written comments to the PSRC, for delivery to us, by April 14, 1995. We expect to convene a public hearing, to consider the POS's submission and responses from the Coordinating Committee and the public, during the first week of in May 1995. We will, in due course, issue an order specifying the time and place of such a hearing.

In anticipation of our review of a revised noise validation method, the Panel believes that it would be helpful if the POS could provide us with the technical information specified in the attached Information

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[14] We note that the POS FAR Part 150 Amendments of 1993 indicate that 7,500 single family residences are eligible for sound insulation and that the POS has accelerated the program to 100 houses per month. Even with this acceleration, completion of the program will take until 2001.

[15] We note that Section 4.C of the Nighttime Limitations Program calls for the POS to specifically determine, after 1997, "with input from the carriers and the public whether [such a limit] . . . is appropriate and consistent with its obligation as an airport proprietor." We see no reason why this decision should be put off so long.

[16] We note that the data in Table 17b of the POS response to our September 1994 data request shows a 2.9 dB drop in measured DNL at the 11 RMS from 1991 to 1994 YTD (and a corresponding 2.7 dB drop in the related ANEL), which already exceeds the *1998* DNL goal in the NVM Report (and the 1999 goal in the Noise Budget). The NVM Report showed that from 1991 to 1994, the DNL had to drop 1.0 dB, corresponding to a 0.76 dB decrease in ANEL.

Request to the Port of Seattle by submitting the requested information to the PSRC, for delivery to us, by February 28, 1995.

We want to reiterate here a final comment that we offered on the Noise Issues at the conclusion of the hearing on December 2. Throughout this proceeding, the public has attempted to draw to our attention the consequences — particularly the noise impacts — that might occur if a third runway were built at the Airport. We again observe that this Panel cannot and will not undertake a review of the potential environmental consequences of building the third runway. Our responsibility, with respect to the Noise Issues, is limited to determining whether the POS has scheduled, pursued and achieved a meaningful reduction in real noise impacts at the existing Airport.

We will soon issue a separate order laying out the next steps for our consideration of Demand/System Management Issues.

Scott P. Lewis
Scott P. Lewis, Chair

William Bowlby
William Bowlby

Martha J. Langelan
Martha J. Langelan

Date: January 9, 1995

Attachment 1 to January 9, 1995 Order on Phase I Noise Issues

INFORMATION REQUESTS TO THE PORT OF SEATTLE

The Panel respectfully requests that the Port of Seattle (POS) and its consultants provide the following information. We ask that each item's information be provided when ready rather than waiting until all items are ready.

1. Please provide the following data on the sound insulation program:

   a. full details on the noise measurement test program for sound insulated homes, including how many have been tested, how many are tested each quarter, how the houses to be tested are chosen, and who conducts the measurements and the data analysis;

   b. measured sound level data for all insulated houses that have been tested; please provide this data separately in terms of sound exposure level (SEL) and maximum level outdoor-to-indoor Noise Level Reduction before and after treatment for these houses; for a representative sample, please show octave band (or 1/3 octave, if available) sound pressure levels (SPL) and A-weighted levels, plus overall SPL and A-weighted level for the same data;

   c. an explanation of the measurement procedure and sampling strategy for each test, including the number of samples, types of aircraft and operations represented by the data, aircraft positions relative to the house during the test, and a map locating the houses represented in the submitted data;

   d. a sample actual calculation from the field-measured data of the resultant Day-Night Level (DNL) reduction;

   e. the mean overall A-weighted sound level change for all insulated houses, the mean Noise Level Reduction for the houses, and the mean cost per house (with plus/minus one standard deviation for all means); please indicate the number of samples used in the calculation of the mean(s);

   f. the total number of insulated houses, the number yet to be treated, and the schedule for treating the remaining houses

   g. the total number of elementary and secondary schools and convalescence facilities within the existing noise mitigation zone.

2. Please provide tables of statistics on measured DNL at the 11 remote monitoring sites, showing for each site for each year since (and including) 1989:

   a. mean measured TOTAL DNL at a site for the year (and the number of days in the calculation), plus/minus one standard deviation, 95% confidence limits, and frequency distribution histogram (in one decibel increments) for the year;

   b. mean measured AIRCRAFT-ONLY DNL at a site for the year (and the number of days in the calculation), plus/minus one standard deviation, 95% confidence limits, and frequency distribution histogram (in one decibel increments) for the year.

3. Please provide a table summarizing the statistical significance (at the 5% level of significance) of the differences in the means in item 4 above (by site, separately for TOTAL and AIRCRAFT-ONLY) *for 1989* compared to each year; please indicate the statistical test used to test significance and show the relevant calculated evidence of significance.

4. Please provide a table summarizing the statistical significance (at the 5% level of significance) of the differences in the means in item 4 above (by site, separately for TOTAL and AIRCRAFT-ONLY) *for each year* (starting in 1989) compared to each subsequent year; please indicate the statistical test used to test significance and show the relevant calculated evidence of significance.

5. Please provide a table summarizing the statistical significance (5% level of significance) of the difference in the mean DNL (averaged over the 11 sites) *for 1989* compared to each year; please indicate the statistical test used to test significance and show the relevant calculated evidence of significance.

6. Please provide a table summarizing the statistical significance (5% level of significance) of the differences in the mean DNL (averaged over the 11 sites) *for each year* (starting in 1989) compared to each subsequent year; please indicate the statistical test used to test significance and show the relevant calculated evidence of significance.

7. Please provide corrections to Table C-78 et al. of the *Flight Plan Project FEIS* for the population in the 80 dB SEL contour for Alternatives 1, 33, 34 and 35. Please provide an explanation of any differences in the SEL population trends between Alternative 1 and the other alternatives compared to the DNL population trends in the same tables.

8. The December 14, 1994 letter from Mr. Dunholter to Ms. Summerhays referred, on the 3rd page, 3rd full paragraph, last sentence, to other current research that replicates the British findings on sleep interference. Please provide citations and abstracts/conclusions from these works. The 12/7/94 letter to the panel from Mr. Peter Townsend of the Federal Way Chapter of the RCAA offered to provide a critique of this British study. We request that Mr. Townsend be asked to provide the critique.

9. At the December hearing, Mr. Dunholter showed a chart comparing DNL and complaints received by the POS. Please send us a copy of that chart and any relevant back-up information.

10. At the December hearing, Mr. Wells of the POS noted that 1-second data from the Noise Monitoring System has been stored for about a year. He also noted that, in the past, SEL data

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was not generally recoverable unless the system "was set to generate SEL numbers" which "is not routinely done."

a. Please specify the times periods, if any, in the past during which the system was set to generate SEL data, perhaps for special studies that were being conducted; to the extent that such past SEL data is available (regardless of whether or not it can be correlated to specific events), please provide tables summarizing this information in 5 dB increments (number of events in each 5 dB range) for each period measured.

b. Please indicate the exact period(s) for which the more recently collected 1-second data is available.

c. Please use a sample of the 1-second data to present the SEL for one departure event that was measured at all (or a major portion) of the RMS locations and the correlated nonnoise data on the event, describing briefly the process used to identify the event and to then obtain both the noise and nonnoise data.

d. Please use another sample of the 1-second data to present the same information for a maintenance or repair ground run-up for a Boeing 727.

e. Please indicate how the capabilities have changed since the recent addition of the new software, and illustrate the same type of event identification and analysis.

f. Please provide a sample histogram of SEL (in 2 dB increments) at RMS #5 for a typical day using the new software's capabilities and showing if and how ground run-up events are included; please show the corresponding operations data for that same day, correlating events to SELs.

11. We ask the POS to request a letter from King County giving the County's interpretation of the County Noise Ordinance as it relates to the Airport ground noise. In particular, we are interested in the daytime exemption from 7 a.m. to 10 p.m. and the special exemption from 6 a.m. to 7 a.m. (as mentioned in the March 1994 POS *South Aviation Support Area FEIS* on pages 4-37, 4-66 and 4-73).

12. We would like a response to the following observations:

The fleet mix used in the ANEL-to-DNL conversion in *Noise Validation Methodology in Compliance with PSRC Resolution A-93-03* ("the NVM Report") was said to represent a mix designed to give the maximum possible DNL reduction for a given ANEL reduction. The report showed that from 1991 to 1994, the DNL should drop 1.0 dB, corresponding to a 0.76 dB drop in ANEL.

Yet, Table 17c of the POS Response to our September 1994 data request shows that, *based on the actual 1994 YTD (year-to-date) operations*, a 3.6 dB reduction relative to 1991 should have occurred using the NVM formula. While ANEL is not shown in Table 17c, we

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would expect the related ANEL difference from 1991 to 1994 YTD to be over 3 dB. Both the NVM DNL and the ANEL reductions computed from the 1994 YTD operations data are radically different from the forecast 1.0 and 0.78 dB reductions in the NVM Report.

At the December hearing, Mr. Bryant of the POS attributed the larger decrease to the nighttime Stage II limitations program phase-in at the end of 1992. The Panel wonders why this effect was not accounted for in the calculations in the NVM Report if, as stated, the Report used fleet mixes designed to give the maximum DNL reduction. Is it simply the fact that the airlines' Stage III conversion was much more rapid than they were willing to agree to in the Noise Mediated Agreement?

Also, the actual measured data in Table 17b of the POS Response to our data request shows a 2.9 dB drop in measured DNL at the 11 RMS from 1991 to 1994 YTD (and a corresponding 2.7 dB drop in the related ANEL). Are we correct in interpreting this result as meaning that the POS is already exceeding the *1998* goal for DNL in the NVM Report, as well as the 1996 goal upon which the POS has proposed that we base our decision. (It appears that the reduction also exceeds the 1999 goal for ANEL in the Noise Budget.) Should the Panel interpret these results to mean that the goals in the NVM were much too modest? Should we expect a reduction through 1996 that follows the trend from 1991 to 1994?

13. Please describe the procedures the POS would use to determine (i) where additional noise monitoring sites should be located, and (ii) how many additional sites would be appropriate, if the existing Noise Monitoring System were to be expanded to provide a better population-emphasized basis for evaluating on-the-ground noise impacts.

homeowners would reject) would not allow us to come back in and complete the process.

We went to a computerized modeling system and we verified the results of that modeling system with field audits, real-time audits, and we verified and made changes in the program to make sure that we're meeting the reduction levels using these field audits.

Currently, we're using an -- we are in an accelerated program. We are inventorying over 120 homes a month and we are preparing insulation packages for between 120 to 130 a month and we verify 10 percent of those with field audits to make sure that we are achieving our goals.

DR. BOWLBY: You said that actual design is not based on the audits but then you

say audits are used to calibrate the design program. I guess I still don't understand what you mean by calibrate the design program.

MR. HERZ: To make changes. We have made a number of changes in the program using the audit system for verification. In the beginning, we were only using a combination of STC 44 windows with STC 35 windows and secondary windows. We have found that the secondary windows and the STC 35 windows are not adequate and we have gone on to use STC 44 windows in all cases.

DR. BOWLBY: Any other changes you have made for this calibration?

MR. HERZ: Right now we are looking at trying to come up with a solution for noise coming down kitchen exhaust fans because of the impacts through ventilation systems at homes.

DR. BOWLBY: Has that not been addressed at all before?

MR. HERZ: It has been addressed but we haven't found a solution that's acceptable with the local jurisdictions' building departments because of fire, life and

INTERIM TECHNICAL ADDENDUM REGARDING THE CITY OF CHICAGO'S USE OF THE INTEGRATED NOISE MODEL

INTERIM TECHNICAL ADDENDUM REGARDING THE CITY OF CHICAGO'S USE OF THE INTEGRATED NOISE MODEL

Plaintiffs have filed a separate motion to defer consideration of the Vigilante Affidavit until completion of Plaintiffs' discovery into the material contained in that Affidavit. Ms. Vigilante's affidavit has a history of serious admitted errors[1] and Plaintiffs have not completed their investigation into the continuing errors and unsubstantiated claims contained in Ms. Vigilante's new material. However, consideration of the motions for summary judgment need not be deferred because of the problems created by the Vigilante errors. The Vigilante Affidavit purports to cover the period 1979-1989. Yet Chicago's statute of limitations argument is based on asserted facts which pre-date 1976. (Chicago brief, pages 74-78). Therefore, the Vigilante material is irrelevant to the consideration of the statute of limitations defense raised by Chicago.

This interim technical addendum to the brief is offered in case the Court decides not to defer consideration of the Vigilante material. While Plaintiffs' investigation still continues, so many glaring deficiencies have already been exposed in the Vigilante material as to render that material worthless.

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1 The City withdrew the first Vigilante Affidavit and submitted a second "Affidavit of Mary L. Vigilante" to the Court in late April, 1993. The second affidavit contains brand new noise contour maps as Exhibits 2 through 9 and brand new numbers in Exhibits 10 and 11. All the exhibits previously submitted to this Court by Vigilante were discarded. This "clean sweep" was necessary because, as Ms. Vigilante acknowledged in a subsequent deposition, every map and every table in her first affidavit contained errors or inaccuracies. (Vigilante deposition, pages 104 *et seq.*) (Cited excerpts from the deposition testimony of Ms. Vigilante and others cited herein are included in the Supplemental Appendix to Plaintiffs' Reply Brief.) The only things that were not redone for the second affidavit were the affidavit, Ms. Vigilante's résumé, and the historical material attached as Exhibit 12.

The Use Of The Model Is Irrelevant, Inappropriate, And Inaccurate

As part of its "argument" on the statute of limitations, Chicago spends several pages describing the affidavit of Mary L. Vigilante and her use of the so-called Integrated Noise Model (INM) Version 2.7. (See Chicago brief, pages 69-74). Chicago makes a number of substantial claims for the INM model and Vigilante's use of the model -- claims which are amazingly bold, considering the fact that long after the Vigilante Affidavit was submitted, it had to be withdrawn and resubmitted due to errors and mistakes in each and every exhibit that was prepared for submission to the Court:

> The noise which plaintiffs contend resulted in damage to their property has been studied and *actually mapped* since 1979. (See App. Vol. VI, Vigilante ¶¶ 2, 3, and Exhibits 2-9) ...
>
> These maps establish *objectively* a picture of the noise for a period 1979 through 1989.
>
> Chicago brief, page 69
>
> Use of the INM is *appropriate in this case to fix actual noise levels* experienced by the schools.
>
> Chicago brief, page 70
>
> Numerous types of data are loaded into the INM, all gathered from or provided by *three official sources* -- the FAA, the Official Airline Guide, and the O'Hare Noise Abatement Office.
>
> Chicago brief, pages 71-72
>
> The INM for O'Hare also includes information on *actual* aircraft arrival and departure, fleet mix, landing and take-off weights, time of day for departures and arrivals, flight paths, flight path usage, runway usage and aircraft engine noise.
>
> Chicago brief, page 72
>
> The time-above analysis calculates the amount of time on an average day *that geographic point was subject to noise in excess of a specific DNL level.*
>
> Chicago brief, page 73

> The results show a remarkable consistency since 1979. For example, Blackhawk Junior High varied from 64.2 DNL in 1979 to 64.6 DNL in 1989. Washington Elementary went from 66.0 DNL to 67.2 DNL in 1989. Sandburg Junior High had minor fluctuations but was essentially unchanged at 55.3-55.1 DNL over the period.
>
> First version of Chicago brief, page 73, submitted to the Court and then withdrawn along with first Vigilante Affidavit
>
> The results show a remarkable consistency since 1979. For example, Blackhawk Junior High varied from 67.4 DNL in 1979 to 65.8 DNL in 1989. Washington Elementary went from 70.5 DNL to 69.4 DNL in 1989. Sandburg Junior High had minor fluctuations but was essentially unchanged at 58.6 to 60.3 DNL over the period.
>
> Revised version of Chicago brief, page 73[2]
>
> Further, the results show that certain of the schools are not within the 65 DNL contour which the FAA uses to indicate significant noise impacts. Generally those are the schools that have not been soundproofed under the joint soundproofing program.
>
> Chicago brief, both versions, page 73
>
> The *INM provides scientific data* for the period 1979 forward.
>
> Chicago brief, both versions, page 73

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2 The revisions submitted by Chicago illustrate one -- out of many -- of the significant areas of erroneous information submitted by Chicago to this Court under the guise of the "junk science" of the INM model as used by Chicago's consultant. Decibels are quantitative descriptions of noise energy and are reported on a *logarithmic*, not an arithmetic, scale. An increase of 3 decibels therefore represents a *doubling* of the noise energy. Thus Chicago's two versions of DNL at these schools -- *both of which are inaccurate (including the second version)* -- showed dramatically different annual average noise results. Consider:

DNL Claimed By Chicago from INM	Blackhawk	Washington	Sandburg
Version from first affidavit	64.2 to 64.6	66.0 to 67.2	55.3 to 55.1
Version from second affidavit	67.4 to 65.8	70.5 to 69.4	58.6 to 60.3

It is not necessary to the decision of the instant cross-motions for summary judgment that this Court accept or reject Chicago's arguments based on the INM. Chicago's INM results are dated from 1979 forward, and the thrust of Chicago's statute of limitations argument *is* that the plaintiffs causes of action accrued *more than a year prior* to the 1975 decision of the Seventh Circuit in *Luedtke*. (Chicago brief, pages 74-75)[3]. But the statements and use of these so-called "scientific" INM results is so outrageous, that the School districts must apprise the Court of several of the gross errors in Chicago's INM presentation.

1. Chicago's consultant admits that her data shows significant levels of noise above acceptable levels at all of the Plaintiffs' schools.

Chicago never tendered a single witness to contradict the sworn affidavits of the teachers and administrators at the Plaintiffs' schools[4]. Instead, Chicago claims that the INM "shows that certain of the schools were are not within the 65 DNL contour which the FAA uses to indicate significant noise impacts." Chicago brief, page 73.

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[3] As discussed in the body of Plaintiffs' brief, even accepting *arguendo* Chicago's argument that the taking causes of action for some of these schools accrued more than one year prior to 1976, the 1975 holding of *Luedtke* that federal statutes preempted state law actions would have tolled the running of the twenty year statute of limitations for takings. Moreover under the continuing nuisance doctrine, there is a continuing nuisance action which is not barred by the statute of limitations.

[4] Q. You have no basis for disagreeing with any of the testimony given by teachers and administrators in this case, do you?
A. I don't believe I have read the testimony.
Q. So, therefore, you have no basis at this point, isn't that right?
A. Yes.
Q. Is that correct?
A. That's correct.

Vigilante deposition, page 334

Chicago's statement is both wrong and misleading. First, FAA does *not* use *average annual* 65 DNL as the line of demarcation for schools harmed by aircraft noise. The measurement for school noise interference is disruption of communication between teacher and student which is an instantaneous value of 45 decibels (dBA). As stated by Mary Vigilante:

> "...*[N]oise levels up to 35 dBA will allow satisfactory speech communication in a normal voice level* up to a distance of 32 feet. The sound level of 45 dBA is used since it represents average teacher to student distance of 16 feet, where a normal voice level is satisfactory for communication.
>
> Vigilante deposition, Exhibit No. 22 (emphasis added)[5]
>
> [Ms. Vigilante] A. I can't speak to the ability to conduct education at a sound level. I can speak to the normal criteria for speech interference. And in any instance where the sound levels are in excess of 65 Ldn the interior sound level would be in excess of 45 decibels, and, therefore, *speech would be interfered with.*
>
> Q. So you are saying when you have an exterior of 65, it is normally considered the fact that the resulting interior will be in excess of 45, and that 45 interferes with normal speech pattern?
>
> A. *In excess of 45 will interfere with normal speech communication.*
>
> Q. All right. So that we have this straight now. The sequence then is as a rule of thumb, an outside or external of 65 or greater will produce an internal of 45 or greater, is that right?
>
> A. In a normal northern climate structure with the windows closed, you normally will get a 20 decibel attenuation.
>
> Q. With the windows closed?
>
> A. Yes.

---

[5] What Vigilante is saying here is that even 45 dBA is a compromise value based on a 16 feet distance between teacher and student. Few classrooms are only 16 feet deep and the students in the back rows are often 32 feet or more from the teacher.

> Q. What attenuation do you get with the windows open?
>
> A. It can vary, but normally around 15.
>
> Q. Normally around 15 and can it be less that?
>
> A. *It can be less.*
>
> Vigilante deposition, page 141 (emphasis added)[6]

> Q. So that if you have a decibel level of 60 with the windows open, you can have interference with speech communication, can you not?
>
> A. If those conditions exist, *presumably yes.*
>
> Vigilante deposition, page 142 (emphasis added)

Relying solely on its "contour" map and no actual witness or actual measurements, Chicago has suggested that the schools *outside* Chicago's INM "contour" map are not adversely affected by noise. Chicago brief, page 73. But on examination, Mary Vigilante admitted that her INM model showed many hours per day of noise interference at the schools which had not yet been soundproofed.[7] As to those schools, Exhibit 11 shows the hypothetical *average* number of minutes *per day* that the aircraft noise level at these schools is estimated by Chicago's INM model to be above 65 dBA:

---

[6] In point of fact, measurements taken by Chicago at a variety of schools scheduled for soundproofing show that the attenuation between the exterior and interior of the schools can be considerably less than 15 decibels -- e.g. less than 5 decibels attenuation. See School Noise Monitoring Analysis (July-September 1991) (Hamill deposition, Exhibit 6). This lack of attenuation means that exterior levels *less than* 65 dBA can have an adverse impact on speech communication in the classroom, since the level for interference is considered by Vigilante to be 45 dBA.

[7] These schools are Medinah South, Lake Park East (partially soundproofed entirely at owners expense), Lake Park West, Edison, Emerson, Field, Sandburg, and Churchville.

Minutes Above 65 dBA on Average Day According to Chicago[8]

SCHOOL	1979	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Medinah South Elem.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Lake Park East H.S.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Lake Park West H.S.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Churchville Jr H.S.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Edison Elem. School	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Emerson Elem. School	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Eugene Field Elem. Sch.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sandburg Junior H.S.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The Court should be aware that these values are most likely bogus. They are based on an INM model, the inputs to which produce the classic "GIGO" ("Garbage In, Garbage Out") (see discussion below). But they are the numbers that Chicago claims represent "scientific" and "objective" measures of the noise experienced at these schools. Accepting *arguendo* these numbers, it means that for each of the schools, the aircraft induced noise totals *several hours per day above the level* that Chicago's own witness says causes interference with speech communication in the classroom. For example:

> Q. For Medinah South, according to your computer model, Medinah South has these numbers time above 65 which represents the minutes in a day, isn't that right?
>
> A. That is correct. Minutes in a 24-hour period.
>
> Q. And with respect to the minutes in the 24-hour period, that would be 214 minutes for 1983, would it not?
>
> A. That is correct.
>
> Q. That is according to my arithmetic about *three and a-half hours?*
>
> A. Approximately.

---

[8] Source: Exhibit 11 to revised Vigilante affidavit submitted by Chicago.

Q. In the day?

A. Yes.

Q. And according to the way you calculate the INM, that's the average number of hours per day over a year that that school --

A. That's correct, it is an average annual condition.

Q. So there are days by definition, because it is an average annual, where the number of hours that that school gets hit with, the numbers of minutes are less than 214; and, there are also days where the number of minutes is greater than 214, isn't that tight?

A. That would be correct.

Q. That would be true for the minutes of exposure in Exhibit 11 for any of the schools mentioned, isn't that right?

A. They would represent average conditions, yes.

Q. So my statement and your answer with respect to the fact that by using an average, it necessarily means that all of the schools are exposed to 65 decibels on some days less than the number shown in Exhibit 11 to Vigilante Deposition Exhibit No. 9, and on other days more than the number of minutes shown on Exhibit 11 to Vigilante Deposition Exhibit No. 9?

A. That is correct.

Q. So for Sandburg Júnior High for example, which is school 22, you show in 1983 that it experiences noise at -- is that two and a-half hours a day above 65?

A. Approximately 152.7, which is about two and a-half hours.

Q. All right. Based on the use of the annual average, that necessarily means that some years or some days I should say within the year, that the noise exposure at Sandburg in 1983 was less than 152 minutes and on other days it was more?

A. That is correct.

* * *

Q. Do you know the range, for example, for Sandburg Junior High School, take for example 1983, the range, the minimum number of minutes that it would be affected by aircraft noise on a given day versus the maximum number of minutes, 152.7 being the average?

A. I do not know the minimum or the maximum.

Vigilante deposition, pages 142-44 (emphasis added)

Thus Chicago's own witness and exhibit demonstrate Chicago's admission -- hoist by the petard of its own "scientific" computer model -- that all of the schools (including the schools not yet soundproofed) suffer from several hours per day -- some days *more*, some days *less* -- of significant noise interference above the levels which Chicago's own witness says interfered with speech communication in the classrooms. Yet Chicago suggests in its brief that these schools are not adversely impacted by noise.

2. **Chicago's use of the INM model is rife with errors and unsubstantiated assumptions for which the backup data and audit trail are either missing or have yet to be provided.**

For purposes of Vigilante's affidavit, Chicago used the FAA's Integrated Noise Model Version 2.7. Like most environmental models -- be they for air emissions pollution, water discharges, or noise emissions -- the INM is what might be called a "source-receptor" model, *i.e.*, the model assumes certain location and strength for the source emission, and then estimates the remaining strength of the emission at the point of the receptor. In the case of the INM model, the source is the aircraft, and the receptor is the school or residence being bombarded by noise energy.

The purpose of any modeling effort is to replicate the real world -- *i.e.*, to insure that the results estimated by the model accurately reflect the real world. In the field of computer modeling, the process of confirming that the model accurately mimics the real world is called validation. No one, including Chicago has validated the INM model at O'Hare to see if it produces accurate results.

> Q. Have you validated or calibrated the integrated noise model at O'Hare with real world conditions?
>
> A. No.
>
> Vigilante deposition in Biddison case, page 14
>
> Q. So, the way the FAA has tried to validate various versions of the INM is to actually go out and actually measure actual noise experienced around an airport and see whether that corresponds to the prediction of the INM, isn't that right?
>
> A. Yes.
>
> Q. And am I not correct that neither Landrum & Brown nor anybody else to your knowledge has ever undertaken such validation for O'Hare?
>
> A. That's correct.
>
> Q. Under any version of the INM model?
>
> A. That is correct.
>
> Vigilante deposition, pages 188-189[9]

The lack of any validation for the use of the INM model at O'Hare against actual results in the real world at O'Hare is particularly significant in light of the other gross errors or glaring gaps in the input data which Chicago has fed into the computer model. This lack of validation is made even more egregious by Chicago and Vigilante's failure thus far to provide

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[9] Chicago, at page 72, note 16 of its brief, tries to suggest that a consultant for the suburban communities found the INM to be a reliable indicator of noise around the airport. However, the relevant pages included by Chicago in Appendix VIII to its brief state only that the INM is generically "useful in evaluating the effects of noise abatement alternatives." The same consultant noted that "there are several widely recognized problems areas in the INM" -- including the fact that the "INM does not produce precise results" and "The INM is only as good as its input." See Appendix VIII of Chicago brief at Tab 16.

the step by step back-up material and sequencing for the running of the model so that Plaintiffs can determine if the model results can be replicated. Indeed, Vigilante has acknowledged that the 2.7 noise contour model which is the basis for the "revised" exhibits 2-9 of her affidavit is missing and that the contour plots shown for the years 1979 and 1982 are only graphic artists renderings of what the XY contours might have been:

> Q. And you don't have any way to tell whether the graphic portrayal that is in Exhibit 2 to Vigilante Deposition Exhibit No. 9 accurately reflects the XY coordinates because you don't have the XY coordinates to check, isn't that right?
>
> A. That's correct.
>
> Q. So they could be in error, isn't that right?
>
> * * *
>
> A. That's correct.
>
> Vigilante deposition, page 114

Among the backup materials currently missing are:

a. The sequential steps assigning flights to various runways and flight tracks.

b. The statistical and data basis for selection of the flight tracks used.

c. The data basis for the altitude assumptions made in the model. And

d. The data basis for assigning aircraft and engine types in the model.

3. Chicago's consultant assumed either erroneous or unsubstantiated facts that distort the <u>horizontal</u> physical location of the aircraft relative to the receptor.

There are several critical inputs to the INM computer model which can have a major impact on where the model assumes the aircraft in a horizontal (XY) location relative to the receptor, *i.e.*, a given school, and how that assumption conforms to the real world. These include 1) the runway that the aircraft is assumed to land on or take off from; and 2) the flight track used by that flight on either arrival or departure.

a. Chicago has been unable to produce for inspection and examination the basis for assuming the flight tracks used in the model. According to Ms. Vigilante, this flight track information came from studies done by Chicago of FAA radar screens, but neither she nor Chicago have produced the study. Flight tracks from other Chicago/FAA studies show flight tracks not used in Vigilante's INM model. There is no substantiation or backup for any of the flight tracks used in the model[10].

b. There is also no substantiation or data backup for the runway use assumed by the model for the flights it has landing and taking-off. Neither Chicago nor the FAA keeps records of which departing or arriving flights used which runways. The FAA used to (and may still) keep records of which runways were open for use (the FAA's "Performance Monitoring System (PMS)"), but keeps no records of which runways were actually used by arriving and departing aircraft.[11]

---

10 In addition to the lack of flight track backup, there is an earlier step in the model input sequence which relates to assignment of flights to geographic "sectors." Chicago has yet to produce the backup for these sectors and until Plaintiffs get this information, it is impossible to conduct a step-by-step audit trace of how Chicago input information into the INM.

11 Q. Now, both ATIS and PMS only speak of runway availability, do they not, or runways open?

A. Runways open for use.

Q. They do not actually tell you which aircraft used which runway, isn't that right?

A. That's correct.

footnote continued on next page

c. Vigilante says that in lieu of actual runway use data, she used handwritten notebook scratch pads -- an example of which is attached hereto -- compiled by the City of Chicago, Department of Aviation to show runways that were assumed to be open for operation. Yet a preliminary examination of these notebook scratch pads shows significant errors and discrepancies between the notebook scratch pads and the contemporaneous FAA data on runways actually in use. For example, as Judith Hamill -- the head of the City's Noise Abatement Office testified:

> Q. So would it be a fair statement that as of 9:00 a.m. on the 5th of January, 1987, Hamill Deposition Exhibit No. 41, which is your steno log from your office, shows a different runway use configuration than does the FAA?
>
> A. It appears to.
>
> Hamill deposition, page 229
>
> Q. I would like to show you the performance monitoring system summary for January 6, 1987 and ask you if you would tell me whether they (the performance monitoring system and the stenobook) show an identical configuration for that period of time?
>
> A. No, they do not.
>
> Hamill deposition, page 230

Q. And they do not actually tell you whether the same number, assuming two runways were open for departures, whether an equal number of aircraft used one runway versus another, isn't that correct?

A. That's correct.

Vigilante deposition, page 257

Q. Again, we have emphasized *one of the problems with runway availability is it doesn't show actual runway use*, isn't that right?

A. Yes.

Vigilante at 323 (emphasis added)

Q. Let's just stay with comparing the PMS to the steno log. Let's start with the first reading you have there, which is what, 800 hours?

* * *

Q. What is the configuration, are [the PMS and the steno log] the same?
A. No. The PMS summary does not show 27 right in use.

Hamill deposition, pages 241-42

Q. The middle one is 9 L, if you take a closer look at it.
A. They say they have got 9 left.
Q. That's what FAA reports, isn't it?
A. That's what they report.
Q. All right. There is a discrepancy between that and what is in the stenobook?
A. That's correct.

Hamill deposition, page 250

In short, there appear to be numerous and repeated errors between the FAA Performance Monitoring System data (which purports to record the runways actually in use) and the notebook scratch pads used by Chicago. Vigilante has confirmed this.[12]

The end result of these problems is that the model is likely not representative of the real world as to where the aircraft is going to be

12 Q. Do you ever go back and determine whether there is a discrepancy or try and determine whether the noise office has accurately reported the data of runway use, of runway availability?
A. We have looked at it from time to time, we have seen some anomalies, some questionable areas. We have no other way of -- no way of verifying that data.
Q. So would it be a fair statement that you have seen some inaccuracies in the reporting by the noise office, but it is the only data available?
A. That's correct.

Vigilante deposition, page 254

positioned horizontally (on an XY coordinate) vis-à-vis the receptor school. For example, the aircraft can be assigned by the computer to a runway it did not actually use -- even assuming runway availability equals the actual runway used (which it does not) and even assuming that there are no errors in recording runway availability information (which there are). In that case, the computer will put the theoretical aircraft over a place where the actual aircraft never was. This error overstates the noise for the area where the theoretical plane has been positioned, and understates the noise for the area under the actual aircraft's flight path.

Similar errors can result in the computer misstating actual noise because of errors in flight track assignments. Chicago has yet to produce the backup material for its selection of assumed flight tracks. Yet Chicago's consultant has acknowledged that radar screen flight tracks published by Chicago show different flight tracks than used in the INM model. Use of erroneous flight tracks can have a significant impact on the noise which the INM computes for a receptor school.

Chicago and Ms. Vigilante have thus far failed to provide plaintiffs with the data basis for her flight track selection. In her deposition testimony she has acknowledged that there are flight tracks that have been and are in use at O'Hare which are not reflected in her flight track selection used for the INM model runs used in her affidavit

4. Chicago's consultant assumed either erroneous or unsubstantiated facts that distort the vertical physical location of the aircraft relative to the receptor.

Just as errors and unsubstantiated assumptions as to assumed facts about the lateral positioning of the aircraft have flawed the results of the INM model at O'Hare, there are equal errors and unsubstantiated assumptions concerning the vertical physical locations of the aircraft -- i.e. the assumed altitude of the aircraft as they pass over the schools or homes. Ms. Vigilante says she used the assumed flight departure profile (altitudes) and thrust settings included in the documentation of version 2.7 of the INM model from the FAA.[13] Yet FAA itself at other airports has found that the assumed departure altitudes and thrust do *not* comport with the real world behavior of planes actually taking off from commercial airports:

> The INM flight profiles and thrust levels for departures are patterned after the FAA-recommended noise abatement departure profile ... . Compliance with the FAA-recommended profile is voluntary.
>
> * * *
>
> At cutback thrust, *the INM underestimated observed noise levels by a considerable margin. This underestimation was explained by the fact that most airlines do not employ the deep thrust cutback assumed by the INM, but use the higher normal climb thrust.*
>
> Flathers, *FAA Integrated Noise Model Validation: Analysis of Air Carrier Flyovers at Seattle-Tacoma Airport, FAA Report FAA-EE-82-19 (September, 1982)*, pages v, vi (emphasis added)

Thus there is no basis for assuming that the assumed altitudes and thrusts in the INM 2.6 model for departures comport with the real world. Moreover, when Plaintiffs asked if Chicago had ever checked with the radar readings for actual departure profiles to see if the model results conformed to reality, Chicago said that it had never checked for this version of the model. Chicago did acknowledge that it had checked actual altitudes for a new and different version of the INM model -- Version 3.9 -- but has refused to provide Plaintiffs with a copy of the results and the underlying data.

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13 Per her deposition, she actually used version 2.6 of the INM.

5. **Chicago's consultant has admitted that the INM model has not been used in a takings case.**

Chicago claims that the INM model is wid..y used as a generic planning tool. But Chicago ignores the fact that the quality, accuracy and representativeness of what is put into the model severely impacts its utility. Given the demonstrated problems of Chicago and its consultant in providing accurate inputs to the model, as well as the admitted limitations of the model itself, it is little wonder that Chicago's consultant admitted that the model results have not been used to establish the presence or absence of a taking.

> Q. Have you ever engaged in the use of the INM model -- have you yourself ever engaged in the use of the INM model to locate or to determine the amount of noise that has impacted on property for purposes of eminent domain proceedings?
>
> A. No, I have not.
>
> Q. Last [sic: Has] Landrum & Brown?
>
> A. To my knowledge, no.
>
> Q. Are you aware of any judicial proceeding where the INM values, such as the ones shown in Exhibit 11, have been used for the basis of the awarding eminent domain damages?
>
> A. I'm not aware of any.
>
> Vigilante deposition, pages 146-47

The INM is simply a computer program. And, as one commentator noted, the "final printout -- 'the deceptively neat package in which the computer [displays] its work product' -- can be a shield behind which is hidden a multitude of programming sins." Elliott, *Computer-Nourished Experts: An Evidentiary and Procedural Perspective*, 43 Brooklyn L. Rev. 1119, 1132 (footnote omitted). Here, as the INM's shield is being removed, a multitude of sins are becoming quite apparent. And those sins show that the INM is, in this action, irrelevant, inappropriate, and inaccurate.

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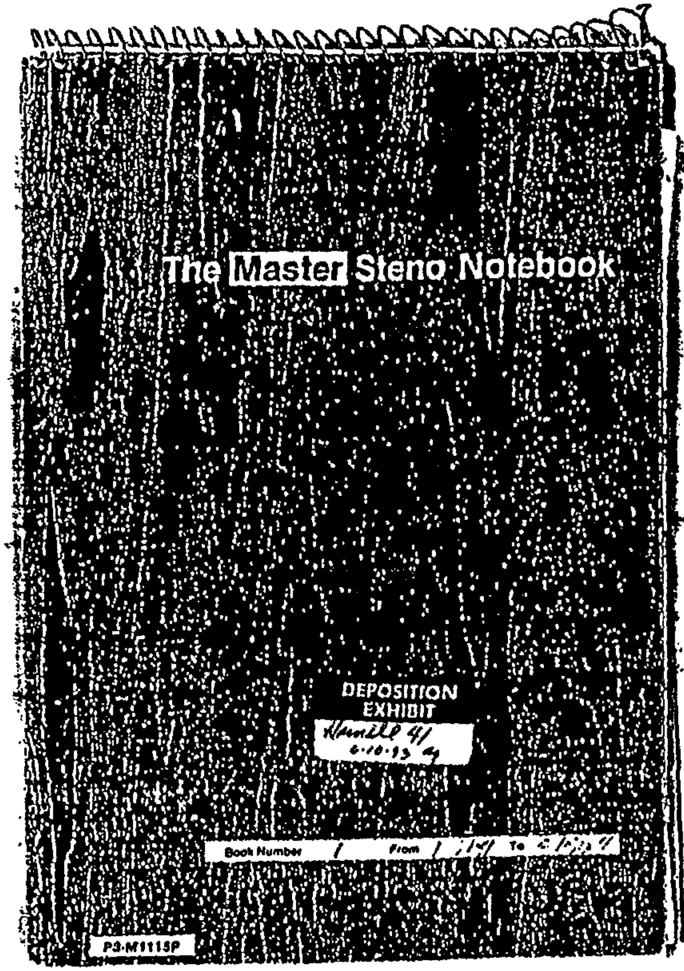

11-5-87

3%	125:05
5000	2000
5 4	10
282	39
180-7	190-11
228 14R	228 14R 9L
221 27L	9L 22
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180-9	38
228 14 9R	190-9
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7 — A-228 14R 9L	
34 D- 221 9L	
170-10	

O'HARE HILTON
the hotel in the airport

213

MAY-27-95 SAT 10:20 PM P.07

14R	14R
400/2500	900/2500
12	15
26	43
180-12	210-15
22R 14R 9R	22R 14R
22L	22L 27L
0955	1030
1000/2500	2600
5/12	12
29	45
180-16	210-24
14R 22L 9R	14R 22L 9L
22L 27L	27L 22L

1030

2600

12 A- 14R 22R

46 D- 22L 27L

150-10

O'HARE HILTON

the hotel in the airport

213

MAY-27-95 SAT 10:21 PM P.08

1530	1730Z	2130
25000	25000	25000
10	10	10
38	37	36
190-8	150-13	170-12
22R 14R 9R	22R-14R-9R	22R-14R
22L 27L	14L-22L	22L-27L

1600W

25000

10

39

180-13

22R 14R

22L 27L

1630Z

25000

10

39

170-10

22R-14R

22L-27L

1830

Lunch

1930

25000

10

36

150-13

22R-14R

27L-22L

2000

Same

14L/32R clsd

0630-0230

2230

25000

10

35

170-12

14R

27L

963

213

213

(26)

Honorable Thomas S. Zilly

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SEP 01 1993

UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF WASHINGTON
AT SEATTLE

MARK STEVEN FAVRO and EILEEN C. FAVRO, husband and wife; HARRIET JANE ARNE; DARLA BAILEY; BETTY BALDWIN; WILLIAM C. BARDON and MARY F. BARDON, husband and wife; CAROL J. BERNARD and WILLIAM H. BERNARD, wife and husband; RUDOLPH W. BERWALD and CAROL W. BERWALD, husband and wife; JOHN I. BOSTICK and SANORA L. BOSTICK, husband and wife; TED A. BOTTORFF and PATRICIA M. BOTTORFF, husband and wife; BEVERLEE A. BROWN; JACK L. BROWN AND RITA D. BROWN, husband and wife; CHARLOTTE BRYAN; ROBERT L. BURNETT and YUMIKO M. BURNETT, husband and wife; CHERYL MARGARET BYERS; ELIZABETH A. CAIRNS; RONALD CLARK and ROSE CLARK, husband and wife; ROY SYD CONNER JR. and LaNEA MARIE CONNER, husband and wife; JOHN H. CONRAD and DOROTHEA G. CONRAD, husband and wife; LIN COOPER; DALE C. CONRADI; ANTHONY COSA and MAYBELLE COSA, husband and wife; CLARK CREECH; RIGMOR DALL; FRANCIS R. DEAN and	NO. C92-1634Z SECOND AMENDED COMPLAINT FOR VIOLATION OF CONSTITUTIONAL RIGHTS AND TRESPASS

HAGENS & BERMAN
ATTORNEYS AT LAW

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LEOLA G. DEAN, husband and wife; DAVID DeCOTEAU and ELLEN DeCOTEAU, husband and wife; BARBARA SUMMERS DENNISTON; CHRISTOPHER B. DUTTON and BARBARA J. DUTTON, husband and wife; PATRICIA ESTAVA; ROGER FOOTE and NORMA FOOTE, husband and wife; WILLIAM FORSYTHE; WILMA F. FRYER; EDNA ELINOR FURNEY; JOSEPH GARCIA and MELODIE GARCIA, husband and wife; ANDREW GILKERSON and KATHLEEN GILKERSON, husband and wife; GLENN O. GOFF; ESTHER MARY GRAFF; ARDETH N. GRANT and GERALD J. GRANT, wife and husband; MARTHA ELAINE GRASSO; ALENE GROSS and BYRON GROSS, wife and husband; INGA ISAKSON and BARRY WENGER; KENNETH AND KATHLEEN HAND, husband and wife; L. RICHARD HARDING and CHARLENE K. MOORE, husband and wife; ROBERT HARPER and LOLA HARPER, husband and wife; ROBERT HAYNES and HELEN HAYNES, husband and wife; IRENE I. HEATH and ARNOLD E. HEATH, wife and husband; ROBERT K. HINTZ and BONNIE J. HINTZ, husband and wife; NORMAN L. AND MARILYN A. HIX, husband and wife; MAYNARD D. HOLTEN and CARMEN L. HOLTEN, husband and wife; WALTER R. HUFF, JR. and MARY C. HUFF, husband and wife; MELVIN F. HURST and KATHRYN L. HURST, husband and wife; DOROTHEA A.M. JASPERS; WARREN JOHNSON and DELORES JOHNSON, husband and wife; MARGARET RUTH JONES; FRANK JOSIE, JR. and MARY D. JOSIE, husband and wife; HOWARD W. KEHRER; DAVE KEISTER; SHIRLEE N. KILIZ; FRANK M.H. KIM and GAIL S.P. KIM, husband and wife; GREG KONTOS and STACEY KONTOS, husband and wife; JOHN E. LAPIN; JAMES AND SHIRLEY LILLIS, husband and

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wife; MARJORIE L. LEGG; JUANITA A. LINDHOLDT; GEORGE LOBDELL and WINIFRED PARKS LOBDELL, husband and wife; WILLIAM D. LOKEN and MARIE LOKEN, husband and wife; HAROLD LONSDALE and EILEEN LONSDALE, husband and wife; CAROLYN MANLEY; BETTE M. MARKLEY and RICHARD H. ROULLARD; WADE and JUDY MASON, husband and wife; TERESA McCLAIN; JAMES G. McCUNE; JOHN R. MCFARLAND and REITA A. MCFARLAND, husband and wife; JOSEPH D. MCKEE and JOSEPHINE B. MCKEE, husband and wife; RALPH M. MCKEE and KAREN L. MCKEE, husband and wife; ROBERT MERTEL and PRISCILLA MERTEL, husband and wife; ILENE MEYER; SIMON J. MIEDEMA and SANDRA J. MIEDEMA, husband and wife; THOMAS D. MILLER and REBECCA A. MILLER, husband and wife; WILLIAM A. MOELLER and F. JEANNE MOELLER, husband and wife; W. SCOTT MORRIS; CARL A. MORRISON and BEVERLY MORRISON, husband and wife; ARTHUR H. NEUBAUER and PATRICIA W. NEUBAUER, husband and wife; DELLA M. NOLL; ANNABELLE NYE; THOMAS H. O'ROURKE and VERNA O'ROURKE, husband and wife; WILLIAM C. O'SULLIVAN and LORI O'SULLIVAN, husband and wife; JACQUELYN K. OPRIS and MICHAEL W. OPRIS, wife and husband; FERENC ORBAN; ARLENE J. PALMER; ALAN PARKER and VIRGINIA PARKER, husband and wife; JACK L. PARKER and PATRICIA A. PARKER, husband and wife; OREN PARKER; DONALD S. PATTERSON and BARBARA E. PATTERSON, husband and wife; SCOTT PIHLSTROM and VALERIE PIHLSTROM, husband and wife; DENNIS G. PINGEON and JANICE PINGEON, husband and wife; SHIRLEY M. PRICE; STEVEN R. RAMELS and JACKIE J. RAMELS,

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husband and wife; JACK RAUB; LEO REYES and SHIRLEY REYES, husband and wife; KATHY NEUENSWANDER-RICHARDS; ARTHUR P. RICKER and PATRICIA R. RICKER, husband and wife; PETER RIO and SHIRLEY RIO, husband and wife; LARRY L. ROSE and DIXIE L. ROSE, husband and wife; RUSSELL A. ROUTT and ANNA M. ROUTT, husband and wife; J. KEITH RUGGENBERG and MARGARET M. RUGGENBERG, husband and wife; PHILLIP A. SACCO and HELEN SACCO, husband and wife; MONTY D. SAMPSON and PATRICIA O. SAMPSON, husband and wife; CHARLES A. SCHUH and P. LEILANI SCHUH, husband and wife; IRENE I. SISCO; NATHAN PRESLEY SLOUGH and CAROLE J. SLOUGH, husband and wife; DONNIE J. SMITH; GERALD M. SMITH and BARBARA A. SMITH, husband and wife; RICHARD J. SORTOR and SUSAN SORTOR, husband and wife; MARILYN F. SPEAR; EVERETT A. STEWART; RONALD E. STOCKS; DUANE C. STOKES and MARCIA D. STOKES, husband and wife; HARLAN STREYLE and SHARON STREYLE, husband and wife; NORMA (SMYTHE) TUININGA and JAY R. TUININGA, wife and husband; ROBERT TYLER and BEVERLY TYLER, husband and wife; RICHARD D. UNDERWOOD and RENÉE P. UNDERWOOD, husband and wife; DALE VON WALD and EDITH VON WALD, husband and wife; GARY VON WALD; LEE WARNER and BONNIE WARNER, husband and wife; WILLIAM A. WATTUM and NORMA I. WATTUM, husband and wife; JAMES W. WILCHER; DORIS R. WILCOX; EMMA WIPPERFURTH and GEORGE C. WIPPERFURTH, wife and husband; DAVID K. WOOD and VIRGINIA L. WOOD, husband and wife; EVERETT L. WOODS; CAROLINE (DOLLY) WRIGHT; WENDELL WRIGHT and

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DENISE WRIGHT, husband and wife; JAMES EDWARD YARBROUGH and MARY JEAN YARBROUGH, husband and wife,

Plaintiffs,

vs.

THE PORT OF SEATTLE, a municipal corporation,

Defendant.

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Plaintiffs file this complaint against the below named defendant. This complaint is alleged upon information and belief, except as to those allegations which pertain to the plaintiffs, which are alleged on knowledge. Plaintiffs' information and belief is based, *inter alia*, upon plaintiffs' investigation of the available facts through counsel herein.

NATURE OF THE ACTION

1. This is a civil rights lawsuit brought by people owning residential property in neighborhoods impacted by the effects of aircraft operations at Seattle Tacoma International Airport ("Sea-Tac"). The rights of these property owners to exclude strangers from using their properties, as well as their rights to comfortably use and enjoy, and to alienate freely, their properties, have been taken and/or damaged by the defendant. Plaintiffs possess these constitutionally-cognizable rights because they own real property in Washington, and defendant's interferences with these rights violates the Fourteenth Amendment of the Constitution of the United States and Wash. Const. Art. I, $ 16.

2. Defendant causes noise, vibration and pollutants from Sea-Tac air operations to physically invade plaintiffs' properties. Such an unpermitted use by the Port of plaintiffs' properties has resulted in diminished market values for their properties and created a noxious and abusively loud living environment.

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3. In an unbroken line of cases, the Washington Supreme Court has held that the Port must compensate homeowners for such damages caused by the effects of its operations. Fully cognizant of its legal duty, the Port nevertheless has evaded its obligation to compensate neighboring homeowners. Delay is defendant's ally.

4. As part of a cohesive strategy to minimize the inevitable acquisition costs associated with legally obtaining the private property rights actually needed adjacent to Sea-Tac's boundaries and aircraft flightlines, the Port embarked on a scheme and course of conduct designed to avoid and/or postpone purchase of these rights. This course of conduct drives down the market values of homes in neighborhoods near the airport. This scheme was comprised of three elements:

(a) First, to stave off demands by neighboring property owners for acquisition of their property and/or payment of damages, the Port made a series of unfulfilled promises that the impacts of Sea-Tac operations on the Port's neighbors would be ameliorated and, if they were not, full market value would be paid to injured homeowners;

(b) Second, nearby owners were lulled into refraining from legal action by the Port's promulgation of a series of forecasts of future Sea-Tac operations that caused nearby homeowners to believe that Sea-Tac operations would increase gradually and that the takeoff and landing noise levels and other operational side effects associated with Sea-

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Tac operations would actually level off and/or decrease in subsequent years. Contrary to these forecasts, commercial aircraft operations have increased by 135% since 1976 and the impacts of takeoff, landing and flight noise, vibration and fumes have correspondingly increased.

(c) Third, the Port undertook affirmative steps to drive down the market values of properties near Sea-Tac. The Port implemented a "Transaction Assistance Program" to assist residents in selling their homes. The Port used the program to drive down property values by recording below-market values with the King County Assessor for the homes purchased by the Port. The Port has also driven down values in residential neighborhoods near Sea-Tac by obtaining "Avigation Easements," purportedly granting the Port the right to conduct aircraft operations in exchange for sound insulation, which the Port promised would eliminate or substantially ameliorate the impacts of aircraft operations. The Port obtained these easements through a uniform and misleading "sales pitch," which downplayed or covered up the significance of the easements to the residents asked to sign them. When their significance was mentioned, the Port advised residents that these easements were a mere formality required by the State in order to obtain assistance from the Port. Uniformly, the Port did not inform those who signed easements that the easements purported to waive all constitutional rights arising from the past and future takings or damagings of their properties. The easements

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had the intended effect of depreciating the market value of not only the property of the individual homeowner who signed the easement, but of the values of all of plaintiffs' homes in the impacted areas.

5. While the Port has been failing to pay for damages caused by Sea-Tac operations and affirmatively taking action to drive down property values, there has been a continuing and dramatic increase in the number of commercial flights at Sea-Tac. In 1990, approximately 345,000 commercial aircraft takeoffs and landings were made from Sea-Tac, compared with the 130,000 flights occurring in the mid-1970's. Most of such operations were by multi-engine jet aircraft and a large percentage of these were by the louder, older "Stage II" aircraft. The resulting increases in takeoff, landing and flight noise, vibration and pollution from Sea-Tac air operations have negatively impacted the values of nearby properties, and have substantially impacted its neighbors' use and enjoyment of their properties.

6. The increases in noise, vibration and fumes has rendered many of the normal attributes of property ownership worthless. For example, families cannot comfortably use their yards and decks for relaxation, barbecues, entertainment or other normal activities associated with home ownership. Mothers are afraid to have their children play outside due to the jet exhaust that continually pollutes this area. Sleep is regularly interrupted by nighttime flight operations.

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7. Plaintiffs are now largely "frozen" in a rapidly declining investment. They cannot move for no one will purchase their home, or, if someone does, the market value is so impaired that they are unable realize the appreciation experienced by homeowners in other areas of King County. Appraisers substantially discount property values of the properties near Sea-Tac. This deep discounting affects market value, because the satisfaction of financing contingencies in sales agreements requires appraised values to be sufficiently high. Similarly, appraisers ascribe discounted values to the impacted properties near Sea-Tac when property owners apply to use their property as security for loans. Appraisers employed by lending institutions must ascribe a sufficiently high equity value for the property to be accepted as security, and a lower appraised value affects the amount of debt that the owner can assume, if the debt is allowed at all. Thus, appraisers' recognition of the impacts of the Port's aircraft operations on values results in lower sales prices, as well as impairing owners' abilities to obtain financing. Appraisers' discounting of properties in the neighborhoods where plaintiffs own property is unequivocal evidence of the diminutions in market value resulting from defendant's actions.

8. Defendant itself admits through its actions that its operations negatively effect the abilities of its neighbors to alienate their properties. Since the mid-1970's, the Port has acknowledged the fact of reduced market values due to its

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aircraft operations and provided cash stipends to those owners who are unable to sell. In some nearby neighborhoods most sales occur only because of the Port's active financial intervention. The Port's sales assistance programs, available to some neighboring owners who cannot sell their properties by normal methods, does not provide compensation for lost appreciation and only allows owners to sell to the Port at a depressed market value. Thus, plaintiffs do not have the option of selling and purchasing another residence of sufficient value in an unimpacted area.

9. Plaintiffs seek compensation because of market effects acknowledged by defendant. In a March 10, 1993 article in the Highline Times-News, Earl Munday (the head of the Port's Noise Remedy Office) described how the Port's sales assistance program operates and alluded to the damages suffered by property owners near the airport:

> . . . if the port followed the normal practice of paying homeowners 100 percent of the market value and then charging them 10 percent for real estate fees and closing costs, it would further overvalue houses, he said. If, for example, a house were appraised at $100,000, the homeowner would receive a guaranteed $90,000, he said. But a buyer may only pay $80,000, or the real market value for the house. The lower price is really what the house is worth since it is located next to the airport, Munday said (emphasis added).

Mr. Munday's frank acknowledgement of the relationship between proximity to Sea-Tac and substantially decreased property values is an admission that plaintiffs' properties are

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suffering diminutions in value because of the airport activities occurring in the vicinity.

10. The Port has taken or damaged the property rights of the owners without providing due process and compensation to plaintiffs. In connection with operating Sea-Tac so as to deprive neighboring owners of their protected property rights, the Port has been obligated by the federal and state constitutions to provide sufficient procedural safeguards. Instead, the Port did not provide plaintiffs with any opportunities even to comment upon, let alone question, the need for the imposition of increasing levels of noxious effects from aircraft operations that were going to impact their properties.

11. In this action, plaintiffs assert claims against the defendant pursuant to 42 U.S.C. § 1983 for violations of the federal constitutional guarantees of substantive and procedural due process. Plaintiffs also assert pendant claims under Art. 1 Section 16 (Amend. 9) of the Washington State Constitution for violations of the Takings Clause and for trespass. Plaintiffs seek to recover just compensation for the value of their property rights taken and/or damaged by the Port, as well as compensatory damages for their injuries suffered.

JURISDICTION AND VENUE

12. This court has subject matter jurisdiction over all claims asserted in this action under 42 U.S.C. § 1983,

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28 U.S.C. §§ 1331 and 1343(a)(3) and principles of pendent jurisdiction.

13. Venue is proper in this district under 42 U.S.C. § 1983, since the facts relating to (i) defendant's liability, (ii) defendant's allegedly depriving conduct resulting from Sea-Tac air operations, and (iii) the source and type of the injuries sustained have each occurred in this district. Venue is also proper since the facts establishing plaintiffs' damages, and defendant's taking of plaintiffs' properties, each occurred in this district. All claims asserted by plaintiffs herein arose in this district, and defendant was and is conducting operations and doing business in this district.

THE PARTIES PLAINTIFF

14. Plaintiff Harriet Jane Arne owns property at 15831 - 9th Avenue South, Seattle, WA 98148-1305. She has been damaged by the acts of defendant as described herein.

15. Plaintiff Darla Bailey owns property at 1025 South 170th, SeaTac, WA 98148. She has been damaged by the acts of defendant as described herein.

16. Plaintiff Betty Baldwin owns property at 13021 - 22nd Avenue South, Seattle, WA 98168. She has been damaged by the acts of defendant as described herein.

17. Plaintiffs William C. Bardon and Mary F. Bardon own property at 16406 - 8th Avenue South, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

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18. Plaintiffs Carol J. Bernard and William H. Bernard own property at 21626 - 3rd Avenue South, Normandy Park, WA 98198. They have been damaged by the acts of defendant as described herein.

19. Plaintiffs Rudolph W. Berwald and Carol W. Berwald own property at 1010 South 174th Street, SeaTac, WA 98148-1547. They have been damaged by the acts of defendant as described herein.

20. Plaintiffs John I. Bostick and Sandra L. Bostick own property at 17021 - 12th Avenue South, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

21. Plaintiffs Ted A. Bottorff and Patricia M. Bottorff own property at 16802 - 8th Place South, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

22. Plaintiff Beverlee A. Brown owns property at 15307 - 12th Avenue South, Seattle, WA 98148. She has been damaged by the acts of defendant as described herein.

23. Plaintiffs Jack L. Brown and Rita D. Brown own property at 1120 South 168th, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

24. Plaintiff Charlotte Bryan owns property at 565 South 158th, Seattle, WA 98148. She has been damaged by the acts of defendant as described herein.

25. Plaintiffs Robert L. Burnett and Yumiko M. Burnett own property at 1040 South 174th Street, SeaTac, WA 98148.

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They have been damaged by the acts of defendant as described herein.

26. Plaintiff Cheryl Margaret Byers owns property at 15429 - 10th Avenue South, Seattle, WA 98148. She has been damaged by the acts of defendant as described herein.

27. Plaintiff Elizabeth A. Cairns owns property at 16672 - 11th Avenue South, SeaTac, WA 98148. She has been damaged by the acts of defendant as described herein.

28. Plaintiffs Ronald and Rose Clark own property at 16856 Des Moines Memorial Drive South, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

29. Plaintiffs Roy Syd Conner Jr. and LaNea Marie Conner own property at 1033 South 171st Street, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

30. Plaintiffs John H. Conrad and Dorothea G. Conrad own property at 1041 South 158th Street, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

31. Plaintiff Dale C. Conradl owns property at 16035 - 12th South, SeaTac, WA 98148. He has been damaged by the acts of defendant as described herein.

32. Plaintiff Lin Cooper owns property at 16444 Des Moines Memorial Drive South, Seattle, WA 98148. He has been damaged by the acts of defendant as described herein.

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33. Plaintiffs Anthony Cosa and Maybelle Cosa own property at 924 South 170th, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

34. Plaintiff Clark Creech owns property at 1049 South 160th Street, SeaTac, WA 98148. He has been damaged by the acts of defendant as described herein.

35. Plaintiff Rigmor Dall owns property at 1015 South 157th Place, Seattle, WA 98148. He has been damaged by the acts of defendant as described herein.

36. Plaintiffs Francis R. Dean and Leola G. Dean own property at 1040 South 171st Street, SeaTac, WA 98148-1523. They have been damaged by the acts of defendant as described herein.

37. Plaintiffs David DeCoteau and Ellen DeCoteau own property at 931 South 156th Street, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

38. Plaintiff Barbara Summers Denniston owns property at 1016 South 174th, Seattle, WA 98148. She has been damaged by the acts of defendant as described herein.

39. Plaintiffs Christopher B. Dutton and Barbara J. Dutton own property at 16657 11th Avenue South, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

40. Plaintiff Patricia Estava owns property at 20135 14th Avenue South, Seattle, WA 98198. She has been damaged by the acts of defendant as described herein.

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41. Plaintiffs Mark Steven Favro and Eileen C. Favro own property at 1018 South 171st, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

42. Plaintiffs Roger Foote and Norma Foote own property at 22018 - 11th South, Des Moines, WA 98198. They have been damaged by the acts of defendant as described herein.

43. Plaintiff William Forsythe owns property at 15315 12th Avenue South, SeaTac, WA 98168. He has been damaged by the acts of defendant as described herein.

44. Plaintiff Wilma F. Fryer owns property at 13025 - 23rd Avenue South, SeaTac, WA 98168. She has been damaged by the acts of defendant as described herein.

45. Plaintiff Edna Elinor Furney owns property at 15722 - 10th Avenue South, SeaTac, WA 98148. She has been damaged by the acts of defendant as described herein.

46. Plaintiffs Joseph Garcia and Melodie Garcia own property at 433 South 214th Street, Des Moines, WA 98198. They have been damaged by the acts of defendant as described herein.

47. Plaintiffs Andrew Gilkerson and Kathleen Gilkerson own property at 1047 South 174th, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

48. Plaintiff Glenn O. Goff owns property at 1034 South 171st Street, Seattle, WA 98148-1523. He has been damaged by the acts of defendant as described herein.

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49. Plaintiff Esther Mary Graff owns property at 825 South 177th Place, Seattle, WA 98148. She has been damaged by the acts of defendant as described herein.

50. Plaintiffs Ardeth N. Grant and Gerald J. Grant own property at 16240 Des Moines Memorial Drive and 16232 Des Moines Way South, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

51. Plaintiff Martha Elaine Grasso owns property at 16662 - 8th Avenue South, Seattle, WA 98148. She has been damaged by the acts of defendant as described herein.

52. Plaintiffs Alene Gross and Byron Gross own property at 2627 South 150th, Seattle, WA 98188. They have been damaged by the acts of defendant as described herein.

53. Plaintiffs Inga Isakson and Barry Wenger own property at 724 South 116th Street, Seattle, WA 98168. They have been damaged by the acts of defendant as described herein.

54. Plaintiffs Robert and Lola Harper own property at 10736 Glen Acres Drive South, Seattle, WA 98168. They have been damaged by the acts of defendant as described herein.

55. Plaintiffs Kenneth Hand and Kathleen Hand own property at 560 South 158th, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

56. Plaintiffs L. Richard Harding and Charlene K. Moore own property at 2056 South 134th Street, Seattle, WA 98168. They have been damaged by the acts of defendant as described herein.

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57. Plaintiffs Robert Haynes and Helen Haynes own property at 17619 - 10th South, Burien, WA 98148. They have been damaged by the acts of defendant as described herein.

58. Plaintiffs Irene I. Heath and Arnold E. Heath own property at 15821 - 12th Avenue South, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

59. Plaintiffs Robert Hintz and Bonnie Hintz own property at 3205 South 150th Street, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

60. Plaintiffs Norman Hix and Marilyn Hix own property at 704 South 212th, Des Moines, WA 98148. They have been damaged by the acts of defendant as described herein.

61. Plaintiffs Maynard D. Holten and Carmen L. Holten own property at 1045 South 173rd, Seattle, WA 98148-1542. They have been damaged by the acts of defendant as described herein.

62. Plaintiffs Walter Huff and Mary Huff own property at 19818 Third Place South, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

63. Plaintiffs Melvin F. Hurst and Kathryn L. Hurst own property at 1026 South 171st, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

64. Plaintiff Dorothea A.M. Jaspers owns property at 21214 - 14th Avenue South, Des Moines, WA 98198. She has been damaged by the acts of defendant as described herein.

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65. Plaintiffs Warren Johnson and Delores Johnson own property at 3755 South 168th Street, SeaTac, WA 98188. They have been damaged by the acts of defendant as described herein.

66. Plaintiff Margaret Ruth Jones owns property at 15404 Tenth Avenue South, Seattle, WA 98148-1121. She has been damaged by the acts of defendant as described herein.

67. Plaintiffs Frank Josie, Jr. and Mary D. Josie own property at 16815 - 8th Place South, Seattle, WA 98148 and 13238 - 22nd South, Seattle, WA 98168. They have been damaged by the acts of defendant as described herein.

68. Plaintiff Howard W. Kehrer owns property at 15413 - 9th Place South, SeaTac, WA 98148. He has been damaged by the acts of defendant as described herein.

69. Plaintiff David Keister owns property at 1215 South 234th Place, Des Moines, WA 98198. He has been damaged by the acts of defendant as described herein.

70. Plaintiff Shirlee N. Kiliz owns property at 1024 South 174th Street, SeaTac, WA 98148. She has been damaged by the acts of defendant as described herein.

71. Plaintiffs Frank M.H. Kim and Gail S.P. Kim own property at 13848 - 29th Avenue South, SeaTac, WA 98168. They have been damaged by the acts of defendant as described herein.

72. Plaintiffs Greg Kontos and Stacey Kontos own property at 825 South 176th, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

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73. Plaintiff John E. Lapin owns property at 15926 Des Moines Memorial Drive South, Seattle, WA 98148. He has been damaged by the acts of defendant as described herein.

74. Plaintiff Marjorie L. Legg owns property at 14405 - 25th Avenue South, Seattle, WA 98168. She has been damaged by the acts of defendant as described herein.

75. Plaintiffs James Lillis and Shirley Lillis own property at 552 South 158th, Burien, WA 98148. They have been damaged by the acts of defendant as described herein.

76. Plaintiff Juanita A. Lindholdt owns property at 17016 Des Moines Memorial Boulevard, Burien, WA 98148. She has been damaged by the acts of defendant as described herein.

77. Plaintiffs George Lobdell and Winifred Parks Lobdell own property at 16054 - 8th Avenue South, SeaTac, WA 98148-1302. They have been damaged by the acts of defendant as described herein.

78. Plaintiffs William D. Loken and Marie Loken own property at 1258 South 132nd, Burien, WA 98168. They have been damaged by the acts of defendant as described herein.

79. Plaintiffs Harold Lonsdale and Eileen Lonsdale own property at 1218 South 200th, SeaTac, WA 98198. They have been damaged by the acts of defendant as described herein.

80. Plaintiffs Bette M. Markley and Richard M. Roullard own property at 164XX 8th Avenue South (Tract 22), 16436 8th Avenue South (Tract 25), 164XX 8th Avenue South (Tract 24), 16452 8th Avenue South (Tract 23E), 16454 8th Avenue South

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(Tract 23W), SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

81. Plaintiffs Wade Mason and Judy Mason own property at 12816 22nd Avenue South, Seattle, WA 98168. They have been damaged by the acts of defendant as described herein.

82. Plaintiff Teresa McClain owns property at 16602 - 8th Avenue South, Seattle, WA 98148. She has been damaged by the acts of defendant as described herein.

83. Plaintiff James G. McCune owns property at 20420 - 12th Place South, SeaTac, WA 98198. He has been damaged by the acts of defendant as described herein.

84. Plaintiffs John R. McFarland and Reita A. McFarland owned property at 1005 South 168th, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

85. Plaintiffs Joseph D. McKee and Josephine B. McKee own property at 1412 South 103rd Street, Seattle, WA 98168. They have been damaged by the acts of defendant as described herein.

86. Plaintiffs Ralph M. McKee and Karen L. McKee own property at 1010 South 171st Street, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

87. Plaintiffs Robert Mertel and Priscilla Mertel own property at 911 South 160th, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

88. Plaintiff Ilene Meyer owns property at 1005 South 171st, Seattle, WA 98148. She has been damaged by the acts of defendant as described herein.

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89. Plaintiffs Simon J. Miedema and Sandra J. Miedema own property at 638 South 146th Street, Burien, WA 98168-3550. They have been damaged by the acts of defendant as described herein.

90. Plaintiffs Thomas D. Miller and Rebecca A. Miller own property at 1112 South 168th, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

91. Plaintiffs William A. Moeller and F. Jeanne Moeller own property at 21215 - 4th Place South, Seattle, WA 98198. They have been damaged by the acts of defendant as described herein.

92. Plaintiff W. Scott Morris owns property at 1010 South 172nd, Seattle, WA 98148. He has been damaged by the acts of defendant as described herein.

93. Plaintiffs Carl A. Morrison and Beverly Morrison own property at 168XX 8th Place South (Old Wilson Rd.), Burien, WA 98168. They have been damaged by the acts of defendant as described herein.

94. Plaintiffs Arthur H. Neubauer and Patricia W. Neubauer own property at 20629 - 12th Place South, Seattle, WA 98198-2916. They have been damaged by the acts of defendant as described herein.

95. Plaintiff Della H. Noll owns property at 1046 South 174th, Seattle, WA 98148. She has been damaged by the acts of defendant as described herein.

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96. Plaintiff Annabelle Nye owns property at 15855 - 9th Avenue South, Seattle, WA 98148. She has been damaged by the acts of defendant as described herein.

97. Plaintiffs Thomas H. O'Rourke and Verna O'Rourke own property at 19031 - 32nd South and 12857 - 22nd South, Seattle, WA. They have been damaged by the acts of defendant as described herein.

98. Plaintiffs William C. O'Sullivan and Lori O'Sullivan own property at 16679 - 11th South, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

99. Plaintiffs Jacquelyn K. Opris and Michael W. Opris own property at 1035 South 174th Street, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

100. Plaintiff Ferenc Orban owns property at 1009 South 171st, Seattle, WA 98148. He has been damaged by the acts of defendant as described herein.

101. Plaintiff Arlene J. Palmer owns property at 1020 South 156th Street, SeaTac, WA 98148. She has been damaged by the acts of defendant as described herein.

102. Plaintiffs Alan Parker and Virginia Parker own property at 1118 South 167th Place, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

103. Plaintiffs Jack L. Parker and Patricia A. Parker owned property at 13114 - 14th Avenue South and 13110 - 14th

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Avenue South, Seattle, WA 98168. They have been damaged by the acts of defendant as described herein.

104. Plaintiff Oren Parker owns property at 15914 Des Moines Way South, Seattle, WA 98148. He has been damaged by the acts of defendant as described herein.

105. Plaintiffs Donald S. Patterson and Barbara E. Patterson own property at 16651 - 11th Avenue South, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

106. Plaintiffs Scott Pihlstrom and Valerie Pihlstrom own property at 15417 - 10th South, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

107. Plaintiffs Dennis G. Pingeon and Janice Pingeon own property at 16410 - 8th Place South, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

108. Plaintiff Shirley M. Price owns property at 16765 - 12th Avenue South, Seattle, WA 98148. She has been damaged by the acts of defendant as described herein.

109. Plaintiffs Steven R. Ramels and Jackie J. Ramels own property at 610 South 162nd, Burien, WA 98148. They have been damaged by the acts of defendant as described herein.

110. Plaintiff Jack Raub owns property at 16852 - 8th Place South, SeaTac, WA 98148. He has been damaged by the acts of defendant as described herein.

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111. Plaintiffs Leo Reyes and Shirley Reyes own property at 1049 South 171st, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

112. Plaintiff Kathy Neuenswander-Richards owns property at 17020 Sylvester Road Southwest, Seattle, WA 98166. She has been damaged by the acts of defendant as described herein.

113. Plaintiffs Arthur P. Ricker and Patricia R. Ricker own property at 15447 - 10th Avenue South, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

114. Plaintiffs Peter Rio and Shirley Rio own property at 17333 12th Avenue South, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

115. Plaintiffs Larry L. Rose and Dixie L. Rose own property at 13243 - 22nd South, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

116. Plaintiffs Russell A. Routt and Anna M. Routt own property at 16646 - 8th Avenue South, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

117. Plaintiffs J. Keith Ruggenberg and Margaret M. Ruggenberg own property at 15833 - 9th Avenue South, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

118. Plaintiffs Phillip A. Sacco and Helen Sacco own property at 1025 South 171st Street, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

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119. Plaintiffs Monty D. Sampson and Patricia O. Sampson own property at 21231 - 14th Avenue South, Des Moines, WA 98198. They have been damaged by the acts of defendant as described herein.

120. Plaintiffs Charles A. Schuh and P. Leilani Schuh own property at 1006 South 174th Street, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

121. Plaintiff Irene I. Sisco owns property at 1012 South 173rd Street, SeaTac, WA 98148. She has been damaged by the acts of defendant as described herein.

122. Plaintiffs Nathan Presley Slough and Carole J. Slough own property at 2040 South 134th, Seattle, WA 98168. They have been damaged by the acts of defendant as described herein.

123. Plaintiff Donnie J. Smith owns property at 23311 - 19th Avenue South, Des Moines, WA 98198. He has been damaged by the acts of defendant as described herein.

124. Plaintiffs Gerald M. Smith and Barbara A. Smith own property at 1001 South 170th, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

125. Plaintiffs Richard J. Sortor and Susan Sortor own property at 16043 - 12th Avenue South, SeaTac, WA 98148. They have been damaged by the acts of defendant as described herein.

126. Plaintiff Marilyn F. Spear owns property at 15332 - 10th Avenue South, Seattle, WA 98148. She has been damaged by the acts of defendant as described herein.

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127. Plaintiff Everett A. Stewart owns property at 13405 Des Moines Memorial Drive South, Burien, WA 98168. He has been damaged by the acts of defendant as described herein.

128. Plaintiff Ronald E. Stocks owns property at 16846 - 8th Avenue South, Seattle, WA 98148. He has been damaged by the acts of defendant as described herein.

129. Plaintiffs Duane C. Stokes and Marcia D. Stokes own property at 16208 8th Avenue South, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

130. Plaintiffs Harlan Streyle and Sharon Streyle own property at 11640 Military Road South, Seattle, WA 98168. They have been damaged by the acts of defendant as described herein.

131. Plaintiffs Norma (Smythe) Tuininga and Jay R. Tuininga own property at 14229 - 6th Avenue South, Seattle, WA 98168. They have been damaged by the acts of defendant as described herein.

132. Plaintiffs Robert Tyler and Beverly Tyler own property at 1052 South 170th and 16853 - 12th Avenue South, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

133. Plaintiffs Richard D. Underwood and Renée P. Underwood own property at 1041 South 171st Street, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

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134. Plaintiffs Dale Von Wald and Edith Von Wald own property at 1018 South 170th and 1103 South 168th, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

135. Plaintiff Gary Von Wald owns property at 1018 South 170th, Seattle, WA 98148. He has been damaged by the acts of defendant as described herein.

136. Plaintiffs Lee Warner and Bonnie Warner own property at 849 South 164th, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

137. Plaintiffs William A. Wattum and Norma I. Wattum owned property at 12301 - 4th Avenue South, Seattle, WA 98168. They have been damaged by the acts of defendant as described herein.

138. Plaintiff James W. Wilcher owns property at 15006 Des Moines Memorial Drive, Seattle, WA 98148. He has been damaged by the acts of defendant as described herein.

139. Plaintiff Doris R. Wilcox owns property at 1007 South 168th, Seattle, WA 98148. She has been damaged by the acts of defendant as described herein.

140. Plaintiffs Emma Wipperfurth and George C. Wipperfurth own property at 1114 South 167th Place, Seattle, WA 98148-1514. They have been damaged by the acts of defendant as described herein.

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141. Plaintiffs David K. Wood and Virginia L. Wood own property at 1017 South 171st Street, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

142. Plaintiff Everett L. Woods owns property at 648 and 649 South 168th, 2612 South 208th, 16807, 16845, 16884 and 16874 - 8th Avenue South, Seattle, WA 98148. He has been damaged by the acts of defendant as described herein.

143. Plaintiff Caroline (Dolly) Wright owns property at 18435 - 2nd Avenue South, Seattle, WA 98148. She has been damaged by the acts of defendant as described herein.

144. Plaintiffs Wendell Wright and Denise Wright own property at 15904 Des Moines Memorial Drive, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

145. Plaintiffs James Edward Yarbrough and Mary Jean Yarbrough own property at 824 South 177th Place, Seattle, WA 98148. They have been damaged by the acts of defendant as described herein.

146. Unless identified individually, the individual plaintiffs are collectively referred to herein as "plaintiffs."

THE PARTY DEFENDANT

147. Defendant Port of Seattle (the "Port") is a municipal corporation formed and operating under the laws of the State of Washington (RCW 53.04, et seq.). At all relevant times, the Port owned and operated Sea-Tac. A key aspect of such operation involves duly-empowered officers and/or Port

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Commissioners authorizing each of the scheduled takeoffs and landings via agreements with third parties who use Sea-Tac for their aircraft.

148. At all relevant times, the Port, through its various officers and Commissioners, acted under color of law when they managed the air operations at Sea-Tac. Such activities constituted the official policy, practice and custom of the Port. When this official policy was executed, its effects deprived plaintiffs of their recognized rights.

149. The formation of the Port is authorized by RCW Chapter 53.04. The Port is governed by an elected Port Commission (RCW 53.12, et seq.). The Port has the power to acquire property (including easements) by purchase and condemnation if such property is necessary for its purposes. Further, the Port has been delegated the plenary right of the sovereign to exercise powers of eminent domain with respect to such properties (RCW 53.08.010). The Port may be sued by virtue of RCW 4.08.120.

150. The invasive nature of the effects of the Port's air operations at Sea-Tac results in a taking of a valuable property right from plaintiffs with a corresponding diminution in the value of their properties. While unimpacted residential properties in King County have appreciated greatly over the past several decades, property value appreciation rates near Sea-Tac have been crippled because of the steadily-increasing effects of air operations. Further, residents near Sea-Tac

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suffer sleep disruptions and anxiety because of the effects of nearby air operations. Despite such apparent deleterious effects, the Port continues to injure nearby property owners. Viewed from the perspective of its' effects on the victims, as is required in a civil rights lawsuit, the Port's depriving conduct has been arbitrary and capricious.

FACTUAL ALLEGATIONS COMMON TO ALL CLAIMS

A. Plaintiffs' Neighborhoods.

151. Plaintiffs reside and own residential property in close proximity to Sea-Tac. Most of plaintiffs' neighborhoods have been recognized by the Port in its planning processes, since at least 1975, as uniquely impacted because of their proximity to Sea-Tac and the impacts of Sea-Tac air operations. The Port offers cash to certain owners in these neighborhoods when traditional methods of selling properties fail, which is a plain admission that its' operations have negatively impacted the values of homes in these areas.

B. History of Sea-Tac Airport

152. In 1942, the Civil Aeronautics Administration (now the FAA) selected an airport site near swampy Bow Lake in King County, Washington. Since neither King County nor the City of Seattle had adequate funds for such a project, the Port of Seattle acquired the original 906 acres and developed the airport. Its southwest King County situation was desirable since it was close to midway between Puget Sound's two major cities, Seattle and Tacoma. Its pastoral rural setting

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promised distance from city congestion and less impact on a sparsely settled community.

153. Sea-Tac's early scale of operations was overshadowed by its area predecessor, nearby Boeing Field. It was not until the advent of the jet age, with its need for longer runways and generally enlarged facilities, that the booming airline industry shifted its local focus to Sea-Tac. In the meantime, the Airport's surrounding land character has undergone considerable change.

154. The area's proximity to manufacturing in south Seattle and Renton was a substantial factor in its rapid postwar growth through the early 1960s. With land-use controls and environmental concerns less sophisticated than today, the accelerating urbanization of the area took its toll in water and air pollution, land-use conflicts, traffic inadequacies and visual blight. Opportunities for commercial ventures, centered on the airport and its surrounding populations, tended to contribute to shortsighted community development rather than more reasoned, long-term considerations.

155. The introduction of large jets in the 1960s to an already growing air industry pushed the airlines and most airports into a whole new scale of operations. The tides of postwar affluence pitched this new mode of air travel to the limits of many an American airport's capabilities, including Sea-Tac's. The Port responded to meet the challenge by touting the many benefits a major airport can bring to a region's

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economic markets. The Port expanded the airport to 1,500 acres, then 2,200 acres, extending runways and expanding terminal and other support facilities.

156. Technology increased the jet's size, enabling payloads to double and triple, but also ushering in large engines with their associated ill effects of heightened noise and deteriorating ambient air quality. In addition, airport growth created an accelerated need for airport-related facilities and land uses in the vicinity, such as increased highway capacity, motels and restaurants, and living accommodations for thousands of airport employees.

157. Although there were attempts at spot remedial actions, no overall strategy developed to alleviate growing conflicts between the airport and its neighbors.

158. Citizens, both individually and in organized groups, were frustrated in their attempts to cope with the worsening noise and air quality situation. By the summer of 1972, it had become abundantly clear to both the Port of Seattle and King County that a coordinated plan of programs for improvement was needed for the Sea-Tac area. The incorporated areas of Normandy Park and Des Moines, the Highline School District and other governments of the area also expressed the need for a remedial program.

C. <u>Sea-Tac Communities Plan</u>

159. In March of 1973, the Port of Seattle and King County initiated a jointly sponsored study to develop a plan for the

coordinated improvements of Sea-Tac International Airport and surrounding communities. The FAA, anxious to assist as a catalyst in developing solutions to airport-vicinity environmental problems, provided a federal grant to develop a program that came to be known as the "Sea-Tac/Communities Plan."

160. The FAA's Airport Trust Fund furnished two-thirds of the money for the 18-month program. The Port and County, using their own personnel and equipment, each contributed in kind to fund the remaining one-third of the cost of the project.

161. The noise remedy program of the Sea-Tac/Communities Plan was designed to assist the airport and the surrounding communities in becoming more compatible over time. The Port developed three general policy objectives of the plan:

a. To minimize noise at the source through local programs where possible.

b. To identify and support national and/or aviation-industry noise-source reduction programs.

c. To apply community-based remedies directly in neighborhoods significantly affected by noise exposure, remedies which deal with residual problems not resolvable at the source.

The recommended noise remedy program that resulted included two categories of noise remedies: (1) remedies that would reduce

noise at the source, and (2) remedies that would be applied within the noise-affected residential neighborhoods.

162. The Sea-Tac/Communities Plan was adopted in 1975/1976 by both the Port of Seattle and King County. In ordinance 2883, King County adopted the Sea-Tac/Communities Plan as "official County policy in determining future actions with the Port of Seattle on matters pertaining to Sea-Tac International Airport, the application of noise programs, development of acquisition areas and other action on the Airport or in the vicinity." In Resolution No. 2626, the Port of Seattle "accepts the Sea-Tac/Communities Plan and endorses its recommendations in general terms as a guide for development of the Sea-Tac International Airport within its community."

163. The Sea-Tac/Communities Plan was the start of a series of promises by the Port designed to convince Sea-Tac's neighbors that the noise, vibration and pollution problems of Sea-Tac would not increase and that the Port would either purchase noise-impacted property or institute effective noise mediation plans.

164. A document published by the Port describing the Sea-Tac/Communities Plan evidences the Port's assurances the noise problems would not worsen over time, that it would purchase noise-impacted property and that it would reduce the impact of noise:

> BASIC FINDINGS. A wide variety of findings and conclusions were produced by and as a

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result of the project. Prime examples include.

* No major expansion of the Airport site is required.

* Noise exposure has peaked and, although expected to decrease with time, will continue to be a problem.

* Numerous property owners adjacent or near Sea-Tac Airport are disturbed by aircraft noise and sincerely believe that they should receive some form of relief or compensation for this condition.

* Property owners are also uncertain and nervous about real estate values in the Airport vicinity.

* Acquisition of all noise sensitive lands by the Port of Seattle could adversely affect the local tax base, the operation of certain special purpose districts, and the integrity of numerous neighborhoods.

* Implementation of appropriate noise remedy programs should permit the Airport to effectively function throughout the 20-year planning period and beyond; this will forestall the need to build a second major airport for many years to come.

* Practical solutions to area wide water quality and drainage problems are available.

* Access to the Airport from the south needs to be improved via a coordinated effort by the County, Port, and State Highway Department.

* Operation of the Airport has little effect on air quality in the area.

KEY ACTIONS. In order to achieve a more compatible Airport/Community relationship,

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the recommended Plan is based on several key actions. They are:

* Establishment of a comprehensive noise remedy program by the Port of Seattle involving acquisition, purchase guarantees, noise insulation, avigation easements, and property advisory services.

* Provision of maximum financial assistance by the FAA for such noise remedy actions.

* Implementation of extensive drainage, water quality, park, and recreation program improvements by King County.

* Recognition of the Plan by HUD/FHA for purposes of improving mortgage insurance policies and practices in the area.

* Agreement by the Port and County to fulfill staffing and budgetary needs of the Plan, and to conduct a Post-Plan Coordination Program. The latter includes the monitoring of (1) noise exposure, (2) water quality, (3) air quality, and (4) actual progress in implementation of the Plan.

Various programs were, and continue to be, implemented under the auspices of the Sea-Tac Communities Plan. However, the vast majority of negatively-impacted property owners near the airport have not been adequately compensated by any Port program.

D. The Port Is Aware of Its Legal Obligation to Fully Compensate Homeowners for All Damages Caused by Sea-Tac

165. While the Sea-Tac Communities Plan was being promulgated, the Port was aware that under Washington law it was constitutionally obligated to compensate homeowners for

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damages caused by the noise, vibration and pollution attendant to aircraft operations. This rule of law was established in Martin v. Port of Seattle, 64 Wn.2d 309 (1964), cert. denied, 379 U.S. 1989 (1965).

166. At the same time the Port was undertaking its promises concerning the impacts of Sea-Tac and assistance to property owners, the doctrine established in Martin was expanded in Highline District v. Port of Seattle, 87 Wn.2d 6 (1976). In Highline, the Washington Supreme Court affirmed the Martin decision and strengthened it by holding that compensation was required for any diminutions in value attributable to interferences from Sea-Tac's airport operations. Id. at 15.

167. The strength of the protection afforded property owners, and the financial responsibilities of the Port for the results of interfering with neighboring owners' property rights, was again affirmed in Petersen v. Port of Seattle, 94 Wn.2d 479 (1980). In Petersen, the Supreme Court strictly limited the Port's right to claim a prescriptive easement that precluded a landowner's taking claim. The court held, that to acquire a prescriptive easement, the Port's use of the air space must be deemed "hostile." The Washington Supreme Court affirmed a trial court finding that the Port's participation in the Sea-Tac Communities Plan, designed to formulate and disseminate information about remedies for adversely effected

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properties, was an action that was inconsistent with a finding of hostility.

168. This trilogy of cases firmly established the obligation of the Port to compensate property owners for the damages to their rights caused by the operations of Sea-Tac. As detailed below, fearful of the costs that could be imposed if it openly declared its use hostile, and fully cognizant of its duty to compensate injured property owners, the Port continued on a course of conduct designed to avoid paying full value for the damages it caused.

E. The Port Continues to Make Further Promises of Impact Reduction

169. Rather than acquire fee interests or avigation easements over the properties damaged by Sea-Tac operations, the Port continued to promulgate, and failed to correct, a series of false statements concerning noise mediation/and or acquisition. These statements were designed to, and did, lull residents of the neighborhoods near Sea-Tac into believing that the Port would assist them and mitigate the impact of the effects of Sea-Tac operations.

170. In July, 1976, the majority of plaintiffs or their predecessors in interest were informed that they were eligible for benefits to ameliorate the impacts on their properties, under a program known as "Neighborhood Reinforcement." This program was an early express acknowledgement by the Port that its conduct of air operations would not be detrimental to its'

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neighbors' property rights, because if damage was caused by the effects of those operations, the Port would provide appropriate compensation. A main feature of this program was the "purchase guarantee," whereby:

> A guarantee will be provided to owners of developed or undeveloped residential property subject to specified levels of aircraft noise that <u>their holdings will be purchased for fair market value in the event they decide to sell</u>.

Other remedies that were promised to nearby residents by the Port's designation of their properties as being eligible for "Reinforcement" included a second purchase assurance program, based on modifications to HUD/FHA Mortgage Insurance Practices, purchases of avigation easements, noise insulation and various property advisory services. Very few, if any, South King County residents were, in fact, offered an opportunity to participate in the Reinforcement program and that program did not offer compensation for the full damages attributable to Sea-Tac operations.

171. In the mid-1980's, the Port announced that the "Transaction Assistance Program" would supersede the previous remedial programs and that neighboring residents would be able to take advantage of benefits under this scheme. The transaction assistance process was described on a flow diagram on page 16 of the January 1985 Noise Remedy Program. This flow chart indicated that after application for transaction assistance ("TA") to the Port, the Port would counsel the

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homeowner on the TA process. The owner would place his home on the market for a specified period, and if there were no sale, the home would continue on the market for an additional period. If there were still no sale, the Port would purchase the home <u>based on a fair market</u> value calculation. The Port would take possession, make whatever repairs or improvements were necessary (such as sound insulation), and then resell the property, burdened with an avigation easement, to a new owner. The TA program had an initial trial period ending in 1986, and since that time a relatively small percentage of eligible property owners have availed themselves of this program. As explained below, those who participated in this program have received substantially less than the full market value for their homes due to the impacts of Sea-Tac operations on property values and the Port's valuation practices.

172. Neighbors of Sea-Tac justifiably relied on these empty statements, hoping that the Port would indeed provide the relief it was representing -- a fair market purchase or sound insulation that would meaningfully counter the ill effects of noise and vibration. In retrospect, the representations by the Port that it would assist its neighbors were false and misleading. Such representations were always contingent upon receiving FAA funds despite the Port's well-defined obligation under state law, set forth in a series of Washington Supreme Court cases, to pay for damages caused to property owners as a result of Sea-Tac operations. As applied to the owners near

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the airport, the series of unfulfilled promises served to do no more than offer false hope and suggest to property owners that litigation would not be necessary for violations of their rights. Because of these promises, the Port's use of plaintiffs' properties has not been hostile.

F. The Port Minimizes the Projected Impacts of Sea-Tac Operations

173. At the same time the Port was promising to alleviate the impact of Sea-Tac operations, it promulgated a series of forecasts of the number of air operations that have, without exception, fallen dramatically short of reality. Had accurate projections been produced, as opposed to the rosy pictures painted by those air operation projections that were widely disseminated, nearby residents could have taken steps at an earlier juncture to vindicate their property rights.

174. The Sea-Tac Communities Plan (1975) projected that annual air carrier operations in 1993 would total 210,000. In 1990, 345,000 air carrier operations actually took place in 1991.

175. The pattern of the promulgation of low projections by the Port as to the future level of air carrier operations is further evidenced by projections promulgated as recently as 1988, which projected that 1990 operations would total approximately 280,000 flights. In fact, only two years after these projections, actual flights exceeded the 1988 projection by 23%.

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176. Plaintiffs could not have been expected to know that the figures the Port had been providing about the magnitude of future aircraft operations were so far below reality. The low projections promulgated over the last several decades dovetailed with the empty commitments to redress impacts caused by Sea-Tac air operations and render the Port's use of plaintiffs' properties non-hostile. By acknowledging plaintiffs' rights to exclude others from using their properties, as such rights relate to its aircraft operations, the Port can not be deemed to have made "hostile" use of plaintiffs' properties.

G. The Port Undertakes Affirmative Acts to Reduce Market Value

177. When the Port purchases residences pursuant to its Transaction Assistance Plan, it pays an owner who has received no offers after having his property listed with an agent for approximately nine months 90% of a value determined by appraisers using comparable properties located as close as possible to the area defined by the Port as "impacted" by its operations. After negotiating such a transaction, the Port reports to the King County Assessor's office only the net price it paid the seller. This practice is in contravention of the requirement that the seller report the gross amount received upon the sale of his property. This practice has the effect of lowering market values of all the other homes in the area for future purchasers, including the Port, and results in a

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spiraling down of property values. When valuing properties, appraisers (other than those employed by the Port for its sales assistance programs) are required to use as "comparables" the geographically-closest and most recent sales. Appraisers obtain their data from the County Assessor's office and the artificially low prices paid by the Port for properties near Sea-Tac are used as indicators of the present market values of properties in plaintiffs' communities.

178. Perceiving their declining real estate values and doubting the promises by the Port that the impacts of aircraft operations would decrease, some homeowners took advantage of the Port's noise attenuation program. This program provided the installation of storm windows and some sound insulation and air circulation fans for some rooms. Three contractors bid for these jobs, per Port specifications, and the Port remits payment for these services and materials to the contractors who provide the low bids. In exchange for these services, the owner must execute an Avigation Easement in favor of the Port.

179. Many of the property owners living near Sea-Tac only agreed to the sound insulation package because only homes burdened with the Port's avigation easements are eligible for the sales assistance program. The need for, and number of properties involved, in these programs is clear evidence of how the real estate markets for residential properties near the airport have been damaged by the Port's operations.

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180. The Port provides contractor reimbursement on a preferential basis; those residents who have lived near Sea-Tac the longest are most eligible to receive sound attenuation service.

181. Targeting long-term residents is different than targeting those residents who are most impacted by Sea-Tac operations. It is striking that those residences most impacted by Sea-Tac operations are not given preference for sound attenuation. This fact is explained by how long-term residents, as a group, have suffered the greatest diminutions in value by virtue of the air operations at Sea-Tac.

182. The offer of the provision of sound attenuation measures to long-term residents is a means utilized by the Port to have such damaged neighbors relinquish valuable personal and property rights and to drive down property values and eventual acquisition costs. As part of the "paper work" residents are required to execute to receive the "free" sound attenuation measures, the Port requires the execution of an "Avigation Easement" document.

183. The events surrounding the Avigation Easements demonstrate the Port's deceptive practices and lack of good faith in dealing with neighboring property owners:

(a) The Port makes execution of an Avigation Easement a necessary precondition for homeowners who wish to participate in the Transaction Assistance Program. Since these residential owners are unable to sell their houses without the

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Program -- due to the impact of Sea-Tac operations on their properties -- they have no meaningful alternative to signing an Avigation Easement. Thus, the Port presents residents with a Hobson's Choice: either remain "frozen" in a housing investment that is declining in value and cannot be sold without Port intervention, or sign an Easement and get Port assistance in selling one's house for an amount substantially below the value the owner would have received had the home not been in an area stigmatized by airport operations.

(b) The Port has also made execution of an Avigation Easement a pre-condition for participation in its sound insulation program. Since many residents cannot afford the cost of sound insulation without Port assistance, they have no meaningful alternative to signing an Easement or continuing to bear intolerable impacts from Sea-Tac operations.

(c) The Avigation Easements are presented as part of a non-negotiable "take it or leave it" package. The Port has an overwhelming advantage in bargaining power. Individuals have no bargaining leverage to insist on terms different from the uniform program offered by the Port.

(d) The Port improperly exploits its overwhelming advantage in bargaining power by inserting oppressive and unreasonable terms in the Avigation Easements. Instead of merely obtaining a right to fly over residents' property, the Port demands a broad waiver clause, which purports to waive all rights a signatory may have to sue the Port for damages caused

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by its unconstitutional deprivation of the residents' property through its operation of Sea-Tac.

(e) The Port employs a uniform "sales pitch" in presenting and procuring the Avigation Easements. This pitch uniformly downplays the significance of the Easement. The Easement typically is described by Port employees as a technicality required by the State. Further, Port employees describe it to residents as merely granting the Port the right to fly aircraft "over the-property" of those residents. Buried in the boilerplate of this document is one sentence purporting to constitute a waiver of certain damages claims in perpetuity and of plaintiffs' constitutional rights. The Port's employees do not explain the rights that the waiver clause in the Easement purports to waive. Nor does the Port recommend that residents retain legal counsel to review the easements presented to them. Indeed, many of the persons who have signed Avigation Easements do not even understand that the document they have signed purports to waive fundamental constitutional rights.

E. <u>The Impacts on Sea-Tac's Neighbors</u>.

184. The impacts of the effects of constantly increasing operations at Sea-Tac on the residential neighborhoods near the airport has been devastating. In 1966, there were a total of 2,822,007 passengers traveling through Sea-Tac; by 1985 there were 11,466,755; and by 1989 the Port processed 15.2 million passengers through Sea-Tac. The increase in aircraft

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operations to carry these passengers has also been dramatic. The number of air carrier operations from Sea-Tac in 1963 was 54,752. In 1971, there were 114,372 air carrier operations. In 1990, that number had swollen to approximately 345,000.

185. The Port raises great amounts of revenue by virtue of the air operations it authorizes at Sea-Tac. Revenue from air operations has increased as the operations levels increase. The Port generates revenue from landing fees (fees per aircraft operation) as well as by levying a charge on a per passenger basis (the huge increases in passenger use generates correspondingly enormous increases in "passenger financing charges"). The Port thus profits handsomely from these substantial increases. Despite the enormous increase in revenues, none of these sums have been used to compensate plaintiffs for the diminutions in property values caused by the effects of the increased operations at Sea-Tac.

186. Operations at Sea-Tac have increased since 1978 in part as a result of deregulation which has had a dramatic change in the number of carriers serving Sea-Tac and the frequency of flights. Prior to 1978, 12 carriers served Sea-Tac, now 38 conduct daily operations as detailed below:

Sea-Tac International Airport
Carriers Serving Sea-Tac - 1988

<u>Air Carriers</u>:

American Airlines
Alaska Airlines
Braniff Airlines
Continental Airlines

<u>International Carriers</u>

Air BC
Canadian International
British Airways
Japan Airlines

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Eastern Airlines
Delta Airlines
Northwest Airlines
United Airlines
Trans World Airlines
Pan Am
USAir
Piedmont Airlines
America West Airlines
Hawaiian Airlines
Sun Country

<u>Commuter Carriers</u>:
Horizon Airlines
San Juan Airlines
Harbor Airlines
United Express

Finnair
SAS
Thai International
Mexicana
Martinair Holland

<u>Air Cargo Carriers</u>
Airborne Express
DHL
Evergreen International
Flying Tigers
Emery
Cargolux
Burlington Air Express
CF Airfreight
AmeriJet
Salair

187. In 1990, the highest percentage of air operations at Sea-Tac were by the Boeing 727 type of jet aircraft. The Boeing 727 is of the louder, older "Stage II" type and there were approximately 50% more 727 landings and take-offs at Sea-Tac than there were of the next most common type of aircraft operating out of Sea-Tac.

188. The Port's own records reveal that in 1990, 47% of the jet aircraft operations at Sea-Tac were of the louder "Stage II" variety.

189. With the increase in the number of aircraft taking off and landing comes more than just noise while the planes are airborne. Each take-off and landing carries with it vibrations that shake and rattle the homes near the airport, cause cracks in walls and decrease the use and enjoyment of property.

190. The increase in take-offs has also caused an increase in noise from taxiing and "runups." When aircraft prepare to

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take off, they frequently run their engines for a period of time at near to or full throttle. Testing engines also can involve subjecting them to full throttle. These "runups" occur for periods of up to five minutes. The noise from the runups blasts adjacent neighborhoods.

191. Another direct effect of increased Sea-Tac operations is an increase in pollution from jet exhaust that cascades down on nearby residential property, coating homes, cars, vegetation and people, with noxioue and toxic fumes.

192. A major disrupting factor that also has increased over time, is the increase in nighttime operations.

193. This increase occurs in part as a result of "redeye" nighttime operations eastbound and operations between Seattle and the Pacific and Alaska. The second highest peak period for Sea-Tac operations occurs between 8 p.m. and 10 p.m., a time when residents seek peace from the rigors of a long work day, children are doing homework and others are trying to sleep. The nighttime noise has also increased from cargo traffic. Traffic from cargo carriers, overnight mail service and freight operations has also increased dramatically in the last two decades. These operations are usually conducted at night after commercial traffic is largely finished. These operations are usually conducted with the older and noisier "Stage II" aircraft. The runups associated with these planes is often longer than those for smaller commercial planes. The taxiing required is often longer due to the heavy loads these jets

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carry. In 1988, 12% of aircraft operations occurred between 10 p.m. and 7 a.m. 1991 figures released by the Port reveal that as of 1989 a total of 966 landings or takeoffs occur daily. Nighttime takeoffs in 1990 averaged 35 at 7 p.m., 25 at 8 p.m., 20 at 9 p.m., 20 at 10 p.m., and landings are on the average 35 at 7 p.m., 25 at 8 p.m., 40 at 9 p.m., and 25 at 10 p.m. Total operations exceed an average of 30 takeoffs and landings as late as 11 p.m., and operations continue on a 24 hour basis. The personal impacts on nearby residents of these operations, which necessarily generate deafening noise and vibrations that punctuate the night, have been substantial. The Port's aircraft operations disrupt sleep patterns, interfere with the use and enjoyment of property and cause decreases in property values.

194. The injuries to property owners from the effects of Sea-Tac operations and the Port's scheme to drive down property values has been devastating. Many recent sales have occurred only because of the financial intervention of the Port. The Port itself has had difficulty or been unable to resell homes purchased through the Transaction Assistance Program. Effects of the air operations at Sea-Tac have prevented plaintiffs from realizing the appreciation of the values of their homes in the manner enjoyed by the property owners in unimpacted areas of King County.

(26)

FIRST CAUSE OF ACTION
(Violations of Substantive Due Process)

195. Plaintiffs reallege and incorporate herein by reference each and every allegation set forth above.

196. Plaintiffs' rights to exclude others from using their properties are rights, privileges or immunities enumerated in and secured by the Fourteenth Amendment to the Constitution of the United States.

197. Despite its long established constitutional obligation to do so, the Port has not lawfully acquired these property rights belonging to plaintiffs by purchasing or otherwise appropriating the required easements.

198. The execution of official policies of the Port, under color of law, resulted in deprivations of plaintiffs' property interests protected by the Fourteenth Amendment.

199. The Port undertook a series of actions which included, but is not limited to, the promoting, authorizing and conducting of aircraft operations at Sea-Tac. Such acts directly and proximately caused flights to use Sea-Tac. These aircraft that used Sea-Tac and enriched the coffers of the Port produce enormous volumes of noise, vibration and pollution that adversely impact nearby private property owners. Plaintiffs' protected property interests were deprived because plaintiffs' properties are being used as the noise, vibration and pollution impact zone necessary for the level of aircraft operations authorized by the Port at Sea-Tac.

(26)

200. The direct impacts of the Port's actions on plaintiffs resulting from the Port's official policies have been arbitrary, capricious and have not been taken in good faith, as evidenced by the following actions, which have been more fully described above:

a. The Port has refused to fully and fairly compensate plaintiffs and members of the class for the injuries caused by Sea-Tac's operations despite having knowledge of these injuries and of its constitutional obligation to provide just compensation;

b. The Port's administration of its' sales facilitation programs lowers nearby property values;

c. The Port has attempted to have its residential neighbors sign away valuable property rights in an unfair, unconscionable and deceptive manner;

d. The Port has concealed and/or chosen to ignore the impacts from Sea-Tac operations on plaintiffs and their neighbors; and

e. The Port has made statements to neighboring residents designed to lull them into believing the Port would alleviate the impact of Sea-Tac operations or pay full non-impacted value, when the Port knew it could not alleviate the impact of Sea-Tac operations and that it did not intend to pay full, non-impacted value.

(26)

201. The Port could have lawfully acquired the right to damage plaintiffs' properties, but has chosen not to do so for economic reasons.

202. The arbitrary and capricious deprivations of plaintiffs' protected property interests caused by the grossly negligent, reckless and callously indifferent imposition of effects from the execution of the Port's policy of authorizing ever-increasing air operations levels constitute a violation of the rights provided by the Fourteenth Amendment to the Constitution of the United States.

203. The execution of this policy constituted the official policy, practice or custom of the Port because the depriving conduct at issue directly resulted from formal undertakings of duly empowered Port officials.

204. Damages resulting from this wrongful conduct includes physical and economic damages to plaintiffs' real properties and their improvements. Other damages include those resulting from how the Port uses nearby properties so as to render the owners' uses of their properties less enjoyable and more difficult and/or intolerable.

205. Accordingly, the necessary effects of official conduct by the Port that deprived plaintiffs of their interests enumerated in, and secured by the Fourteenth Amendment, renders the Port liable to plaintiffs under 42 U.S.C. § 1983.

(26)

211. Pre-deprivation notice and opportunities to be heard should have been provided to plaintiffs, because such hearings would have been feasible and practicable and the injuries that in fact occurred were sufficiently predictable.

212. The execution of official policies of the Port caused the impositions of noxious noise, vibration and pollution levels upon plaintiffs' properties. Such depriving conduct resulted directly from the Port's policies regarding aircraft operations at Sea-Tac. The Port knew such impacts would occur.

213. The deprivations of plaintiffs' protected interests caused by the grossly negligent, reckless and callously indifferent failure of the Port to provide the required procedural safeguards constitute a violation of the rights provided by the Fourteenth Amendment to the Constitution of the United States.

214. Damages resulting from the Port's failure to institute and maintain the required procedural safeguards include physical and economic damages to plaintiffs' real properties and their improvements. Other damages include those resulting from how the Port uses these properties so as to render the owners' use of their property less enjoyable and more difficult.

215. Accordingly, the Port's failure to provide adequate procedural safeguards concomitant with the deprivations of the plaintiffs' property interests enumerated in and secured by the

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(26)

Fourteenth Amendment violated plaintiffs' procedural due process rights protected by 42 U.S.C. § 1983.

THIRD CAUSE OF ACTION
(Taking and Damaging of Property by Inverse Condemnation Without Just Compensation)

216. Plaintiffs reallege and incorporate herein by reference each and every allegation set forth above.

217. The Port, pursuant to its exercise of the prerogative of the sovereign, has taken or damaged valuable private property interests of plaintiffs via eminent domain without the provision of just compensation.

218. The private property interests taken or damaged by the Port, include, but are not limited to, plaintiffs' rights to their exclusive use, possession and enjoyment of their properties. Such interests will be taken or damaged in the future, as the Port will continue a high level of air operation activities at Sea-Tac, including but not limited to takeoffs and landings.

219. Such private property interests were obtained by the Port concomitant with its conduct of the air operations at Sea-Tac.

220. No condemnation proceedings or other necessary pre-deprivation proceedings were instituted or maintained by the Port prior to the taking or damaging of plaintiffs' private property interests.

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(26)

221. Just compensation has not been provided to plaintiffs for their valuable private property interests taken or damaged by the Port.

222. The taking or damaging by a sovereign of private property interests absent the provision to such properties' owners of just compensation violates Article I, § 16 (Amend. 9) of the Constitution of the State of Washington.

FOURTH CAUSE OF ACTION
(Trespass)

223. Plaintiffs reallege and incorporate herein by reference each and every allegation set forth above.

224. Plaintiffs have the right to be free from physical invasion of their private properties. Correspondingly, defendant has the duty not to physically invade plaintiffs' private properties.

225. Defendant's operation of Sea-Tac constitutes an intentional physical invasion or trespass impacting plaintiffs' rights. These physical invasions proximately cause substantial damages to plaintiffs including, but not limited to, anxiety, sleep disruption, loss of use and enjoyment of both outdoor and indoor living areas, stress and damages to improvements to real property, such as cracks in interior walls.

DEMAND FOR TRIAL BY JURY

226. Plaintiffs hereby demand a trial by jury.

PRAYER FOR RELIEF

WHEREFORE, plaintiffs pray that this Court enter an order:

(26)

1. Awarding damages to each plaintiff to compensate for the injuries suffered resulting from the deprivations of their property rights, as well as compensatory damages for anxiety and the loss of their rights to enjoyably use and dispose of their properties, and such other amount of special compensatory damages as may be shown to exist;

2. Awarding just compensation to plaintiffs for their property interests taken and/or damaged by defendants;

3. Awarding plaintiffs compensation for the damages caused by the trespasses upon their real properties caused by defendant;

4. Awarding plaintiffs their costs of suit and their attorneys' fees under Title 42 U.S.C. § 1988; and

5. Awarding such other and further relief that this Court may deem just and proper.

DATED: Sept. 1, 1993.

HAGENS & BERMAN

By [signature]
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(26)

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Attorneys for Plaintiffs

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EXHIBIT III

AIRCRAFT NOISE COALITION
1648 S. 310TH ST., #12
FEDERAL WAY, WA 98003
(206)839-2947

Contact person:
Peter Townsend
President
Phone (206)839-2947
Fax (206)839-2927

MARCH 24, 1993
1.00 PM

PRESS RELEASE

SEATTLE HAS ALMOST WORST AIRCRAFT NOISE RECORD IN U.S.

SEA-TAC AIRPORT, BECAUSE OF ITS LOCATION AND NUMBER OF FLIGHT OPERATIONS, IMPACTS MORE PEOPLE PER OPERATION THAN NEARLY ALL OTHER MAJOR U.S. AIRPORTS. (See page 3 #s 2A & 2B)

THE FOLLOWING STATISTICS HAVE BEEN OBTAINED THIS MONTH DIRECTLY FROM THE F.A.A IN WASHINGTON D.C. REGARDING SEA-TAC INT'L AIRPORT:

1. NUMBERS OF AIR CARRIER PASSENGERS ENPLANED IN 1990 (a) — 7,596,000

2. NATIONAL RANKING FOR 1,000s OF PASSENGER ENPLANEMENTS ON CARRIER FLIGHTS IN 1990 (a) — #21

3. NATIONAL RANKING IN 1,000s OF PEOPLE IN WORST AIRCRAFT NOISE (65 LDN) AREAS* (b) — #9

*This is the contour area in which FAA will pay to insulate against the worst jet noise - the contour maps are updated by FAA every 5 years and are currently based on an average of 1985 data.

1

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4. 1,000s OF OPERATIONS (TAKE-OFFS AND LANDINGS) (a & c)

	1985	1990	% INCREASE
AIR CARRIER AIRCRAFT (OVER 60 SEATS)	155	192	24%
COMMUTER AIRCRAFT (UP TO 60 SEATS)	60	151	152%
TOTAL ALL AIRCRAFT	215	343	59
NATIONAL RANKING IN COMMUTER OPERATIONS (c):	31ST	5TH	-

SOURCES FOR PARAS 1 - 4 ABOVE ARE:

(a) FAA TERMINAL AREA FORECAST DOT/FAA/APO JULY 1992.
(b) FAA WASHINGTON, D.C. LETTER TO PETER TOWNSEND DATED MARCH 1, 1993.
(c) 3/9/93 FAXED INFORMATION TO PETER TOWNSEND BY MR. T. HENRY OF FAA OFFICE OF AVIATION POLICY AND PLANS WASHINGTON, D.C. (PHONE 202-267-3103)

COMMENTS ON THE ABOVE DATA

1. WE HAVE ATTEMPTED TO CORRELATE NATIONALLY THE NOISE (AS MEASURED AND GIVEN TO US BY FAA IN TERMS OF 1,000s OF PEOPLE IN THE 65 LDN AREA) TO THE SOURCE OF THE NOISE (THE ANNUAL 1990 NUMBER OF AIRCRAFT OPERATIONS (OPS) AS SHOWN BY FAA.)

2

NAT'L RANK.

2. SEA-TAC DATA IN NATIONAL RANKING OF WORST MAJOR AIRPORTS FOR CITIZENS AFFECTED BY AIRCRAFT NOISE**, SHOWS:

A) FOR AIR CARRIER AIRCRAFT (OVER 60 SEATS) — #3 WORST

AIRPORT ***	1,000s OF PEOPLE IN 65 LDN AREA	1,000s ANNUAL OPS	RATIO OF PEOPLE IN 65 LDN AREA TO # OPS.	NOISE RANKING IN WORST ORDER
NEW YORK	674	493	1.367	1
MIAMI	130	279	0.466	2
SEATTLE	78	192	0.406	3

B) FOR TOTAL AIRCRAFT — #5 WORST

AIRPORT ***	1,000s OF PEOPLE IN 65 LDN AREA	1,000s ANNUAL OPS.	RATIO OF PEOPLE IN 65 LDN AREA TO # OPS.	NOISE RANKING IN WORST ORDER
NEW YORK	674	663	1.017	1
MIAMI	130	379	0.343	2
BOSTON	99	405	0.244	3
CHICAGO	210	880	0.239	4
SEATTLE	78	343	0.227	5

***JFK/LAGUARDIA COMBINED.

**(1,000s IN 65 LDN AREAS, RELATIVE TO NUMBER OF 1990 AIRCRAFT OPERATIONS.)

3. THUS SEA-TAC HAS THE 3RD OR 5TH WORST RECORD IN THE U.S. PER FLIGHT OPERATION IN RELATION TO NUMBER OF PEOPLE IMPACTED. THIS IS IN SPITE OF HAVING ONE OF THE HIGHEST STAGE

III PLANE MIXES OF QUIETER JETS (71%.) THIS DOES NOT BODE WELL FOR THE NEXT EIGHT YEARS WHEN THE PORT OF SEATTLE STATES THAT THE QUIETER JETS WILL OFFSET THE EXTRA 30% OF FLIGHTS CAUSED BY THE THIRD RUNWAY.

4. THE PORT OF SEATTLE AND THE AIR CARRIERS HAVE TOLD THE PUBLIC THAT SEA-TAC HAS ONE OF THE BEST "AIRCRAFT NOISE REDUCTION PROGRAMS IN THE COUNTRY. THEY HAVE BEEN SILENT ON JUST HOW SEVERE SEA-TAC NOISE IS COMPARED TO THE REST OF THE U.S.

5. THE PORT OF SEATTLE HAS MISLED THE PUBLIC, THE BUSINESS COMMUNITY, THE MEDIA, THE PUGET SOUND REGIONAL COUNCIL AND STATE AIR TRANSPORTATION COMMISSION BY WITHHOLDING THIS INFORMATION. IF THE PORT OF SEATTLE DID NOT KNOW THESE FACTS, IT SHOULD NOT HAVE PUSHED A THIRD RUNWAY WITHOUT MAKING THE INQUIRIES WE DID.

6. CONSIDER WHAT THIS INFORMATION WOULD DO TO INC MAGAZINE AND OTHER STUDIES SHOWING THE SEATTLE QUALITY OF LIFE AS CLOSE TO #1! QUALITY OF LIFE IS THE #1 DRIVER OF SEATTLE BUSINESS! CONSIDER WHAT IT DOES TO PORT PRESIDENT GARY GRANT'S STATEMENT THAT "SEATTLE RESIDENTS CONTINUE TO ENJOY A QUALITY OF LIFE HARD TO FIND ELSEWHERE" (PORT OF SEATTLE PUBLICATION - THE WORKING WATERFRONT - MARCH 93.)

7. IT IS VERY EVIDENT FROM THE STATISTICS IN PARA 4 ON THE 2ND PAGE THAT THE "SUPPOSED" CRISIS IN SEA-TAC CAPACITY HAS BEEN CAUSED BY THE HUGE INCREASE IN COMMUTER FLIGHTS.

8. FLIGHT OPERATIONS TO AND FROM SEA-TAC DO NOT GO OVER LOW DENSITY OR UNOCCUPIED AREAS IN COMPARISON TO MANY OTHER U.S. AIRPORTS; THEY GO OVER ONE OR TWO MILLION PEOPLE ON <u>BOTH</u> TAKE-OFFS <u>AND</u> LANDINGS AND HAVE NO OTHER ALTERNATIVE. THIS IS ONE OF THE MAIN REASONS WHY WE AND PUGET SOUND REGIONAL COUNCIL SUPPORT A NEW REGIONAL AIRPORT OUTSIDE OF URBAN AREAS, CONNECTED WITH HIGH SPEED RAIL TO SEATTLE, ETC.

9. WE SUPPORT CHANGING THE PRESENT PUGET SOUND REGIONAL COUNCIL TRANSPORTATION BOARD RESOLUTION AS FOLLOWS:

a. DELETE REFERENCE TO "THE FOUR COUNTY AREA" IN THE SEARCH FOR A NEW AIRPORT. A WIDER SEARCH AREA IS NEEDED. SEA-TAC WILL REMAIN AS AN ORIGIN/DESTINATION AIRPORT CLOSE IN TO TOWN.

b. DELETE ALL REFERENCE TO STUDYING THE THIRD RUNWAY IN VIEW OF OUR DRASTIC FINDINGS.

c. PSRC HAS THE RESPONSIBILITY FOR PLANNING ALL ADDITIONS OR CHANGES AND FINAL APPROVAL TO THE REGIONAL AIRPORT SYSTEM PLAN AND/OR TO THE APPROVAL OF ANY THIRD RUNWAY AT SEA-TAC.

d. THE GRASS ROOTS CITIZENS SHOULD HAVE MUCH MORE OFFICIAL REPRESENTATION ON POLICY MAKING AND GOVERNING BOARDS FOR REGIONAL AIRPORT AFFAIRS.

e. THE 4-POST PLAN OF FAA SHOULD NOT OPERATE EXCEPT FOR THE TIME BEING AT TIMES OF HIGH TRAFFIC VOLUME AT SEA-TAC. THIS WOULD AVOID MOST OF THE HAVOC IT HAS CAUSED TO THOUSANDS OF CITIZENS SLEEP AND QUALITY OF LIFE.

10. THE DATA USED IS THE LATEST AVAILABLE FROM FAA. THE PORT OF SEATTLE MAY ARGUE THAT SEA-TAC HAS MADE STRIDES IN REDUCING THE NOISE SINCE 1985. HOWEVER, ALL OTHER AIRPORTS WOULD PROBABLY ARGUE THE SAME. WE DOUBT THAT SEA-TAC'S OVERALL RANKINGS WOULD HAVE CHANGED MATERIALLY. CORROBORATION FOR THIS IS A 2/17/93 REPORT FROM MR. HANS ASCHENBACH, CONSULTANT TO THE CITY OF DES MOINES, THAT THE NOISE CONTOURS AROUND SEA-TAC GREW 3.2% FROM 1987/88 TO 1991. (ATTACHED).

11. ANC REPRESENTS 12,000 CITIZENS IN KING, SNOHOMISH AND PIERCE COUNTIES.

Peter H. Townsend

PETER H. TOWNSEND
PRESIDENT
AIRCRAFT NOISE COALITION

Population Exposed to 65 LDN

Rank (1)	Airport	Population	Base Year	Data Source
1	O'Hare	209,890	1988	Part 150
2	Atlanta-Hartsfield	80,000	1984	Part 150
3	Dallas-Ft.Worth	16,834	1989	DEIS(2)
4	Los Angeles	92,291	1983	other(3)
5	Denver	14,666	1989	EIS(4)
6	San Francisco	44,440	1982	other
7	St. Louis	79,600	1986	Part 150
8	Newark	65,078	1986	other
9	La Guardia	461,749	1986	other
10	Phoenix	30,993	1987	Part 150
11	Greater Pittsburg	6,634	1984	Part 150
12	Miami	130,000	1985	other
13	Detroit-Wayne Co	37,510	1986	Part 150
14	Boston-Logan	99,000	1980	other
15	Kennedy	212,210	1980	other
16	Minneapolis-St. Paul	18,554	1987	Part 150
17	Charlotte	13,243	1988	Part 150
18	Memphis	72,780	1985	other
19	Houston Int'l	4,022	1984	EIS
20	Philadelphia	n/a		
21	Washington-National	24,500	1989	other
22	Orlando	3,480	1985	Part 150
23	Honolulu	6,468	1987	other
24	Las Vegas-McCarren	17,090	1987	other
25	Seattle-Tacoma	78,146	1984	Part 150
26	Balt-Washington	14,194	1987	other
27	Salt Lake City	3,915	1984	Part 150
28	Cincinnati	2,019	1985	EIS
29	Kanas City	282	1980	81 EIS,p.34
30	Cleveland	28,730	1981	84 part 150,p.82,p9

Footnotes:
1. Source 'Terminal Area Forecasts' FAA-APO-90-6 July 1990 (Air carrier operations)
2. Draft Environmental Impact Statement
3. Information obtained directly from airports or other studies.
4. Environmental Impact Statement

(2a)

AIRSPACE STUDY
WORKING PAPER I

Prepared for

The Port of Seattle/Sea-Tac International Airport
King County International Airport
Washington State Aeronautics Division
Federal Aviation Administration

Prepared by

P&D Technologies
972 Town & Country Road
Orange, California 92668
(714) 835-4447

In association with

Aviation Simulations International
Thompson Consultants International
Market Street Computer Systems Inc.

MARCH 1988

These three interactions occur during: (1) IFR south flow conditions; (2) IFR north flow conditions; and (3) visual approaches in south flow conditions.

IFR CONDITIONS-SOUTH FLOW

During IFR conditions when Sea-Tac and Boeing Field are operating with south flows, interactions exist between the arrivals to the two airports. Although a minimum of 1,000 feet of altitude separation exists between the published Instrument Landing System (ILS) approaches, a need exists to protect a Boeing Field missed approach capability. In weather conditions which allow Boeing Tower controllers to see the Sea-Tac arriving aircraft, visual separation is provided by the controllers and no loss in capacity is experienced. This operating arrangement is known as Plan Alpha. Cloud ceilings at Boeing must be at least 2,000 feet for Boeing Tower personnel to see Sea-Tac arrivals. The yearly frequency of occurrence of south flow conditions, with ceilings below 2,000 feet is approximately 17 percent. Based on observations, this is estimated to drop to about 16 percent during the busiest part of the day, 7:00 a.m. to 9:00 p.m. Additionally, weather conditions below minimums (closed conditions) at Sea-Tac would reduce the occurrence of the interaction by another 1 or 2 percent.

Although weather statistics would indicate this interaction should occur approximately 15 percent of the time, the time impact is less. Air Traffic Controllers have minimized the conflict at Sea-Tac by adopting special procedures that have reduced the loss of capacity. Under certain weather conditions and with known Boeing Field pilots, the Sea-Tac approaching aircraft will be advised to maintain 3,000 feet MSL until Boeing Tower advises TRACON that the landing is assured at Boeing. At this point the Sea-Tac approaching pilot is given his final approach clearance and authorization to land. If the Boeing Field approaching pilot executes a missed approach, TRACON will vector the Sea-Tac approach back into the arrival stream and one arrival interval or slot is lost in arrival capacity at Sea-Tac. The situation occurs very rarely.

If pilot proficiency of the Boeing Field arrival is unknown, TRACON will leave an interval or slot empty in the Sea-Tac arrival stream in order to provide for the Boeing missed approach. This situation results in the loss of one or two arrival

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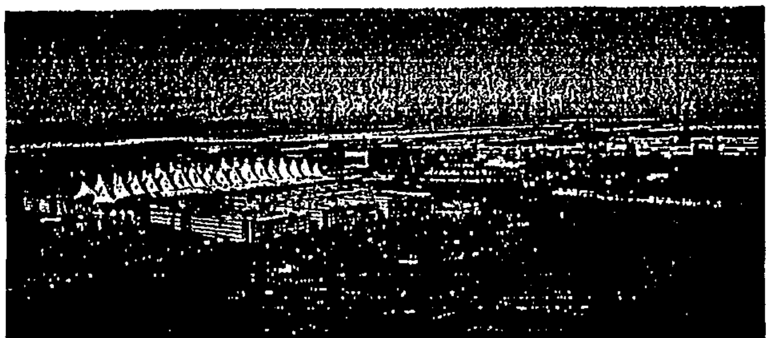
U.S. Department of Transportation

Federal Aviation Administration

1993 Aviation System Capacity Plan

DOT/FAA/ASC-93-1



Denver International Airport (DIA) under construction

Prepared by:
Federal Aviation Administration
Office of System Capacity and Requirements
Washington, DC 20591

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Technical Report Documentation Page

1. Report No. DOT/FAA/ASC-93-1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle 1993 Aviation System Capacity Plan		5. Report Date
		6. Performing Organization Code ASC-1
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address MITRE Corporation, McLean, VA; Transportation Systems Center, Cambridge, MA; MiTech Incorporated, Rockville, MD; JIL Systems, Arlington, VA		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
		13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address U.S. Department of Transportation; Federal Aviation Administration; Office of System Capacity and Requirements; Washington, DC 20591		14. Sponsoring Agency Code ASC-1

15. Supplementary Notes

This report resulted from a collaborative effort by the Office of System Capacity and Requirements, other FAA organizations, the MITRE Corporation, the Transportation Systems Center, MiTech Incorporated, and JIL Systems.

16. Abstract

A comprehensive review of the Federal Aviation Administration's program to improve the capacity of the National Air Transportation System. The Plan identifies the causes and extent of capacity and delay problems currently associated with air travel in the U.S. and outlines various planned and ongoing FAA projects that will reduce the severity of the problems in the future. The major areas of discussion are:

1) Airport Development
2) Airport and Airspace Capacity
3) Technology for Capacity Improvement
4) Marketplace Solutions

17. Key Words Civil Aviation; Airport Capacity; Aviation Capacity; Aviation Delay Reduction	18. Distribution Statement Document is available to the public through the National Technical Information Service Springfield, VA 22161

19. Security Classif. (of this report) UNCLASSIFIED	20. Security Classif. (of this page) UNCLASSIFIED	21. No. of Pages 376	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

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Seattle-Tacoma International Airport Capacity Design Team Project Summary

Recommendations

Improvements to Existing Airfield

1. Improved exit and taxiway construction
2. Reduce in-trail spacing to 2.5 nm
3. CAT I ILS on Runway 16L (IFR-1)
4. LDA approach to Runway 16L/34R and ILS to Runway 16R/34L
5. Noise abatement effect on departures
6. Install wake vortex advisory system

New Runway Improvements

Commuter Runway

7. Commuter Runway 17C/35C (converted Taxiway D)
8. LDA to Runways 17C/35C and ILS to Runway 16L/34R
9. Install wake vortex advisory system

Dependent Runway

10. Air carrier (dependent) Runway 16W/34W
11. LDA approaches to Runway 16W/34W
12. CAT I ILS on Runway 16W (IFR-1)
13. CAT II ILS on Runway 16W (over CAT I)
14. CAT I ILS on Runway 34W (IFR-1)
15. Staggered approaches to Runways 16L & 16W and 34R & 34W - 2.0 nm stagger
16. Staggered approaches to Runways 16L & 16W and 34R & 34W - 1.5 nm stagger
17. Operate Runway 16R/34L as primary runway versus Runway 16L/34R with Runway 16W/34W
18. Install wake vortex advisory system

Independent Runway

19. Air carrier (independent) Runway 16W/34W
20. CAT II on Runway 16W (only)

Demand Management

21. Uniformly distribute scheduled commercial operations

March 26, 1989

Task force to tackle runway traffic before the worst happens

by Theresa Morrow
Times business reporter

It is one of the epic regional issues of the next decade: Everyone wants to fly and no one wants an airport in his back yard. In the case of the future of air traffic in the Seattle area, fences are going up in back yards from Snohomish County to the north to Pierce County to the south.

People who use Seattle-Tacoma International Airport experience congestion only at the parking garage, where it is possible to wind your way to the top and back down again without finding a space.

But by 2000, that kind of head-spinning congestion may have spilled over onto the runways. If planners' projections are true, travelers will be faced with a kind of airspace roulette: Some will find their flights are delayed only slightly; others could spend a good hour or more twiddling their thumbs while planes stack up on the taxiways.

As the Seattle region grows, the pressure on its one major airport grows with it. As aviation gridlock looks as if it may become a reality, airport planners begin to whisper about the need for new runway space.

That's when everyone begins tossing around ideas for an airport that won't affect their back yard. Fantastic and realistic possibilities share the bill: How about an airport at Moses Lake? Or on a barge in Puget Sound? Or how about paving Vashon Island? Then there's Paine Field, McChord Air Force Base, Boeing Field, or perhaps an airport near Lake Sammamish.

Those who live near Paine Field or McChord say the answer is to expand Sea-Tac. But those who live near Sea-Tac are opposed.

"We've been walked on and walked on," said David Smith of Citizens Against Sea-Tac Expansion (CASE). "We're prepared if necessary to take legal action."

The airport now has two runways, 800 feet apart. During clear weather, two aircraft can land parallel to each other at the same time. But when visibility is poor, which is about 17 percent of the time, aircraft can make instrument landings through clouds only in single file — and that's when the worst delays will occur as the air traffic increases. Currently, poor weather knocks landings down to 32 per hour from the average 60 in good weather.

The Federal Aviation Administration requires that for independent parallel instrument landings, runways must be 4,300 feet apart — almost a mile.

CASE was formed soon after a meeting at Kennedy High School last summer at which 500 people turned out to oppose a study by the Puget Sound Council of Governments (PSCOG) that mentioned a third runway smack in the middle of Burien.

[illegible]

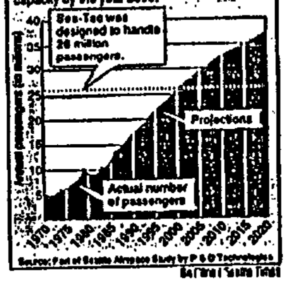
Please see AIRPORT on E 4

TOMORROW IN THE TIMES

The Port of Seattle is promoting Seattle-Tacoma International Airport as a main cargo-handling connection between Pacific Rim countries and Europe.
Business Monday.

The travelers

The number of passengers at Seattle-Tacoma International Airport is expected to reach capacity by the year 2000.



Source: Port of Seattle Airspace Study by P & D Technologies

Has our weather changed since 1989?

213 Port of Seattle for the neighbors of Seattle-Tacoma International Airport

FORUM

December 1994

PSRC ends search for airport sites

Airport Master Plan Update continues

Stage 3 fleet about 83 percent

Hotel EIS scoping period ends Dec. 15

Comments on Noise Aspects of the Regional Airport System Plan

Prepared for

The Regional Coalition on Airport Affairs
801 S. W. 174th Street
Normandy Park, Washington
98166

by

James D. Chalupnik
5600 N. E. 77th Street
Seattle, Washington
98115

January 12, 1993

SEA-TAC
Stage 1,2,and 3
October 26, 1992

__Abstract__

Recently established Stage 3 standards require lower noise levels than previous Stage 2 standards for subsonic Turbojets. Federal Law requires, with certain extensions and exceptions, the phase-out or upgrade of all Stage 2 Aircraft by December 31, 1999. Test flights measuring noise show that Stage III aircraft are a few decibels (dBA) quieter than Stage 2 aircraft. But, for people on the ground, not all Stage 3 aircraft reduce noise significantly.

Stage 3 rules reduce Stage 2 noise levels often by only 3 or 5 dBA and at most 7 dBA. A study by Brown-Buntin Associates, Inc. show that a 3 dBA reduction, although it represents half as much energy, is barely detectable to human ears. Rather, noise must be reduced by 10 dBA or by 10 times the energy in order for people to perceive significant sound reduction.

Depending on the weight of the aircraft and weather conditions, Stage 3 compliant aircraft may vary significantly. For example, the Stage 3 727-100 series may fall short of Stage 2 727-100's noise levels by as much as 8 units or by as little as .02 units. In addition, not all Stage 3 aircraft are quieter than all stage 2 aircraft. For instance, many Stage 3 Boeing 747's may exceed noise levels of Stage 2 737's.

Modifying old aircraft to be Stage 3 compliant can be done by two processes: "hush kits" or re-engining. Because modifications offer a cheaper option than buying new aircraft for airlines in a time of severe economic losses, modified aircraft may be a significant percentage of future aircraft. While modifications adapt aircraft to meet Stage 3 regulations, reductions are minimal and as a result, noise reductions may be undetectable to human ears.

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TABLE 1[1]

Stage 2 Commercial Turbojet	Total NEL*
1. B727-100-JT8D -7	98.23
2. B737-JT8D-17	94.29
3. B747-100/JT9DTD	97.86
4. DC-850 DC-8-50/JT3D-3	99.61
5. DC-9-10/JT8D-7	92.77
6. B727-200-JT8D-7	100.41
	Average NEL 97.18

Stage 3 Commercial Turbojet	Total NEL
1. B737-300/CFM56-3-B1	85.96
2. B747-100QN/JT9DFL	92.63
3. B747-200B/JT9D-7Q	94.50
4. B727 FEDEX HUSHKITB727	98.21
5. DC-8-70/CFM56-2	88.71
6. L-1011-500/RB211-524	92.04
7. B727RE VALSAN B727RE	90.92
	Average NEL 92.83
	Difference 4.35

*Noise Exposure Level; a measurement calculated by plugging four Single Event Level noise measurements into a formula as described in STIA Noise Budget Program.

[1] Sea-Tac International Noise Budget, Document #10-B 82790.DH4, January 1991.

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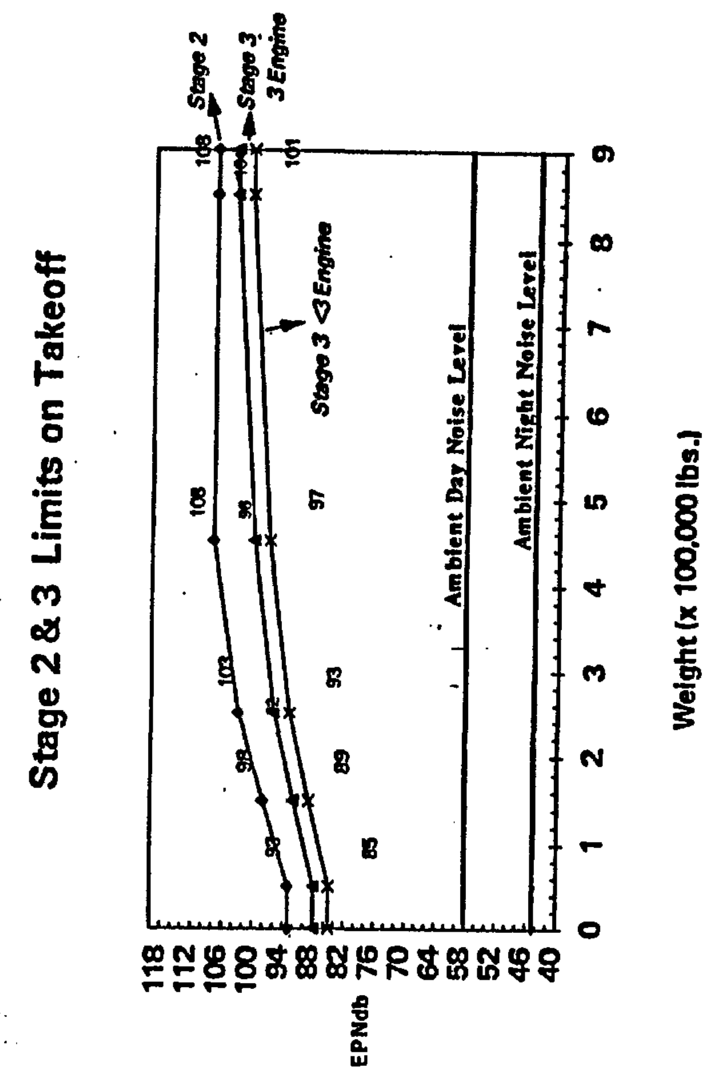
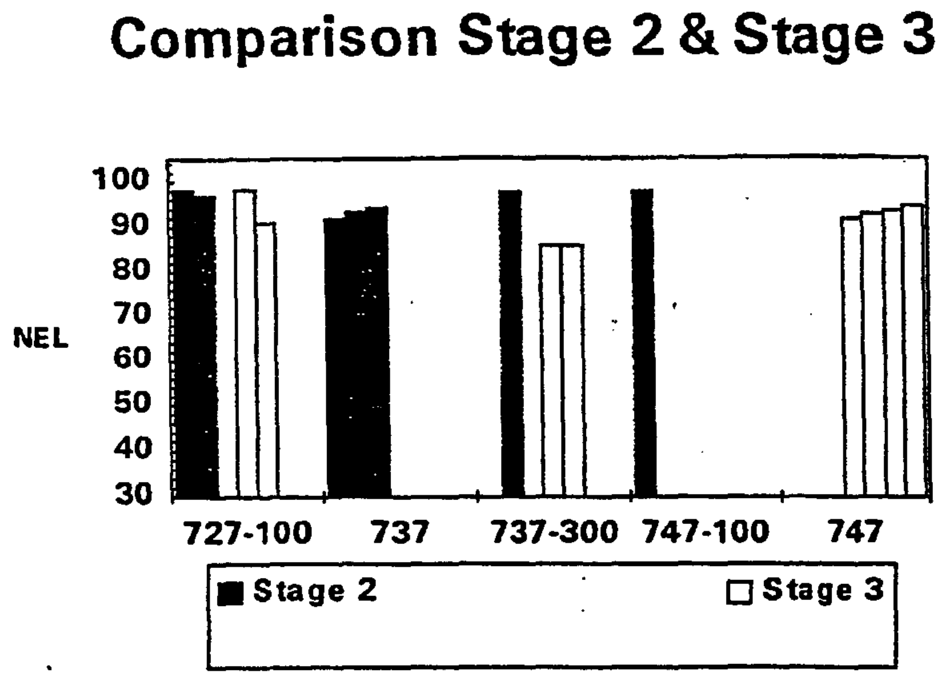
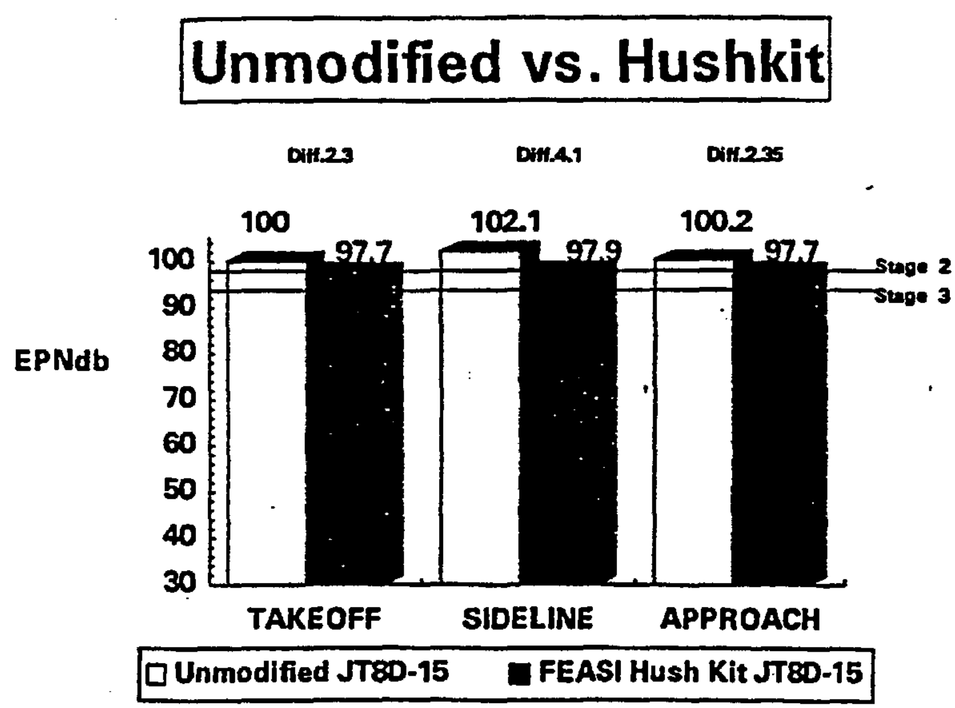


Graph A.

Graph C


Comparison Stage 2 & Stage 3
NEL
100
90
80
70
60
50
40
30
727-100
737
737-300
747-100
747
Stage 2
Stage 3


Unmodified vs. Hushkit
Diff.2.3
Diff.4.1
Diff.2.35
100
97.7
102.1
97.9
100.2
97.7
Stage 2
Stage 3
EPNdb
100
90
80
70
60
50
40
30
TAKEOFF
SIDELINE
APPROACH
Unmodified JT8D-15
FEASI Hush Kit JT8D-15

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Pork Patrol
221 S.W. 153rd St., Suite 136
Seattle, WA 98166
(206) 547-PORK

Expert Arbitration Panel
c/o Mr. Jerry Dinndorf
Puget Sound Regional Council
1011 Western Avenue, Ste 600
Seattle, WA 98101

April 17, 1995

Dear Expert Panel Member,

The Pork Patrol is a citizens watchdog organization formed to root out self-indulgent spending, waste, mismanagement and abuse by City, State and limited purpose governments. Our organization consists of a cross section of serious, independent citizens who live in the greater Seattle, Puget Sound area. Thank you for the opportunity to submit our comments on issues discussed in the Expert Panels Procedural Order and the May 1995 Revised Noise Validation Methodology prepared for the Port of Seattle by Mestre Greve Associates.

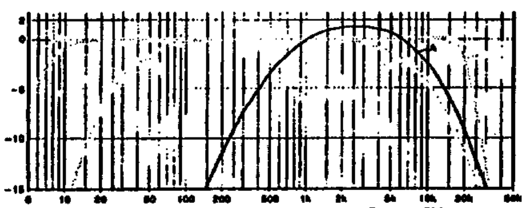
We are concerned that the proposed noise reduction methodology is based upon a metric with frequency-weighting characteristics which render it unusable for the measurement of low frequency aircraft noise which impacts people on the ground. We recognize that the FAA utilizes the A-weighted metric (including Ldn) for measurement of aircraft noise, however, Puget Sound Regional Council resolution A-93-03 does not restrict the Expert Panel to a specific noise metric, but permits the Panel to countenance any metrics or methodologies the panel deems suitable to carry out it's mandate to confirm that the methodology developed and submitted to the Panel is capable of measuring actual "on the ground" reductions of aircraft noise impacting the population, and subsequently, to verify that the Port of Seattle has reduced noise impacts in the communities affected by SeaTac airport's operations using this methodology.

Expert Arbitration Panel
April 17, 1995
Page 2

The Expert Panel has noted that low frequency noise is an important issue in noise reduction methodology. In its procedural Order on Phase I Noise Issues (pg. 7, footnote 11) issued January 9, 1995 the Panel wrote:

> "Additionally, as the POS noise consultant indicated in the hearings, the reduction in A-weighted DNL is caused solely by a reduction in maximum A-weighted levels (and SEL) of individual aircraft. We suspect that this reduction is probably driven by a reduction in the more easily attenuated frequencies near and above 1000 Hz, with perhaps little or no reduction in the more difficult-to-reduce lower frequencies (which are heavily attenuated in the A-weighted calculation). It is these lower frequencies that seem to be the cause of much of the complaints about interior noise impacts (including window rattle). A 5 dB reduction in overall A-weighted level from an individual flyover may not be sufficient to be viewed by residents as a meaningful improvement. Even an 8-10 dB reduction in overall A-weighted level, which would typically be considered as substantial, may not adequately solve the low frequency noise, vibration and rattle problems.
>
> Finally, POS data provided to the Panel by the Pork Patrol (*Final Project Report, Summary of Test Results, AIP 3-53-0062-13*) shows many cases where the actual measured 'additional sound reduction after insulation' was less than the 'designed additional sound reduction'."

The Expert Panel's observation that the A-Weighted metric discounts noise energy at lower frequencies on a sliding scale is illustrated below. The graphic reveals that sound levels measured from sources at 400 hertz using this metric are attenuated by 5 decibels more than sound pressure levels measured from sources at 1,000 Hz.



Frequency Weighting Characteristics for A-Weighted Scale
Source: Bruel & Kjaer

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April 17, 1995
Page 3

The distribution of aircraft noise frequencies are discussed in a 1981 study produced for the Environmental Protection Agency (EPA). The graph below shows a sample of aircraft noise with respective frequency component magnitudes adjusted according to the A-Weighted metric:

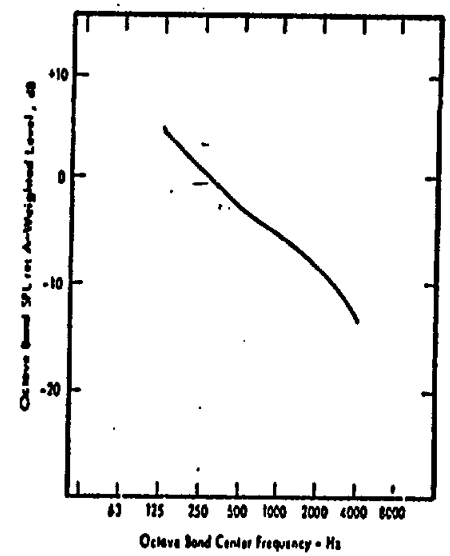

Figure B-6 - AIRCRAFT NOISE SPECTRUM
Source: A Study of Soundproofing Requirements for Residences Adjacent to Commercial Airports
Wyle Labs./Wyle Research Arlington, VA Prepared for Environmental Protection Agency
August 1981 Document No. EPA 550/9-82-328

This report noted:

> "The aircraft noise spectrum of Figure B-6 used in this comparison was derived from sound level measurements of commercial aircraft operations. Two noise measurements were utilized - one under the landing path and one under the takeoff path located approximately within the NEF 40 contour of Los Angeles International Airport. Approximately one hour of data was reduced for each site and the energy-equivalent noise level in each octave band was determined. These were time-averaged spectra which were dominated by the noise spectra of the aircraft flyovers. The frequency spectra for takeoff and landing were similar in shape (both decreasing in level with increasing frequency) so they were combined into the single average aircraft noise spectrum shown in Figure B-6."

It is important to emphasize that the sound pressure levels of the frequencies recorded in the aircraft noise spectrum above (Figure B-6) have been A-weighted. In other words actual (absolute) sound pressure levels at 400 Hz shown in figure B-6 are actually 5 decibels greater than the sound pressure level at 1,000 Hz. (See A-weighted scale above) According to Figure B-6 the A-weighted sound pressure level of aircraft noise at 125 Hz is approximately 20 decibels greater than sound pressure levels at 4,000 Hz. Also, the A-weighting scale attenuates noise frequencies at 125 Hz by approximately 15 decibels more than noise at 4,000 Hz. Thus, the actual (absolute) range of sound pressure levels in the aircraft noise spectrum are 35 decibels greater in the 125 Hz range than the 4,000 Hz range. The A-weighted metric thus seems a poor descriptor for measuring sound energy concentrated at lower frequencies including noise which rattles the teacups of residents located near SeaTac airport or close to its flight tracks.

We feel that methodologies proposing reductions in noise "impacts" must include reductions of un-weighted noise or a combination of A-weighted and lower frequency noise levels. The Port's proposed noise reduction methodology which proposes noise reduction amounting to several decibels measured on the A-weighted scale will not accomplish this goal.

On the subject of the population affected by the year 2020 (Question 7 of the Expert Panels Information Request to the Port of Seattle) we are concerned about the projections of populations residing under the 80 SEL noise contour noise footprint under the primary flight paths for each of the runways. We attempted an estimate of the affected population by superimposing a map which shows the geographic boundaries of the 80 SEL noise contours for the MD-83 aircraft (Figure C-17 from the Flight Plan Project produced by Mestre Greve Associates) onto the Transportation Analysis Zone (TAZ) map for the year 2020 produced by the Puget Sound Regional Council in conjunction the PSRC's Vision 2020 planning This plan projects increases of population in the central Puget Sound area including highly concentrated populations described by the counter-intuitive term "Urban Villages". We would ask the Port's consultant to explain the methodology used to arrive at the estimate of population subjected to 80 SEL noise levels.

Related to the projection year 2020 projections of 80 SEL noise contours, I have also enclosed information provided by FAA circular No. 36-1F titled Noise Levels for U.S. Certificated and Foreign Aircraft dated June 5, 1992 and FAA Circular No. 36-3F titled Estimated Airplane Noise Levels in A-Weighted Decibels dated August 10, 1990. According to the FAA circulars, variations in noise levels greater than 5 dB in the noise levels of these aircraft occur based upon differences in aircraft weights and engine configuration. Added to a plus or minus 5 dB level of accuracy in the INM noise modeling program it appears the geographic boundaries for the MD-80 aircraft 80 SEL contours could likely encompass the 80 SEL noise footprint for 727-200 aircraft which appears on Figure C-17.

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Expert Arbitration Panel
April 17, 1995
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The panel has previously noted that many impacted residents (The Port's 1990 Part 150 update estimated a population of 67,000 residing in 21,119 housing units) currently subjected to noise levels of 65 Ldn and above are not presently eligible for noise insulation because they are not within the boundaries of the "pre-shrunk" year 2000 65 Ldn noise contours which define eligibility for the Port's noise programs. The Revised Noise Reduction Methodology does not address this situation of the tens of thousands of residents thus trapped in the "acoustical twilight zone" formed by the Port's purportedly shrinking noise contours. It seems likely these noise impacted "geographically impaired" persons will become noise impacted "vitally impaired" persons before their homes are noise insulated!

In conclusion, we would like to thank the panel for reviewing and addressing these important issues. We feel a methodology which addresses real "on the ground" impacts is possible but the presently proposed methodology fails to accomplish the task. Zoomorphically speaking, we believe pigs will fly before real on the ground noise level reductions are achieved at SeaTac using the Port's currently proposed methodology. Thank you for your consideration.

Sincerely,

Al Furney, Chair

Enclosures:

Excerpts from FAA Circular No. 36-1F titled Noise Levels for U.S. Certificated and Foreign Aircraft dated June 5, 1992

Excerpts from FAA Circular No. 36-3F titled Estimated Airplane Noise Levels in A-Weighted Decibels dated August 10, 1990.

Figure C-17 from the Flight Plan Project Final Environmental Impact Statement produced by Mestre Greve Associates October 1992

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MR. LEWIS: How about February?
MS. DALTON: The way that we deal
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with this particular question in the studies, if you look at page 16, and what you'll notice there is an annual number of operations, a daily number of operations, and then what we call equivalent days. Are you with me?
MS. LANGELAN: We are with you.
MR. LEWIS: Yeah.
MS. DALTON: The assumption here is that this busy profile doesn't occur every day, so we're calling it -- instead of 365 days a year we are making the day 332 days a year.
MR. LEWIS: But how much lower is

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the demand profile, say, on February 15th? How does the --
MS. DALTON: Don't know.
MR. LEWIS: I take it you haven't attempted -- I take it the weather here is different typically in February than it is in August.
MS. DALTON: Right.
MR. LEWIS: And you haven't correlated in your simulation model what may be a systematic relationship between differences in the demand profile and differences in your weather.
MS. DALTON: That's right. That's right.
MS. LANGELAN: You have not correlated.
MS. DALTON: Yes, that's right. You're right.
MR. FELDMAN: I think that you could assume between the highest day and the lowest day roughly a 15 percent difference. I mean, we're averaging somewhere between 950 to 1,000 operations a day on any given day. And that does increase during, you know, busier

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months and certainly before and after holidays.
MR. LEWIS: The point I'm making simply, and that I think Bill is making, is that if your highest demand days occur under one weather scenario but your modeling delay is applying that high profile to a different weather scenario, you are going to get some error introduced. Whether it's significant or not is a statistical question, one can only know by running a model. There is no way ex ante to know whether it's significant or not.
But in model design it would be an improvement, it seems to me, to take account of the fact that not only is the demand profile not constant throughout the year, the weather isn't constant throughout the year, and in fact there

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day
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R6A

CHAPTER IV
ENVIRONMENTAL IMPACTS
SECTION 2 - LAND USE

Chapter IV, Section 2: Land Use

Comment IV-2-1 -- Land use -- noise -- correct & incorrect premises. The preparers of the DEIS state that aircraft noise is generally regarded as the primary impact of an airport on surrounding land use. DEIS IV.2-1, col. 1.

(a) This premise of the land-use section (2) of the impacts chapter (IV) of the DEIS is correct.

(b) We disagree with the incorrect premise that society, the DEIS, the lead agencies, & governments generally should ignore all noise impacts outside the 65 Ldn contour. See our comments on the noise section, supra. As the discussion below of land-use regulations by near-airport cities will show, some levels of government are of opinion that noise below the 65 Ldn level is of concern. R-6-9 R-6-10

(c) And, as our comments on the noise section explain, we are not persuaded that the 65 Ldn contours presented in this DEIS are accurate.

(d) Nor do we agree that the the Ldn metric is the only useful metric for measuring adverse noise impacts.

(e) Finally, it is particularly important to remind the reader that we strongly dissent from the view that Sea-Tac generated noise will decline sharply in the future. It is as yet unclear whether all Stage 3 aircraft will be quieter than every Stage 2 aircraft. Citizen observers feel that the larger Boeing 747s generate a great deal of noise close to ground level. The PSRC Expert Arbitration Panel that the Ports current noise budget & nighttime flight restrictions program would reduce noise, but not enough so that citizen on the ground can hear it. (See our comments on noise, Section 1.) The schedule for phasing out Stage 2 aircraft is potentially subject to stretching out & delays. For any minor gain from substitution of an aircraft with Stage 3 engines for one with Stage 2, there will be an offsetting loss arising from increased air traffic at Sea-Tac (& at Boeing Field International), there will be more noise resulting from the Port's ardent wooing of East Asian interests to send more heavy cargo aircraft to the Port -- aircraft that are immune from the Port's noise regulations. Further, as we indicate in a comment on socio-economic impacts, we are by no R-6-18 R-6-11 R-6-21

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means persuaded that if built, the third runway will be operated as posited in the DEIS, which would be a most inefficient use of public money & of a public facility. Rather, we are persuaded that the Port may well actually operate the runway to achieve a major capacity increase for heavy (& noisy) aircraft, not as a subsidy to inefficient commuter operators. as the DEIS implies.

Comment IV-2-2 -- Methodology. As is obvious from our comment IV-2-1, supra, we find the methodology of using 65 Ldn as the only method of measuring noise impact to be unsatisfactory. We refer the reader to our noise comments for further detail. The preparers are to be commended, however, for at least providing mapping of 60 Ldn contours (though we believe the contours to be more extensive than shown). As we suggest in a later comment on this section, mapping & study should extend to the 55 Ldn contour & to other metrics. Until the FEIS adopts more reasonable metrics & uses more accurate devices (including legitimate on-ground, state-of-the-art sampling) to construct noise-contour maps, the descriptions of noise impact will not be credible. R-6-9

Comment IV-2-3 -- Mitigation (pp. IV.2-4 - 2-6). The existing, snail's-pace mitigation programs are not adequate to mitigate observable harmful impacts. Insulation of residential structures is fine, but no-one knows how to insulate a yard, garden, deck, or patio. Insulation is simply not good enough. It follows that insufficient mitigation cannot be used as an excuse for ignoring impacts, though that is the thrust of the DEIS. The FEIS should face up to the physical realities & recognize that insulation is not enough. R-7-23

Comment IV-2-4 -- Mitigation (p. IV.2-4). The DEIS errs in attributing the Port's noise-mitigation program to the mis-named Noise Mediation Agreement. What little the Port does was mandated many years ago by other, more potent authorities. The failed mediation process should not bear the blame. R-6-29

Comment IV-2-5 -- General land-use concerns. The discussion in section 2, Chapter IV, is necessarily bound up with the discussion in Chapter III, the mandatory description of affected environment. For convenience's sake, our comments on the landuse aspects of Chapter III will be included here.

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Comment IV-2-6 -- Present uses -- study area (DEIS III-1; DEIS IV.2-2). The DEIS study area is far too small; this is an consequence of the mistaken adoption of the 65 Ldn parameter as the sole test of impacts, & is compounded by the acceptance of the Port's mis-calculated, self-serving contour map. The study area should expand to 55 Ldn, & should also include areas under significant SEL impacts. A proper study area should include all areas under the North-South approach/departure routes & all areas subject to out-the-pipe acceleration noise, such as the portions of Seattle, Mercer Island, the East of Lake Washington communities like Medine, all under the "East Turn", & those under the "West Turn" & those under the comparable turns South of the Airport, and those under the 4-post routing. R-6-3

Comment IV-2-7 -- Compatability. See p. III-2, col. 2. The DEIS seems to think that is the function of local land-use planning to "ensure the compatability of their land uses with airport operations". Has the airport operator no duty to ensure that its operations are consistent with the expressed needs of the people on the ground? Or is it "Airport Uber Alles"? If everything has to be changed to accomodate the airport, then the Port of Seattle has abruptly become the chief land-use planning agency for the three-county area -- all without seemingly needful amendments to the Constitution or changes in the Revised Code. We think that the DEIS is wrong in this particular.

The FEIS should recognize that, since the early 1970s, the King County & the Sea-Tac communities have endeavored to plan land-use in a manner compatible with the Airport's operations, while the Airport was to endeavor to be as good a neighbor as it could. The Plan's projections of increases in passenger enplanements into the 1990s closely follow actual growth. The plan's projections of increases in passenger enplanements into the 1990's closely follow actual growth. A third runway was not even hinted at. R-7-11

The County & the cities planned accordingly. This planning was consisten with the Airport's Master Plan & with the 1985 Master Plan Update in which *"it was determined at the outset that now new runways at Sea-Tac would be considered, primarily because (1) the existing runway configurations had previously been determined to* *provide adequate capacity for the planning period, (2) there already has been an enormous investment in the existing runways, and (3) construction of a new runway would have a large environmental impact. Similarly, it was reconfirmed that Sea-Tac should continue to accomodate general aviation activity only to the extent that such activity supports its function as the principal air carrier airport in the region.'* (1985 Master Plan Update, p. 1)

It is the Port that now wants a radical change in long existing understandings. It is utterly unreasonable for the Port & FAA to expect generations worth of compatible planning all based on three long-term plans in which the Port actively participated, to be overturned at the flourish of an E.I.S. or Master Plan Update.

R-7-11

Comment IV-2-8 -- Land use -- compatability. The DEIS reports, p. III-2, that the extent to which the City of SeaTac's land-use regulations will apply to the Airport is "currently the subject of an interlocal negotiations process". It would be more accurate to say that negotiations, if any, have broken down, & that the City of SeaTac is suing the Port to achieve recognition of its governmental authority. The FEIS should make the correction, though it would be wise not to hazard a guess on the outcome of the ligitation.

R-7-27

Comment IV-2-9 -- Land use -- transit. Much of the DEIS discussion of existing & future land use in Chapter III & in Chapter IV, Section 2, turns on assumptions about the future of rapid (rail) transit & of the Vision 2020 transportation plan of the Puget Sound Regional Council. See e.g., p. III-3, III-7, IV.2-15. The FEIS needs to take into consideration that the voters have once again defeated the regional leadership on the rapid-transit issue, that as things now stand, there will NOT be rapid-rail stations in SeaTac, & all the other elements of the plan are also not on the cards at this time.

Comment IV-2-10 -- Land use -- transportation plan of PSRC. Reference is made, p. IV.2-15, to the so-called Vision 2020 Growth Strategy & Transportation Plan of the former Puget Sound Council of Governments. The FEIS might as well realize that that plan, which was dead on arrival, has now been taken off life sup+port, with the voters' defeat of the proposed regional transit system. The FEIS would

also do well to recognize that much of what was included in that plan went well beyond the statutory authority of that agency or its successor, the Puget Sound Regional Council (PSRC). The FEIS might also address the question, if the Vision 2020 plan was a comprehensive plan, not just a collection of wish lists, then what does the defeat of its central element do to the viability of the other elements?

R-4-2
R-4-3

Comment IV-2-11 -- Land-use -- Vision 2020 Update. Reference is made, DEIS IV.2-16, to a PSRC update of the Vision 2020 plan. We are aware of no public process regarding this update, & learned of it for the first time in this DEIS. If there has been a DEIS on the Update, we know not of it. We regard the update as a red herring, of no validity. Is this another PSCOG/PSRC docu+ment bought & paid for by the Port? We seriously question whether, as the DEIS hints, the State growth management act has designated the PSRC to take over the planning process from the counties & cities. The FEIS needs to clarify this matter.

R-4-1
R-7-28

Comment IV-2-12 -- Statutes -- citation of. In citing statutes of the State of Washington, the FEIS should follow the standard practice (NOT followed in the DEIS): statutes are cited by their codified section numbers, & the only proper exception is those rare instances in which a very recently passed act has not been assigned code section numbers. The code is cited as RCW (standing for Revised Code of Washington). The section number is a three-part number, the first group of digits representing the title number, followed by a full stop. The second group of numbers is the chapter number, followed by a full stop. The last group of numbers is the section number (sometimes with subsection or paragraph numbers). It is customary to indicate in parentheses after the RCW number the year date of the version of the RCW to which reference is being made. The statutes of this State are to be found in public libraries in the familiar green RCW binders, not in the form of individual acts. The average reader has no convenient access to acts as such, only to code sections.

R-18-28

Comment IV-2-13 -- Land use -- local planning processes. The DEIS, pp. IV.2-7 through 2.14, makes much of the alleged failure of the planning processes in the Cities of SeaTac, Des Moines, Normandy Park, Burien, & Tukwila to make proper provision for the

R-7-11
R-7-27

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expansion of the Airport. Most of this discussion is best characterized as self-serving propaganda, & no doubt the indivi+dual municipalities will deal with it all in their several com+ments. We believe that self-serving propaganda should be eliminated from the text of the FEIS & from the mind-set of the preparers & decision-makers. The EIS process is supposed to help to decide whether an alternative should or should not be adopted, not to serve as a vehicle for thinly-veiled attacks on those whose independent policies are perceived as a threat to the project not yet through the environmental-review process, not yet adopted by the lead agencies (supposedly). The FEIS should take a neutral tone, & should evaluate the potential conflict in land use policies in an even-handed way.

Comment IV-2-14 -- Land use -- essential facility. We believe that the DEIS errs in supposing that, because the City of SeaTac has identified the Airport as an "essential public facility" (p. IV.2-8, col. 1), the expansion of the airport has thereby been determined to be essential, & subject to no incidental or direct controls. Nor can it be fairly said that a unilateral determination that something is an "essential public facility" thereby compels all other actors to acceptance of all the much-extended possible consequences of that designation, or of the designation itself.

R-7-11
R-7-27

Comment IV-2-15 -- Land use --alternatives. (a) The discussion at DEIS IV.2-15 more properly belongs in, or perhaps should be repeated in, the Alternatives portion of the FEIS. The isolated discussion here may serve to mislead readers as to the true extent of the alternatives to Sea-Tac expansion that should be considered.

(b) Note also that this discussion is marred by the assumption that the subregional rail-transit system is still a viable proposition. The FEIS should make the appropriate corrections. R-9-2

CHAPTER IV
ENVIRONMENTAL IMPACTS
SECTION 6 - SOCIAL IMPACTS

Chapter IV, Section 6: Social Impacts

Comment IV-6-1 -- Social Impacts -- Methodology. The Social Impacts section of the DEIS errs in the respect that it only considers a tiny fraction of the three-county that is directly, adversely impacted by the airport & its activities. The FEIS should address the social impacts on the entire three-county area. The FEIS should not be limited in its consideration of these issue to the primary (construction) area, the Runway Protection Zone, & the area to be acquired by the Port of Seattle in fee. (See discussion, DEIS IV.6-1, under the heading,](1) METHODOLOGY).

Comment IV-6-2 -- Social Impacts -- Methodology. The DEIS has fallen into the error of considering impacts in much-too-small an area in part because it disregards the noise pollution outside its own, toonarrowly drawn 65 Ldn contours, an issue addressed in our comments on Section 2, Noise, & on Section 7, Human Health, infra. After the noise & health portions of the FEIS are written with proper consideration to accurate 65 Ldn contours, with use of other & more accurate noise metrics, & with actual noise sampling by appropriate technology at appropriate locations, then the Social Impacts section should be re-thought & re-cast.

Comment IV-6-3 -- Social Impacts -- Methodology. The DEIS has fallen into the error of considering impacts in much-too-small an area in part because it uses inaccurate & inappropriate data & methods in considering the impacts of air pollution, an issue addressed in our comments on Section 9, Air Quality, & on Section 7, Human Health, infra. After the air-pollution portion of the FEIS is written with the aid of actual field sampling, with analysis based on more appropriate assumptions as to health risks, & with the elimination of analysis based on questionable computer models using questionable assumptions to process extremely dubious data, then then the Social Impacts section should be re-thought & re-cast.

Comment IV-6-4 -- Social Impacts -- Methodology. (a) In revising section 6, the preparers should consider those impacts discussed briefly in our comment IV-8-13, that is, the disruptive effect on individuals & on established neighborhoods that might result from large-number, short-time-scale sales of residences to escape overflight impacts. It is here suggested that at a point in time large numbers of people in adversely-impacted

nieghborhoods may despair of gaining relief from overflight impact (especially noise). A perception that the third and/or fourth runway is inevitable might well be a precipitating factor. At that point, the rate of placement of houses on the market would rise sharply, as owners seek to sell before property values plummet, & something approaching panic sets in. This is not a unique phenomonon in real-property history. One obvious impact would be a falling-off of property values, possibly a crash.

(b) Another impact that merits thoughtful discussion would be a rending of the social fabric, as neighbors scatter to distant places, to be replaced by people with no prior connections with each other or the community. The more prosperous & wellestablished the neighborhood, the greater the disruption caused by such flight from seemingly irremediable harm.

Comment IV-6-5 -- Social Impacts -- Methodology. In revising section 6, the impacts just referred to in Comment IV-6-4 need to be addressed in a different context: in some parts of the three-county area there are neighborhoods where the ties of community are weak, where residential land lies unbuilt-upon, where it is hard to attract & to keep needed retail outlets & useful services. In most instances, these neighborhoods are also characterized by an over-representation of people of color, of recent immigrants from outside the U.S., & by people of low income (often all at once). We suggest that, owing to the constraints of topography, the principal flightlines from Sea-Tac pass over the larger part of such neighborhoods, & thus over the largest concentrations of people of color, of poor circumstances, &c. The social impact of aircraft noise & air pollution, properly measured & properly assessed, falls very disproportionately on people in 'protected' classes, & on their neighborhoods. We adopt here the comments of Seattle Community Council Federation on this matter.

Comment IV-6-6 -- Social Impacts -- Displacement. We suggest that the EIS is mistaken in positing in its discussion of displacement (p. IV.6-3) that people leaving the acquisition zones will relocate in near-by neighborhoods. The FEIS should address the possibility (which we think is the high likelihood) that given the chance to escape, displaced families will seek to relocate far, far from the airport. The likely exceptions will be people who feel that they are locked into employment (typically, ill-paid, not infrequently part-time or casual) in the immediate area,

& who lack funds for adequate transportation to reach the workplace from remoter neighborhoods. The implications from such a differential displacement require further study. R-8-14

Comment IV-6-7 -- Social Impacts -- General. In the long term, erroneous decisions, such as the one proposed in this DEIS to center all major commercial aviation activity for the State on a crowded site in the center of the metropolitan area without regard to the resulting harm, cannot help but diminish the quality of life of the entire three-county area, as well as creating further erosion of trust between citizens & out-of-touch governments. There is a wonderfully arrogant touch of a "let them eat cake" attitude in all of this. Noise? The DEIS preparers don't hear any noise, so neither do the citizens. Air pollution? It's measured on trick computers, so it doesn't exist. Well, maybe it exists but it doesn't actually violate the law, so it's of no consequence. Health? No one particular person has been shown to have actually died from noise & air pollution, so there are no health problems, & if there were, the methodology of determining cause of death wouldn't appeal, bureaucratically, so disregard it. In a democracy, one would like to feel that government can be trusted. Wrong-headed decisions, justified by bad science & unsound analysis, weaken the social fabric, with incalculable harm downstream. R-8-4

The FEIS would be far better received -- though opposition to the proposed project would not be lessened -- if it candidly admitted R-6-1B that noise has adverse impacts, that the F.A.A. has spread the noise widely & indiscriminately, that there is no relief in sight, & that the fourth runway is just an EIS away, too. R-3-35

Comment IV-6-8 -- Social Impacts -- Economic Impacts -- Map. (a) There needs to be a map similar to Ex. IV.6-1 (i.e., showing census tracts & ethnic data), but covering all areas of intense overflights.

(b) The street names & census-tract numbers on map Ex. IV.6-1 are almost impossible to read without the aid of a hand lens; appropriate improvements should be made in the FEIS. R-8-15

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CHAPTER IV
ENVIRONMENTAL IMPACTS
SECTION 7 - HUMAN HEALTH

Comments on Chapter 4-Section 7: Human Health

Our comments on this section are in two groups. In the first group, Comments IV-7-A through IV-7-C, we include three studies of certain issues included within the scope of the Chapter; these studies present materials, data, findings, and analyses not included in the DEIS, which should be addressed in the FEIS. Also included are seven exhibits, reproduced in photocopy. They appear immediately following our comments. The balance of this section is our comments on particular points raised in the Human Health section of the DEIS or suggested by it.

Items included as Comments IV-7-A through IV-7-C.

Comment IV-7-A: Submission to PSRC Expert Arbitration Panel on Noise Impacts: "Report on the Proposed Reduction in Noise Levels at the Seattle-Tacoma Airport"; Alice H. Suter, Ph.D. (October 26, 1996)

Comment IV-7-B: "Sleep, Noise, and Immunosuppression" published in M.Vallet (Ed.) Noise as a Public Health Problem. Proceedings of the 6th International Congress. Nice, 5-9 July, 1993, Vol. 2, pp 575-578. Arcueil Cedux, France: INRETS.

Comment IV-7-C: Submission to PSRC Expert Arbitration Panel on British Sleep studies including:

1) In the High Court of Justice, Queen's Bench Division, Crown Office List, In the Matter of an application for Judicial Review, The Queen -v- The Secretary of State for Transport, Ex Parte: The Council of the London Borough of Richmond upon Thames and others. Crown Office Re. No. CO/2110/93 Affidavit of Walter Holland and Affidavit of Birgetta Berglund.

2) Abridged curriculum vitae for Holland & Berglund

3) Scientific Review of "Report of a Field Study of Aircraft Noise and Sleep Disturbance" issued Dec. 1992 by the Department of Transport, United Kingdom, Birgitta Berglund, Ph.D. (May, 1993); and

4) "The U.K. Sleep Disturbance Study--A Critique", Jeffrey Gazzard. (A Presentation to the N.O.I.S.E. Annual Meeting, Irving, Texas July 15th 1993)

Comment 7-1 : A volunteer experienced in scientific literature research has undertaken a computer data-base study of the scientific, medical & technical literature on health effects of aircraft noise. The raw results of this search have been printed out, & constitute Exhibit IV.7-1 to our comments. It will be noted that this Exhibit runs to more than 200 pages, encompassing an estimated 450 separate citations of publications of potential interest to investigators studying the issue of the effects of noise on human populations. This includes only publications dated January 1991 or later. Owing to copyright complications, we are unable to include the approximately 250 pages of synopses of this studies.

Almost without exception, these publications are found in learned journals, published or sponsored by accredited universities or recognized learned societies. It can be assumed that many were also subjected to peer review before being accepted for publication.

(a) The computer-data-base research shows that impact of aircraft noise on human activity has baen the subject of ever-increasing investigation by researchers from numerous disciplines. This investigation does not occur in a vacuum -- the intense research activity itself is an indication that the investigators, & the editors & reviewers of the journals in which they publish, are aware that there is something significant to investigate. Yet the DEIS dismisses this huge body of research & its conclusions as having serious methodological problems, on the basis of an unpublished & unlocatable paper supposedly emanating from an unknown Federal agency. The DEIS errs in dismissing this matter without proper study.

(b) The DEIS seriously errs when it regards the unreviewed, unpublished declarations of Federal bureaucrats as having greater weight in matters of science than the work of serious investigators, having genuine credentials, working & publishing under the established rules for scientific investigation. This error should be

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corrected in the FEIS. The following corrective measures are suggested:

(1) Any papers relied on by the FEIS that are internal Federal publications (*i.e.*, not published in independent, recognized learned journals) should be properly cited in the recognized (& unique) method for such citation, which includes the Government Printing Office document number. Failure to provide proper citations disables readers. For example, we are unable to locate in the repository of Federal documents at the University of Washington the paper referred to at DEIS p.IV.7-2, note 4, for no document number is provided & the publishing body (Inter-Agency Committee) is not a known Federal agency. R-1-6

(2) Only in extraordinary circumstances should unpublished work be cited, most especially unpublished work by non-scientists.

(3) If it is felt absolutely necessary to cite unpublished Federal studies, the FEIS should at least disclose the relevant credentials, if any, of the investigators. R-16-6

This issue of citation of literature is one that we raised in our scoping comments, hoping to persuade the DEIS/FEIS preparers to avoid this very situation, & this issue recurs throughout the DEIS.

(c) If there are problems with methodology in relevant studies, the FEIS would do better to state what those problems are & how they can be corrected.

(d) The possible existence of serious methodological problems in this or that study does not necessarily invalidate the general conclusion to which studies lead -- in this instance, the conclusion that aircraft noise is indeed a problem.

(e) It should be noted that airport/aircraft noise is an issue everywhere that there is a major, in-city or near-city airport. In the United States, many thousands of citizens in hundreds of cities & towns are reporting increased aggravation from increased noise. This noise is generated by Federally-regulated aircraft, aided in their operations by Federal subsidies, & traveling to & from airports built in

part with Federal funds. The Federal government (particularly the F.A.A.) is sponsoring this noise. Thus, the F.A.A., like its counterpart civil-aviation agencies abroad, has serious responsibilities in this regard, & cannot escape them by asserting, EIS by EIS, that the state of the research (by others) is unsatisfactory. The F.A.A., like its counterpart agencies abroad, has a duty to investigate this matter thoroughly, preferably through outside, independent investigators, & not, as here, to avoid & evade by unsupported blanket criticism of methods of the studies that reach conclusions inconvenient to the agency & its clients. R-16-6

(f) The exhibit, IV-7-1, shows that there is a huge body of work in this general field. Seemingly, the F.A.A. is generally unaware of this work. What does the F.A.A. propose to do to come to speed on this problem?

Comment 7-2 -- Noise -- physiological effects. Although the DEIS concludes, p. IV.7-2, col. 2, that the impacts will mostly be measured in "annoyance," it fails to present any annoyance surveys done in communities experiencing at least ≥55 Ldn for Sea-Tac both now & projected with the alternatives.

Comment 7-3 -- Noise -- physiological effects. The DEIS states, p. IV.7-1: "The U.S. Environmental Protection Agency (EPA)'s Levels Document indicates that exposure to sound levels of 70 Leq (24-hr) (approximately 75 DNL or 74.6 dBA for 8 hours) or higher on a continuous basis, over a very long period, at the human ear's most damage-sensitive frequency may result in a very small but permanent loss of hearing" (citing in note 1, Information on levels of environmental noise requisite to protect health and welfare with an adequate margin of safety, USEPA, Office of Noise Abatement and Control, Washington, D.C. (March 1974), no GPO number provided). R-7-7

While this is obviously correct, the DEIS fails to state how many people live & work in the vicinity of Sea-Tac experiencing ≥ 70 Ldn, 75 DNL, and 74.6 dBA for 8 hours, respectively and the demographic profile of this population -- age, sex, and races.

Comment 7-4 -- Noise -- physiological effects. Even more importantly, the DEIS fails to mention that the EPA Levels document recommends noise levels in residential areas of ≤55 dB Ldn outdoors and ≤45 dB Ldn indoors in order "to protect public health and welfare from the effects of environmental noise." [emphasis added]. The DEIS fails to state how many people live in areas exposed to noise levels ≥ 55 dB Ldn recommended in the EPA levels document, or to describe the demographics of that population, or the potential health risks associated with levels ≥ 55 Ldn. It fails to examine the ability of the "mitigation by insulation" programs to achieve ≤45 dBA indoors. R-7-7

Comment 7-5 -- Noise -- physiological effects. The DEIS asserts, pp. IV.7-5, that "aircraft noise levels of 115 dBA, permitted by OSHA for 15 minutes per day, would never be experienced by residents around Sea-Tac Airport as shown in Appendix C. Appendix C shows that the peak sound exposure level (SEL) currently impacting residents closest to Sea-Tac is 111.7 dBA, at site 4299 (grid site F29). Thus, hearing damage would not be expected for residents near Sea-Tac." R-6-31

(a) However, questions exist as to whether taxi-way & runups have been included in the noise analysis, and in the SEL data (see our Comments on Chapter IV, Section 1.) Runups can and frequently do produce sound exceeding 115 dBA and many last for 30 minutes in a 24-hour period. Without the data, the DEIS fails to show that runups do not exceed the high noise short-term standards. R-6-17

(b) Furthermore, this standard is, again, a workplace standard where those exposed are exposed voluntarily & paid to do their job (& are covered by industrial insurance), not unwilling members of the general public in their own homes & yards.

(c) These standards were not established considering pregnant women, infants, children, the ill or the elderly, and may not necessarily apply to them.

Comment 7-6 -- Noise -- physiological effects. The EIS states, p. IV.7-1, col. 2, that "The Bureau of Labor workplace related noise standards permit unprotected workers to be exposed to average noise levels of 90 dBA for eight hours per day. There has been pressure from medical researchers to lower the eight-hour R-16-6 R-16-24

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standard to 85 dBA. As is shown in Chapter IV, Section I "Noise", average aircraft noise levels do not reach or exceed 85 to 90 dBA (as measured in DNL)." It is inappropriate to use occupational standards for environmental noise pollution where those exposed are unwilling and not paid for their exposure. It is well-established in the literature that "control" or "lack of it" over the noise source significantly affects a person's response to the noise. See Comment IV-7-A. Control subsequently also affects the likelihood that a person will experience the psychological and/or physiological affects from the noise. In addition, occupational standards do not contemplate potentially sensitive populations, such as babies, children, the elderly, the ill and pregnant women. R-16-24

Further, it is not a sufficient environmental analysis to say, as the DEIS in effect does, that there is no significant harm unless the noise violates the law (workplace standards) -- law, indeed, set up for a rather different purpose. R-16-5

Comment 7-7 -- Noise -- Psychological effects. Although the DEIS correctly states, p. IV.7-1, col. 2, that "[t]he single-event noise levels from many aircraft which operate from runways at the Airport commonly exceed 85 dBA on neighboring residential land uses", it fails to point out the well-known NASA sleep studies, Effects of Noise on Man, ONR, 1950; Effects of Noise on Man, NASA Reference Publication 1115, 1984, all by Karl D. Kryter of SRI International, showing that 80 SEL creates sufficient noise to waken a person inside with the windows closed, assuming a diminution of 20 dBA from going inside and closing the windows (see p. IV.7-4, where it is erroneously stated that homes in the Sea-Tac are typical cold-climate construction).

(a) The drafters of this part of the DEIS are apparently from Chicago and are unaware that Seattle, despite its more northerly location, does not have a cold climate but a temperate-marine climate. Palm trees can be grown north as far as Bellingham. Most older homes were built with very little or no insulation. The City of Seattle has had a major on-going program to encourage people to install insulation in existing homes for energy conservation. In cold R-7-34

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climates, insulation is a routine part of original construction. Only in recent years have builders routinely included double-paned glass in new residential construction for energy conservation. In cold climates, double-paned glass is routine in new construction. Local homeowners are only slowly retrofitting double-paned glass again, for energy conservation. Another indicator of the temperate (not, cold) climate is the rarity of air conditioning. At our latitude (much to the North of Chicago, which is at almost exactly the latitude of Crescent City, California) it does not get dark in summer until after 9 p.m. On hot days, it is traditional to eat out on the deck or in the back garden and just leave the windows open to cool the house down at night. It is very doubtful that most homes in this area could achieve a 20 to 25 dBA reduction by moving inside and closing the windows. R-7-34 R-16-5

(b) The DEIS fails to examine the impacts on sleep disruption that the alternatives will have on the airport communities. Large numbers of people will be brought under new flight routes with jets directly overhead. This airport sits in the middle of the most densely populated corridor in four states with flightlines running out, not just over the middle of the State's most populous city (Seattle), but also its third (Tacoma) & sixth (Federal Way), in addition to the smaller cities in the Highline communities. How many more people will be waked up by a passing plane creating 80 SEL? What are the demographics of the population likely to be affected. R-7-7

(c) The SEL maps --Exhibits C-2 through C-7. Appx. C, pp. C-285 through C-290) should be done for the north side of the airport over the densely populated Seattle area. The existing maps only show conditions at and south of the airport. The flight tracks on the south do not resemble the north in any way.

(d) The SEL's for the more commonly used four-post flight route should be shown in addition to the Duwamish/Elliot Bay noise abatement route. Logs showing the actual percentage of time each is used should also be given. It is widely-noted that since the institution of the four-post plan, the former noise abatement routes are rarely flown; if the co-lead agencies believe otherwise, let the FEIS present some real proof. R-4-14

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(e) The numbers of people likely to be affected by each SEL of a Stage 2 and Stage 3 light and heavy jets should be calculated & reported.

Comment 7-8 -- Noise -- physiological effects. The DEIS claims incorrectly, p. IV.7-2, col. 1, that "[i]n spite of years of study attempting to isolate the effects of airport noise on humans, the impacts appear to be so low that they cannot be related to the general satisfaction of the research community, particularly below DNL 70 dB." R-16-26

(a) This misstates the findings of *Federal Agency Review of Selected Airport Noise Analysis Issues*, FICON (August 1992) cited as support in note 4, p. IV.7-2. This report does NOT state that the effects are too so low that they cannot be related to the satisfaction of the research community, but only that more research needs to be done, an entirely different conclusion.

(b) The scientific validity of this summary is questionable as it has not been published in the scientific literature nor given peer review and its author's qualifications are unknown. The document is not generally available to the public and is not cited by GPO or federal document number. The obscure FICON Committee is listed as author. FICON is not even listed in the catalog of the Government Documents Library at the University of Washington -- a designated federal repository. R-16-26

(c) What original research (that is, not reviews of other work) has been done by FICON and where has it been published for peer review? Only those doing research & being published in the professional and academics journals, and therefore subject to peer comment and review, can represent the views of the scientific research community. R-16-27

(d) The DEIS has a duty to discuss the potential impacts and the burden is on the preparers to show that there are no significant health impacts. The burden is not upon those who suffer from those impacts to scientifically prove isolated physiologic effects of noise.

Comment 7-9 -- Noise -- physiological effects. The FICON report just discussed asserts that "*Because the Schultz curve [...] provides the only widely accepted dose-response relationship between environmental noise (in terms of DNL) and a health and welfare parameter, annoyance, DNL has been accepted as the most useful and informative metrics for describing the noise exposure of a community caused by an airport ....*" However, subsequent studies have shown that "annoyance levels" for aircraft noise occur at significantly lower levels of DNL than other types of transportation noise. Exhibit 2 of our comments on health impacts contains a review of these studies by Dr. Alice Suter 8. (This review was presented to the PSRC Expert Panel in December 1994 and was known to the authors of the DEIS prior to publication. We include it here *in toto* as a portion of our comments on the DEIS and ask that each of its major points be considered.)

Comment 7-10 -- Noise -- physiologic effects -- methodological problems in research finding significant risk. The DEIS claims. p. IV.7-2, that "*[a]ccording to a recent summary of aviation noise research some international researchers have published data indicating that a significant physiological risk exists. However, the summary of such studies indicates that virtually all of the studies have had serious methodological problems and therefore questionable results.*"

(a) The summary cited (n. 4, *loc.cit.*) is a summary of U.S. Federal Government studies, not all research on noise impacts. U.S. Federal government studies were severely curtailed in 1982 when funding was cut for the EPA noise office. (*The Dormant Noise Control Act and Options to Abate Noise Pollution*, Sidney A . Shapiro, Rounds Professor of Law University of Kansas, Report for the Administrative Conference of the The United States, 1991.) (Consequently, most of the scholarly research has been done in universities & hospitals in Europe.)

(b) The citation here is another pamphlet produced by the mysterious FICON. This pamphlet is apparently is not in print. We were unable to obtain a copy at the public library or the government documents repository at the University of Washington. How do

members of the public contact FICON? This practice of citing unavailable documents as authority for dubious propositions is strikingly characteristic of this DEIS, &, to repeat ourselves, was exactly warned against in our scoping comments. For all any ordinary reader can tell, citations of this sort are purely imaginary. The FEIS needs to remove the veil of obscurity. Better yet, the FEIS should rely on genuine scientific literature, not on bureaucratic fluff.

(c) To say vaguely that there are supposed methodological problems with all research ever done, merely on the basis of some unpublished pamphlet prepared by one committee of federal bureaucrats whose office is unlisted in government directories, is a transparent attempt to sprinkle disappearing powder over existing field research. This is not acceptable, misinforms public-policy-makers, and does not extinguish the FAA's duty under NEPA and the Port of Seattle's duty under SEPA and NEPA to discuss all potential health impacts from noise and the populations exposed to them. The FEIS needs to do a lot better.

(d) The FEIS should state the physiologic risks identified by the "international researchers" & referred to in the FICON document under discussion; the FEIS should cite the studies involved.

Comment 7-12 -- Noise -- physiological effects -- methodological problems in research finding significant risk. We would agree with the authors of the DEIS that this research is difficult & in some cases inconclusive. However, health research is always difficult, public-health research particularly so. Health research cannot be conducted in ways that would harm the people being studied, further complicating matters. Very few public health studies escape some difficulties. However, "methodological problems" do not necessarily mean that the results are questionable, only that there are some limitations in what they mean. If the writers of the DEIS reject a particular study identifying a physiologic risk, FEIS should explain the findings and the particular methodological limitations of the study. Without this information, it is impossible to give specific comments.

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Comment 7-13 -- Noise -- physiological effects -- methodological problems. The authors of the FICON report referred to in Comments 7-11 & 7-12 do not distinguish between epidemiological, physiologic, clinical studies, survey and dose-response studies and they should, specifically when discussing methodology.

Comment 7-14 -- Noise -- physiological effects. The DEIS attributes to one researcher (p. IV.7-2, col. 1) the view that several problems that occur in trying to associate exposure to airport noise with adverse health effects are 1) oriented measurements of noise yield a poor indication of personal noise exposure, and 2) long latency periods between exposure and disease greatly complicate interpretation of research findings.

(a) So what? The DEIS seems to assume that this is sufficient to extinguish the need to discuss the health impacts of noise pollution and, apparently, sufficient cause to reject all studies published in the peer-reviewed scientific literature as suffering methodological problems. It is not. By this standard, health studies on almost every subject would be rejected. All epidemiological & pollution exposure studies (except perhaps radiation which can be measured by wearable badges) lack methods of defining individual dose response. The individual dose response for the AIDS virus is unknown. That doesn't mean that exposure of tens of thousands of innocent individuals to the AIDS virus won't have serious health impacts.

(b) Most things which have a potential to cause cancer, heart disease, hypertension, & hearing loss have a long latency period. The latency period for AIDS is unknown and extremely variable. That doesn't mean that there is no health impact.

(c) This is an absurdist & willful misunderstanding of the scientific process, not an honest discussion of what are the known and likely impacts of long term exposure to noise pollution.

R-16-5

Comment 7-15 -- Noise -- physiologic effects -- experts working on DEIS. We can find no physicians, epidemiologists, or

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other qualified health researchers on the list of document preparers, DEIS ch. VI. The FEIS should indicate who prepared each section (noise pollution, air pollution, water pollution, air safety and real-estate losses) of the health impacts section and their medical & scientific qualifications.

R-16-6

Comment 7-16 -- Noise -- real-property values -- not a health issue. See DEIS p. IV.7-4. (a) Losses in property values are not generally considered health impacts, much less a psychological impact. The reasoning that this may cause stress is valid, but obviously the major impact is economic. The discussion of real-estate values should have been in the socio-economic impacts sections where people would be more likely to find it. Because of its present inappropriate location in the DEIS, those who seek a discussion of that particular issue, & who do not read the entire impact statement, or non-relevant portions, are likely to note only the absence of a discussion of diminution of property value, file that comment, only to be told in response to look under the psychological part of the health impacts section. This would prevent them from being able to make substantive comments on the loss of real-estate values absent reading the entire document to find the discussion buried in the "health impacts section". Given that very, very few copies of the 2200 page impact statement are available to the public, it is highly likely that people would comment on only one section. The remedy to this error would be to give those who note the absence of a discussion of real-estate losses as their comments to the socio-economic section (because they did not find it in health impacts) should be told where is buried in the health impacts section and given a 60-day extension for filing additional comments.

R-16-32 R-1-5

(b) Part of this problem might have been avoided if the DEIS had been furnished with a good index. We note that our scoping comments requested an index for the DEIS & the FEIS, which we believe is legally required; no index was provided for the DEIS (& no explanation for its absence). The FEIS should come with a proper index, including entries for the appendices & for persons & institutions whose work is quoted, discussed, or relied on.

R-1-9

R-16-9

Comment 7-17 -- Noise -- Impact on real-estate values. Our substantive comments on the real-estate value issue are found in the section of this paper relating to socio-economic impacts.

Comment 7-18: -- Annoyance (p. 7-2, & seq.) When discussing "annoyance", the impact statement should note that the term "annoyance" is used in scientific circles to rank people's reaction to noise ranging from mild intrusions to physical torture and should not be taken to mean minor or insignificant. It should also note whether the studies only included "highly annoyed" or if they included other measures of annoyance. Furthermore, they should indicate if the study was done on aircraft noise specifically or just transportation noise generally.

Comment 7-19: -- Aircraft Noise & Mental Health (DEIS p. IV.7-2) The DEIS asserts at p. IV.7-2, that there is little "*reliable evidence*" of a relationship between aircraft noise and mental health. The F.A.A. document that the DEIS cites (n.7) is a ten-year-old pamphlet written by a couple of F.A.A. bureaucrats reviewing even older studies. It is also out of print. A great deal of evidence has been gathered subsequent to 1985. We refer you not only our Exhibit 7-1 the data base search since 1991, but also to the 1992 literature review by Drs. Dennis Hansen and Lee Sanders. (See our Exhibit 7-7 at p.6. They report "Studies have shown a marked increase in the use of tranquilizer and sedatives around jet airports [citations omitted] and an increase in the rate of alcoholism and its associated medical problems [citation omitted]. Experts have said that noise heightens aggressive behaviors and dampens helpful impulses which may in part explain an increased incidence of crime & domestic violence in airport communities [citations omitted]. Man studies have shown an increased number of psychiatric admissions from noise-impacted neighborhoods around jet airports. [citations omitted.]

(b) See Also, Kryter, K.D. "Association of Heathrow Airport Noise with Psychiatric Admissions." Psychol. Med. 20:1022, 1990, and Kryter, K.D. "Aircraft Noise and Social Factors in Psychiatric Hospital Admission Rates: A Reexamination of Some Data" Psychol. Med., May 20(2): 395-411, 1990, finding a statistically significant

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correlation between mental hospital admissions and aircraft noise exposure.

Comment 7-20: The DEIS mentions, p.IV.7-3 a controversial British sleep study which has been heevily criticized by the research community and has not yet been given formal publication in any scientific journals nor sujected to peer review--as have large numbers of other studies. For criticism of the U.K. study, see all documents contained in our comment IV.7-C. Also discussed in the same place is an in-progress study being done by the U.S. Air Force which is not yet published and is therefore, not of any use. The British sleep study was done and paid for for the British Civil-aviation agencies in response to pressure from airport operators wishing to expand night flights; and the U.S. Air Force has found its training flight & other activities the recent source of considerable complaint. The sponsors of both studies have an interest in minimizing the impacts of noise from airports.

Sleep problems are among the most frequent complaints from excessive airport noise pollution, and the existence of these two disputed studies does not address the existing sleep problems or potential impacts of nightly disturbance of the sleep of hundreds of thousands of residents (or, the sleep of thousands of day sleepers.) Which residents in the Sea -Tac area will experience noise levels sufficient to disturb sleep. What are the demographics of the population, age, race, sex of those affects by noise levels sufficient to disturb sleep. R-7-7

Comment 7-21: Laboratory studies show fairly consistently that noise disrupts sleep, beginning at about 45 SEL, and awakening large numbers of people at about 60 SEL; 80 SEL is considered to be the level at which people can be awakened inside with the windows closed. The FEIS should at least provide these data.

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Comment IV-7-22 -- Health -- air safety. From the DEIS, the reader would gather that air safety at Sea-Tac is not an issue. Indeed, a reader of the DEIS would wonder how anything could ever go wrong, here or at any other airport under the control of the F.A.A. Yet, aviation accidents do happen, even in the U.S.A., & when they happen, they are sometimes catastrophic. The FEIS should candidly evaluate the safety risks that arise from the present & projected flight paths. We see no indication that flight paths will -- or can -- be significantly altered to prevent large commercial aircraft from flying at relatively low altitudes over the two most populous cities of the western part of the State. What is the statistical risk of large aircraft striking such high, & heavily-peopled, structures as the Columbia Center, Harbor View Medical Center, & the like? Does the F.A.A. have disaster plans for such contingencies? R-16-15

Comment IV-7-23 -- Health -- air safety -- additional considerations. It appears to be a premise of the DEIS that adding more traffic, larger aircraft, faster aircraft at Sea-Tac, at Boeing Field, & so on has no safety implications. We suggest that this premise is faulty, & at the least must be articulated & justified in the FEIS. Larger aircraft imply larger safety "boxes", as do faster ones. The FEIS needs to discuss the consequences to the air-traffic-control system of having aircraft -- more & more of them -- from several different air facilities all avigating in & around the major local airfields, three of which very nearly abut one another. Can the BFI traffic be safely interwoven with the Renton & Sea-Tac traffic, to say nothing of the McChord traffic, under the more-crowded conditions of the foreseeable future? R-16-16 R-3-30

Comment IV-7-24 -- Health -- ground safety. (a) It goes without saying that in terms of ground safety, we & the lead agencies all are concerned about the possible consequences to people on the ground -- innocent bystanders, so to speak -- in the case of a crash. All take-off & landing approaches are over heavily populated areas. The DEIS leaves this question alone, but the FEIS should address it. R-16-15

(b) Another ground-safety concern is the handling of the criss-cross ground traffic of aircraft landing & departing. The FEIS should graphically present proposed control methods to prevent on-ground collisions. The FEIS needs to discuss in straightforward numerical terms what the impacts will be on the efficiency of the third runway if proper procedures are put in place to prevent what some have called 'incursions'.

(c) It would be helpful for the FEIS to tell us all how many other airports in the U.S.A. have both ends of all their runways aimed at major cities, on hills, with lots of tall buildings. We suspect that the Sea-Tac situation is nearly unique -- another good reason, a safety reason, for looking for a more suitable site for the airport that is to meet the regional air travel needs into the foreseeable future. R-16-17

R-16-1

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REPORT ON THE PROPOSED REDUCTION IN NOISE LEVELS
AT THE SEATTLE-TACOMA AIRPORT

Prepared by Alice H. Suter, Ph.D.
for the Regional Commission on Airport Affairs
October 26, 1996

To: PSRC Expert Panel on Noise and Demand/Systems Management

<u>Panel's Request to the Public for Information</u>

This report will address the Panel's request #2: "Detailed descriptions of any technical reasons why achievement of the noise reduction performance objectives of the Noise Budget and Nighttime Limitations Program established by the POS would not be expected to produce a significant reduction in real noise impacts on-the-ground."

The key word in this request is "impacts." The dictionary defines "impact" as "the striking of one body against another" (Urdang and Flexner, 1968). In this case one body is the sound pressure generated by aircraft operations and the other body is the community of individuals living nearby. Interestingly, the Mestre Greve (1994) report commissioned by the Port of Seattle is solely concerned with noise measurement and prediction and makes no mention of the impact on the community. But it is meaningless to describe the details of the noise stimulus without describing its impact on the recipients.

Another significant omission from the Mestre Greve report and in much of the discussion of the noise climate at Sea-Tac is the proposed third runway. The Procedural Order in the matter of the Expert Arbitration Panel quotes Resolution A-93-03 to say that "the region should pursue vigorously ... a third runway at Sea-Tac" and that the third runway "shall be authorized by April 1, 1996 ... (w)hen noise reduction performance objectives are scheduled, pursued and achieved based on independent evaluation, and based on measurement of real noise impacts." This statement implies that the approval of the third runway is an accomplished fact once the Port has established a "significant reduction of real, noise impacts on-the-ground." Although the prospect of the third runway is seldom mentioned by the Port or its consultant, its specter looms over the community and cannot be separated from the impact of existing noise exposure or of that predicted for 1996.

This report will show that the performance objectives of the

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Noise Budget and Nighttime Limitations Program cannot be expected to produce a significant reduction in real noise impact on the community. There are a number of reasons for this:

1. The predicted decreases in ANEL of 1.55 dB and DNL of 2.1 dB may not occur because they are within the margin of error of such predictions.

2. Even if they do occur, these decreases in ANEL and DNL will not be perceptible to residents.

3. The predicted decreases in ANEL and DNL will not produce a significant decrease in adverse effects on the community.

4. Using the DNL metric alone is not sufficient to predict the total impact.

5. The proposed reduction is grossly insufficient because it reduces noise exposures from levels that are unacceptable to levels that are still unacceptable.

1. <u>Margin of error</u>

In her testimony before the Panel, Susan Evans pointed out the well-known fact that aircraft noise exposure *forecasting* is not an exact science. While consultants usually do the best job they can, the outcome is influenced by such a wide variety of factors that the actual levels rarely match the predictions. These factors include the exact mix of Stage II and Stage III aircraft, whether the Stage III aircraft are hush-kitted, re-engined, or manufactured, and if they are manufactured, where they fall in the range of noisy to quiet within the Stage III category. Numbers of operations may also change, as Ms. Evans pointed out, to say nothing of the increased number of operations that could be expected if a third runway were constructed.

Panelists Martha Langeian and Bill Bowlby queried Paul Dunholter from Mestre Greve about the use of the standard noise modeling technique (INM), whether or not it had been tailored to the Sea-Tac airport, and the extent to which it has overpredicted or underpredicted noise levels. Mr. Dunholter replied that it had not been tailored to Sea-Tac, that most aircraft types were actually measured to be within plus or minus 3 dB and that the total DNL was "in the range of 3 dB."

It seems ludicrous to base major policy decisions on a predicted noise reduction obtained using a standard (unmodified) prediction model with a margin of error that is greater than the predicted noise reduction itself. Even if the DNL margin of error were a total of 3 dB, meaning plus or minus 1.5 dB, this margin of error is virtually the same as the predicted 1.55 dB ANEL reduction

and is dangerously close to the predicted average DNL reduction of 2.1 dB.

2. <u>The predicted decrease will not be perceptible.</u>

FICON:

Neither a decrease in ANEL of 1.55 dB nor a decrease in DNL of 2.1 dB will be perceptible to the airport neighbors. This is despite Mr. Dunholter's statement that the FICON document uses "1.5 dB as a threshold of significance [of]... change" and that the FAA uses 1.5 dB as a guideline for the preparation of an EIS. Actually, the drafters of FICON's technical report use a 3-dB *increase* at DNL 60 dB and a 1.5 dB *increase* at DNL 65 dB to *trigger the need for further analysis*. There is nothing in the report to indicate that FICON considers 1.5 dB a significant *decrease* in noise exposure. The report does state that although it is difficult for individuals to detect a 3-dB change, a community would find such a change "clearly noticeable." It cites no scientific evidence to support this point, however, only a personal communication from William Galloway (FICON, 1992).

FAA Order 1050.1 does establish an *increase* in DNL of 1.5 dB in noise sensitive areas as a trigger for further analysis, but the FICON report cites no evidence to support this level. It appears to be a policy decision only, although probably a judicious one because it refers to proposed increases in noise exposure level.

Panelist Bill Bowlby states quite rightly that a decrease from a DNL of 90 to a DNL of 87 would not be particularly noticeable, (even though the sound energy would be cut in half), but the same reduction in DNL could be achieved by cutting the number of operations in half, and this would be clearly noticeable.

Sound energy vs. loudness:

The statement in the Mestre Greve report that a reduction in ANEL of 1.55 dB amounts to a reduction of 30 percent is misleading. When only sound energy is considered, a reduction of 3 dB is indeed a reduction of 50 percent, but people's ears do not perceive the same increments. It is a well known concept in psychoacoustics that it takes a reduction of 10 dB to achieve a 50 percent reduction in loudness (Stevens, 1957, 1972; Zwicker and Scharf, 1965). Therefore, a reduction of 1.55 dB amounts to a reduction of only about 8 percent rather than 30 percent, and it is highly unlikely that anyone would notice it. This is why Mr. Bowlby was correct in his assumption that even a 3-dB reduction in sound energy would not be particularly noticeable, whereas a reduction in numbers of operations would be. In this case, people are responding to something besides DNL.

The same principle holds true for judgements of noisiness, (sometimes referred to as "perceived noisiness"), which have been used to assess peoples' reactions to aircraft noise. Kryter (1984) has found that the 10-dB increase per doubling and halving of noisiness applies up to peak indoor levels of about 80 dB(A), but after that the function becomes somewhat steeper.

What is detectable?

Experiments show that the smallest increment in sound level that people can detect is about 0.5 to 1 dB *in the laboratory*. These loudness judgements are based on the comparison of sounds that occur very close together in time, nearly simultaneously. Investigators have found, however, that after an interval of about one second, the judgements become contaminated by one's ability to remember (eg. Florentine, 1986). If laboratory subjects have difficulty remembering the loudness of *specific* sounds after a period of one second, it goes without saying that it would be impossible to remember such small increments in *averaged* sounds (like DNL) over a period of years, such as from 1990 to 1996. Moreover, as we will point out, these judgements become influenced by much more than one's memory.

The question arises, then as to the size of a change, and specifically a decrease, in average noise level that is detectable by a community. The evidence is not at all clear. For example, Fidell and Silvati (1991) measured the long-term annoyance from noise in the vicinity of the Atlanta airport in the residents of a large number of homes either treated or untreated with acoustical insulation. The authors estimate that the acoustical insulation added about 5 dB to the transmission loss of a typical wood frame structure. The investigation found no significant difference in the annoyance of residents in treated as compared to untreated homes. Therefore, the 5-dB reduction in DNL (at least indoors) was not significant.

With respect to decreases in road-traffic noise, de Jong (1990) reports that in general, no significant effect occurs with minor changes, defined as 3 dB or less, but that a positive effect may be expected if the reduction from noise insulation is 12 dB or more. De Jong points out, however, that since costs are involved in erecting barriers or installing insulation, more noise reduction may be necessary for a comparable decrease in annoyance than if there was a reduction in the source itself. It appears, from at least these limited data, that a reduction of somewhere between 5 dB and 12 dB is necessary to produce a noticeable change in the community's reaction. But a reduction in annoyance is even more unlikely in the present case because of certain non-acoustical factors.

3. <u>The predicted decrease will not result in a significant decrease in adverse effects</u>.

Non-acoustic variables:

The traditional method of evaluating the impact of aircraft/airport noise on communities has been to conduct attitudinal surveys by telephone and, after an analysis of the data, to determine the percentage of the population "highly annoyed" as a function of given levels of aircraft noise in DNL. Research projects in recent years point to the fact that much of the variability in the resulting data is due not only to noise exposure level but to a limited number of attitudinal variables. According to Job (1993), some 60 percent of the variance in group data and only 9-29 percent of the variance in individual data is explained by noise exposure. Much of the rest of the variance is accounted by the following attitudinal factors (Fields, 1993):

1. Fear that an aircraft may crash.

2. A belief that the aircraft noise could be prevented or reduced by designers, pilots, or authorities related to the airlines.

3. An expressed sensitivity to noise.

In his extensive study of these non-acoustic factors, Fields (1993) does not reject the assumption that there will be changes in annoyance following changes in noise level. The point is that any such changes are likely to be greatly influenced by these three factors: fear, perception of preventability, and sensitivity.

The Schultz curve:

The criterion used to predict the percentage of a community that will be "highly annoyed" by given levels of aircraft/airport noise is a function commonly known as the "Schultz curve," named for the acoustical expert who developed it. Schultz (1978) analyzed a number of studies, plotted some 161 data points, and developed a predictive equation based on a regression analysis of these data. The studies included noise from airports, highways, road traffic, railroads, and tram lines.

Recently, a revision of the Schultz curve was published by Fidell, Barber, and Schultz (1991), which added 15 new studies, making a total of 453 data points. The new curve predicts slightly more annoyance than the original curve at a DNL of about 75 dB and below, and slightly less than before above that point. A relatively similar update of the Schultz curve appears in the FICON (1992) report, which we will assume to be the most recent version.

According to the latest version of the Schultz curve, the percentage of those highly annoyed residents exposed to the Sea-Tac baseline ANEL of 74.52 dB would have been 35.52 percent, and the percentage exposed to the predicted level of 72.97 dB in 1996 would be 31.05 percent, a decrease of 4.54 percent. Figure 1 shows the predicted percentage of the population highly annoyed according to year, with ANEL plotted in the upper part of the graph. (The reductions in both parameters are barely noticeable on the graph.)

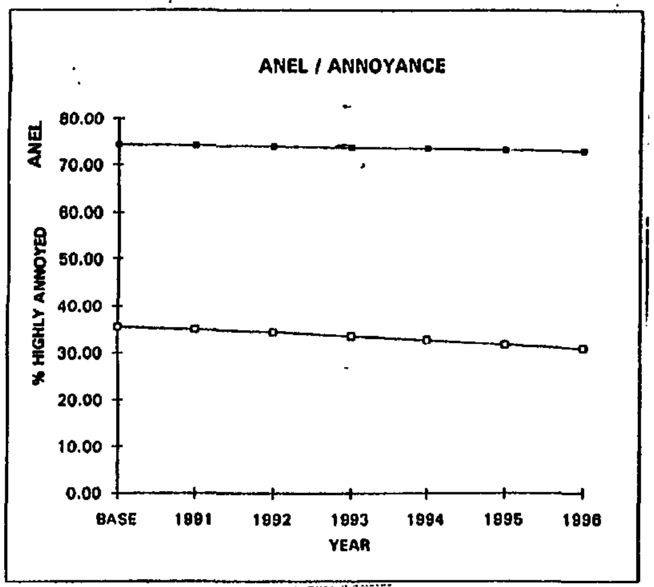

Fig. 1. Percent highly annoyed (open squares) due to corresponding ANEL levels (filled squares). ANEL data are taken from Table 3 of the Mestre Greve report (1994) and the estimated percentages of highly annoyed are calculated from the equation for the updated Schultz curve (FICON, 1992).

These predictions assume that the calculated noise reductions would be realized, that the Schultz curve accurately describes the population highly annoyed, and that any intervening variables would not be important -- three highly questionable assumptions.

In fact, if the community had been surveyed in 1990 and were to be again in 1996, it would be unlikely that there would be any decrease at all in the percentage highly annoyed. This is true, at least in part, because of the magnitude of the contribution of the three attitudinal variables discussed above. In light of the ever-present threat of the new runway, these attitudinal variables are bound to be critical factors, especially the community's perception of preventability.

4. <u>DNL alone is not sufficient to describe the impact</u>.

As many witnesses have testified, the DNL metric does not tell the whole story. While it is useful in making certain predictions, the way it is used has many shortcomings, and the metric itself needs to be supplemented in many cases.

Other descriptors, such as the "Sound Exposure Level" (SEL) and the "Time Above" (TA) statistic are often recommended for specific locations where speech communication is important (FICON, 1992). There are some 29 schools and colleges located within the DNL 65 dB contour, and aircraft noise is bound to have a serious impact on these students and their teachers. This impact must be assessed before any proper analysis of the current or predicted conditions can occur, let alone any ideas about the installation of a new runway. The use of supplemental measures, such as SEL or TA would be necessary for this assessment.

Another critical element in describing the impact is the number of aircraft operations. In many circumstances, people are more likely to notice changes in the number of operations than in the overall DNL. This is due in part to the need to reduce noise level by 10 dB (rather than 3 dB) to effect a halving of loudness or noisiness. A 10-fold reduction in the number of overflights would also amount to a halving of sound energy, but it would be considerably more noticeable and have a much greater benefit. To state it slightly differently, a Stage III plane is typically about half as *loud* as a Stage II plane, even though it puts out only about one-tenth the sound energy (Stewart, 1993).

There are two particular circumstances where people are also likely to notice changes in numbers of operations more than changes in DNL. One is in places like schools, where speech communication is critical and the number of interruptions is at least as important as the sound level and the length of each overflight. Another is in situations where people like to spend time out of doors. Acoustical consultant Noral Stewart has found that in places where people put a high value on enjoying their property out of doors, a single noisy Stage II plane would be preferable to several quieter Stage III planes, even though they might have the same total energy. The reason is that the recipient could "get it over with" and enjoy the period of respite (Stewart, 1993).

This is an important point when considering the impact on the Sea-Tac neighbors, where the beautiful natural setting is a preeminent attraction. With Mount Rainier on one side and Puget Sound on the other, most families in the area want to spend time on their decks. In addition to their homes, residents want to spend recreational and leisure time elsewhere in the impacted area, such as the harbor in Des Moines and the winding paths along the Sound.

Despite their importance, numbers of operations have been omitted from the proposed noise reduction objectives. Perhaps one reason for this is that the Mestre Greve report shows gradually increasing numbers of operations between the base year and 1993, and this trend could very well continue into 1996 and beyond. More importantly, nothing is said about the projected increase in operations that is destined to accompany a third runway.

5. Reducing the levels from unacceptable to unacceptable.

Severity of exposure:

The Port's projections showing shrinking noise contours between 1991 and 1996 look impressive, but the public should not be misled for a number of reasons. First, as mentioned above, the achievement of the 1996 contours is questionable, and even if they are achieved, the projected reduction in ANEL of only 1.55 dB (or 2.1 dB in the average DNL), is not likely to be noticeable. Also, it is important to remember that noise exposure contour lines are not break points, but represent locations on a continuum of noise levels. This means that moving from just inside the DNL 65 dB contour to a DNL of 63 or 64 dB cannot be expected to provide instant relief, and, for that matter, cannot even be expected to be noticeable.

The fact is that very many residents living within the impacted areas will be exposed to extremely high, barely tolerable levels of noise. Even if the predictions turn out to be accurate, the Port estimates that in 1996, 1300 people will still reside within the DNL 75 dB contour, which has been labeled a "severe exposure" and "unacceptable" by HUD, and by FAR Part 150 as unacceptable for residential land use, even after the incorporation of noise attenuation. Schools and other noise sensitive properties will also be located in this area.

If the predictions are correct, nearly 14,000 people will

reside in noise levels above DNL 70 dB, considered "significant exposure" and "normally unacceptable" by HUD. An estimated 44,000 people exposed above DNL 65 dB will reside in areas that are considered "normally unacceptable" by HUD, and, according to FAR Part 150, that are "incompatible with residential or school land uses unless measures are taken to achieve additional noise level reductions." (FICON, 1992)

The impact is more severe than the Schultz curve would predict:

According to the Schultz curve, approximately 31 percent of the exposed population would be highly annoyed at the predicted DNL of 72.97 dB in 1996. But several investigations have shown that the percentage of persons highly annoyed by aircraft noise is considerably higher than that from other types of transportation noise. The Schultz curve, however, includes all types of transportation noise, with the understandable result that there is a large amount of variability around the single regression curve.

Figure 2, from Fidell et al. (1991) shows the authors' version of the Schultz curve using a quadratic fitting function, which they found accounts for 44 percent of the variance. (Note the wide scatter of data points.) The data in Figure 3 (also from Fidell et al., 1991) should help to explain this variability. The data were collected by Canadian researchers (Hall, et al., 1981) who contrasted annoyance from aircraft noise in the vicinity of the Toronto airport to annoyance from road traffic noise. The graph shows the aircraft noise data points and road traffic noise data points plotted alongside the 1978 Schultz curve. This figure clearly shows that annoyance due to aircraft noise is considerably greater than it is for comparable levels of road traffic noise. Fidell and his colleagues (1991) studied the data from several other airports and found that the aircraft noise data points fell substantially above the Schultz curve in nearly every case.

European and other international noise experts have also found that the Schultz curve underestimates annoyance due to aircraft noise. Dutch researcher Passchier-Vermeer (1993) has summarized the results of various studies of transportation noise. Figure 4, from Miedema (1992) (in Passchier-Vermeer, 1993), shows the relative annoyance from aircraft noise (A), highway noise (H), other road traffic noise (O), and railroad noise (R). Aircraft noise is clearly the most annoying. Figure 5, also from Miedema, shows the percent "severely annoyed" as a function of DNL from various noise sources. Aircraft noise is the most annoying transportation noise source, although annoyance from impulse noise appears to be even greater. These annoyance functions are contrasted to the 1978 Schultz curve, shown by the dashed line. At a DNL of 70 dB, the Schultz curve predicts about 25 percent of the exposed population to be severely annoyed, whereas Miedema's data would predict greater than 75 percent.

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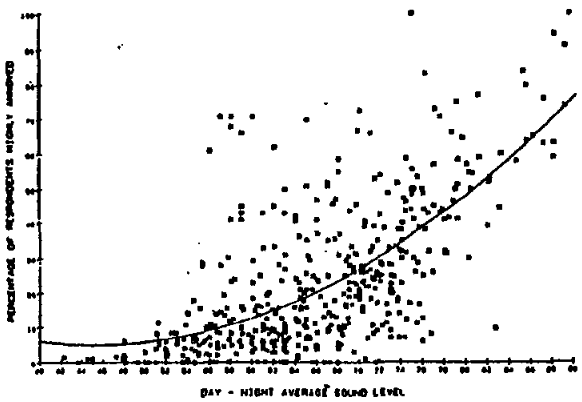

Fig. 2. Updated Schultz curve showing quadratic fit to 453 data points. From Fidell, Barber, and Schultz (1991).

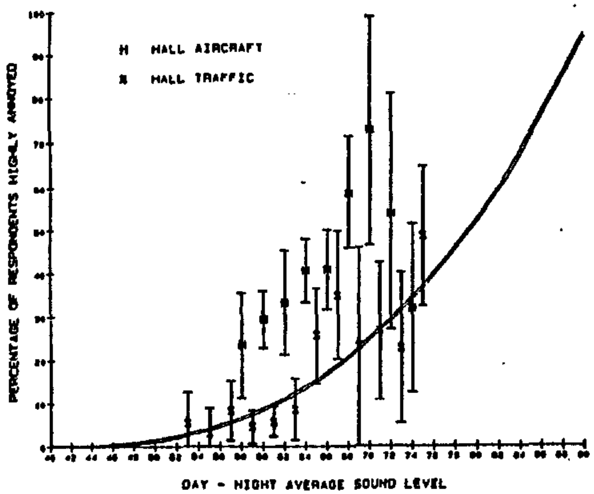

Fig. 3. Relationship among the percentage highly annoyed from aircraft noise (H), road traffic noise (%), and the 1978 Schultz curve. From Fidell Barber, and Schultz (1991).

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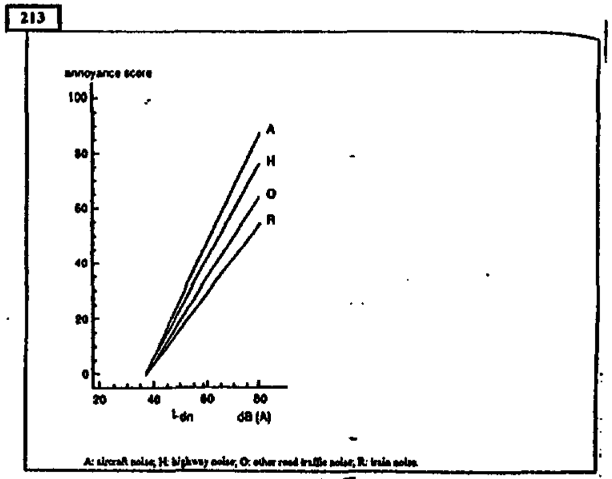

Fig. 4. Relative annoyance as a function of noise level in DNL (L_{dn}) for four types of noise source. From Miedema (1992) as cited by Passchier-Vermeer (1993).

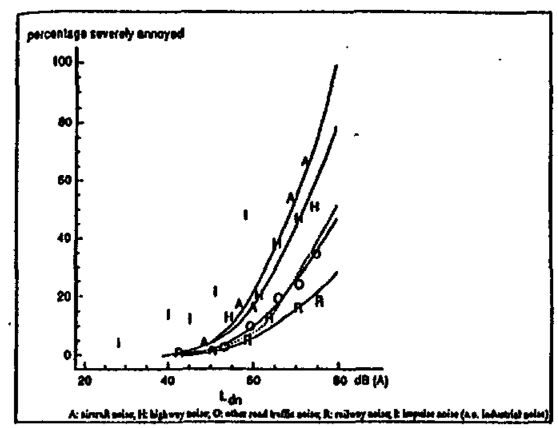

Fig. 5. Percentage severely annoyed by various noise sources as a function of noise level in DNL (L_{dn}). The 1978 Schultz curve is represented as a dashed line. From Miedema (1992) as cited by Passchier-Vermeer. See also Miedema (1993).

Additional research from the Netherlands points to the fact that aircraft noise is more disturbing than other types of transportation noise. A study by de Jong and his colleagues investigated the relative disturbance caused by highway traffic, railroad, and aircraft noise in different activities (de Jong et al., 1992). Table I shows the percentage of people disturbed according to noise level, noise source, and category of activity.

Table I. Percentage of people expressing disturbance during specific activities as a function of 24-hour equivalent sound level (L_{eq}) (from de Jong et al., 1992, translated and cited in Passchier-Vermeer, 1993).

Activity / Noise source	L_{eq} 61-65 dB	L_{eq} 66-70 dB
Talking		
Highway traffic	35	45
Railroad traffic	35	35
Aircraft traffic	75	80
Watching TV		
Highway traffic	25	40
Railroad traffic	60	40
Aircraft traffic	60	75
Listening to the radio		
Highway traffic	20	40
Railroad traffic	45	40
Aircraft traffic	45	50
Reading		
Highway traffic	25	30
Railroad traffic	10	10
Aircraft traffic	30	35
Fear		
Highway traffic	35	40
Railroad traffic	5	5
Aircraft traffic	30	40

The table shows that aircraft noise is more disturbing than the other noise sources in nearly every category and that the differences increase with increasing noise level. For example, at average levels (L_{eq}) of 66-70 dB the percentage of people expressing disturbance from aircraft noise during talking and watching TV was nearly twice that for the other noise sources. For listening to the radio and reading it was also higher, but the difference was not as dramatic. The authors have also included fear as a category, and the responses indicate that the levels of fear

associated with aircraft noise were higher than railroad noise but about the same as highway traffic.

In Figure 6, Passchier-Vermeer (1993) has plotted the percentage of people whose activities are disturbed by aircraft noise (from de Jong, 1992) alongside the percentage severely annoyed by aircraft noise (from Miedema, 1992). These data provide yet another indicator that the percentage "highly annoyed" predicted by the Schultz curve, greatly underestimates the percentage of people adversely affected by aircraft noise. For example, at an average level of 70 dB, approximately 30 percent are highly annoyed according to the Schultz curve, compared to about 60 percent according to Miedema's curve and up to 80 percent disturbed while talking or watching TV. (While it is true that Passchier-Vermeer has plotted her data as a function of 24-hour L_{eq} rather than DNL, the approximate relationship should be the same.)

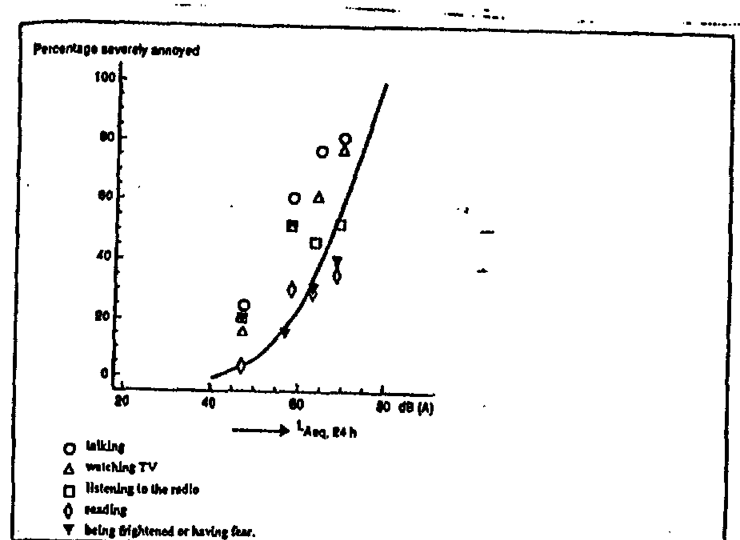

Fig. 6. Percentage severely annoyed (solid line) and the percentage disturbed (data points) by aircraft noise. From Passchier-Vermeer (1993) using the data of Miedema (1992) and de Jong (1992).

In still another recent study of community annoyance, Bradley (1994) found that annoyance from aircraft noise was substantially greater than would have been predicted by the Schultz curve at airports in Canada, Switzerland, the U.K., Norway, Japan, and Australia.

Various reasons have been suggested for the differences between reaction to aircraft noise and to other transportation noise sources. One of the attitudinal factors mentioned above (Fields, 1993) appears to be more directed toward airports than toward other sources: the belief that authorities could prevent the noise. An additional explanation is that aircraft noise is highly intermittent and is therefore less predictable. Several studies have shown that unpredictable noise produces greater adverse effects than predictable noise (eg. Glass and Singer, 1972; Percival and Loeb, 1980). According to a model developed by Canadian researchers (Hall *et al.*, 1985 and Taylor *et al.*, 1987, cited in de Jong, 1990) the differences can be explained by using single events, rather than average noise levels.

Once again, it is clear that DNL does not tell the whole story, especially where aircraft noise is concerned, and that the traditionally used Schultz curve underestimates the impact considerably.

The "highly annoyed" criterion is also an insufficient descriptor of the impact:

Several researchers in psychoacoustics have pointed out that the traditional use of the criterion "highly annoyed" is insufficient to characterize the effects of noise. The use of this criterion has been criticized on the grounds that it is such an extreme measure of community reaction, it treats attitudinal data categorically rather than scaling it, and it fails to analyze the distribution of annoyance (see Job, 1993; Griffiths, 1983). Job (1993) cites the finding by Hede *et al.* (1979) that there are many words that people use to characterize their reactions to noise that do not correspond to "annoyance." Job (1993) points out that "People may react with anger, disappointment, withdrawal, feelings of helplessness, depression, anxiety, distraction, agitation, or exhaustion...." (p. 50) rather than mere annoyance. Thus the inadequacy of the term "annoyance" may account for quite a bit of the unexplained variance.

Perceived control:

Another aspect of reaction to noise that may be closely related to the belief that the authorities could have prevented the noise is that of perceived control over the noise. Studies of the effects of noise on performance and behavior have shown clearly that the severity of human reaction is closely related to one's

control or even perceived control over the noise (Glass and Singer, 1972; Singer *et al.*, 1990). A study of the effects of perceived control over aircraft noise showed a highly significant correlation between perceived control with annoyance scores and a smaller but not statistically significant correlation with subjective health scores (Altena, 1989, cited by Passchier-Vermeer, 1993).

Airports, therefore, provide an ideal example of a situation where, if an expansion occurs against the wishes of a community, feelings of lack of control will be a powerful influence on the community's subsequent reaction.

The components of annoyance and other adverse effects:

It is important to remember that expressions of annoyance, disturbance, or being bothered are not merely "attitudes" but are comprised of specific adverse effects as well as feelings. These effects include interference with sleep, conversation, watching TV, and the enjoyment of one's property. These effects have been described in detail in publications by the U.S. Environmental Protection Agency and others referenced here. (See especially EPA, 1973 and 1974; Passchier-Vermeer, 1993; and Suter, 1992a and 1992b.)

It is clear from research conducted over the years that the noise levels to which the neighbors of Sea-Tac are exposed is producing adverse effects now -- effects that will not be allayed by reducing the average overall level by 1.55 dB. DNLs of 65 dB to higher than 75 dB are excessive. Many years ago the U.S. EPA identified a DNL of 55 dB as necessary to protect the population against the unwanted effects of noise (EPA, 1974). Recent research confirms the findings of the earlier investigations relied upon by the EPA that high levels of annoyance are often generated at levels well below the DNL of 65 dB used by the FAA and its consultants (Fidell *et al.*, 1985; Fidell *et al.*, 1991; Hall *et al.*, 1981; Miedema, 1992).

The levels of noise in the environment around Sea-Tac adversely affect the teaching-learning relationship, as most teachers will attest. They lead to what has been called "jet-pause teaching." Studies show that such levels may be expected to cause decrements in children's reading skills, long-term recall, and tolerance for frustration (Bronzaft and McCarthy, 1975; Cohen and Weinstein, 1981; Hygge *et al.*, 1993).

These noise levels are well above the DNL of 45 dB identified by the U.S. EPA to protect against sleep interference (EPA, 1974), as well as the levels recommended by other experts on the effects of noise on sleep (Griefahn, 1990; Eberhardt, 1987 and 1990; Vallet *et al.*, 1976 and 1990). They increase the chances of awakening from sleep and they diminish sleep quality by causing people to

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shift from heavier to lighter stages of sleep.

With respect to the extra-auditory health effects of noise, no clear dose-response relationships exist at this time, although there is evidence suggesting adverse health effects from high levels of noise in general (Ising and Kruppa, 1993; Peterson et al., 1978, 1981, and 1983; Rehm, 1983) and some evidence implicating aircraft noise in particular (Hygge et al., 1993; Ising and Kruppa, 1993; Knipschild and Oudshoorn, 1977). The current thinking on the subject is that these effects are most likely mediated psychologically, through aversion to noise. This would make it virtually impossible to predict adverse health effects as a function of noise exposure level. The distinct possibility of adverse health effects, does, however, stress the importance of minimizing excessive levels of noise, especially when such factors as preventability and controllability are important contributors.

Summary

It should be clear by now that the performance objectives of the Port of Seattle's Noise Budget and Nighttime Limitations Program will not produce a significant reduction in real noise impact on the community. The predicted decreases in ANEL may not occur because they are within the margin of error of such predictions, but, even if they do, they will most likely be imperceptible to the impacted residents. Decreases in DNL of 1.55 dB (or 2.1 dB) are too small to be noticeable. The statement by the Port's consultant that the noise will be decreased by 30 percent by the year 1996 is misleading, since the ear perceives changes in loudness in much larger increments than the equal energy rule would predict.

The reaction of the community is not likely to change at all between the base year and 1996, and, in fact, may intensify because of the importance of the non-acoustic variables. In the case of Sea-Tac in particular, where there is so much anxiety about the prospect of a third runway and so much skepticism about the responsiveness of the airport authority, non-acoustic factors are destined to play a very important role.

The evidence is also very clear that the use of DNL alone, especially in the form of the Schultz curve, greatly underestimates the adverse reaction of the community. It should only be a matter of time before U.S. scientists discontinue the use of the Schultz curve in its present form for the prediction of community reaction to aircraft noise.

Finally, the Panel must consider that the impact of aircraft noise on the community surrounding Sea-Tac is already excessive. It degrades the quality of teaching and learning, it disrupts

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sleep, it interferes with the enjoyment of property and the natural surroundings, and it causes undue disturbance for literally thousands of citizens every day. The levels experienced by Sea-Tac's beleaguered neighbors are already 10 dB to nearly 25 dB above those recommended by the EPA to protect the public health and welfare. The approval of a new runway on the basis of the ephemeral and inadequate reductions forecast for 1996, or even for 2001, is ill advised and would most likely have a pernicious effect on the community.

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CURRICULUM VITAE

ALICE H. SUTER, PH.D.

Ashland, OR 1993-
Cincinnati, OH 1990-1993
Silver Spring, MD 1982-1988

Provides consultation to federal and local government agencies, corporate medical departments, product manufacturers, unions, consulting firms, trade associations, and attorneys.

Specific areas of consultation have included:

- Hearing conservation program development and analysis
- Noise measurement
- Audiogram interpretation
- Community noise problems
- Effects of noise on hearing
- Effects of noise on speech communication and signal recognition
- Effects of hearing loss on speech communication and the perception of warning signals
- Effects of hearing protectors on speech communication and signal recognition
- Effects of noise on task performance
- Effects of aircraft noise on individuals and communities
- Effects of community noise on the elderly
- Federal and state regulatory requirements
- Worker compensation
- Worker training and education

Provides hearing conservation program development, analysis, and counseling for employers with potentially hazardous noise conditions.

Presents training and refresher courses in occupational hearing conservation for company safety and health personnel.

Develops technical reports on the effects of noise on workers and product users.

Develops educational, informational, and market survey materials in hearing conservation and related areas.

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PREVIOUS EXPERIENCE

Visiting Scientist, Research Audiologist - National Institute for Occupational Safety and Health 1988-1990.

Designed and conducted research on hearing protectors and hearing conservation programs. Provided technical consultation in the development of noise criteria and research programs to other Federal agencies and to other NIOSH divisions. Developed information on noise exposure, hearing loss, and noise control in construction and agriculture. Taught in NIOSH training courses for industrial hygienists, physicians, nurses, and other professionals.

Adjunct Professor of Audiology - Gallaudet University 1983-1988.

Taught a graduate course in audiology entitled "Community and Industrial Audiology".

Senior Scientist and Manager, Noise Standard - U.S. Department of Labor, Occupational Safety and Health Administration 1978-1982.

Directed a team of audiologists, lawyers, and economists in preparation of the amendment to OSHA's noise standard for hearing conservation programs. Managed contracts to study engineering control of noise exposure and noise measurement techniques. Chaired Inter-Agency Regulatory Liaison Group, Subcommittee on Noise. Represented OSHA on an inter-agency task force on worker compensation for hearing impairment.

Senior Bioacoustical Scientist - U.S. Environmental Protection Agency, Office of Noise Abatement and Control 1973-1978.

Developed criteria for noise-induced hearing loss and other effects of noise including the psychological, extra-auditory physiological, performance, and communication effects. While on detail from the EPA to the Aerospace Medical Research Laboratory, conducted original research on the ability of individuals with noise-induced hearing loss to understand speech in various noise backgrounds. Served as Executive Secretary for the Federal Inter-Agency Panel on Noise Effects Research.

Director, Audiometric Assistant Program - National Association of Hearing and Speech Agencies 1971-1973.

Directed a national, pilot training program for supportive personnel in audiology. Organized workshops and developed educational material for audiologists and the lay public on noise abatement and hearing conservation.

Audiology Trainee and Doctoral Student - Veterans Administration Hospital and University of Maryland 1968-1970.

Audiological assessment, hearing aid evaluation, and counseling of hearing-impaired veterans while pursuing doctoral studies in audiology.

Supervisory Audiologist 1965-1968, Clinical Audiologist 1962-1965, Speech and Hearing Therapist 1961-1962, D.C. Department of Public Health.

Supervisory and clinical audiology with preschool and school-age children.

Teacher of the Deaf - Maryland School for the Deaf 1960-1961.

Classroom teaching of first-year deaf children.

EDUCATION

Ph.D., Audiology - University of Maryland - 1977
M.S.Ed., Education of the Deaf - Gallaudet College - 1960
B.A., Liberal Arts - American University - 1959

PROFESSIONAL

Ad Hoc Member:
- Safety and Occupational Health Study Section, National Institutes of Health 1984, 1987

Editorial:
- Echoes, Newsletter of the Acoustical Society of America
  - Co-editor (ad hoc) 1990-1991
  - Editor 1991-Present
- Hearing Conservation News
  - Editor 1984-1988
- Sound and Vibration
  - Contributing Editor 1982-1994

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Honors and Awards:
- Fellow - Acoustical Society of America
- Fellow - American Speech-Language-Hearing Association
- Outstanding Leadership and Service Award - National Hearing Conservation Association
- Outstanding Hearing Conservationist Award - National Hearing Conservation Association

International:
- Delegate to -
  - U.S./U.S.S.R. Task Force on the Urban Environment 1974, 1975
- Invited Lecturer -
  - Audiological Society of Italy and Acoustical Society of Italy 1980
  - Audiological Society of Australia 1988
- Consultant to -
  - World Health Organization 1976, 1978, 1990
  - 3M Korea 1987
  - 3M Japan 1987

National Institute for Occupational Safety and Health:
- Panelist - Proposed National Strategy for the Prevention of Occupational Hearing Loss 1985
- Working Group Member - Hearing Conservation Handbook 1988

National Institute on Deafness and Other Communication Disorders:
- Planning Committee Member - Consensus Conference on Noise and Hearing Loss 1989

Professional Affiliations:

Acoustical Society of America
- Member 1974-Present
- Fellow 1987-
- Executive Council 1986-1989
- Committee on Public Relations 1988-Present
  - Chair 1988-1994
- Technical Committee on Noise 1980-1989, 1991-1994
- Technical Committee on Physiological and Psychological Acoustics 1976-1979

Acoustical Society of America - Cincinnati Chapter
- Member 1989-1993
- Secretary 1989-1990
- Vice-President 1990-1991
- President 1991-1992

American Institute of Physics
- Public Relations Advisory Committee 1990-1993

American National Standards Institute
Acoustical Standards Management Board 1978-1982
Working Group S1-7 Dosimeters 1981-1991
Working Group S3-62 Impulse Noise 1978-1986
Working Group S12-12 Evaluation of Hearing Conservation Programs 1984-1991
Working Group S12-26 Field Effectiveness and Physical Characteristics of Hearing Protectors 1987-1991

American Speech-Language-Hearing Association
Certified in Audiology
Member 1963-Present
Fellow 1993-
Committee on Bioacoustics Standards and Noise Standards 1993-1994
Committee on Hearing Conservation and Industrial Audiology 1978-1980, 1984-1986
Committee on Noise as a Public Health Hazard 1978-1980
Committee on the Status of Women 1974-1975
Chair 1974
Liaison to the Council for Accreditation in Occupational Hearing Conservation 1984-1986
Member - Task Force on Audiology II 1988
Member - Planning Committee and Faculty 1991
Combatting Noise in the '90s: A National Strategy for the U.S.

Council for Accreditation in Occupational Hearing Conservation
Certified Course Director
Board of Directors 1984-1986

National Academy of Sciences/National Research Council Committee on Hearing, Bioacoustics, and Biomechanics
Advisor 1984-Present

National Hearing Conservation Association
Member 1982-Present
Program Chair 1984
Executive Council 1984-1987
Publications Committee 1984-Present

LECTURING AND PUBLIC SPEAKING

Has been guest lecturer in noise and industrial audiology at the Johns Hopkins University, Columbia University, Gallaudet University, University of Cincinnati, Miami University, University of Maryland, University of California at Berkeley, University of Washington, University of Wisconsin, and Towson State University.

Presented testimony to Congress and at public hearings on the federal, state, and local level.

Served as expert witness in various community and occupational noise cases.

Delivered papers on technical, educational, and policy matters to over thirty professional, trade, business, union, and service organizations.

PUBLICATIONS

Articles:

Suter, A. H. (1993). The relationship of the exchange rate to noise-induced hearing loss. Noise/News International, 1, #3, pp. 131-151.

Suter, A.H. (1993). Now is the time to improve OSHA's noise standard. Spectrum, published by the National Hearing Conservation Association, Des Moines, IA, pp. 1-21.

Suter, A.H. (1992). Sorting out the noise issues. In E. Cherow (Ed.) Proceedings of the ASHA Audiology Superconference: ASHA Reports #21. (pp. 33-37). American Speech-Language-Hearing Association, Rockville, MD.

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Suter, A.H. (1983). Outlook for occupational noise regulations in the United States. Proceedings of the 1983 International Conference on Noise Control Engineering (pp. 1239-1242). Edinburgh, U.K.: Institute of Acoustics.

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Books:

Suter, A.H. (1993). Hearing Conservation Manual (3rd ed.), Council for Accreditation in Occupational Hearing Conservation, Milwaukee, WI.

Suter, A.H. (1992). Communication and Job Performance in Noise: A Review, ASHA Monographs No. 28. American Speech-Language-Hearing Assoc., Rockville, MD.

Technical Reports:

Suter, A.H. (1992). The Relationship of the Exchange Rate to Noise-Induced Hearing Loss. Prepared under contract to the National Institute for Occupational Safety and Health, Cincinnati, OH (NTIS No. PB-93-118610).

Suter, A.H. (1991). Noise and Its Effects. Report for the Administrative Conference of the U.S., Washington, DC.

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U.S. Army Human Engineering Laboratory, Aberdeen Proving Ground, MD.

Suter, A.H. (1989). The Effects of Noise on Performance. TM 3-89. U.S. Army Human Engineering Laboratory, Aberdeen Proving Ground, MD.

Suter, A.H. (1989). The Effects of Hearing Loss on Speech Communication and the Perception of Other Sounds. TM 4-89. U.S. Army Human Engineering Laboratory, Aberdeen Proving Ground, MD.

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Suter, A.H. and Franks, J.R. (Eds.) (1990). A Practical Guide to Effective Hearing Conservation Programs in the Workplace. DHHS (NIOSH) Publication No. 90-120. National Institute for Occupational Safety and Health, Cincinnati, OH.

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H.P. Jones

Sleep, noise, and immunosuppression

Dr. K. Altena & Dr. D.G.M. Beersma

Published in:
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Presented at:
"The 6th International Congress on Noise as a Public Health Problem", Nice 1993

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Dear Peter,
Even though the immediate battle is over, this may prove useful in the future.
Yours, Hugh

DR. KLAAS ALTENA

PSYCHOLOOG

Oldeholtpade zondag 10 oktober 1993

Dr. H.P. Jones
HACAN
52, The Vinyard,
Richmond
Surrey, TW10 6AT
England

Dear Mr. Jones,

It took me quite some time before I could find an opportunity to respond to your letter. I am a private psychotherapist and my agenda is overflowing.
In the last months, the discussion on night flights, admissible number and level of noise, is in a last phase. The government is about to make a decision and the prospects are not positive. It means that we might expect L_{Aeq} = 27 as the norm for nighttime noise due to night flights. It means that too many night flights are possible. The departments of Transportation and Environment have formed a Working Group to report on norms and regulations for night flights. And this Working Group has chopsen the norm of L_{Aeq} = 27. Now the discussion is on a political level and it is to be expected that within a few months the standards will be chopsen. There is much resistance in the Netherlands against night flights. Bui the research headed by Ollerhead meant a set back. Proponents of night flights refer to this study to refute arguments of opponents. In scientific circles, however, this report is qualified as not meeting scientific standards. During the conference in Nice (Noise as a Public Health Problem, Nice 5-9 July) the papers presented by the group of Ollerhead met serious criticisms. In his presentation for the congress, Ollerhead spoke of "wounds to be cared for". I can not remember all the separate criticisms, but of course I remember my own. I asked James Horne if he could explain why he relied so much on subjective reports of sleep quality while he in his book "Why we sleep (1988)" rejects these subjective reports as not representing what really happens during sleep. His answer: "I cannot explain" (!). Other criticisms referred to the correlation between wrist movements and interruptions of

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sleep and the sampling method. Generally there was no support for the methodology of using wrist movements as indicators of sleep interruption by night flights. (In a study by Hofman and Kumar for the Department of Environment, the methodology was severely criticized. The co-author of our paper, Domien Beersma, on the relationship between night time noise and the immune system, has in a separate comment the methodology of Ollerhead's research also severely criticized). In the conclusions of the congress (summaries by the team chairs), the research of Ollerhead c.s. was not mentioned.

Domien Beersma and I have written a paper for the congress. I have included a copy of this paper. In team no. 5 of the congress this approach was met with interest and it was concluded that this topic deserved further research. The Duth Society for Sleep-Wake Research has included this paper in the yearbook 1993. Mrs. Hofman of the University of Amsterdam intents to organize a meeting of researchers to discuss the possibilities of research.

If you want a detailed critic, of the study of Ollerhead, my collegue, Domien Beersma, who is a sleep researcher, may be prepared to do so (his adress is in the paper). You can also try to reach Mrs. Hofman (Department of Psychology, University of Amsterdam, Weesperplein 8, 1018 XA Amsterdam, the Netherlands, telephone: 020-5256848.)

Yours Sincerely

K. Altena

SLEEP, NOISE, AND IMMUNOSUPPRESSION

ALTENA Klaas* and BEERSMA Domien G.M.**

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** Academic Hospital, Department of Biological Psychiatry
PO 30.001 9700 RB Groningen the Netherlands

Abstract

This paper reviews evidence concerning the immunosuppressive effects of exposure to nocturnal noise. The purpose is to contribute to the setting of norms. Data will be reviewed which show (1) that aspects of the immune system are tightly connected to sleep processes, (2) that sleep disturbances suppress these aspects and the respective functions of the immune system, (3) that sleep physiology can be disturbed by noise even when subjects are not awakened, and (4) that nocturnal noise can exert immunosuppressive effects. To prevent immunosuppression, nocturnal noise should not exceed 40 dB(A). (L_{Amax} and L_{Aeq}).

SLEEP proceeds from wakefulness via stage 1,2,3, and stage 4 to REM sleep each night. This sequence is cyclically repeated about five times per night for normal adults. Sleep stages 1,2,3 and 4 are also called nonREM sleep; stages 1 and 2 are the lighter sleep stages, stages 3 and 4 the deeper sleep stages (called Slow Wave Sleep, SWS). SWS is characterized by a high proportion of EEG delta waves of low frequency (<4 Hz) and high amplitude (>75 μV); REM sleep is characterized by Rapid Eye Movements, a high frequency low voltage EEG as in the waking state, and muscular atonia.

THE IMMUNE SYSTEM protects against infectious microbial agents, viruses, parasites, bacteria and fungi, that can cause pathological tissue damage. Innate immunity acts as the first line of defence against infectious agents and most potential pathogens are checked before they establish an overt infection. If these first defences are breached, the adaptive immune system is activated and produces a specific reaction to each infectious agent which normally eradicates that agent. The following aspects are related to sleep: Natural Killer cells (NK's) are cells of the innate immune system and have the intrinsic capability to recognize and destroy virally infected cells and tumour cells. They are part of the first line of defence but are also activated by the adaptive immune system, e.g., when T cells of this system react to tumour cells and produce interferon to recruit and activate NK's. Cytokines are molecules which mediate interactions between cells. Interleukins (Il), interferon (IFN), and tumour necrosis factor (TNF) are cytokines that function in the immune system and influence sleep. Interleukines are molecules involved in the communication between cells of the immune system. They activate cells of the immune system. Il-1 and Il-2 activate NK's to cytotoxic (cell destroying) activity. IFN increases the resistance of cells to viral infections.

SLEEP DISTURBANCE IS IMMUNOSUPPRESSIVE. Recent immunological research has found an intimate relationship between sleep and the immune system. Krueger and Karnovsky (1987) concluded that many substances that lead to immune responses also enhance sleep and actually have been found in the brain, suggesting that sleep may be intimately involved in processes that encounter infections. Opp et al. (1992) reviewed evidence on the relationship between microbial infection, cytokines and sleep. They conclude that cytokines modulate sleep, and sleep serves an adaptive function in combating infectious disease. Moldofsky et al. (1986) found a dramatic activity of the immune system, dependent on SWS and consisting of a proliferation and activation of components of the immune system. Before sleep onset, NK cell activity is *increased*. At the onset of SWS there is a peak in the plasma Il-1 activity, followed by a peak in Il-2 plasma activity and about 1 hr later a sharp decline in NK activity. Moldofsky et al. (1989) found that sleep deprivation led to enhanced nocturnal plasma Il-1 and Il-2 like activities. With resumed nocturnal sleep, there was a prolonged decline in NK activity (measured as spontaneous cytolytic activity for human tumour cells). In this experiment the finding was replicated that before sleep onset, the activity of NK increases and drops after onset of *sleep*; it was argued that this decrease might be related to redistribution of NK cells into tissues for immune surveillance and lysis of pathogenic cells. Palmblad et al. (1976, 1979) found immunosuppressive effects in sleep deprivation experiments. Irwin et al. (1992) found a positive relationship between sleep EEG parameters (total sleep time, sleep efficiency, and duration of nonREM sleep) and Natural Killer cytotoxicity in both depressed and control subjects (fig. 1). Sleep efficiency is defined as the ratio of total sleep time to time in bed (%). These findings provide an electrophysiological basis to other studies that found a relationship between insomnia in controls, depressives, persons undergoing stress, and cytotoxicity of NK's. Sleep deprivation also leads to a reduced amount of NK's (Irwin. WF RS-congress, Hawai, 1993).

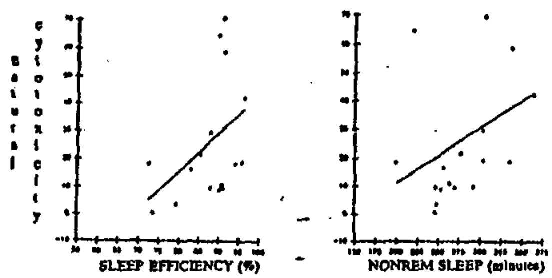

Fig. 1 Correlations (control subjects) between NK cytotoxicity and sleep efficiency (left) and between NK cytotoxicity and nonREM sleep (right); Irwin et al. (1992); figures reprinted with permission from the American Psychosomatic Society (copyright 1992).

NOCTURNAL NOISE CAN CAUSE SLEEP DISTURBANCES. A relationship between peak level, number of noise events and percentage awakenings has been described by Griefahn (1990). Sleep physiology, however, can also be disturbed without awakenings. Short arousals (EEG, ECG, EOG, respiratory response) can be observed in response to nocturnal noise, as well as disturbances of sleep stage distribution. Disturbances of sleep stage distribution generally result in lighter sleep. Osada et al. (1968, 1969, 1972) report a shift to lighter sleep at levels of 40 dB(A) and higher (intermittent and continuous noise). Osada et al. (1974) report a shift to lighter stages of sleep with one or more stages and a decrease in

percentage of high amplitude low frequency EEG with 18 peaks of 30 dB(A) and background noise < 30 dB(A). Eberhardt et al. (1987a) reports a loss of SWS with 50 peak levels of L_{Amax} = 45 dB(A) and background noise level of 27 dB(A); at a level of L_{Amax} = 55 dB(A) an increased awake time and a decrease in amount of REM sleep was found. At a continuous level of 36 dB(A), except for a slight delay in the onset of stage 4, no influence on sleep stage distribution was found. These were results of a laboratory experiment. A study in the normal home environment with subjects exposed to heavy road traffic revealed that a 8 dB(A) *reduction* of noise level by mounting sound-insulating material, resulted in an earlier onset and prolonged duration of SWS (Eberhardt et al., 1987b).

At the level of sleep physiology, responses to disturbing noise can be observed even when the disturbances do not lead to awakenings. Such disturbances appeared to lead to an increased need for deep nonREM sleep (Dijk and Beersma, 1989). Furthermore, it must be noted that after an awakening and after falling asleep again, it takes time to reach the same level of deep sleep as occurred prior to the disturbance. Depending on the intensity of the disturbance, this may take more than half an hour. During this period recovery processes are less efficient than they could have been without disturbance (Achermann & Borbély, 1990).

NOCTURNAL NOISE CAN HAVE IMMUNOSUPPRESSIVE EFFECTS. Osada et al. (1968, 1969, 1972, 1974) found that proliferation of leucocytes during sleep, is inhibited by noise. Osada et al. (1968) found that increases of eosinophils and basophils (subclasses of leucocytes), observed in undisturbed controls, were remarkable inhibited by continuous traffic and factory noise of 40 dB(A). Two types of intermittent noise each half hour for the duration of 5 minutes, produced the same effect (Osada et al., 1969). Osada et al. (1972) found an immunosuppressive effect of train and aircraft noise of 50 or 60 dB(A) (with intervals of onset of 5, 10 or 20 minutes and a total exposure time of 20 min.) and continuous noise of 40 dB(A). (Subjects in this experiment were not exposed to intermittent noise of 40 dB(A)). Number of eosinophils and basophils, and total number of leucocytes decreased during exposition, but their percent changes were not influenced by the type or level of noise. Osada et al. (1974) studied the effects of 18 noise peaks (20 sec. duration each and total exposure time of 6 minutes) with background level < 30 dB(A). Increase of eosinophils and basophils was significantly inhibited by noise exposure even with peak levels of 40 dB(A).

SLEEP STAGE DISTRIBUTION SHOULD BE PROTECTED. Based on sleep stage changes and awakening reactions, most authors recommend a critical level for noise exposure of L_{Aeq} = 40 dB(A) for continuous noise (Eberhardt et al., 1987a, pp. 69-70). Dormolen et al. (1988) conclude that the threshold for sleep arousals is 30 dB(A). Griefahn (1990) concluded that with increasing number of noise events the level at which 10% awakenings result, approaches 53 dB(A) (L_{Amax} indoor level); L_{Amax} at which 10% sleep arousals result approaches 48 dB(A). Ollerhead et al. (1992) concluded that below outdoor event levels of about L_{Amax} = 80 dB(A) (aircraft noise), the awakening rate is 1 in 75. This result is probably due to the recording technique used: wrist movements are supposed to indicate awakenings, while a person can obviously be awake without moving the wrist and a person also can make wrist movements while being asleep. Nocturnal noise which disturbs the distribution of sleep stages, including an increased sleep latency, decreased total sleep time, decreased sleep efficiency and decreased length and intensity of SWS, should be considered a health risk because of direct immunosuppressive effects. EEG-measurement of sleep disturbance below awakening threshold is necessary to relate sleep disturbance to suppression of the immune system; the measurements of number of awakenings is not sufficient to indicate immunosuppressive effects. Data, reviewed in this paper, suggest that the threshold for immunosuppressive effects may lie at about 40 dB(A) continuous and intermittent noise.

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IN THE HIGH COURT OF JUSTICE
QUEEN'S BENCH DIVISION
CROWN OFFICE LIST

Crown Office Ref. No.
CO/2110/93

In the matter of an application by the Council of the London Borough of Richmond Upon Thames and others to apply for Judicial Review (Order 53)

(i) Deponent: W.W.Holland
(ii) First Affidavit
(iii) Sworn:
(iv) Filed on behalf of: the Applicant

AFFIDAVIT OF WALTER HOLLAND

I, Walter Werner Holland of 11 Ennerdale Road, Kew, Richmond, Surrey TW9 3PG, Professor of Public Health Medicine, MAKE OATH and say as follows:

1. This affidavit relates to the Department of Transport's Aircraft Noise and Sleep Disturbance Study which has clearly been an important factor in the decision to which these proceedings relate.

2. The Report of this Study is exhibited as document D in exhibit "CES-1" to Colin Stanbury's affidavit filed in this matter and where appropriate I refer to it in this affidavit as "the Final Report".

3. Besides affidavits filed on behalf of the Applicant, I have also read the affidavits of Roberta McWatt and Dr. John Ollerhead filed on behalf of the Department of Transport.

4. This affidavit is filed on behalf of the Applicant and primarily is by way of reply to Ms McWatt's and Dr Ollerhead's assertions as to the quality of the Sleep Disturbance Study and the reliance that was therefore be placed upon it formulating the decision of 6th July 1993 about new night flight quotas. It also deals with discrepancies between the Final Report and Final Draft of that document. This was a point

first raised by Mr Gould. I understand that the Respondent sought particularising of this and it is convenient to include a list the discrepancies which seem most odd to the Applicant in the exhibit to this affidavit. I also give my views on the significance of this point.

5. The points I make in this affidavit are true to the best of my knowledge, information and belief. To the extent that they are judgemental, they are also based upon experience. I should explain that I am not a noise expert, but am looking at this issue from the more general viewpoint of a public health expert. Noise affects populations in the same way that other public health matters do, and it is entirely valid therefore to express my opinion from this point of view. I have done my best to avoid errors of detail, but the amount and detail of material involved is such that it is not impossible that there are small factual errors. However, as will become clear, the thrust of this affidavit relates to the overall quality of the Sleep Disturbance Study.

6. The bundle now produced and shown to me marked "WWH-1" includes the following further documents. For ease of reference the tab lettering follows the previous exhibits to affidavits filed herein on behalf of the Applicant:

Tab O is a copy of my curriculum vitae.

Tab P contains correspondence which I have had with the Department of Transport and others about the Sleep Disturbance Report:

a.	28.5.93	DTp to Holland.
b.	2.6.93	Holland to Rylander.
c.	2.6.93	Holland to Diamond
d.	4.6.93	Holland to McGregor (Sec. of State for Tpt)
e.	8.6.93	Diamond to Holland
f.	10.6.93	Holland to Diamond
g.	13.7.93	Diamond to Holland
h.	19.7.93	Holland to Diamond
i.	15.7.93	Holland to DTp
j.	22.7.93	DTp to Holland

k. 28.7.93 Holland to DTp
l. 29.7.93 Diamond to Holland
m. 30.8.93 Rylander to Holland

Tab Q contains copies of papers presented at a conference in Nice in July 1993. These are:

a. *Aircraft Noise and Sleep Disturbance: A UK Field Study* by Ollerhead and Jones.
b. *Social Surveys of Night-time Effects of Aircraft Noise* by Ollerhead and Diamond.
c. *Random Effects Models for the Study of Noise Disturbance* by Diamond, Egger and Holmes.
d. *A Field Study of Sleep Disturbance: Effects of Aircraft Noise and Other Factors on 5742 Nights of Actimetrically Monitored Sleep in a Large Subject Sample* by Horne, Pankhurst, Reyner, Hume and Diamond" (Table 3 onwards omitted from exhibit).

Tab R is a full copy of the Final Draft of the Sleep Disturbance Report dated November 1992.

Tab S is a summary of the main differences between the Final Draft of the Sleep Disturbance report and the Final Report itself.

Tab T is an extract from Hansard dated 24th May 1993.

Qualifications

7. I am professor of Public Health Medicine and Chairman of the Division of Community Health at the United Medical and Dental Schools of Guy's and St. Thomas', in the University of London. I have held this post since 1968. I am past President of the Faculty of Public Health Medicine of the Royal Colleges of Physicians of London, Edinburgh and Glasgow. I am past President of the International Epidemiological Association.

8. As Professor of Public Health Medicine I am involved in the execution

of a wide variety of studies of environmental and social factors on health as well as the organisation and planning of health services.

9. Tab O of "WWH-1" is a copy of my curriculum vitae. As this shows, I am a member of a large number of advisory committees both in the U.K. and abroad, including being an Expert Advisor to the World Health Organisation (WHO) on Environmental Pollution and directing a WHO collaborating centre for Research for non-communicable diseases Prevention and Control. I have extensive experience of advising the UK Government's Department of Health on public health issues including the carrying out of studies which influence government policy.

10. With this background it would not be responsible to become involved in proceedings like these unless it was clear to me that there were serious problems with the scientific basis on which the decision in question was being made.

11. It is true that I live in west London and am aware of aircraft noise. It was due to this awareness that I became interested in the proposals to revise the night noise rules and made further investigations about it. However this awareness has no effect on my objective concerns about the Sleep Disturbance Study.

12. I should also say that my concerns arose entirely independently of these proceedings. Tab P contains correspondence which I have had with the Department of Transport and others. I confirm that my views as stated below reflect consideration of the reponses I have received from those I have corresponded with, including Professor Diamond, one of the researchers in the Sleep Disturbance study.

13. Apart from my own concerns about the quality of the Final Report, I also became concerned to learn that this study did not have the universal approval from international experts inferred from the acknowledgements in it.

Summary of concerns

14. In my experience the government, rightly, sets store by the scientific basis on which policy decisions are made. This is confirmed by Ollerhead and Jones (two of the authors of the Sleep Disturbance Study) at the beginning of their paper at Tab Q, (a) of "WWH-1".

15. There are differing views as to the validity of the methodology and conclusions of the Sleep Disturbance Study. This will be evident from the correspondence in Tab P, including Professor Diamond's response to my points in his letter of 29th July 1993. I understand that it is not for the High Court in these proceedings to determine what the correct technical answer is.

16. What this affidavit shows, however, is that there is very serious doubt about the validity of the methodology and conclusions of the Sleep Disturbance Study. In my view it is therefore irresponsible for the government to make such a serious public health decision as it has done having such evident regard to a report like this one.

17. Despite Professor Diamond's letter of 29th July 1993 and the papers given in Nice exhibited at Tab Q of "WWH-1", I believe there are fundamental errors in the design, analysis and interpretation of the Sleep Disturbance Study. These are briefly explained below. Furthermore the correspondence, and subsequent papers, have increased my concerns since there are unexplained discrepancies in the number of events and persons analysed both within and between the reports. The worst example is the mistake in Table 3 of the Final Report of the Sleep Disturbance Study (where "no" and "yes" were transposed in tabulation of key information). The fact that this gross error was not picked up before the report was issued, during the process of checking the Final Draft for factual errors (as explained by Dr Ollerhead in paragraph 14 of his affidavit) shows a degree of carelessness which undermines the credibility of the report. In documents of this degree of importance, such errors are unacceptable. Checks should have been made to pick the error up, not simply before the Final Report, but (I would have expected) long before the Final Draft.

18. There is a further aspect to these concerns which reinforces the doubts which I have. That is that the Final Report of the Sleep Disturbance Study of December 1992 differs markedly from the Final Draft submitted in November 1992. The Final Draft is exhibited at Tab R and a summary of the main changes is at Tab S. Taken individually, many of the differences are in themselves unsurprising, the sorts of differences one often sees between a final draft report and the finished version.

19. However, taken together the changes are significant. I believe that even a casual reader comparing the two would be left with the feeling that what may have been (despite serious technical criticism) a *bona fide* scientific report (the Final Draft) has been edited for the published version (ie. the Final Report) to put it in the best possible light.

20. This is not a point I make lightly. I am not suggesting that the makers and/or final editors of the report have acted in bad faith in the sense of dishonestly suppressing data etc. They presumably knew that an important public policy decision on night flights rested largely on the outcome of their work and wished to put the results of that in as good a light as possible. However, what they have done goes beyond the acceptable bounds of final editing. Dr Ollerhead says in his affidavit that the changes in question were those "considered necessary to correct factual errors, to include additional results or to improve intelligibility and clarity". I agree such changes would be acceptable. However the changes in fact go far beyond that but (as mentioned above) do not even pick up all the errors. In my experience of this sort of work, I have never seen documents altered to such an extent at such a late stage.

Technical concerns – the Final Report

21. My concerns about the Department of Transport's Sleep Disturbance Study are as follows. Unless otherwise indicated, references are to the Final Report at Tab D to the exhibit to Colin Stanbury's affidavit.

22. Professor Diamond's letter of 29th July 1993 does not answer my major

questions. He attempts to answer some of the points by becoming involved in abstruse mathematical theory. The Sleep Disturbance Study has led to an important public policy decision affecting thousands of people. It is vital that the methodology and conclusions of such work should be readily understandable and unambiguous. Such explanations should not be necessary: the report should be clear, on its face, to the intended reader. In this case one would expect it to be clear to reasonably well educated laymen, including the Secretary of State (who was to consider it in making his decision).

Genesis of the report

23. The normal procedure in production of a scientific report is to base the final version on the foundation of sound technical work. In this case, it is clear that that the opposite has happened: the Final Report was produced in December 1992, while making it clear that further technical papers were still in the course of preparation. These presumably included the ones exhibited to this affidavit (Tab Q) which were presented at the July 1993 Nice conference. In due course, they will presumably be subject to peer review and may (or may not) be accepted for publication in established journals. I suspect that part of the reason I, and others, are criticising the Sleep Disturbance Report in the way we are presently is that it simply has not gone through the accepted rigorous screening process that a study of this nature deserves.

24. Dr Ollerhead says that the Sleep Disturbance Study was "probably the most comprehensive study of sleep disturbance in the home ever undertaken anywhere in the world" and the implication of his evidence and Ms McWatt's is that because it was a "big" study it was therefore a reliable one upon which a policy decision could confidently be made. I do not know how this study compares with other sleep research work (as explained, this is not my speciality). However, it is trite to say that in all walks of life, scientific studies included, "big" (or even "biggest") does not necessarily mean "good".

25. In a Parliamentary Answer of 24th May 1993 (Tab T, "WWH—1"), the Minister of State at the Department of Transport, commenting on

whether the present restrictions on night flying would be maintained until after review of the Sleep Disturbance Study by a panel of experts, said that experts had already given advice on the study (this is a matter I refer to below) and that "we expect there will be considerable academic interest and debate on the subject for some time to come". Scientific papers are often subject to continued debate and analysis both before and after they have been peer reviewed and published. So the Minister's statement is not surprising in that respect. What is surprising is that he is prepared to accept the findings of the report not only without peer review, but also as discussed without prior publication, let alone peer review, of the technical papers underlying it. In my view, the Minister's reply in Parliament was therefore glib to the point of irresponsibility.

Site selection

26. The number of sites (2) for each airport are too small and the levels of noise recorded and reported give no indication of the variability both by time and by date (Final Report, Table 4). Comparison of this table with Figure 2, which shows higher noise levels 2 years earlier, demonstrates the need for this.

27. It is unsatisfactory to amalgamate findings at 4 airports. As Professor Diamond states in his letter of 29th July, there is a wide variation in the range of aircraft noise exposure between airports. Although he states there are no intrinsic geographic variations in sleeping behaviour, there are geographic variations in social behaviour, such as time of going to bed, time of last meal, type of housing, furnishing, etc. Thus the design and analysis chosen in the Sleep Disturbance Study restricts the variation of the effect of outdoor noise on individual subjects, because it may be obscured by the variation in exposure between the airports. In view of the small number of sites, it is quite possible that the variation in exposure to noise may be explained by between-airport variance rather than the between-exposure variance. Thus the choice of study sites actually restricts the variance in noise exposure, and in turn the possibility of drawing conclusions from outdoor noise levels from aircraft activity.

Subject selection

28. The method of selection of the individuals on whom measurements were made is obscure. Approximately 200 social survey interviews were undertaken for each site and yet the number of addresses listed is very different for each site – ranging from 669 to 397 (Table 2). It is difficult to understand how the sample was drawn, what questions were asked, etc. In interpreting any survey it is crucial that information is given on precisely how the sample of subjects included at *each* stage has been selected, the precise questions asked by interviewers, and the instructions given to the interviewers. This has never been disclosed, though it has been stated that the subjects were not aware of the purpose of the study.

29. Of the 200 odd interviews at each site, approximately 50 volunteers were interviewed. It is quite impossible to determine the criteria for these. To an epidemiologist like me, the response rates are horrendously low. To pick a final sample of 227 individuals on whom measurements were made, out of an original 3,896 addresses, is strange. This is a response rate of about 6 per cent. I am not aware of a public health decision made on the basis of such a ludicrously small sample chosen in such a curious way. Although the authors defend their sample response, the following figures demonstrate my concerns—

Original interview — 1,636 subjects (1 person per household).

Of these 1,636 subjects, 971 (59%) agreed to take part in the study.

Of these 971 subjects, 614 had a further interview (=37% of original sample).

Of these 614 subjects, 220 agreed to actimetry and EEG (=13% of original sample, and =36% of those who had a further interview).

50 of these subjects had both actimetry and EEG (=3% of original sample).

227 subjects agreed to actimetry only (=14% of original sample, and =37% of those who had a further interview).

30. I am afraid that epidemiologists/public health physicians would not be satisfied with such a low response rate, whether from the initial or the subsequent sampling. In the studies with which I am involved we aim to acieve a response rate of at least 67%. In a recent study of about 250,000 individuals in a *mailed* survey (when one normally expects a lower response rate) we obtained this level of response. In a private census investigation in an inner city area of London, which involved medical examinations, we achieved a response rate of about 99% in a sample of about 10,000. These examples illustrate how low the response rate was in the current study, and therefore how unsatisfactory it is to draw the conclusions that have been drawn from it.

31. It is known that susceptibility to noise is greater in the elderly and in men. The objectives of the study were stated to determine the relationship between aircraft noise and the probability of sleep disturbance. It is therefore curious that the young (under 50) and women are over-represented in the sleep disturbance study compared to those in the social survey.

32. There were other exclusions which further upset the sampling process. For example it was confined to people who were available during the survey period, who were not deaf (no objective measure of this was made), who were not suffering from arthritis or rheumatism which disrupts sleep, and who were not taking (an undefined quantity of) alcohol. In addition it is stated that the 4.4% of subjects were on hypnotics (sleeping pills) were excluded: it is not defined whether these were individuals taking such tablets daily or only intermittently, and (as acknowledged the paper at Tab Q (d), page 10 by Horne *et al*, but not suggested in the Final Report) of course it may have been that such people were taking them to counteract aircraft noise.

Interview methods

33. To a public health researcher of almost 40 years' experience it is

curious that instructions or explanations to participants are not available for scrutiny. It is well known in epidemiological work that the way questions are phrased, and the behaviour (even including dress) of interviewers influences the responses given. I have always been meticulous in making my documents available. I note Dr Ollerhead is critical of the Social Survey at Tab I of exhibit "TJG-1" to Terence Gould's affidavit: but at least the local authorities included their questionnaire in their report.

Individual noise exposure

34. The relations between the noise monitor sites and the individuals participating is not clarified. Although it is stated that all houses were within the given "noise contour" – the validity of this statement has not been checked. (It is also difficult to understand in view of Roberta McWatt's evidence to the effect that no such contours exist for night time noise.) No checks have been made of the difference in noise exposure in different houses. This is particularly important in view of the different types of houses in different areas. Although the authors dismiss this (footnote at page 4 of the Final Report) and consider this as taken into account in the analysis, it reinforces the argument I make in paragraphs 24 and 25 above.

Arousal rates and window state

35. The Final Report discusses the difference in arousal rate between houses with single and double windows, and with open and shut windows. This is illustrated in Figure 56 which shows a clear gradient for arousal between open/shut/single/double windows in noisy compared with quiet conditions. (The point is more obvious in Figure 8.18 of the Final Draft Report, which shows the same information, but uses a different projection in the graphical presentation.) The Final Report dismisses this as "not being of statistical significance". It is elementary in statistics to look at what figures and tables tell you, rather than depending on tests of statistical significance which depend on a variety of factors.

Sample size

36. Although it is stated that the pilot investigation indicated that 50 subjects would be needed at each site, the report nowhere states the rationale for this sample size. Most investigations start off by determining the effect to be identified. For example, if one was looking for a difference in two populations where 50% of subjects were woken in one population, and 0% were woken in the other, the sample size would be much smaller than if one were looking for a difference of say 40% in one population and 30% in another. In relation to aircraft noise, if one were willing to accept that 5% of the population was woken at a noise level of 75 dBA, the sample size would be much greater than if one was looking for an awakening rate of say 30% at this noise level, because of the variability of waking at night. Most statistics textbooks give tables of sample size required to show a given effect. It is curious that the investigators were so imprecise in this respect while using very complex statistical equations for their analyses.

Noise, time and sleep disturbance correlation

37. Both in the Final Report and a subsequent, unpublished paper (Tab Q, (a)) the authors claim that there is a threshold for noise disturbance, i.e. that people are only disturbed if noise is above a certain level. It is not surprising that they make this statement — even though it is both counter-intuitive and different to that of other studies — since they make no measurement below 75 dbA. In fact their graphs (Fig. 50) show a fall in arousal rate as noise increases from 75 dbA and 80 dbA – a very curious finding – on which no comment is made.

38. The authors state (page 34 of the Final Report) that "it is clear from this analysis that in general aircraft noise has a negligible effect upon overall patterns of arousal from sleep" while tables 7 (actimetry) and 4 (noise level) show a correlation. These conclusions are also different from those of the November draft report at page 26—

- "aircraft events with the highest noise levels, say greater than

95 dbA max, have a greater than average chance of disturbing sleep, perhaps 50–100 per cent greater".

- "Individual variations in noise sensitivity are important, two or three per cent of people are more than twice as likely to be disturbed by aircraft noise as the average person".
- "At particular times of sleep i.e. during periods of sleep lightenings, noise disturbance rates are around twice the average".

39. It is strange for Professor Diamond to dismiss this correlation in his letter of 29th July. The tables show a higher average rate of actimetry activity (which he correlates with awakening) in those areas with higher noise levels. The variation is about 31% (6.97 to 4.79) in actimetry. The noise exposures to aircraft Leq are highest at this site (HGN); other noise exposures are also higher at most times but not to the same extent. The site with lowest mean actimetry (SWM) also has lower aircraft Leq in Table 4 (there it is 64.2 at HGN, and 49.6 at SWM, a difference of 23%). This cannot be dismissed and demonstrates the fallacy of trying to amalgamate findings for different airports. A far better analysis would be to examine the variability between aircraft noise and sleep disturbance at each airport individually.

40. The Final Report summary states (page xiv, para 21) "that sensitivity to aircraft noise seems to diminish at the end of the nights' sleep". However page 23 of the Final Report states "a major focus of the analysis has therefore been to control for the powerful confounding effects of individual variations in arousability". Pages 26 and 27 state that arousals are greater in the morning, yet the Ollerhead and Jones study (Tab Q, paper (a), page 49) states that it "controls for time of night". It is necessary to show that the time of night is related to the probability of being disturbed in the absence of aircraft noise, or at the very least that there is no interaction between time of night and noise, otherwise one may adjust out some of the effect of aircraft noise in the early morning.

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Aims of the study

41. The aims of the analysis, and thus the conclusions, are confused. Were the authors concerned with establishing the proportion of people affected by aircraft noise, or at what levels of aircraft noise people are affected? The authors describe between-subject variation — but this is irrelevant, as one is only concerned with the probability of a subject being disturbed relative to his or her baseline level of disturbance at minimum noise level. A *within*-subject analysis is required (and has not been done) as it would not make assumptions about how to describe *between*-subject variation. The essential question is not the variation in arousal in a population of different individuals in different areas exposed to different levels of noise (between-subject variation) but the variation in any single individual to being aroused at different noise levels.

Validation of actimetry

42. The so-called objective method of sleep disturbance used (wrist movements, actimetry) have been validated against "sleep-EEG" (measurement of brain activity). This validation is, however, very small, only 6 out of 50 subjects at each of 8 sites. The 6 "sleep-EEG" cases were studied during 4 nights each, while the 50 actimeter cases were studies for 15 nights each. The statistical, analytic base is thus very small considering the large amount of intra- as well as inter-variability of both EEG and actimetry. The results of the validation are reported to be quite uncertain – that is 40 ±10 per cent of the arousals actually represent awakenings. As an epidemiologist concerned with the use of physiological measurements in field situations on many occasions I would not have accepted instruments of such low validity. To explain this point, if any two tests correlate on only 50% of occasions this implies that the correlation can occur by chance. Thus the results of the validation (Final Report, page 18) do not confirm that they are any better than would occur by chance.

43. The approach of the study's authors, including Dr Ollerhead (para 12) is that actimetry is used because it is a "very efficient" way of

measuring arousals from sleep. It may be *cost* efficient, but that is not the same as saying it is satisfactory from a scientific point of view. It may be that it can be validated to show that it is indeed a satisfactory method. But in the absence of that, it may be as or more "efficient" to rely on refinements to traditional methods eg. subjects keeping diaries of sleep disturbance. I have specific experience (in the field of lung disease) where, despite fears that it would not work, subjective measurement turned out to be just as good as objective measurement.

44. When originally preparing this affidavit, I observed that it was very strange that the report does not examine what seemed the most curious finding that while on the basis of actimetry only about 5 per cent of arousals are attributed to aircraft noise, Table 3 shows that 77 per cent of the sample included in the actimetry study "were awakened at night by aircraft noise" and 91 per cent had made a formal complaint. As discussed above, I now realise that this was a result of an error, but even considering the table correctly written, with 23% having been woken by noise, this is still nearly five times more than the actimetry studies suggest and therefore warrants further investigation. In his affidavit (para 6(d)) Dr Ollerhead says that the subjective and objective findings are "not inconsistent". I do not think it proper thus to disregard such a substantial difference. Incidentally I can positively confirm that the copy of the Final Report which I obtained did not have any erratum slip in relation to Table 3.

45. Thus the definition of sleep disturbance used in the Final Report is incompatible with the operational definition in terms of awakenings due to the low validity of the actimeter measurement of wrist movements as indicative of awakenings. The authors of the Final Report assume that actimetry is a valid measure of awakening. Yet in their comparison of actimetry and EEG, they show a poor correlation. Further their conclusions of awakening and response to a subjective questionnaire (see above) are so different that one wonders whether such a conclusion is valid.

<u>Other experts</u>

46. The report states in the Preface "of great importance to the study was the advice freely given by a number of eminent experts on sleep, most of whom attended a three-day seminar in the spring of 1992 to discuss the problem in detail". Purely by chance one of these is known to me, Prof. R. Rylander of the Department of Environmental Medicine, University of Gothenburg, Sweden. I wrote to him (Tab P) to determine whether my concerns were justified and subsequently spoke with him by telephone. I was surprised when he told me that he had attended the meeting and that the visiting scientists were not informed that the study would be used to determine the frequency of night flights. He said that many of the visitors thought that the study was inadequate, used poor methods to determine sleep disturbance, and was inappropriate. He said that if he had been told that this study would be used for policy formulation he would have been even more critical. He also said that some of the people mentioned in the preface to the Final Report did not even attend the seminar, though they were invited. This is confirmed in the Department of Transport's letter of 22nd July (Tab P). In view of this, I am most surprised by the comments about expert support in paragraph 17 of Dr Ollerhead's affidavit. Prof. Rylander confirmed his views in a recent letter (Tab P).

Discrepancies — Final Draft and Final Report

47. A summary of the main differences with comment on individual points where applicable is at Tab S. I did not prepare this summary myself, but it and the questions/comments raised reflects in detail the overall impression one has of the Final Report. As mentioned above, it is not so much the individual points which concern me (though some are significant), but rather the effect that these have on the tone of the Final Report, particularly considering the purposes to which it was intended to be used.

Conclusion

48. I consider on the basis of the above review that the "Report of a Field

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Study of Aircraft Noise and Sleep Disturbance" is seriously flawed both in terms of the population investigated, the methods of noise exposure measurement and the methods of measurement of sleep disturbance. There are also serious flaws in the design of the analysis which neglect to take into account subject variability, and to adjust for factors known to influence arousal (and thus minimises the "effect" of noise).

49. Important errors in proof reading, the omission of a number of crucial findings from the final draft and changes between the final draft and final report, and the curious position of the expert panel featured so prominently in the Preface to the Final Report, raise serious issues of scientific values/integrity.

50. As a public health physician involved in advising national and international authorities on the formulation of policy concerned with the protection of public health, I would not consider that this study meets the commonly agreed criteria for execution and acceptance of the conclusions. I am surprised and shocked that the Department of Transport is buttressing its policy on such a study.

Sworn at

This day of 1993

Before me,

Solicitor

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Crown Office Ref. No.
CO/2110/93

IN THE HIGH COURT OF JUSTICE
QUEEN'S BENCH DIVISION
CROWN OFFICE LIST

In the matter of an application for Judicial Review

The Queen -v- The Secretary of State for Transport

Ex parte: The Council of the London Borough of Richmond Upon Thames and others

AFFIDAVIT OF BIRGITTA BERGLUND

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Ref: RMB

Solicitors for the Applicant

IN THE HIGH COURT OF JUSTICE
QUEEN'S BENCH DIVISION
CROWN OFFICE LIST

Crown Office Ref. No.
CO/2110/93

In the matter of an Application for Judicial Review

The Queen –v– The Secretary of State for Transport

Ex parte: The Council of the London Borough of Richmond Upon Thames
The Royal Borough of Windsor and Maidenhead
Tandridge District Council
The London Borough of Hillingdon
Slough Borough Council

(i) Deponent: B. Berglund
(ii) First Affidavit
(iii) Sworn:
(iv) Filed on behalf of: the Applicant

AFFIDAVIT OF BIRGITTA BERGLUND

I, Birgitta Berglund, University Professor, of the Department of Psychology, Stockholm University, S-106 91 Stockholm, Sweden MAKE OATH and say as follows—

1. This affidavit is filed on behalf of the Applicant. I make it in reply to assertions, which I understand have been made in affidavits filed on behalf of the Respondent, that the Department of Transport's *Report of a Field Study of Aircraft Noise and Sleep Disturbance* ("the Study") published in December 1992 provides reliable evidence about the effects of noise on sleep.

2. The bundle which is now produced and shown to me marked "BB-1" contains two documents:

- A copy of my *curriculum vitae.*

- A brief report which I prepared on this matter earlier in the year.

3. I confirm that what I say in this affidavit is true, or, in context, is true so far as I am able to judge based on my knowledge and experience.

Qualifications

4. I am presently Professor of Environmental Psychology at the University of Stockholm, Sweden. My speciality is the effects of noise. I am frequently consulted by organisations such as the Swedish Building Research Council, the Nordic Noise Group and the Swedish Environmental Protection Board on matters associated with environmental noise standards and the effect of noise on human beings, and how such effects can be controlled and avoided.

5. I am a consultant to the World Health Organisation and I have recently led a WHO team of scientists investigating and drawing up a new WHO Environmental Health Criteria Document which defines new standards on community noise exposure.

6. From 1988 to July 1993 I was the Scientific Secretary of the International Commission on the Biological Effects of Noise (ICBEN). I was honoured to be made President of the ICBEN at its convention in July 1993 in Nice.

Background to my involvement with this matter

7. During May 1993 the Knutsford and Mobberley Joint Aircraft Action Group (which I understand is interested in environmental matters at Manchester Airport) asked me to carry out a scientific review of the Study. A copy of my report is in exhibit "BB-1".

8. That report was not intended to be a full "peer review" of the Study. That would have been a much bigger exercise, and I would have

involved other experts in the field. All I was asked to do was examine the Study in a relatively superficial way and advise the Manchester group whether I saw problems with it.

9. It will be clear from reading my report that I was very concerned about the methodology and conclusions of the Study. The report of a study of this magnitude and importance should be rigorously peer-reviewed before publication, and especially before it is used for basing a policy decision on such an important issue as the effects of aircraft noise on the residents of and around London. That was not done. Several papers linked to the Study were presented at the recent ICBEN conference. However none of these have been peer-reviewed either.

10. In view of what I concluded from my earlier report, I am doubtful that the report of the Study would in fact stand up to peer-review.

11. Anyway, I repeat that in my opinion it would be mistaken for the UK Government to consider using the report of the Study as a basis for policy formulation before independent experts have accepted it as valid.

Sworn at

This day of September 1993

Before me,

British Embassy/consular official

August 1993 (8 pages)

BB-1

ABRIDGED CURRICULUM VITAE

Personal History:

Name: M. Birgitta Berglund

Current position: Full Professor of Environmental Psychology

Business address: Department of Psychology, University of Stockholm, S-106 91 Stockholm, Sweden

Research affiliation: Institute of Environmental Medicine of the Karolinska Institute

Telephone: +46 8 16 38 57 (office)

Telefax: +46 8 16 55 22 (office)

Birth date: April 19, 1942

Education:

1967 Filosofie kandidatexamen (B.A.), Social Science Faculty, Stockholm University, Sweden

1971 Filosofie doktorsexamen (Ph.D.) in Psychology, Stockholm University.

1973 Docent in Psychology, Stockholm University [The Title of Docent corresponds approximately to U.S. Associate Professor qualification.]

1976 Declared competent as Full Professor in Psychology at the University of Uppsala, Sweden.

Academic Appointments:

1971-76 Research Assistant Professor in Sensory Psychology, University of Stockholm (personal chair from the Swedish Council for Social Science Research). (6 months in 1975 Full Professor of Applied Psychology & 3 months in 1976 Full Professor of Psychology; both during sabbatical leaves).

1976-80 Research Associate Professor in Sensory Psychology, University of Stockholm (personal chair from the Swedish Council for Research in the Humanities and Social Sciences).

1980-86 Research Associate Professor in Environmental Psychology, Swedish Council for Research in the Humanities and Social Sciences (contract for offices and laboratories with the Department of Psychology, University of Stockholm).

1986- Full Professor of Environmental Psychology, Department of Psychology, University of Stockholm (personal chair from the Swedish Council for Building Research).

1981-88 Research Director of the Unit of Dwelling Hygiene, Department of Hygiene, Swedish National Institute of Environmental Medicine, Stockholm, Sweden (by affiliation).

1988- Research Director of the Unit of Psychology, Institute of Environmental Medicine of the Karolinska Institute, Stockholm, Sweden (by affiliation).

Area of Academic Specialization:

Basic Research: Experimental Psychology; Perception; Sensory Processes; Sensory Dysfunction; Audition, especially Psychoacoustics; Chemical Senses; Cutaneous Senses; Psychophysics and Scaling, including Multidimensional Scaling.

Applied Research: Environmental Psychology; Community Noise; Indoor Air Quality; Outdoor Air Pollution; Industrial Psychology; Methods of Field Experimentation; Questionnaire Techniques; Methods for Quality Assurance.

Basic research interests focus on psychophysical studies in various sensory systems: audition, olfaction, vision, and the skin senses. There is an emphasis on the functional processes and their use for applied research on physical environmental problems such as community noise, odorous air pollution, and indoor air quality. General concern is to establish limit values for physical quantities not only from a toxicological point of view but with regard to adverse sensory reactions, human comfort and health. The main goal is to reveal early signs of dysfunction due to potential hazards in the environment. A second area of concern is to develop scaling methods for measuring perceptual attributes that are possible to calibrate as well as standardize. Allied basic research interests are in temporal effects on perception and effects of combining various sensory stimulations, such as sound mixing or mixing of chemicals.

Creation of Research Laboratories. (1) A Psychoacoustical Laboratory at the University of Stockholm with equipment specialized for community noises with regard to sound generation, sound measurement and sound reproduction (digital technique, stereo, large dynamic range) and (2) Indoor Air Quality Laboratories at the University of Stockholm and the Karolinska Institute with equipment specialized for low concentrations of volatile organic compounds. Generation of gases by olfactometric technique, chemical analysis and sampling and exposure of air at ppb concentrations. Hood and chamber exposures for humans. Stationary as well as mobile laboratories.

Research Grants:
Since 1972, research grants from the Swedish Council for Social Science Research, the Swedish Council for Research in the Humanities and Social Sciences, the Swedish Council for Building Research, the Swedish Environment Protection Board, the Swedish Work Environment Fund, and the Swedish Council for Planning and Coordination of Research.

Visiting Guest Researchers:

1975-76 Professor Gary B Rollman, University of Western Ontario, London, Canada (12 months). Research in *"Pain Perception and Psychophysical Methods"*.

1977 Grant for Visiting Researcher Professor Martha Teghtsoonian, Smith College, Northampton, MA, USA (6 months). Project on *"Human Perception of Space and Behavior"* from Swedish Council for Building Research.

1978-79 Professor Eugene Lechelt, University of Alberta, Western Ontario, Canada (12 months). Research in *"Skin Perception and Psychophysical Methods"*.

1982- Professor Trygg Engen, Brown University, Providence, RI, USA, (1982: 6 months, Fulbright fellow; 1983-85: 6 months in 1-month periods; 1987 and on 1 month each year). Research in *"Olfactory Perception with Clinical and Environmental Applications"*.

1983-92 Professor John C Baird, Dartmouth College, Hanover, NH, USA (1-3 months visits each semester; 1991-92: 12 months). Research in *"Signal and Pattern Analysis in Sensory Systems (Audition & Olfaction)"*.

1985-86 Professor Elliot Noma, Rutgers University, New Brunswick, NJ, USA (2 months per semester). Research in *"Model Development for Pattern Recognition and Interaction Processes in Sensory Systems"*.

1987-90 Professor Anna Preis, Institute of Acoustics, A. Mickiewicz University, Poznan, Poland (1 month each year). Research in *"Psychoacoustical Approaches to Annoyance"*. [In July 1990, Preis joined the staff of the University of Stockholm as Research Associate Professor, a personal chair from the Swedish Environment Protection Board in "Psychoacoustics and Community Noise"].

1988 Professor Sonoko Kuwano and Professor Seiichiro Namba, College of General Education, Osaka University, Japan (1 month). Research in *"Psychoacoustical Approaches to Noise Varying with Time"*.

1991 Dr. Jan Jarzecki, Institute of Acoustics, A. Mickiewicz University, Poznan, Poland (1 month). Research in *"Acoustical Measurement"*.

1992 Professor Rufin Makarewicz, Institute of Acoustics, A. Mickiewicz University, Poznan, Poland (1 month). Research in *"Sound Propagation and the Perception of Environmental Sounds"*.

1992-93 Dr. Piotr Miecznik, Institute of Acoustics, A. Mickiewicz University, Poznan, Poland (9-month stipend from Swedish Institute; 2 months visit). Research in *"Perception of Intermittent Sounds"*.

1994 *Forthcoming*: Dr. Soames Job, Department of Psychology, Sydney University, Australia (6-month stipend from Swedish Institute). Research in *"Questionnaire Techniques for Annoyance Surveys"*.

Supervisor for Doctoral Dissertations:

1974 Leif T Svensson "Relativity and Additivity in Olfactory Perception", University of Stockholm [First position: Assistant Professor, Umeå University, Sweden].

1981 Sarah S. Knox "Biofeedback of Alpha: Methodological Aspects and Theoretical Considerations", University of Stockholm (Positions: Research Assistant Professor, University of Stockholm; 1986 Research Associate Professor, Department of Psychiatry, Lafayette Clinic, Detroit, Michigan, USA].

1987 Richard Ahlström "Environmentally Induced Sensory Dysfunction", University of Stockholm [Positions: Research Director of Sensory Analysis, Swedish Food Research Institute, Gothenburg, Sweden; Associate Professor, University of Sundsvall/Härnösand, Sweden].

1988 Lennart Högman "Theory and Methods of Near Threshold Odor Psychophysics", University of Stockholm [Positions: Research Assistant Professor, Swedish Food Research Institute, Gothenburg, Sweden; Associate Professor, Stockholm University, Sweden].

1992 Lena Lundin "On Building Related Causes to the Sick Building Syndrome", University of Stockholm [First position: Private Consulting].

1992 Steven Nordin "On Psychophysical Evaluation of Olfactory Sensitivity in Health and Disease", Stockholm University [First position: Post-doctoral fellowship, Nasal Dysfunction Clinic, Division of Head and Neck Surgery, University of California at San Diego, CA, USA].

1993 *Mats J. Olsson* "The Perception of Odors in Interaction", Stockholm University [First position: Post-doctoral position, John B. Pierce Laboratory, Inc., and Yale University, New Haven, CT, USA].

1993 Krystyna Rankin " Differential Effects of Context on Intensity Judgements of Taste and Smell: Perceptual Change or Judgemental Bias", Stockholm University [First position: Post-doctoral position, Monell Chemical Research Center, Philadelphia, PA, USA].

Teaching:
Graduate courses (1971-) in "Environmental Psychology", "Sensory Psychology", "Stimulation and Registration Techniques in Sensory Psychology", "Indoor Air Quality", "Community Noise", and "Environmental Psychophysics", University of Stockholm. Research seminar series on (1975-79) "Perceptual Research and its Applications" and on (1982-88) "Risk Analysis in Environmental Psychology and Physiology", University of Stockholm, Karolinska Institute and the Swedish National Institute of Environmental Medicine, Stockholm, Sweden.

Organizer of Conferences:

International Symposium "Environmental Hazards and People at Risk" within the IAAP Congress in Applied Psychology, Edinburgh, Scotland, July 26-29, 1982.

Nordic Conference "Adverse Effects of Noise" for the Nordic Noise Group of the Nordic Council of Ministers, Stockholm, Sweden, July 6-7, 1983. (ca. 25 participants)

International Conference "Adverse Effects of Community Noise - Research Needs" for the Nordic Noise Group of the Nordic Council of Ministers, Stockholm, Sweden, November 14-17, 1983. (26 participants).

International Conference "Fechner Day '86" for the International Society for Psychophysics (ISP), Cassis, France, October 20-22, 1986. (ca 40 participants)

International Conference "Adverse Effects of Aircraft Noise" for the Nordic Noise Group of the Nordic Council of Ministers, Stockholm, Sweden, April 6-8, 1987. (17 participants)

The "5th International Congress on Noise as a Public Health Problem - Noise '88" (B. Berglund, U. Berglund, J. Karlsson & T. Lindvall) for the International Commission on Biological Effects of Noise (ICBEN) and the Nordic Noise Group of the Nordic Council of Ministers, Stockholm, Sweden, August 21-25, 1988. (500 participants)

Invited Colloquia:

University of North Dakota, Grand Forks, ND, USA, March 1972.

University of Montana, Missoula, Montana, USA, March 1972. (Public lecture)

Thurstone's Psychometric Laboratory, University of North Carolina, Chapel Hill, NC, USA, April 1972. (Public lecture)

Department of Environmental Psychology, City University of New York, USA, May 1972.

WHO Psychosocial Center, Karolinska Institute, Stockholm, January 1975.

Department of Psychology, Northeastern University, Boston, MA, USA, May 1978.

Noise Effect Branch, NASA, Langley Fields, VA, USA, May 1978.

Department of Psychology, Uniformed Services University of the Health Sciences, Department of Defense, Bethesda, ML, USA, May 1978.
ASEA Research Inc., Västerås, Sweden, April 1984.
Harvard School of Public Health, Boston, MA, USA, March 1985.
Science Center, Osaka University, Osaka, Japan, October 1986.
Institute for Water, Soil and Air Hygiene, Berlin (West), November 1986.
Georgia Institute of Technology, Atlanta, GA, USA, September 1988.
Institute of Environmental and Occupational Medicine, University of Aarhus, Denmark, August, 1989.
Helsinki University of Technology, Finland, February 1990.

Professional Expert Function in Organizations:

1977-90 Chairman (1984-) and Member of the Doctoral Dissertation Committee, the Faculty of Social Sciences, University of Stockholm.
1978-83 & 1988-93 Invited Member of the International Noise Team No. 6: "Community Response to Noise" at the International Commission on Biological Effects of Noise (ICBEN).
1982-86 European coordinator for the Division of Environmental Psychology, International Association of Applied Psychology (IAAP).
1983-91 Chairman (1991) and Member of the Scientific Committee for Noise, Research Division, Swedish Environmental Protection Board.
1983-87 Member of the Research Delegation, the Research Department, Swedish Institute of Occupational Health and Safety.
1985-87 Temporary scientific advisor for World Health Organization for a working group on "Air Quality Guidelines for Certain Malodorous Air Pollutants"; a working group on "Formaldehyde"; and a working group on "Indoor Air Quality: Organic Pollutants".
1986- Vice President (1990-) and Member of the Executive Committee of the International Society for Psychophysics (also one of the Founders in 1985).
1987-93 Governmental representative for Social Science Research in the Board of the National Institute for Occupational Health, Stockholm, Sweden.
1988-91 Govermental representative for Social Science Research in the Board of the Research Division, Swedish Environmental Protection Board.
1988-98 Chairman (1993-98) and Secretary (1988-93) of the International Commission on Biological Effects of Noise (ICBEN).
1988-89 Scientific expert of the Advisory Committee on Energy and the Environment (for its general position paper, July 1989), the American Society of Mechanical Engineers, Washington D.C., USA.
1989-92 Scientific expert of the Committee of Environmental Health, the American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE), Atlanta, USA.
1990-94 Scientific Expert and responsible for draft of forthcoming "Environmental Health Criteria Document on Community Noise" (B. Berglund & T. Lindvall) for the World Health Organization.
1990- Member of the Executive Committee of the International Association of Applied Psychology (IAAP).
1990- Member of the Research Department, The University of Falun/Borlänge.
1991- Vice President (1993-) and Secretary (1991-1993) of the International Academy of Indoor Air Sciences (also one of the Founders in 1991).
1991- Member of the Nordic Noise Group of the Nordic Council of Ministers.
1991- Member of the Board of the Scientific Colour Council, Stockholm, Sweden.
1992- Governmental representative for Social Science Research in the Board for Energy Development, Swedish Council for Industrial and Technical Development.

Editoral Work, Reviews for Journals & Reviews for Grant Proposals:

Guest Editor for the interdiciplinary scientific journal Environment International, 1986, vol. 12 and 1989, vol. 15: both special issues on "Indoor Air Quality".
Guest Editor for Environment International, 1990, vol. 16: special issue on "Public Health Implications of Environmental Noise", and, 1991, vol. 17: special issue on "Healthy Buildings".

Member of the Editoral Board of (1981-90) Journal of Environmental Psychology (Academic Press), (1988-) Environment International (Pergamon Press), and (1990-) Indoor Air–International Journal of Indoor Air Quality and Climate (Munksgaard Press).
Consulting reader for Perceptual and Motor Skills (1972-), USA; Sensory Processes (1975-79), USA; The Journal of the Acoustical Society of America (1982); Chemical Senses (1983-, earlier Chemical Senses & Flavour), USA; Perception (1984-), UK.
Special reviewer of grant proposals for National Science Foundation (1974-), USA; National Institute of Health (1977-), USA; Swedish Council for Building Research (1978-); Swedish Environment Protection Borad (1983-).

Membership (only) of Professional Societies:

1970- Fysiologföreningen (Society of Physiology), Stockholm, Sweden.
1972- Invited Member of the Psychometric Society, USA.
1978- European Chemoreception Research Organization (ECRO).
1979- (1992: Fellow) The American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE), Atlanta, USA.
1982- Division of Environmental Psychology, International Association of Applied Psychology (IAAP).
1985- Svenska Akustiska Sällskapet (SAS: Swedish Acoustical Society).
1985- Air Pollution Control Association (APCA), new name 1989: Air & Waste Management Association, USA.
1985- Invited Member of the Area Group in Perception of the Swedish Council for Research in the Humanities and Social Sciences, Stockholm, Sweden
1986- Invited Member of the Area Group in Environmental Psychology of the Swedish Council for Research in the Humanities and Social Sciences, Stockholm, Sweden.
1989- Environmental Design Research Organization (EDRA), Oklahoma City, OK, USA.
1992- American Association of the Advancement of Science.
1992- Invited Member of the New York Academy of Sciences.
1992- American Psychological Society.

Papers presented at Professional Meetings:

Nearly all papers (ca. 60) for Professional Meetings have been published (see some of them in the abridged list of publications).

Abridged List of Publications 1966-1993 (about 30%)

1966
Ekman, G., Berglund, B., & Berglund, U. Loudness as a function of the duration of auditory stimulation. Scand. J. Psychol., 1966, 7, 201-208.

1967
Berglund, B., & Berglund, U. A further study of the temporal integration of loudness. Rep. Psychol. Lab., Univer. Stockholm, 1967, No. 229.
Berglund, B., Berglund, U., & Ekman, G. Temporal integration of vibrotactile stimulation. Percept. mot. Skills, 1967, 25, 549-560.

1969
Berglund, B., Berglund, U., Ekman, G., & Frankenhaeuser, M. The influence of auditory stimulus intensity on apparent duration. Scand. J. Psychol., 1969, 10, 21-26.
Ekman, G., Frankenhaeuser, M., Berglund, B., & Waszak, M. Apparent duration as a function of intensity of vibrotactile stimulation. Percept. mot. Skills, 1969, 28, 151-156.

1970
Berglund, U., & Berglund, B. Adaptation and recovery in vibrotactile perception. Percept. mot Skills, 1970, 30, 843-853.

1971
Berglund, B. An analysis of some basic mechanisms of sensory perception with direct scaling methods. Rep. Psychol. Lab., Univer. Stockholm, 1971, Suppl. 6. (Doctoral Dissertation)

1972

Berglund, B., Berglund, U., Jonsson, E., & Lindvall, T. Människan som mätinstrument. [Man as a Measuring Instrument] Swedish Medical Journal, 1972, 69, No. 23 (Human Environment Issue). (In Swedish)

1973

Berglund, B., & Berglund, U. Perceived duration of brief sensory signals. Percept. mot. Skills, 1973, 36, 1248-1250.

1974

Berglund, B., Berglund, U., & Lindvall, T. A psychological detection method in environmental research. Environ. Res., 1974, 7, 342-352.

1975

Berglund, B., Berglund, U., & Lindvall, T. Scaling loudness, noisiness and annoyance of aircraft noise. J. Acoust. Soc. Amer., 1975, 57, 930-934.

Berglund, B., Berglund, U., & Lindvall, T. A study of response criteria in populations exposed to aircraft noise. J. Sound &Vib., 1975, 41, 33-39.

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1983

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1984

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1990

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1991

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1993

Preis, A., & Berglund, B. Perceived annoyance of intermittent sounds. In M. Vallet (Ed.), Noise as a Public Health Problem (Noise & Man '93). Arcueil, France: l'INRETS, 1993, vol. 2, pp. 343-346.

27.7.93

WALTER W. HOLLAND, CBE

PROFESSOR OF PUBLIC HEALTH MEDICINE IN THE UNIVERSITY OF LONDON

DEPARTMENT OF PUBLIC HEALTH MEDICINE
UNITED MEDICAL AND DENTAL SCHOOLS OF GUY'S AND ST. THOMAS'S HOSPITALS
(UNIVERSITY OF LONDON)

CURRICULUM VITAE

Born	5th March 1929
Nationality	British
University	St. Thomas's Hospital Medical School, London University (1948-1954)
Marital Status	Married 1964. Three sons.

DEGREES AND PROFESSIONAL QUALIFICATIONS

1951	B.Sc. (Special) in Physiology, with Honours (2nd Upper)
1954	M.B.,B.S. (Honours), with distinction in Obstetrics and Gynaecology
1964	M.D.
1971	M.R.C.P. (without examination)
1972	F.F.C.M. (converted to F.F.P.H.M., 1990)
1973	F.R.C.P.
1977	M.R.C.G.P. (without examination)
1982	F.R.C.G.P.
1990	F.R.C.P. Edin. (Honorary)
1992	F.R.C.Path. (without examination)
1993	F.F.P.H.M.Ireland (Honorary)

SCHOLARSHIPS, PRIZES AND HONOURS

1970	Elected Life Time Member of Society of Scholars, Johns Hopkins University
1977	Inaugural Lecturer, Johns Hopkins University Society of Hygiene
1981	Doctor Honoris Causa, University of Bordeaux
1984-85	Fogarty Scholar-in-residence, National Institutes of Health, Bethesda, Maryland, U.S.A.
1984	Theodore Badger Visiting Professor, Harvard University Medical School, Cambridge, Mass., U.S.A.
1985	Elected Honorary Member, American Epidemiological Society
1985	First Sawyer Scholar-in-residence, Case Western Reserve Medical School, Cleveland, Ohio, U.S.A.
1985	Elected Honorary Member, American Epidemiological Society
1986	Elected Corresponding Member, Deutsche Gesellschaft fur Pneumologie und Tuberkulose
1989	Awarded Salomon Neumann Medal by German Society of Social Medicine
1990	Doctor Honoris Causa, Free University of Berlin
1991	Elected Foreign Member of Scientific Board of 3rd Medical Faculty of Charles University, Prague
1991	Elected "Hero of Public Health" by Johns Hopkins University School of Hygiene
1992	Awarded CBE
1993	18.3.93 First Cochrane Lecturer, Green College, Oxford
1993	24.3.93 Second Health Sciences Public Lecturer, City University, London.
1993	Honorary Member of the Society for Social Medicine

POSTS

1955-56	Casualty Officer and House Physician, St. Thomas's Hospital
1956-58	National Service in RAF. Epidemiological Research Laboratory, Central Public Health Laboratory, Colindale

POSTS, cont.

1958-68	Various Lecturer and Senior Lecturer posts in Medicine and Clinical Epidemiology at St. Thomas's Hospital Medical School and London School of Hygiene and Tropical Medicine, including MRC Research Fellowship at the Statistical Research Unit and Department of Epidemiology, LSHTM, and Research Fellowship at Department of Epidemiology, Johns Hopkins University, Baltimore.
1968-	Professor of Clinical Epidemiology and Social Medicine, St. Thomas's Hospital Medical School.
1991-	1.11.91: Title changed to: Professor of Public Health Medicine in the University of London.
1968-	Honorary Director, Social Medicine and Health Services Research Unit, St. Thomas's Hospital Medical School
1974-77	Sub-Dean, St. Thomas's Hospital Medical School

OTHER POSTS

1962-69	Various Visiting Lectureships and Consultancies in U.K. and abroad including:
	Eastman Dental Hospital
	Division of Air Pollution and the Environmental Protection Agency, U.S. Public Health Service, Washington
	California State Health Department
	University of Rochester, New York
	National Centre for Health Services Research, U.S. Public Health Service.
1969-81	Various Visiting Professorships including:
	School of Public Health, UCLA, Los Angeles, U.S.A.
	Monash Medical School, Melbourne, Australia
	Stanford University Medical School, Clivedea, England
	Free University of Berlin and University of Saarbrucken
	Universities of Toulouse, Marseilles and Bordeaux

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MEDICAL SCHOOL AND HOSPITAL COMMITTEES

1970-74	Chairman, Committee on Community Medicine, St. Thomas's Hospital
1974-77	Sub-Dean, Academic Representative on District Management Team
1978-83	Chairman, Cardio-respiratory Health Care Planning Team
1980-82	Member, School Council, St. Thomas's Hospital Medical School
1981-82	Member, United Medical Schools Co-ordinating Committee
1982-89	Member, Council of Governors, United Medical and Dental Schools
1982-88	Member, West Lambeth District Health Authority
1983-86	Vice-Chairman, West Lambeth District Health Authority

SOUTH EAST (South West) THAMES REGION

1966-72	Member, Joint Consultative Committee for South Western Metropolitan Regional Hospital Board
1974-82	Medical School Representative, Area University Liaison Committee. S.E. Thames Regional Health Authority
1979-82	Chairman, S.E. Thames Health Care Planning Team for Cardio-respiratory Disease
1982-86	Member, Regional University Liaison Committee
1989-	Member, Institute of Public Health Steering Committee

UNIVERSITY OF LONDON

1964-74	Chairman, University of London Undergraduate Teachers Sub-committee of the Board of Studies in Preventive Medicine and Public Health (Community Medicine)
1972-74	Chairman, Board of Studies in Community Medicine, University of London
1974-81	Member, University of London Joint Medical Advisory Committee of the Academic and Collegiate Councils

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EXAMINER

1965-92	Between these dates I have been examiner, external examiner and specialist examiner at Universities of Glasgow; Wales; Belfast; Groningen; Holland; Oxford; Cambridge; Manchester; London; Aarhus, Denmark; York; Rotterdam; Holland; Leuven, Belgium; Keele.

FACULTY OF COMMUNITY MEDICINE/FACULTY OF PUBLIC HEALTH MEDICINE

1971-77) 1987-89)	Member of Board of Faculty of Community Medicine
1989-92	President, Faculty of Community Medicine. (Public Health Medicine, Dec. 1989).

DEPARTMENT OF HEALTH

1963	Member, Ministry of Health, Chief Medical Officer's Committee of Chronic Bronchitis
1965-70	Member, Ministry of Health Committee on Laboratory Automation and Screening Trials
1965-74	Member, Ministry of Health Standing Advisory Committee of Hospital Medical Records
1967-90	Member, Panel on Child Nutrition of the Committee on Medical Aspects of Food Policy
1969-73	Member, Sub-committee on Screening
1970	Member, Advisory Committee to Secretary of State, Department of Health and Social Security, on Regional Health Councils
1970-90	Member, Sub-committee on Nutritional Surveillance
1971-77	Member, Laboratory Development Advisory Group
1971-77	Chairman, Clinical Sub-group of LDAG
1971-74	Member, Working Party on Collaboration with Local Government
1973-77	Member, Committee on Medical Aspects of Chemicals in Food and the Environment - Physical Environment Sub-committee
1973-77	Member, Independent Committee on Smoking (Hunter Committee)

DEPARTMENT OF HEALTH, continued

1975-77	Member, Working Party on Allocation of Resources (RAWP)
1977-80	Member, Working Party on Lead in Environment
1977-82	Member, Air and Soil Committee
1980-85	Member, DHSS/NHS Health Information Steering Group (Korner)
1981-	Member, Independent Scientific Committee on Smoking (Froggatt Committee)
1983-86	Chairman, Faculty of Community Medicine - Health Information Steering Group on Health Outcome Measures
1989-92	Member, Standing Medical Advisory Committee
1991-	Member of Clinical Standards Advisory group Sub-Committee on Access and Availability
1991-	Member, Secretary of State's Health of the Nation Wider Health Group

GLOUCESTERSHIRE HEALTH AUTHORITY

1992-	Non-Executive Director

MEDICAL RESEARCH COUNCIL

1963-65	Member, Committee on the Aetiology of Chronic Bronchitis
1963-66	Secretary, Sub-committee on Respiratory Symptom Questionnaire
1965-73	Secretary and Member, Panel on Epidemiology of Chronic Bronchitis
1965-73	Member and Assistant Secretary, Committee on Research in Chronic Bronchitis
1967-74	Secretary, Committee on General Epidemiology
1987-91	Member, Health Services Research Committee

OFFICE OF POPULATION CENSUS AND SURVEYS

1970-87	Member, Committee on Medical Nomenclature and Statistics
1988-	Member, Consultant Advisory Panel

NUFFIELD PROVINCIAL HOSPITALS TRUST

1966-90	A series of Working Parties and Committees

KING EDWARD VII HOSPITAL FUND FOR LONDON

1973-90	A series of Working Parties and Committees

OTHER ORGANISATIONS (NATIONAL)

1970-74	Chairman, Scientific Advisory Committee of the South Metropolitan Cancer Registry, London
1977-81	Chairman, Independent Medical Advisory Committee on Tobacco Substitutes to Tobacco Companies
1980-82	President, Section of Epidemiology and Community Medicine, Royal Society of Medicine
1982-	Vice President, Section of Epidemiology and Community Medicine, Royal Society of Medicine.
1985	Chairman, Society for Social Medicine.
1985-	Part-time Member, Data Protection Tribunal
1987-88	Specialist Adviser, House of Lords Select Committee on Science and Technology, Sub-committee "Medical Research"
1989-92	Member of Council, the Royal college of Physicians
1989-92	Member, Conference of Medical Royal Colleges and their Faculties in the U.K.
1990-92	Vice-Chairman of Conference of Medical Royal Colleges and their Faculties in the U.K.
1990-92	Chairman, Public Health Medicine Consultative Committee

WORLD HEALTH ORGANISATION

1965-	A series of Committees, including:
1965-92	Member, Expert Advisory Panel on Air Pollution.
1981	Chairman, Joint WHO/HQ/EURO Meeting on an Integrated Noncommunicable Diseases Prevention and Control Programme

WORLD HEALTH ORGANISATION, cont.

1986-	Director, WHO Collaborating Centre for Integrated Non-communicable Disease Research
1988-	Member, WHO Technical Advisory Group of the Acute Respiratory Infections Control Programme
1988-	Chairman, WHO Global Scientific Advisory Group Integrated Programme for Community Health in Non-communicable Diseases. (Interhealth Programme)
1992	Chairman, CINDI meeting in London
1993-	Member, WHO Expert Advisory Panel on Health Situation and Trend Assessment

EUROPEAN COMMUNITY

1960-	A series of Committees, including:
1977-	Chairman, Panel on Epidemiology and Social Medicine (DOV)
1983-	Adviser in Epidemiology on Studies of Respiratory Disease (DOV)

OTHER ORGANISATIONS (INTERNATIONAL)

1964-68	Editor and Member of Executive Council, International Epidemiological Association
1968-71	General Secretary and Member of Executive Council, International Epidemiological Association
1976-79	Member, Scientific Advisory Panel of German Doctors' Association in der Bundesrepublik Deutschland
1977	Adviser, Bosch Foundation, Stuttgart, W. Germany
1977-83	Chairman, Scientific Committee on Respiratory Diseases, International Union against Tuberculosis
1980-84	Member, Bundesarztekammer Scientific Advisory Committee (W.Germany)
1988-91	Member, Scientific Advisory Committee, GSF, Munich, Germany.
1987-90	President, International Epidemiological Association
1990-	Member of Executive Council of International Epidemiological Association

SOCIETIES

British Medical Association

Fellow, Royal Society of Medicine

Fellow, Royal Statistical Society

Fellow, Royal Society of Arts

International Epidemiological Association

American Statistical Association

International Union Against Tuberculosis

American Public Health Association

Association d'Epidemiologistes de la Langue Francaise (ADELF)

PRINCIPAL PUBLICATIONS

Holland WW, Stewart S.

Screening in Health Care: Benefit or Bane?
London: Nuffield Provincial Hospitals Trust. 1990

Holland WW (Ed).

European Community Atlas of Avoidable Death.
2nd ed.
Oxford: Oxford University Press, 1991.

Holland WW, Detels R, Knox G. (Eds)

Oxford Textbook of Public Health. 2nd ed., edited with the assistance of Beverley Fitzsimons and Lucy Gardner.
Volume 1: Influences of Public Health
Volume 2: The Methods of Public Health
Volume 3: The Investigative Methods and Special Applications
Oxford: Oxford University Press, 1991.

Plus approximately 300 original scientific articles etc.

IN THE HIGH COURT OF JUSTICE
QUEEN'S BENCH DIVISION
CROWN OFFICE LIST

Crown Office Ref. No.
CO/2110/93

In the matter of an application by the Council of the London Borough of Richmond Upon Thames and others to apply for Judicial Review (Order 53)

(i) Deponent: W.W.Holland
(ii) First Affidavit
(iii) Sworn:
(iv) Filed on behalf of: the Applicant

AFFIDAVIT OF WALTER HOLLAND

I, Walter Werner Holland of 11 Ennerdale Road, Kew, Richmond, Surrey TW9 3PG, Professor of Public Health Medicine, MAKE OATH and say as follows:

1. This affidavit relates to the Department of Transport's Aircraft Noise and Sleep Disturbance Study which has clearly been an important factor in the decision to which these proceedings relate.

2. The Report of this Study is exhibited as document D in exhibit "CES-1" to Colin Stanbury's affidavit filed in this matter and where appropriate I refer to it in this affidavit as "the Final Report".

3. Besides affidavits filed on behalf of the Applicant, I have also read the affidavits of Roberta McWatt and Dr. John Ollerhead filed on behalf of the Department of Transport.

4. This affidavit is filed on behalf of the Applicant and primarily is by way of reply to Ms McWatt's and Dr Ollerhead's assertions as to the quality of the Sleep Disturbance Study and the reliance that was therefore be placed upon it formulating the decision of 6th July 1993 about new night flight quotas. It also deals with discrepancies between the Final Report and Final Draft of that document. This was a point

first raised by Mr Gould. I understand that the Respondent sought particularising of this and it is convenient to include a list the discrepancies which seem most odd to the Applicant in the exhibit to this affidavit. I also give my views on the significance of this point.

5. The points I make in this affidavit are true to the best of my knowledge, information and belief. To the extent that they are judgemental, they are also based upon experience. I should explain that I am not a noise expert, but am looking at this issue from the more general viewpoint of a public health expert. Noise affects populations in the same way that other public health matters do, and it is entirely valid therefore to express my opinion from this point of view. I have done my best to avoid errors of detail, but the amount and detail of material involved is such that it is not impossible that there are small factual errors. However, as will become clear, the thrust of this affidavit relates to the overall quality of the Sleep Disturbance Study.

6. The bundle now produced and shown to me marked "WWH-1" includes the following further documents. For ease of reference the tab lettering follows the previous exhibits to affidavits filed herein on behalf of the Applicant:

Tab O is a copy of my curriculum vitae.

Tab P contains correspondence which I have had with the Department of Transport and others about the Sleep Disturbance Report:

a.	28.5.93	DTp to Holland.
b.	2.6.93	Holland to Rylander.
c.	2.6.93	Holland to Diamond
d.	4.6.93	Holland to McGregor (Sec. of State for Tpt)
e.	8.6.93	Diamond to Holland
f.	10.6.93	Holland to Diamond
g.	13.7.93	Diamond to Holland
h.	19.7.93	Holland to Diamond
i.	15.7.93	Holland to DTp
j.	22.7.93	DTp to Holland

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k.	28.7.93	Holland to DTp
l.	29.7.93	Diamond to Holland
m.	30.8.93	Rylander to Holland

Tab Q contains copies of papers presented at a conference in Nice in July 1993. These are:

a. *Aircraft Noise and Sleep Disturbance: A UK Field Study* by Ollerhead and Jones.
b. *Social Surveys of Night-time Effects of Aircraft Noise* by Ollerhead and Diamond.
c. *Random Effects Models for the Study of Noise Disturbance* by Diamond, Egger and Holmes.
d. *A Field Study of Sleep Disturbance: Effects of Aircraft Noise and Other Factors on 5742 Nights of Actimetrically Monitored Sleep in a Large Subject Sample* by Horne, Pankhurst, Reyner, Hume and Diamond" (Table 3 onwards omitted from exhibit).

Tab R is a full copy of the Final Draft of the Sleep Disturbance Report dated November 1992.

Tab S is a summary of the main differences between the Final Draft of the Sleep Disturbance report and the Final Report itself.

Tab T is an extract from Hansard dated 24th May 1993.

Qualifications

7. I am professor of Public Health Medicine and Chairman of the Division of Community Health at the United Medical and Dental Schools of Guy's and St. Thomas', in the University of London. I have held this post since 1968. I am past President of the Faculty of Public Health Medicine of the Royal Colleges of Physicians of London, Edinburgh and Glasgow. I am past President of the International Epidemiological Association.

8. As Professor of Public Health Medicine I am involved in the execution

of a wide variety of studies of environmental and social factors on health as well as the organisation and planning of health services.

9. Tab O of "WWH-1" is a copy of my curriculum vitae. As this shows, I am a member of a large number of advisory committees both in the U.K. and abroad, including being an Expert Advisor to the World Health Organisation (WHO) on Environmental Pollution and directing a WHO collaborating centre for Research for non-communicable diseases Prevention and Control. I have extensive experience of advising the UK Government's Department of Health on public health issues including the carrying out of studies which influence government policy.

10. With this background it would not be responsible to become involved in proceedings like these unless it was clear to me that there were serious problems with the scientific basis on which the decision in question was being made.

11. It is true that I live in west London and am aware of aircraft noise. It was due to this awareness that I became interested in the proposals to revise the night noise rules and made further investigations about it. However this awareness has no effect on my objective concerns about the Sleep Disturbance Study.

12. I should also say that my concerns arose entirely independently of these proceedings. Tab P contains correspondence which I have had with the Department of Transport and others. I confirm that my views as stated below reflect consideration of the reponses I have received from those I have corresponded with, including Professor Diamond, one of the researchers in the Sleep Disturbance study.

13. Apart from my own concerns about the quality of the Final Report, I also became concerned to learn that this study did not have the universal approval from international experts inferred from the acknowledgements in it.

Summary of concerns

14. In my experience the government, rightly, sets store by the scientific basis on which policy decisions are made. This is confirmed by Ollerhead and Jones (two of the authors of the Sleep Disturbance Study) at the beginning of their paper at Tab Q, (a) of "WWH-1".

15. There are differing views as to the validity of the methodology and conclusions of the Sleep Disturbance Study. This will be evident from the correspondence in Tab P, including Professor Diamond's response to my points in his letter of 29th July 1993. I understand that it is not for the High Court in these proceedings to determine what the correct technical answer is.

16. What this affidavit shows, however, is that there is very serious doubt about the validity of the methodology and conclusions of the Sleep Disturbance Study. In my view it is therefore irresponsible for the government to make such a serious public health decision as it has done having such evident regard to a report like this one.

17. Despite Professor Diamond's letter of 29th July 1993 and the papers given in Nice exhibited at Tab Q of "WWH-1", I believe there are fundamental errors in the design, analysis and interpretation of the Sleep Disturbance Study. These are briefly explained below. Furthermore the correspondence, and subsequent papers, have increased my concerns since there are unexplained discrepancies in the number of events and persons analysed both within and between the reports. The worst example is the mistake in Table 3 of the Final Report of the Sleep Disturbance Study (where "no" and "yes" were transposed in tabulation of key information). The fact that this gross error was not picked up before the report was issued, during the process of checking the Final Draft for factual errors (as explained by Dr Ollerhead in paragraph 14 of his affidavit) shows a degree of carelessness which undermines the credibility of the report. In documents of this degree of importance, such errors are unacceptable. Checks should have been made to pick the error up, not simply before the Final Report, but (I would have expected) long before the Final Draft.

18. There is a further aspect to these concerns which reinforces the doubts which I have. That is that the Final Report of the Sleep Disturbance Study of December 1992 differs markedly from the Final Draft submitted in November 1992. The Final Draft is exhibited at Tab R and a summary of the main changes is at Tab S. Taken individually, many of the differences are in themselves unsurprising, the sorts of differences one often sees between a final draft report and the finished version.

19. However, taken together the changes are significant. I believe that even a casual reader comparing the two would be left with the feeling that what may have been (despite serious technical criticism) a *bona fide* scientific report (the Final Draft) has been edited for the published version (ie. the Final Report) to put it in the best possible light.

20. This is not a point I make lightly. I am not suggesting that the makers and/or final editors of the report have acted in bad faith in the sense of dishonestly suppressing data etc. They presumably knew that an important public policy decision on night flights rested largely on the outcome of their work and wished to put the results of that in as good a light as possible. However, what they have done goes beyond the acceptable bounds of final editing. Dr Ollerhead says in his affidavit that the changes in question were those "considered necessary to correct factual errors, to include additional results or to improve intelligibility and clarity". I agree such changes would be acceptable. However the changes in fact go far beyond that but (as mentioned above) do not even pick up all the errors. In my experience of this sort of work, I have never seen documents altered to such an extent at such a late stage.

Technical concerns – the Final Report

21. My concerns about the Department of Transport's Sleep Disturbance Study are as follows. Unless otherwise indicated, references are to the Final Report at Tab D to the exhibit to Colin Stanbury's affidavit.

22. Professor Diamond's letter of 29th July 1993 does not answer my major

questions. He attempts to answer some of the points by becoming involved in abstruse mathematical theory. The Sleep Disturbance Study has led to an important public policy decision affecting thousands of people. It is vital that the methodology and conclusions of such work should be readily understandable and unambiguous. Such explanations should not be necessary: the report should be clear, on its face, to the intended reader. In this case one would expect it to be clear to reasonably well educated laymen, including the Secretary of State (who was to consider it in making his decision).

Genesis of the report

23. The normal procedure in production of a scientific report is to base the final version on the foundation of sound technical work. In this case, it is clear that that the opposite has happened: the Final Report was produced in December 1992, while making it clear that further technical papers were still in the course of preparation. These presumably included the ones exhibited to this affidavit (Tab Q) which were presented at the July 1993 Nice conference. In due course, they will presumably be subject to peer review and may (or may not) be accepted for publication in established journals. I suspect that part of the reason I, and others, are criticising the Sleep Disturbance Report in the way we are presently is that it simply has not gone through the accepted rigorous screening process that a study of this nature deserves.

24. Dr Ollerhead says that the Sleep Disturbance Study was "probably the most comprehensive study of sleep disturbance in the home ever undertaken anywhere in the world" and the implication of his evidence and Ms McWatt's is that because it was a "big" study it was therefore a reliable one upon which a policy decision could confidently be made. I do not know how this study compares with other sleep research work (as explained, this is not my speciality). However, it is trite to say that in all walks of life, scientific studies included, "big" (or even "biggest") does not necessarily mean "good".

25. In a Parliamentary Answer of 24th May 1993 (Tab T, "WWH—1"), the Minister of State at the Department of Transport, commenting on

whether the present restrictions on night flying would be maintained until after review of the Sleep Disturbance Study by a panel of experts, said that experts had already given advice on the study (this is a matter I refer to below) and that "we expect there will be considerable academic interest and debate on the subject for some time to come". Scientific papers are often subject to continued debate and analysis both before and after they have been peer reviewed and published. So the Minister's statement is not surprising in that respect. What is surprising is that he is prepared to accept the findings of the report not only without peer review, but also as discussed without prior publication, let alone peer review, of the technical papers underlying it. In my view, the Minister's reply in Parliament was therefore glib to the point of irresponsibility.

Site selection

26. The number of sites (2) for each airport are too small and the levels of noise recorded and reported give no indication of the variability both by time and by date (Final Report, Table 4). Comparison of this table with Figure 2, which shows higher noise levels 2 years earlier, demonstrates the need for this.

27. It is unsatisfactory to amalgamate findings at 4 airports. As Professor Diamond states in his letter of 29th July, there is a wide variation in the range of aircraft noise exposure between airports. Although he states there are no intrinsic geographic variations in sleeping behaviour, there are geographic variations in social behaviour, such as time of going to bed, time of last meal, type of housing, furnishing, etc. Thus the design and analysis chosen in the Sleep Disturbance Study restricts the variation of the effect of outdoor noise on individual subjects, because it may be obscured by the variation in exposure between the airports. In view of the small number of sites, it is quite possible that the variation in exposure to noise may be explained by between-airport variance rather than the between-exposure variance. Thus the choice of study sites actually restricts the variance in noise exposure, and in turn the possibility of drawing conclusions from outdoor noise levels from aircraft activity.

Subject selection

28. The method of selection of the individuals on whom measurements were made is obscure. Approximately 200 social survey interviews were undertaken for each site and yet the number of addresses listed is very different for each site – ranging from 669 to 397 (Table 2). It is difficult to understand how the sample was drawn, what questions were asked, etc. In interpreting any survey it is crucial that information is given on precisely how the sample of subjects included at *each* stage has been selected, the precise questions asked by interviewers, and the instructions given to the interviewers. This has never been disclosed, though it has been stated that the subjects were not aware of the purpose of the study.

29. Of the 200 odd interviews at each site, approximately 50 volunteers were interviewed. It is quite impossible to determine the criteria for these. To an epidemiologist like me, the response rates are horrendously low. To pick a final sample of 227 individuals on whom measurements were made, out of an original 3,896 addresses, is strange. This is a response rate of about 6 per cent. I am not aware of a public health decision made on the basis of such a ludicrously small sample chosen in such a curious way. Although the authors defend their sample response, the following figures demonstrate my concerns—

Original interview — 1,636 subjects (1 person per household).

Of these 1,636 subjects, 971 (59%) agreed to take part in the study.

Of these 971 subjects, 614 had a further interview (=37% of original sample).

Of these 614 subjects, 220 agreed to actimetry and EEG (=13% of original sample, and =36% of those who had a further interview).

50 of these subjects had both actimetry and EEG (=3% of original sample).

227 subjects agreed to actimetry only (=14% of original sample, and =37% of those who had a further interview).

30. I am afraid that epidemiologists/public health physicians would not be satisfied with such a low response rate, whether from the initial or the subsequent sampling. In the studies with which I am involved we aim to acieve a response rate of at least 67%. In a recent study of about 250,000 individuals in a *mailed* survey (when one normally expects a lower response rate) we obtained this level of response. In a private census investigation in an inner city area of London, which involved medical examinations, we achieved a response rate of about 99% in a sample of about 10,000. These examples illustrate how low the response rate was in the current study, and therefore how unsatisfactory it is to draw the conclusions that have been drawn from it.

31. It is known that susceptibility to noise is greater in the elderly and in men. The objectives of the study were stated to determine the relationship between aircraft noise and the probability of sleep disturbance. It is therefore curious that the young (under 50) and women are over-represented in the sleep disturbance study compared to those in the social survey.

32. There were other exclusions which further upset the sampling process. For example it was confined to people who were available during the survey period, who were not deaf (no objective measure of this was made), who were not suffering from arthritis or rheumatism which disrupts sleep, and who were not taking (an undefined quantity of) alcohol. In addition it is stated that the 4.4% of subjects were on hypnotics (sleeping pills) were excluded: it is not defined whether these were individuals taking such tablets daily or only intermittently, and (as acknowledged the paper at Tab Q (d), page 10 by Horne *et al*, but not suggested in the Final Report) of course it may have been that such people were taking them to counteract aircraft noise.

<u>Interview methods</u>

33. To a public health researcher of almost 40 years' experience it is

curious that instructions or explanations to participants are not available for scrutiny. It is well known in epidemiological work that the way questions are phrased, and the behaviour (even including dress) of interviewers influences the responses given. I have always been meticulous in making my documents available. I note Dr Ollerhead is critical of the Social Survey at Tab J of exhibit "TJG-1" to Terence Gould's affidavit: but at least the local authorities included their questionnaire in their report.

<u>Individual noise exposure</u>

34. The relations between the noise monitor sites and the individuals participating is not clarified. Although it is stated that all houses were within the given "noise contour" – the validity of this statement has not been checked. (It is also difficult to understand in view of Roberta McWatt's evidence to the effect that no such contours exist for night time noise.) No checks have been made of the difference in noise exposure in different houses. This is particularly important in view of the different types of houses in different areas. Although the authors dismiss this (footnote at page 4 of the Final Report) and consider this as taken into account in the analysis, it reinforces the argument I make in paragraphs 24 and 25 above.

<u>Arousal rates and window state</u>

35. The Final Report discusses the difference in arousal rate between houses with single and double windows, and with open and shut windows. This is illustrated in Figure 56 which shows a clear gradient for arousal between open/shut/single/double windows in noisy compared with quiet conditions. (The point is more obvious in Figure 8.18 of the Final Draft Report, which shows the same information, but uses a different projection in the graphical presentation.) The Final Report dismisses this as "not being of statistical significance". It is elementary in statistics to look at what figures and tables tell you, rather than depending on tests of statistical significance which depend on a variety of factors.

Sample size

36. Although it is stated that the pilot investigation indicated that 50 subjects would be needed at each site, the report nowhere states the rationale for this sample size. Most investigations start off by determining the effect to be identified. For example, if one was looking for a difference in two populations where 50% of subjects were woken in one population, and 0% were woken in the other, the sample size would be much smaller than if one were looking for a difference of say 40% in one population and 30% in another. In relation to aircraft noise, if one were willing to accept that 5% of the population was woken at a noise level of 75 dBA, the sample size would be much greater than if one was looking for an awakening rate of say 30% at this noise level, because of the variability of waking at night. Most statistics textbooks give tables of sample size required to show a given effect. It is curious that the investigators were so imprecise in this respect while using very complex statistical equations for their analyses.

Noise, time and sleep disturbance correlation

37. Both in the Final Report and a subsequent, unpublished paper (Tab Q, (a)) the authors claim that there is a threshold for noise disturbance, i.e. that people are only disturbed if noise is above a certain level. It is not surprising that they make this statement — even though it is both counter-intuitive and different to that of other studies — since they make no measurement below 75 dbA. In fact their graphs (Fig. 50) show a fall in arousal rate as noise increases from 75 dbA and 80 dbA – a very curious finding – on which no comment is made.

38. The authors state (page 34 of the Final Report) that "it is clear from this analysis that in general aircraft noise has a negligible effect upon overall patterns of arousal from sleep" while tables 7 (actimetry) and 4 (noise level) show a correlation. These conclusions are also different from those of the November draft report at page 26—

- "aircraft events with the highest noise levels, say greater than 95 dbA max, have a greater than average chance of disturbing sleep, perhaps 50–100 per cent greater".

- "Individual variations in noise sensitivity are important, two or three per cent of people are more than twice as likely to be disturbed by aircraft noise as the average person".

- "At particular times of sleep i.e. during periods of sleep lightenings, noise disturbance rates are around twice the average".

39. It is strange for Professor Diamond to dismiss this correlation in his letter of 29th July. The tables show a higher average rate of actimetry activity (which he correlates with awakening) in those areas with higher noise levels. The variation is about 31% (6.97 to 4.79) in actimetry. The noise exposures to aircraft Leq are highest at this site (HGN); other noise exposures are also higher at most times but not to the same extent. The site with lowest mean actimetry (SWM) also has lower aircraft Leq in Table 4 (there it is 64.2 at HGN, and 49.6 at SWM, a difference of 23%). This cannot be dismissed and demonstrates the fallacy of trying to amalgamate findings for different airports. A far better analysis would be to examine the variability between aircraft noise and sleep disturbance at each airport individually.

40. The Final Report summary states (page xiv, para 21) "that sensitivity to aircraft noise seems to diminish at the end of the nights' sleep". However page 23 of the Final Report states "a major focus of the analysis has therefore been to control for the powerful confounding effects of individual variations in arousability". Pages 26 and 27 state that arousals are greater in the morning, yet the Ollerhead and Jones study (Tab Q, paper (a), page 49) states that it "controls for time of night". It is necessary to show that the time of night is related to the probability of being disturbed in the absence of aircraft noise, or at the very least that there is no interaction between time of night and noise, otherwise one may adjust out some of the effect of aircraft noise in the early morning.

Aims of the study

41. The aims of the analysis, and thus the conclusions, are confused. Were the authors concerned with establishing the proportion of people affected by aircraft noise, or at what levels of aircraft noise people are affected? The authors describe between-subject variation — but this is irrelevant, as one is only concerned with the probability of a subject being disturbed relative to his or her baseline level of disturbance at minimum noise level. A *within*-subject analysis is required (and has not been done) as it would not make assumptions about how to describe *between*-subject variation. The essential question is not the variation in arousal in a population of different individuals in different areas exposed to different levels of noise (between-subject variation) but the variation in any single individual to being aroused at different noise levels.

Validation of actimetry

42. The so-called objective method of sleep disturbance used (wrist movements, actimetry) have been validated against "sleep-EEG" (measurement of brain activity). This validation is, however, very small, only 6 out of 50 subjects at each of 8 sites. The 6 "sleep-EEG" cases were studied during 4 nights each, while the 50 actimeter cases were studies for 15 nights each. The statistical, analytic base is thus very small considering the large amount of intra- as well as inter-variability of both EEG and actimetry. The results of the validation are reported to be quite uncertain - that is 40 ±10 per cent of the arousals actually represent awakenings. As an epidemiologist concerned with the use of physiological measurements in field situations on many occasions I would not have accepted instruments of such low validity. To explain this point, if any two tests correlate on only 50% of occasions this implies that the correlation can occur by chance. Thus the results of the validation (Final Report, page 18) do not confirm that they are any better than would occur by chance.

43. The approach of the study's authors, including Dr Ollerhead (para 12) is that actimetry is used because it is a "very efficient" way of

measuring arousals from sleep. It may be cost efficient, but that is not the same as saying it is satisfactory from a scientific point of view. It may be that it can be validated to show that it is indeed a satisfactory method. But in the absence of that, it may be as or more "efficient" to rely on refinements to traditional methods eg. subjects keeping diaries of sleep disturbance. I have specific experience (in the field of lung disease) where, despite fears that it would not work, subjective measurement turned out to be just as good as objective measurement.

44. When originally preparing this affidavit, I observed that it was very strange that the report does not examine what seemed the most curious finding that while on the basis of actimetry only about 5 per cent of arousals are attributed to aircraft noise, Table 3 shows that 77 per cent of the sample included in the actimetry study "were awakened at night by aircraft noise" and 91 per cent had made a formal complaint. As discussed above, I now realise that this was a result of an error, but even considering the table correctly written, with 23% having been woken by noise, this is still nearly five times more than the actimetry studies suggest and therefore warrants further investigation. In his affidavit (para 6(d)) Dr Ollerhead says that the subjective and objective findings are "not inconsistent". I do not think it proper thus to disregard such a substantial difference. Incidentally I can positively confirm that the copy of the Final Report which I obtained did not have any erratum slip in relation to Table 3.

45. Thus the definition of sleep disturbance used in the Final Report is incompatible with the operational definition in terms of awakenings due to the low validity of the actimeter measurement of wrist movements as indicative of awakenings. The authors of the Final Report assume that actimetry is a valid measure of awakening. Yet in their comparison of actimetry and EEG, they show a poor correlation. Further their conclusions of awakening and response to a subjective questionnaire (see above) are so different that one wonders whether such a conclusion is valid.

Other experts

46. The report states in the Preface "of great importance to the study was the advice freely given by a number of eminent experts on sleep, most of whom attended a three-day seminar in the spring of 1992 to discuss the problem in detail". Purely by chance one of these is known to me, Prof. R. Rylander of the Department of Environmental Medicine, University of Gothenburg, Sweden. I wrote to him (Tab P) to determine whether my concerns were justified and subsequently spoke with him by telephone. I was surprised when he told me that he had attended the meeting and that the visiting scientists were not informed that the study would be used to determine the frequency of night flights. He said that many of the visitors thought that the study was inadequate, used poor methods to determine sleep disturbance, and was inappropriate. He said that if he had been told that this study would be used for policy formulation he would have been even more critical. He also said that some of the people mentioned in the preface to the Final Report did not even attend the seminar, though they were invited. This is confirmed in the Department of Transport's letter of 22nd July (Tab P). In view of this, I am most surprised by the comments about expert support in paragraph 17 of Dr Ollerhead's affidavit. Prof. Rylander confirmed his views in a recent letter (Tab P).

Discrepancies — Final Draft and Final Report

47. A summary of the main differences with comment on individual points where applicable is at Tab S. I did not prepare this summary myself, but it and the questions/comments raised reflects in detail the overall impression one has of the Final Report. As mentioned above, it is not so much the individual points which concern me (though some are significant), but rather the effect that these have on the tone of the Final Report, particularly considering the purposes to which it was intended to be used.

Conclusion

48. I consider on the basis of the above review that the "Report of a Field

Study of Aircraft Noise and Sleep Disturbance" is seriously flawed both in terms of the population investigated, the methods of noise exposure measurement and the methods of measurement of sleep disturbance. There are also serious flaws in the design of the analysis which neglect to take into account subject variability, and to adjust for factors known to influence arousal (and thus minimises the "effect" of noise).

49. Important errors in proof reading, the omission of a number of crucial findings from the final draft and changes between the final draft and final report, and the curious position of the expert panel featured so prominently in the Preface to the Final Report, raise serious issues of scientific values/integrity.

50. As a public health physician involved in advising national and international authorities on the formulation of policy concerned with the protection of public health, I would not consider that this study meets the commonly agreed criteria for execution and acceptance of the conclusions. I am surprised and shocked that the Department of Transport is buttressing its policy on such a study.

Sworn at

This day of 1993

Before me,

Solicitor

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Crown Office Ref. No.
C0/2110/93

IN THE HIGH COURT OF JUSTICE
QUEEN'S BENCH DIVISION
CROWN OFFICE LIST

In the matter of an application for Judicial Review

The Queen -v- The Secretary of State for Transport

Ex parte: The Council of the London Borough of Richmond Upon Thames and others

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IN THE HIGH COURT OF JUSTICE
QUEEN'S BENCH DIVISION
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Crown Office Ref. No.
C0/2110/93

In the matter of an Application for Judicial Review

The Queen -v- The Secretary of State for Transport

Ex parte: The Council of the London Borough of Richmond Upon Thames
The Royal Borough of Windsor and Maidenhead
Tandridge District Council
The London Borough of Hillingdon
Slough Borough Council

(i) Deponent: B. Berglund
(ii) First Affidavit
(iii) Sworn:
(iv) Filed on behalf of: the Applicant

AFFIDAVIT OF BIRGITTA BERGLUND

I, Birgitta Berglund, University Professor, of the Department of Psychology, Stockholm University, S-106 91 Stockholm, Sweden MAKE OATH and say as follows—

1. This affidavit is filed on behalf of the Applicant. I make it in reply to assertions, which I understand have been made in affidavits filed on behalf of the Respondent, that the Department of Transport's *Report of a Field Study of Aircraft Noise and Sleep Disturbance* ("the Study") published in December 1992 provides reliable evidence about the effects of noise on sleep.

2. The bundle which is now produced and shown to me marked "BB-1" contains two documents:

- A copy of my *curriculum vitae.*
- A brief report which I prepared on this matter earlier in the year.

3. I confirm that what I say in this affidavit is true, or, in context, is true so far as I am able to judge based on my knowledge and experience.

Qualifications

4. I am presently Professor of Environmental Psychology at the University of Stockholm, Sweden. My speciality is the effects of noise. I am frequently consulted by organisations such as the Swedish Building Research Council, the Nordic Noise Group and the Swedish Environmental Protection Board on matters associated with environmental noise standards and the effect of noise on human beings, and how such effects can be controlled and avoided.

5. I am a consultant to the World Health Organisation and I have recently led a WHO team of scientists investigating and drawing up a new WHO Environmental Health Criteria Document which defines new standards on community noise exposure.

6. From 1988 to July 1993 I was the Scientific Secretary of the International Commission on the Biological Effects of Noise (ICBEN). I was honoured to be made President of the ICBEN at its convention in July 1993 in Nice.

Background to my involvement with this matter

7. During May 1993 the Knutsford and Mobberley Joint Aircraft Action Group (which I understand is interested in environmental matters at Manchester Airport) asked me to carry out a scientific review of the Study. A copy of my report is in exhibit "BB-1".

8. That report was not intended to be a full "peer review" of the Study. That would have been a much bigger exercise, and I would have

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involved other experts in the field. All I was asked to do was examine the Study in a relatively superficial way and advise the Manchester group whether I saw problems with it.

9. It will be clear from reading my report that I was very concerned about the methodology and conclusions of the Study. The report of a study of this magnitude and importance should be rigorously peer-reviewed before publication, and especially before it is used for basing a policy decision on such an important issue as the effects of aircraft noise on the residents of and around London. That was not done. Several papers linked to the Study were presented at the recent ICBEN conference. However none of these have been peer-reviewed either.

10. In view of what I concluded from my earlier report, I am doubtful that the report of the Study would in fact stand up to peer-review.

11. Anyway, I repeat that in my opinion it would be mistaken for the UK Government to consider using the report of the Study as a basis for policy formulation before independent experts have accepted it as valid.

Sworn at

This day of September 1993

Before me,

British Embassy/consular official

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August 1993 (8 pages)

BB-1

ABRIDGED CURRICULUM VITAE

Personal History:

Name:	M. Birgitta Berglund
Current position:	Full Professor of Environmental Psychology
Business address:	Department of Psychology, University of Stockholm, S-106 91 Stockholm, Sweden
Research affiliation:	Institute of Environmental Medicine of the Karolinska Institute
Telephone:	+46 8 16 38 57 (office)
Telefax:	+46 8 16 55 22 (office)
Birth date:	April 19, 1942

Education:

1967 Filosofie kandidatexamen (B.A.), Social Science Faculty, Stockholm University, Sweden

1971 Filosofie doktorsexamen (Ph.D.) in Psychology, Stockholm University.

1973 Docent in Psychology, Stockholm University [The Title of Docent corresponds approximately to U.S. Associate Professor qualification.]

1976 Declared competent as Full Professor in Psychology at the University of Uppsala, Sweden.

Academic Appointments:

1971-76 Research Assistant Professor in Sensory Psychology, University of Stockholm (personal chair from the Swedish Council for Social Science Research). [6 months in 1975 Full Professor of Applied Psychology & 3 months in 1976 Full Professor of Psychology; both during sabbatical leaves].

1976-80 Research Associate Professor in Sensory Psychology, University of Stockholm (personal chair from the Swedish Council for Research in the Humanities and Social Sciences).

1980-86 Research Associate Professor in Environmental Psychology, Swedish Council for Research in the Humanities and Social Sciences (contract for offices and laboratories with the Department of Psychology, University of Stockholm).

1986- Full Professor of Environmental Psychology, Department of Psychology, University of Stockholm (personal chair from the Swedish Council for Building Research).

1981-88 Research Director of the Unit of Dwelling Hygiene, Department of Hygiene, Swedish National Institute of Environmental Medicine, Stockholm, Sweden (by affiliation).

1988- Research Director of the Unit of Psychology, Institute of Environmental Medicine of the Karolinska Institute, Stockholm, Sweden (by affiliation).

Area of Academic Specialization:

Basic Research: Experimental Psychology; Perception; Sensory Processes; Sensory Dysfunction; Audition, especially Psychoacoustics; Chemical Senses; Cutaneous Senses; Psychophysics and Scaling, including Multidimensional Scaling.

Applied Research: Environmental Psychology; Community Noise; Indoor Air Quality; Outdoor Air Pollution; Industrial Psychology; Methods of Field Experimentation; Questionnaire Techniques; Methods for Quality Assurance.

Basic research interests focus on psychophysical studies in various sensory systems: audition, olfaction, vision, and the skin senses. There is an emphasis on the functional processes and their use for applied research on physical environmental problems such as community noise, odorous air pollution, and indoor air quality. General concern is to establish limit values for physical quantities not only from a toxicological point of view but with regard to adverse sensory reactions, human comfort and health. The main goal is to reveal early signs of dysfunction due to potential hazards in the environment. A second area of concern is to develop scaling methods for measuring perceptual attributes that are possible to calibrate as well as standardize. Allied basic research interests are in temporal effects on perception and effects of combining various sensory stimulations, such as sound mixing or mixing of chemicals.

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B. Berglund

Creation of Research Laboratories: (1) A Psychoacoustical Laboratory at the University of Stockholm with equipment specialized for community noises with regard to sound generation, sound measurement and sound reproduction (digital technique, stereo, large dynamic range) and (2) Indoor Air Quality Laboratories at the University of Stockholm and the Karolinska Institute with equipment specialized for low concentrations of volatile organic compounds. Generation of gases by olfactometric technique, chemical analysis and sampling and exposure of air at ppb concentrations. Hood and chamber exposures for humans. Stationary as well as mobile laboratories.

Research Grants:

Since 1972, research grants from the Swedish Council for Social Science Research, the Swedish Council for Research in the Humanities and Social Sciences, the Swedish Council for Building Research, the Swedish Environment Protection Board, the Swedish Work Environment Fund, and the Swedish Council for Planning and Coordination of Research.

Visiting Guest Researchers:

1975-76 Professor Gary B Rollman, University of Western Ontario, London, Canada (12 months). Research in *"Pain Perception and Psychophysical Methods"*.

1977 Grant for Visiting Researcher Professor Martha Teghtsoonian, Smith College, Northampton, MA, USA (6 months). Project on *"Human Perception of Space and Behavior"* from Swedish Council for Building Research.

1978-79 Professor Eugene Lechelt, University of Alberta, Western Ontario, Canada (12 months). Research in *"Skin Perception and Psychophysical Methods"*.

1982- Professor Trygg Engen, Brown University, Providence, RI, USA, (1982: 6 months, Fulbright fellow; 1983-85: 6 months in 1-month periods; 1987 and on 1 month each year). Research in *"Olfactory Perception with Clinical and Environmental Applications"*.

1983-92 Professor John C Baird, Dartmouth College, Hanover, NH, USA (1-3 months visits each semester; 1991-92: 12 months). Research in *"Signal and Pattern Analysis in Sensory Systems (Audition & Olfaction)"*.

1985-86 Professor Elliot Noma, Rutgers University, New Brunswick, NJ, USA (2 months per semester). Research in *"Model Development for Pattern Recognition and Interaction Processes in Sensory Systems"*.

1987-90 Professor Anna Preis, Institute of Acoustics, A. Mickiewicz University, Poznan, Poland (1 month each year). Research in *"Psychoacoustical Approaches to Annoyance"*. [In July 1990, Preis joined the staff of the University of Stockholm as Research Associate Professor, a personal chair from the Swedish Environment Protection Board in "Psychoacoustics and Community Noise"].

1988 Professor Sonoko Kuwano and Professor Seiichiro Namba, College of General Education, Osaka University, Japan (1 month). Research in *"Psychoacoustical Approaches to Noise Varying with Time"*.

1991 Dr. Jan Jarzecki, Institute of Acoustics, A. Mickiewicz University, Poznan, Poland (1 month). Research in *"Acoustical Measurement"*.

1992 Professor Rufin Makarewicz, Institute of Acoustics, A. Mickiewicz University, Poznan, Poland (1 month). Research in *"Sound Propagation and the Perception of Environmental Sounds"*.

1992-93 Dr. Piotr Miecznik, Institute of Acoustics, A. Mickiewicz University, Poznan, Poland (9-month stipend from Swedish Institute; 2 months visit). Research in *"Perception of Intermittent Sounds"*.

1994 *Forthcoming*: Dr. Soames Job, Department of Psychology, Sydney University, Australia (6-month stipend from Swedish Institute). Research in *"Questionnaire Techniques for Annoyance Surveys"*.

Supervisor for Doctoral Dissertations:

1974 Leif T Svensson "Relativity and Additivity in Olfactory Perception", University of Stockholm [First position: Assistant Professor, Umeå University, Sweden].

1981 Sarah S. Knox "Biofeedback of Alpha: Methodological Aspects and Theoretical Considerations", University of Stockholm [Positions: Research Assistant Professor, University of Stockholm; 1988 Research Associate Professor, Department of Psychiatry, Lafayette Clinic, Detroit, Michigan, USA].

1987 Richard Ahlström "Environmentally Induced Sensory Dysfunction", University of Stockholm [Positions: Research Director of Sensory Analysis, Swedish Food Research Institute, Gothenburg, Sweden; Associate Professor, University of Sundsvall/Härnösand, Sweden].

1988 Lennart Högman "Theory and Methods of Near Threshold Odor Psychophysics". University of Stockholm [Positions: Research Assistant Professor, Swedish Food Research Institute, Gothenburg, Sweden; Associate Professor, Stockholm University, Sweden].

1992 Lena Lundin "On Building Related Causes to the Sick Building Syndrome", University of Stockholm [First position: Private Consulting].

1992 Steven Nordin "On Psychophysical Evaluation of Olfactory Sensitivity in Health and Disease", Stockholm University [First position: Post-doctoral fellowship, Nasal Dysfunction Clinic, Division of Head and Neck Surgery, University of California at San Diego, CA, USA].

1993 Mats J. Olsson "The Perception of Odors in Interaction", Stockholm University [First position: Post-doctoral position, John B. Pierce Laboratory, Inc., and Yale University, New Haven, CT, USA].

1993 Krystyna Rankin " Differential Effects of Context on Intensity Judgements of Taste and Smell: Perceptual Change or Judgemental Bias", Stockholm University [First position: Post-doctoral position, Monell Chemical Research Center, Philadelphia, PA, USA].

Teaching:

Graduate courses (1971-) in "Environmental Psychology", "Sensory Psychology", "Stimulation and Registration Techniques in Sensory Psychology", "Indoor Air Quality", "Community Noise", and "Environmental Psychophysics", University of Stockholm. Research seminar series on (1975-79) "Perceptual Research and its Applications" and on (1982-88) "Risk Analysis in Environmental Psychology and Physiology", University of Stockholm, Karolinska Institute and the Swedish National Institute of Environmental Medicine, Stockholm, Sweden.

Organizer of Conferences:

International Symposium "Environmental Hazards and People at Risk" within the IAAP Congress in Applied Psychology, Edinburgh, Scotland, July 26-29, 1982.

Nordic Conference "Adverse Effects of Noise" for the Nordic Noise Group of the Nordic Council of Ministers, Stockholm, Sweden, July 6-7, 1983. (ca. 25 participants)

International Conference "Adverse Effects of Community Noise - Research Needs" for the Nordic Noise Group of the Nordic Council of Ministers, Stockholm, Sweden, November 14-17, 1983. (26 participants).

International Conference "Fechner Day '86" for the International Society for Psychophysics (ISP), Cassis, France, October 20-22, 1986. (ca 40 participants)

International Conference "Adverse Effects of Aircraft Noise" for the Nordic Noise Group of the Nordic Council of Ministers, Stockholm, Sweden, April 6-8, 1987. (17 participants)

The "5th International Congress on Noise as a Public Health Problem - Noise '88" (B. Berglund, U. Berglund, J. Karlsson & T. Lindvall) for the International Commission on Biological Effects of Noise (ICBEN) and the Nordic Noise Group of the Nordic Council of Ministers, Stockholm, Sweden, August 21-25, 1988. (500 participants)

Invited Colloquia:

University of North Dakota, Grand Forks, ND, USA, March 1972.
University of Montana, Missoula, Montana, USA, March 1972. (Public lecture)
Thurstone's Psychometric Laboratory, University of North Carolina, Chapel Hill, NC, USA, April 1972. (Public lecture)
Department of Environmental Psychology, City University of New York, USA, May 1972.
WHO Psychosocial Center, Karolinska Institute, Stockholm, January 1975.
Department of Psychology, Northeastern University, Boston, MA, USA, May 1978.
Noise Effect Branch, NASA, Langley Fields, VA, USA, May 1978.
Department of Psychology, Uniformed Services University of the Health Sciences, Department of Defense, Bethesda, ML, USA, May 1978.
ASEA Research Inc., Västerås, Sweden, April 1984.
Harvard School of Public Health, Boston, MA, USA, March 1985.
Science Center, Osaka University, Osaka, Japan, October 1986.
Institute for Water, Soil and Air Hygiene, Berlin (West), November 1986.
Georgia Institute of Technology, Atlanta, GA, USA, September 1988.
Institute of Environmental and Occupational Medicine, University of Aarhus, Denmark, August, 1989.
Helsinki University of Technology, Finland, February 1990.

Professional Expert Function in Organizations:

1977-90 Chairman (1984-) and Member of the Doctoral Dissertation Committee, the Faculty of Social Sciences, University of Stockholm.

1978-83 & 1988-93 Invited Member of the International Noise Team No. 6: "Community Response to Noise" at the International Commission on Biological Effects of Noise (ICBEN).

1982-86 European coordinator for the Division of Environmental Psychology, International Association of Applied Psychology (IAAP).

1983-91 Chairman (1991) and Member of the Scientific Committee for Noise, Research Division, Swedish Environmental Protection Board.

1983-87 Member of the Research Delegation, the Research Department, Swedish Institute of Occupational Health and Safety.

1983-87 Temporary scientific advisor for World Health Organization for a working group on "Air Quality Guidelines for Certain Malodorous Air Pollutants"; a working group on "[illegible]"; and a working group on "Indoor Air Quality: Organic Pollutants".

[illegible] Vice President (1990-) and Member of the Executive Committee of the International Society for Psychophysics (also one of the Founders in 1985).

1987-93 Governmental representative for Social Science Research in the Board of the National Institute for Occupational Health, Stockholm, Sweden.

1988-91 Govermental representative for Social Science Research in the Board of the Research Division, Swedish Environmental Protection Board.

1988-98 Chairman ([illegible]) and Secretary ([illegible]) of the International Commission on Biological Effects of Noise (ICBEN).

1988-89 Scientific expert of the Advisory Committee on Energy and the Environment (for its general position paper, July 1989), the American Society of Mechanical Engineers, Washington D.C., USA.

1989-92 Scientific expert of the Committee of Environmental Health, the American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE), Atlanta, USA.

1990-94 Scientific Expert and responsible for draft of forthcoming "Environmental Health Criteria Document on Community Noise" (B. Berglund & T. Lindvall) for the World Health Organization.

1990- Member of the Executive Committee of the International Association of Applied Psychology (IAAP).

1990- Member of the Research Department, The University of Falun/Borlänge.

1991- Vice President (1993-) and Secretary (1991-1993) of the International Academy of Indoor Air Sciences (also one of the Founders in 1991).

1991- Member of the Nordic Noise Group of the Nordic Council of Ministers.

1991- Member of the Board of the Scientific Colour Council, Stockholm, Sweden.

1992- Governmental representative for Social Science Research in the Board for Energy Development, Swedish Council for Industrial and Technical Development.

Editoral Work, Reviews for Journals & Reviews for Grant Proposals:

Guest Editor for the interdiciplinary scientific journal Environment International, 1986, vol. 12 and 1989, vol. 15: both special issues on "Indoor Air Quality".

Guest Editor for Environment International, 1990, vol. 16: special issue on "Public Health Implications of Environmental Noise", and, 1991, vol. 17: special issue on "Healthy Buildings".

Member of the Editoral Board of (1981-90) Journal of Environmental Psychology (Academic Press), (1988-) Environment International (Pergamon Press), and (1990-) Indoor Air–International Journal of Indoor Air Quality and Climate (Munksgaard Press).

Consulting reader for Perceptual and Motor Skills (1972-), USA; Sensory Processes (1975-79), USA; The Journal of the Acoustical Society of America (1982); Chemical Senses (1983-, earlier Chemical Senses & Flavour), USA; Perception (1984-), UK.

Special reviewer of grant proposals for National Science Foundation (1974-), USA; National Institute of Health (1977-), USA; Swedish Council for Building Research (1978-); Swedish Environment Protection Borad (1983-).

Membership (only) of Professional Societies:

1970- Fysiologföreningen (Society of Physiology), Stockholm, Sweden.
1972- Invited Member of the Psychometric Society, USA.
1978- European Chemoreception Research Organization (ECRO).
1979- (1992: Fellow) The American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE), Atlanta, USA.
1982- Division of Environmental Psychology, International Association of Applied Psychology (IAAP).
1985- Svenska Akustiska Sällskapet (SAS; Swedish Acoustical Society).
1985- Air Pollution Control Association (APCA), new name 1989: Air & Waste Management Association, USA.
1985- Invited Member of the Area Group in Perception of the Swedish Council for Research in the Humanities and Social Sciences, Stockholm, Sweden
1986- Invited Member of the Area Group in Environmental Psychology of the Swedish Council for Research in the Humanities and Social Sciences, Stockholm, Sweden..
1989- Environmental Design Research Organization (EDRA), Oklahoma City, OK, USA.
1992- American Association of the Advancement of Science.
1992- Invited Member of the New York Academy of Sciences.
1992- American Psychological Society.

Papers presented at Professional Meetings:

Nearly all papers (ca. 60) for Professional Meetings have been published (see some of them in the abridged list of publications).

Abridged List of Publications 1966-1993
(about 30%)

1966

Ekman, G., Berglund, B., & Berglund, U. Loudness as a function of the duration of auditory stimulation. Scand. J. Psychol., 1966, 7, 201-208.

1967

Berglund, B., & Berglund, U. A further study of the temporal integration of loudness. Rep. Psychol. Lab., Univer. Stockholm, 1967, No. 229.

Berglund, B., Berglund, U., & Ekman, G. Temporal integration of vibrotactile stimulation. Percept. mot. Skills, 1967, 25, 549-560.

1969

Berglund, B., Berglund, U., Ekman, G., & Frankenhaeuser, M. Th influence of auditory stimulus intensity on apparent duration. Scand. J. Psychol., 1969, 10, 21-26.

Ekman, G., Frankenhaeuser, M., Berglund, B., & Waszak, M. Apparent duration as a function of intensity of vibrotactile stimulation. Percept. mot. Skills, 1969, 28, 151-156.

1970

Berglund, U., & Berglund, B. Adaptation and recovery in vibrotactile perception. Percept. mot Skills, 1970, 30, 843-853.

1971

Berglund, B. An analysis of some basic mechanisms of sensory perception with direct scaling methods. Rep. Psychol. Lab., Univer. Stockholm, 1971, Suppl. 6. (Doctoral Dissertation)

1972

Berglund, B., Berglund, U., Jonsson, E., & Lindvall, T. Människan som mätinstrument. (Man as a Measuring Instrument) Swedish Medical Journal, 1972, 69, No. 23 (Human Environment Issue). (In Swedish)

1973

Berglund, B., & Berglund, U. Perceived duration of brief sensory signals. Percept. mot. Skills, 1973, 36, 1248-1250.

1974

Berglund, B., Berglund, U., & Lindvall, T. A psychological detection method in environmental research. Environ. Res., 1974, 7, 342-352.

1975

Berglund, B., Berglund, U., & Lindvall, T. Scaling loudness, noisiness and annoyance of aircraft noise. J. Acoust. Soc. Amer., 1975, 57, 930-934.

Berglund, B., Berglund, U., & Lindvall, T. A study of response criteria in populations exposed to aircraft noise. J. Sound & Vib., 1975, 41, 33-39.

Berglund, B., Berglund, U., & Lindvall, T. A psychological approach to environmental control. Man-Environment Systems, 1975, 5, 179-180.

Berglund, B., Berglund, U., & Lindvall, T. On perceptual interaction of noise and odor. Rep. Dep. Psychol., Univer. Stockholm, 1975, No. 445.

Berglund, B., Berglund, U., & Lindvall, T. Scaling of annoyance in epidemiological studies. Proc. CEC-WHO-EPA International Symposium "Recent Advances in the Assessment of the Health Effect of Environmental Pollution". Luxembourg: CEC, 1975, vol. I, pp. 119-137.

1976

Berglund, B., Berglund, U., & Lindvall, T. Scaling loudness, noisiness and annoyance of community noises. J. Acoust. Soc. Amer., 1976, 60, 1119-1125.

1977

Berglund, B. Quantitative approaches in environmental studies. Internat. J. Psych., 1977, 12, 111-123.

Berglund, B., Berglund, U., Jonsson, E., & Lindvall, T. On the scaling of annoyance due to environmental factors. Environ. Psych. & Nonverbal Beh., 1977, 2, 83-92.

1978

Berglund, B., & Berglund, U. Loudness and annoyance of single and combined community noises. Rep. Dep. Psychol., Univer. Stockholm, 1978, No. 524. (Invited Paper at the 95th ASA-Meeting: Abstract published in J.Acoust. Soc. Amer., 1978, suppl. 1)

1980

Berglund, B., Berglund U., & Lindvall, T. Loudness separation of community noises. In J.V. Tobias, G. Jansen & W.D. Ward (Eds.), Noise as a Public Health Problem. Rockville, Maryland: ASHA Reports 10, 1980, pp. 349-354.

Berglund, B., Berglund, U., Gustafsson, B., & Lindvall, T. Loudness separation and loudness confusion of community noises. Rep. Dep. Psychol., Univer. Stockholm, 1980, No. 561.

1981

Berglund, B., Berglund, U., Goldstein, M., & Lindvall, T. Loudness (or annoyance) summation of combined community noises. J. Acoust. Soc. Amer., 1981, 70, 1628-1634.

1983

Berglund B., Berglund, U., & Lindberg, S. Master scaling of environmental loudness. Rep. Dep. Psychol. Stockholm, 1983, No. 610.

1984

Berglund, B., Berglund, U., & Lindvall, T. (Eds.), Adverse Effects of Community Noise -Research Needs. Oslo, Norway: Nordic Council of Ministers, 1984.

1986

Berglund, B., & Berglund, U. Hörstyrka hos ljud från högspänningsledningar [Perceived loudness of sounds from high-voltage power lines]. Stockholm: Swedish Environment Protection Board, Report No. 3035, 1986. (In Swedish)

Berglund, B., Berglund, U., & Lindberg, S. Loudness of impulse sound from different weapons. In R. Lotz (Ed.). Inter Noise '86. New York: Noise Control Foundation, Berglund, B., Berglund, U., & Lindvall, T. Scaling of loudness from power line noise. Transactions of the Acoustical Society of Japan, 1986, No. N86-10-3.

Berglund, B., Berglund, U., & Lindvall, T. The psychophysics of complex impulse sound. Transactions of the Acoustical Society of Japan, 1986, No. N86-10-4.

Berglund, B., Berglund, U., & Lindvall, T. On the meaning of annoyance. Transactions of the Acoustical Society of Japan, 1986, No. N86-10-5.

1987

Berglund, B., Berglund, U., & Lindvall, T. Measurement and control of annoyance. In H.S. Koelega (Ed.), Environmental Annoyance: Characterization, Measurement, and Control. Amsterdam: Elsevier, 1987, pp. 29-44.

Berglund, B., Berglund, U., & Lindvall, T. Models of sensory interaction. In A. Okada & O. Manninen (Eds.), Recent Advances in Researches on the Combined Effects of Environmental Factors. Kanazawa, Japan: Kyoei Co., Ltd., 1987, pp. 283-294.

Berglund, B. Environmental psychophysics is interdisciplinary psychology. In S. Hygge & R. Ulrich (Eds.), Research on Environments and People: Methods, Quality Assessment, New Directions. Stockholm, Sweden: Swedish Council for Building Research, D8:1987, pp. 32-41.

Berglund, B., Berglund, U., & Lindberg, S. Loudness of community noise: Assessment, calibration and calculation. In Proceedings from Inter-Noise '87, Beijing, China: Acoustical Society of China, 1987, vol. II, pp. 1669-1672.

1988

Berglund, B., Berglund, U., Karlsson, J., & Lindvall, T. (Eds.), Noise as a Public Health Problem. Vol. 1: Abstract Guide. Stockholm: Swedish Council for Building Research, D15:1988.

Berglund, B., Berglund, U., Karlsson, J., & Lindvall, T. (Eds.), Noise as a Public Health Problem. Vol. 2: Hearing, Communication, Sleep and Nonauditory Physiological Effects. Stockholm: Swedish Council for Building Research, D16:1988.

Berglund, B., Berglund, U., Karlsson, J., & Lindvall, T. (Eds.), Noise as a Public Health Problem. Vol. 3: Performance, Behaviour, Animal, Combined Agents and Community Responses. Stockholm: Swedish Council for Building Research, D17:1988.

Berglund, B., Berglund, U., Preis, A., & Rankin, K. Does equal loudness mean equal annoyance? In B. Berglund, U. Berglund, J. Karlsson, & T. Lindvall (Eds.), Noise as a Public Health Problem. Vol. 3: Performance, Behaviour, Animal, Combined Agents and Community Responses. Stockholm: Swedish Council for Building Research, D17:1988, pp. 145-152.

Kuwano, S., Namba, S., Berglund, B., Berglund, U., & Lindberg, S. On the definition of loudness, noisiness, and annoyance using selected [illegible] method. In B. Berglund, U. Berglund, J. Karlsson, & T. Lindvall (Eds.), Noise as a Public Health Problem. Vol. 3. Performance, Behaviour, Animal, Combined Agents and Community Responses. Stockholm: Swedish Council for Building Research, D17:1988, pp. 223-228.

1989

Berglund, B., & Nordin, S. Loudness and brainstem auditory evoked response for intermittent sound. In P. Pravica & G. Drakulic (Eds.), 13. International Congress on Acoustics. Vol. 1: Invited Lectures Theme 1 & 5. Novi Beograd: SAVA Center, 1989, pp. 377-380.

Baird, J.C., Berglund, B., Berglund, U., & Lindvall, T. Symptom patterns as an early warning signal for community health problems. Environ. Internat, 1989, 16. (in press)

Baird, J.C. & Berglund, B. Thesis for environmental psychophysics. Journal of Environmental Psychology, 1989, 9, 345-356.

1990

Berglund, B., & Lindvall, T. (Eds.). Noise as a Public Health Problem. Volume 4: New Advandes in Noise Research - Part I. S -holm: Swedish Council for Building Research, D1:1990.

Berglund, B., & Lindvall, T. (Eds.). Noise as a Public Health Problem. Volume 5: New Advandes in Noise Research - Part II. Stockholm: Swedish Council for Building

Berglund, B., & Lindvall, T. Noise as a public health problem. In B. Berglund & T. Lindvall (Eds.), Noise as a Public Health Problem. Volume 5: New Advandes in Noise Research - Part II. Stockholm: Swedish Council for Building Research, D2:1990, pp. 13-14.

Berglund, B., Preis, A., & Rankin, K. Relationship between loudness and annoyance for ten community sounds. Environ. Internat., 1990, 16, 523-531.

Berglund, B., & Nordin, S. Utilizing individual differences in loudness measurement. In F. Müller (Ed.), Fechner Day '90. Würzburg, FRG: Institute für Psychologie, Universität Würzburg, 1990, pp. 117-122.

Berglund, B., & Lindvall, T. (Eds.). Special issue on Public Health Implications of Environmental Noise. Environ. Internat., 1990, 16, Nos.4-6, pp. 313-601.

Berglund, B., Lindvall, T., & Nordin, S. (Eds.). Adverse Effects of Aircraft Noise. Environ. Internat., 1990, 16, 315-337.

Berglund, B. Loudness scaling in environmental Psychophysics. In E. Wzimek (Ed.), Subjective and Objective Evaluation of Sound. Singapore: World Scientific Publ., 1990, pp. 3-14.

1991

Berglund, B., & Preis, A. Is perceived annoyance more subject-dependent than perceived loudness. In T. Pritz (Ed.), Proc. 9th FASE Symposium and 10th Hungarian Conference on Acoustics. Budapest: Scientific Society for Optics, Acoustics and Filmtechnics, 1991, pp. 67-72.

Berglund, B. Quality Assurance in environmental psychophysics. In S.J. Bolanowski & G.A. Gescheider (Eds.), Ratio Scaling of Psychological Magnitudes—In Honor of the Memory of S.s.Stevens. Hillsdale, NJ.: Erlbaum, 1991, ch. 11, pp. 140-162.

Baird, J.C., Berglund, B., Berglund U. & Lindberg, S., Stimulus sequence and the exponent of the power function for loudness. Perceptual & Motor Skills, 1991, 73, 3-17.

Kuwano, S., Namba, s. Hashimoto, T., Berglund, B., Da Rui, Z., Schick, A., Hoege, H., & Florentine, M. Emotional expression of noise: A cross-cultural study. J. Sound & Vib., 1991, 151, 421-428.

Berglund, B. The role of loudness as guide for community noise. In A. Lawrence (Ed.), Inter-Noise '91. The Cost of Noise. Poughkeepsie, N.Y.: Noise Control Foundation, 1991, pp. 45-48.

Berglund, B., Harder, K., & Preis, A. Annoyance perception of sound and information retrieval. In A. Lawrence (Ed.), Inter-Noise '91. The Cost of Noise. Poughkeepsie, N.Y.: Noise Control Foundation, 1991, pp. 819-822.

1992

Berglund, B., Lindvall, T., & Nordin, S. Environmentally induced changes in sensory sensitivities. Ann. N. Y. Acad. Sci., 1992, 641, 304-322.

Berglund, B., Harder, K., & Preis, A. Perceived annoyance of intermittent sounds. In G. borg & G. Neely (Eds.), Fechner Day '92. Stockholm: International Society for Psychophysics, 1992, pp. 27-32.

1993

Preis, A., & Berglund, B. Perceived annoyance of intermittent sounds. In M. Vallet (Ed.), Noise as a Public Health Problem (Noise & Man '93). Arcueil, France: l'INRETS, 1993, vol. 2, pp. 343-346.

27.7.93

WALTER W. HOLLAND, CBE

PROFESSOR OF PUBLIC HEALTH MEDICINE IN THE UNIVERSITY OF LONDON

DEPARTMENT OF PUBLIC HEALTH MEDICINE
UNITED MEDICAL AND DENTAL SCHOOLS OF GUY'S AND ST. THOMAS'S HOSPITALS
(UNIVERSITY OF LONDON)

CURRICULUM VITAE

Born	5th March 1929
Nationality	British
University	St. Thomas's Hospital Medical School, London University (1948-1954)
Marital Status	Married 1964. Three sons.

DEGREES AND PROFESSIONAL QUALIFICATIONS

1951	B.Sc. (Special) in Physiology, with Honours (2nd Upper)
1954	M.B.,B.S. (Honours), with distinction in Obstetrics and Gynaecology
1964	M.D.
1971	M.R.C.P. (without examination)
1972	F.F.C.M. (converted to F.F.P.H.M., 1990)
1973	F.R.C.P.
1977	M.R.C.G.P. (without examination)
1982	F.R.C.G.P.
1990	F.R.C.P. Edin. (Honorary)
1992	F.R.C.Path. (without examination)
1993	F.F.P.H.M.Ireland (Honorary)

SCHOLARSHIPS, PRIZES AND HONOURS

1970	Elected Life Time Member of Society of Scholars, Johns Hopkins University
1977	Inaugural Lecturer, Johns Hopkins University Society of Hygiene
1981	Doctor Honoris Causa, University of Bordeaux
1984-85	Fogarty Scholar-in-residence, National Institutes of Health, Bethesda, Maryland, U.S.A.
1984	Theodore Badger Visiting Professor, Harvard University Medical School, Cambridge, Mass., U.S.A.
1985	Elected Honorary Member, American Epidemiological Society
1985	First Sawyer Scholar-in-residence, Case Western Reserve Medical School, Cleveland, Ohio, U.S.A.
1985	Elected Honorary Member, American Epidemiological Society
1986	Elected Corresponding Member, Deutsche Gesellschaft fur Pneumologie und Tuberkulose
1989	Awarded Salomon Neumann Medal by German Society of Social Medicine
1990	Doctor Honoris Causa, Free University of Berlin
1991	Elected Foreign Member of Scientific Board of 3rd Medical Faculty of Charles University, Prague
1991	Elected "Hero of Public Health" by Johns Hopkins University School of Hygiene
1992	Awarded CBE
1993	18.3.93 First Cochrane Lecturer, Green College, Oxford
1993	24.3.93 Second Health Sciences Public Lecturer, City University, London.
1993	Honorary Member of the Society for Social Medicine

POSTS

1955-56	Casualty Officer and House Physician, St. Thomas's Hospital
1956-58	National Service in RAF. Epidemiological Research Laboratory, Central Public Health Laboratory, Colindale

POSTS, cont.

1958-68	Various Lecturer and Senior Lecturer posts in Medicine and Clinical Epidemiology at St. Thomas's Hospital Medical School and London School of Hygiene and Tropical Medicine, including MRC Research Fellowship at the Statistical Research Unit and Department of Epidemiology, LSHTM, and Research Fellowship at Department of Epidemiology, Johns Hopkins University, Baltimore.
1968-	Professor of Clinical Epidemiology and Social Medicine, St. Thomas's Hospital Medical School,
1991-	1.11.91: Title changed to: Professor of Public Health Medicine in the University of London.
1968-	Honorary Director, Social Medicine and Health Services Research Unit, St. Thomas's Hospital Medical School
1974-77	Sub-Dean, St. Thomas's Hospital Medical School

OTHER POSTS

1962-69	Various Visiting Lectureships and Consultancies in U.K. and abroad including:
	Eastman Dental Hospital
	Division of Air Pollution and the Environmental Protection Agency, U.S. Public Health Service, Washington
	California State Health Department
	University of Rochester, New York
	National Centre for Health Services Research, U.S. Public Health Service.
1969-81	Various Visiting Professorships including:
	School of Public Health, UCLA, Los Angeles, U.S.A.
	Monash Medical School, Melbourne, Australia
	Stanford University Medical School, Cliveden, England
	Free University of Berlin and University of Saarbrucken
	Universities of Toulouse, Marseilles and Bordeaux

MEDICAL SCHOOL AND HOSPITAL COMMITTEES

1970-74	Chairman, Committee on Community Medicine, St. Thomas's Hospital
1974-77	Sub-Dean, Academic Representative on District Management Team
1978-83	Chairman, Cardio-respiratory Health Care Planning Team
1980-82	Member, School Council, St. Thomas's Hospital Medical School
1981-82	Member, United Medical Schools Co-ordinating Committee
1982-89	Member, Council of Governors, United Medical and Dental Schools
1982-88	Member, West Lambeth District Health Authority
1983-86	Vice-Chairman, West Lambeth District Health Authority

SOUTH EAST (South West) THAMES REGION

1966-72	Member, Joint Consultative Committee for South Western Metropolitan Regional Hospital Board
1974-82	Medical School Representative, Area University Liaison Committee. S.E. Thames Regional Health Authority
1979-82	Chairman, S.E. Thames Health Care Planning Team for Cardio-respiratory Disease
1982-86	Member, Regional University Liaison Committee
1989-	Member, Institute of Public Health Steering Committee

UNIVERSITY OF LONDON

1964-74	Chairman, University of London Undergraduate Teachers Sub-committee of the Board of Studies in Preventive Medicine and Public Health (Community Medicine)
1972-74	Chairman, Board of Studies in Community Medicine, University of London
1974-81	Member, University of London Joint Medical Advisory Committee of the Academic and Collegiate Councils

EXAMINER

1965-92	Between these dates I have been examiner, external examiner and specialist examiner at Universities of Glasgow; Wales; Belfast; Groningen; Holland; Oxford; Cambridge; Manchester; London; Aarhus, Denmark; York; Rotterdam; Holland; Leuven, Belgium; Keele.

FACULTY OF COMMUNITY MEDICINE/FACULTY OF PUBLIC HEALTH MEDICINE

1971-77) 1987-89)	Member of Board of Faculty of Community Medicine
1989-92	President, Faculty of Community Medicine. (Public Health Medicine. Dec. 1989).

DEPARTMENT OF HEALTH

1963	Member, Ministry of Health. Chief Medical Officer's Committee of Chronic Bronchitis
1965-70	Member, Ministry of Health Committee on Laboratory Automation and Screening Trials
1965-74	Member, Ministry of Health Standing Advisory Committee of Hospital Medical Records
1967-90	Member, Panel on Child-Nutrition of the Committee on Medical Aspects of Food Policy
1969-73	Member, Sub-committee on Screening
1970	Member, Advisory Committee to Secretary of State, Department of Health and Social Security, on Regional Health Councils
1970-90	Member, Sub-committee on Nutritional Surveillance
1971-77	Member, Laboratory Development Advisory Group
1971-77	Chairman, Clinical Sub-group of LDAG
1971-74	Member, Working Party on Collaboration with Local Government
1973-77	Member, Committee on Medical Aspects of Chemicals in Food and the Environment - Physical Environment Sub-committee
1973-77	Member, Independent Committee on Smoking (Hunter Committee)

DEPARTMENT OF HEALTH, continued

1975-77	Member, Working Party on Allocation of Resources (RAWP)
1977-80	Member, Working Party on Lead in Environment
1977-82	Member, Air and Soil Committee
1980-85	Member, DHSS/NHS Health Information Steering Group (Korner)
1981-	Member, Independent Scientific Committee on Smoking (Froggatt Committee)
1983-86	Chairman, Faculty of Community Medicine - Health Information Steering Group on Health Outcome Measures
1989-92	Member, Standing Medical Advisory Committee
1991-	Member of Clinical Standards Advisory group Sub-Committee on Access and Availability
1991-	Member, Secretary of State's Health of the Nation Wider Health Group

GLOUCESTERSHIRE HEALTH AUTHORITY

1992-	Non-Executive Director

MEDICAL RESEARCH COUNCIL

1963-65	Member, Committee on the Aetiology of Chronic Bronchitis
1963-66	Secretary, Sub-committee on Respiratory Symptom Questionnaire
1965-73	Secretary and Member, Panel on Epidemiology of Chronic Bronchitis
1965-73	Member and Assistant Secretary, Committee on Research in Chronic Bronchitis
1967-74	Secretary, Committee on General Epidemiology
1987-91	Member, Health Services Research Committee

OFFICE OF POPULATION CENSUS AND SURVEYS

1970-87	Member, Committee on Medical Nomenclature and Statistics
1988-	Member, Consultant Advisory Panel

NUFFIELD PROVINCIAL HOSPITALS TRUST

1966-90	A series of Working Parties and Committees

KING EDWARD VII HOSPITAL FUND FOR LONDON

1973-90	A series of Working Parties and Committees

OTHER ORGANISATIONS (NATIONAL)

1970-74	Chairman, Scientific Advisory Committee of the South Metropolitan Cancer Registry, London
1977-81	Chairman, Independent Medical Advisory Committee on Tobacco Substitutes to Tobacco Companies
1980-82	President, Section of Epidemiology and Community Medicine, Royal Society of Medicine
1982-	Vice President, Section of Epidemiology and Community Medicine, Royal Society of Medicine.
1985	Chairman, Society for Social Medicine.
1985-	Part-time Member, Data Protection Tribunal
1987-88	Specialist Adviser, House of Lords Select Committee on Science and Technology, Sub-committee "Medical Research"
1989-92	Member of Council, the Royal college of Physicians
1989-92	Member, Conference of Medical Royal Colleges and their Faculties in the U.K.
1990-92	Vice-Chairman of Conference of Medical Royal Colleges and their Faculties in the U.K.
1990-92	Chairman, Public Health Medicine Consultative Committee

WORLD HEALTH ORGANISATION

1965-	A series of Committees, including:
1965-92	Member, Expert Advisory Panel on Air Pollution.
1981	Chairman, Joint WHO/HQ/EURO Meeting on an Integrated Noncommunicable Diseases Prevention and Control Programme

WORLD HEALTH ORGANISATION, cont.

1986-	Director, WHO Collaborating Centre for Integrated Non-communicable Disease Research
1988-	Member, WHO Technical Advisory Group of the Acute Respiratory Infections Control Programme
1988-	Chairman, WHO Global Scientific Advisory Group Integrated Programme for Community Health in Non-communicable Diseases. (Interhealth Programme)
1992	Chairman, CINDI meeting in London
1993-	Member, WHO Expert Advisory Panel on Health Situation and Trend Assessment

EUROPEAN COMMUNITY

1960-	A series of Committees, including:
1977-	Chairman, Panel on Epidemiology and Social Medicine (DGV)
1983-	Adviser in Epidemiology on Studies of Respiratory Disease (DGV)

OTHER ORGANISATIONS (INTERNATIONAL)

1964-68	Editor and Member of Executive Council, International Epidemiological Association
1968-71	General Secretary and Member of Executive Council, International Epidemiological Association
1976-79	Member, Scientific Advisory Panel of German Doctors' Association in der Bundesrepublik Deutschland
1977	Adviser, Bosch Foundation, Stuttgart, W. Germany
1977-83	Chairman, Scientific Committee on Respiratory Diseases, International Union against Tuberculosis
1980-84	Member, Bundesarztekammer Scientific Advisory Committee (W.Germany)
1988-91	Member, Scientific Advisory Committee, GSF, Munich, Germany.
1987-90	President, International Epidemiological Association
1990-	Member of Executive Council of International Epidemiological Association

SOCIETIES

British Medical Association

Fellow, Royal Society of Medicine

Fellow, Royal Statistical Society

Fellow, Royal Society of Arts

International Epidemiological Association

American Statistical Association

International Union Against Tuberculosis

American Public Health Association

Association d'Epidemiologistes de la Langue Francaise (ADELF)

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Screening in Health Care: Benefit or Bane?
London: Nuffield Provincial Hospitals Trust.
1990

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European Community Atlas of Avoidable Death.
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Oxford: Oxford University Press, 1991.

Holland WW, Detels R, Knox G. (Eds)

Oxford Textbook of Public Health. 2nd ed., edited with the assistance of Beverley Fitzsimons and Lucy Gardner.
Volume 1: Influences of Public Health
Volume 2: The Methods of Public Health
Volume 3: The Investigative Methods and Special Applications
Oxford: Oxford University Press, 1991.

Plus approximately 300 original scientific articles etc.

1

Stockholm, 31st May 1993.

Scientific Review of
"Report of a Field Study of
Aircraft Noise and Sleep Disturbance"
(issued December, 1992, by the Department of Transport, United Kingdom)

by

Birgitta Berglund
Department of Psychology, Stockholm University
S-106 91 Stockholm Sweden

The Objectives of the Report

As shown in a relatively recently published review of the scientific literature, various kinds of adverse effects result from aircraft noise exposure (Berglund, Lindvall & Nordin, 1990). The present report is concerned with night-time noise exposures in areas around airports and, therefore, the research problem has been restricted to effect of noise on sleep. In particular, the study tries to determine: (a) the relationships between outdoor aircraft noise levels and the probability of sleep disturbance and (b) the variation of these relationships with time of night. The rational for undertaking the study is that the current night restrictions of flight activities at Heathrow and Gatwick Airports are based in part, on the results of studies conducted more than 10 years ago. A main aim of the study has been to obtain "objective" measurements of sleep disturbance rather than "subjective" measurements, around appropriate airports in United Kingdom.

The objectives of the study are based on an analysis of the research literature that from a scientific point of view is unsatisfactory. Among the references actually given in the report, more than half appear in so-called technical reports which have not been peer-reviewed. This fact is unfortunate because of the large amount of grants necessary for field studies of this kind. Although it is well known, and also pointed out in the introduction section of the report, the person-related characteristics have not been fully considered. For example, without analysing the population living around the airport, it presumed that everybody exposed will be sleeping at night. Since shift-workers were excluded, is the proportion of shift-workers always negligible around UK airports? My other example relates to the choice of determining outdoor aircraft noise levels only. Even if comparability in exposures between areas will be improved this way, an estimation of the median and range of indoor exposures in various areas is certainly necessary for predicting probability of sleep disturbance. In calculating such indoor exposure statistics, consideration should also be given to the possibilities to sleep with open windows.

I find there is a lack of discussion in the report about the connection between night time restrictions in air activities and daytime allowances inside, for example various constant quota per 24 hours. In the day, annoyance reports, communication problems and various adverse health effects will be at issue independent of the probabilities for sleep disturbances at night and their after-effects appearing in daytime. The main goal for the Department of Transportation must be non-affected populations with regard to adverse health effects preferably with some

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"Objective" Measurement of Sleep Disturbance

The most commonly used method for measuring sleep in humans is based on recordings of evoked brain potentials, the electroencephalograph (EEG). With regard to noise exposure, most "sleep EEG" studies have been conducted in the laboratory and only very few in residential homes. Some of these studies have tried to assess body movements during sleep also. On the other hand, sleep quality in homes has been determined by questionnaire surveys focussing on the perception of sleep and its after effects as well as mood. Thus, there is a problem of representativeness (from voluntary subjects to regular population) and generalizability (from laboratory to field) of current knowledge about the effects of noise on sleep.

In the present study, a new procedure to measure sleep disturbance due to aircraft noise in the field was tried. An actimeter was used to measure fine limb movements of the wrist. A body of literature exists which has shown that sleep and body movements such wrist movements are inversely correlated. The fine wrist movements are used as an intervening variable and it is in turn here presumed to be indicative of sleep disturbance. So far, fine limb movements of the wrist and its relationship to sleep disturbance due to aircraft noise has not been proven. Therefore, a validation is tried in the present study of wrist movements against "sleep-EEG" during actual noise exposure. This validation study is unfortunately kept very small involving only 6 out of 50 subjects at each of 8 different study areas (different exposures). The 6 "sleep-EEG" cases were studied during 4 nights each while the 50 actimeter cases were studied during 15 nights each. This means that the validation study only involved 6 subjects (4 nights each) for each of 8 different study areas. The statistical base for the validation is very small indeed considering the presumed large intra - as well as inter-individual variance for both the EEG and the actimeter measurements. The results of the validation is also reported to be quite uncertain, that is 40 ± 10% of arousals represent actual awakenings!

In this connection, the definition of sleep disturbance used in the report is incompatible with the operational definition in terms of awakenings due to the low validity of the actimeter measurement of wrist movements as indicative of awakenings.

Study Sites

The selection of study sites is somewhat unexpected considering the aim of the study being to determine the relationship between outdoor noise exposure and probability of noise disturbance. In determining such a relationship great caution should be given the possibility to obtain a large and true variation in noise exposure. By selecting only two areas at each airport a large portion of the exposure variance may be characterized as between-airport variance rather than between-exposure variance. In my opinion the choice of study sites actually restricts the variance in noise exposure, and thus the possibility to draw conclusions about outdoor noise levels from aircraft activity. After all, the remedial actions should involve the latter, at least the present night-time quota does.

Since a new outcome measure (actimeter) is being used in the present study, it should have been a great advantage from a study-design point of view to select also one or two control areas where no aircraft exposure

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The issue of control sites is discussed in the report and such control is rejected on other grounds. In my opinion, the control sites are necessary for establishing a good validation of the outcome measure because phenomena such as habituation and adaptation to environmental exposure may have influenced the validity of the outcome measure. As it now stands, the actimeter measures may not be viewed to be very valid for awakenings caused by noise exposure.

An indication of how good the selection of study sites is may be found in Fig 16 where the very much annoyed from aircraft noise spread in roughly two "exposure" classes, those living in site EDG, SWH, and HLW forming one class separated from the other sites. The exposure patterns during nights as well as sound pressure levels vary substantially between these areas (Fig 6) and a classification of sites according to exposure pattern during night would look quite different. It follows that 8 such different study sites may represent too multifaceted exposure conditions for being successful in forming any good dose-response relationship, particularly when both the dose and the response is integrated into an indicator based on uncertain assumptions.

Study Populations

Since the study populations were not selected to be representative samples of people who lived around the four airports but rather quota samples for each site, no representativeness in conclusions for the populations living around the four airports is present in this report. This makes the results of the report invalid for drawing conclusions about remedial actions with regard to flight activities during night at these four airports. Since the validation experiment of the outcome measure (actimeter measures vs. sleep-EEG measures) relies on the same sample, the generlizability of the results from the 6 out of the 50 subjects (in turn out of 200 subjects) from each area may not be considered any greater than the generalizability of results from the laboratory experiment to the field study. The probability that the 6 subjects per study site would be representative for the population living around the airports is very low.

It seems strange to me that the study sites and the study populations were selected as described in the report considering the objectives of the study listed in the beginning of the same report.

Resolution in Exposure and Outcome Measures

The presentation of results lack measures (estimates) of variation in exposure as well as outcome measure (actimeter). It is not clear if the resolution in the indicator scales is actually good enough to differentiate the study sites from each other. The inter-individual differences and the question of susceptible persons is most relevant to the resolution of scales. In the report there is a worry that the procedure of selecting voluntary subjects as well as excluding some subjects may have distorted the sample to include only the less susceptible persons.

Noise Exposure and Probability of Sleep Disturbance

This report has not addressed the question of number & kind of aircraft and sleep disturbance. The selection of the two sites at each of the three airports is vital for the results in terms of causation.

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It is relatively clear to me how the people were selected (quota) but not the sites in terms of exposure variance brought into the data analysis. In fact, the data treatment starts with a dichotomization of 60 dB (lower levels of outdoor noise events never known) but it would have been interesting to see what happens between these two categories and the outcome measure (actimeter). Instead, the study shows what happens between >60 dB and <90 dB. It is highly suspicious to me that the sleep disturbance does not change between 60 and 90 dB! This may reflect a weakness in the outcome measure of sleep disturbance (actimeter) or a low resolution in the determinant measure (outdoor noise level). The dose-response model should perhaps be more concerned with the exposure pattern during night than outdoor noise level. In addition, an estimation of the additional variance contributed by the outdoor-indoor exposure relationship may be fruitful.

The U.K. Sleep Disturbance Study - A Critique
(A Presentation to the N.O.I.S.E. Annual Meeting, Irving, Texas July 15th 1993)

Thank you, Charles, and thanks also to N.O.I.S.E. for inviting me here to Irving. I'm the spokesman for the Knutford & Mobberley Joint Airport Action Group. Our town & village sit at the end of Manchester Airport's runway and the Group campaigns to prevent the unrestricted expansion of our noisy neighbor.

Before I talk to you about the U.K. Department of Transports' Sleep Disturbance Study, I thought you might like to see a short clip from a regional BBC program about Manchester Airport's plans for a second runway, needed, they tell us, to take passengers from 11 million a year right now to 30 million in the year 2005. Both the Airport and ourselves were given a crew in the BBC and allowed to script, produce & edit our own 3 minute film leading into a studio--based discussion on the problems and benefits of the second runway plans. I'm sure you'll recognize some familiar arguments! I hope you found that clip interesting and that our campaign stance is clear--even though not all of you would support us wholeheartedly!

In January this year the Department of Transport announced the publication of the results of its 3-year Sleep Disturbance Study. In September of the year before (1992) we had a fair taste of where things might lead to from press reports such as this from the "Daily Telegraph" of September 1st headed "Call to ease night curbs an airliners', in which Britannia, one of the U.K.'s premier charter airlines puts the case for more night flights.

The study's main conclusion was that "once asleep, very few people living near airports are at risk from any substantial sleep disturbance due to aircraft noise, even at the highest event noise level." Our initial reaction on reading the summary of the report was the sound of jaws hitting the floor! Around Manchester Airport the response of those of us living under the flight paths was that if you believed that you'd probably believe that Boris Yeltsin is a democrat!

Later that month, the Department issued a 'Consultation Paper' detailing new Night Flight proposals for London's airports. This outlined a kind of 'noise budget' based on certification levels of aircraft types with a point quota system ranging from '0', and therefore exempt, rating through to 16 points for Concorde. The Sleep Disturbance Study was quoted as "proving" that "noise from aircraft below 80 dB(A) was most unlikely to cause disturbance." But why, you might say, should we at Manchester Airport worry about what happens at Heathrow, Gatwick & Stansted? Our concern was heightened by the fact that instead of a 3-year rolling agreement on absolute number of night flights, we only had a one-year agreement in place pending the outcome of the Sleep Disturbance Study and the subsequent Night Flight proposals. These indicated that the Civil Aviation Authority saw this as a possible Europe-wide standard!

I should also add that Manchester Airport was the prime mover behind an original Manchester-based pilot a study, a forerunner to the one we're looking at today.

When we finally obtained a full copy of the report in mid-February our 'first look' review highlighted seven main areas of concern. Let's look at the first four of these.

We found there was a huge gap between the measured results and the report's own social survey findings, a substantial 'subjective vs. objective' difference. For example, Figure 27 shows the response when subjects were asked 'what causes you to wake up.' Overall 'aircraft noise' ranked 2nd to 'partner/child' as the main causal factor. You can also see the difference between sites--the Gatwick sites showing a significantly lower rating for aircraft noise disturbance than the other sites.

This may be explained by our second concern, the choice and location of the sites featured in figures 6(a) to (h). Notice the difference in traffic, both overall levels and phasing, and in absolute dB values, too. Interestingly at both Stanwell Moor (Heathrow) and Heald Green (Manchester) the tables show large numbers of ANE's (and therefore planes!) exceeding the current noise infringement level of 102 PndB (equivalent to 89 dB(A)). As a result, both airports have now agreed to monitor landing noise--but we don't yet have a starting date for this!!

According to the Manchester table, more than 150 aircraft movements should have been fined 50% of their landing fee during August 1991 for exceeding the penalty level!

We feel that averaging out the results from sites which show such wide variances in their geographical relationship to the airports and flight paths concerned, also, the noise levels experienced and the subjects measured individual responses, is statistically unsafe.

We were also quite staggered at the total lack of a control site--although the study team tell us they consider the Stansted sites to be a control! We don't believe this is the best example of scientific methodology we've ever seen. Our final three concerns are as follows: We also felt that the use of wrist-mounted actimeters and the validation of this technique by EEG Study is an area we find totally unconvincing.

However, we registered 11 out of 10 on the scale of outright amazement when we then found in section 7(a) of the Report, 'Window State', that differences in arousal rates when bedroom windows were open or closed were 'small, and, after confounding factors are controlled, they turn our to be statistically insignificant! The report states in several places that work on various aspects is continuing and indeed the reference section lists a further 5 complex studies from members of the Team that have yet to be published. The report is itself not easily understood by other that the most expert expert-- so this is where we turned for help.

Before we look at the 'how'sand who's' of our attempt to understand the flawed nature of this study, a closer look at figure 50 might indicate just why we questioned the reports veracity. This apparently shows quite simply that more noise actually helps you sleep! And, as some of you already know, it wasn't only people around U.K. airports who expressed surprise at the findings. Civil Servants from our Department of Transport flew to Washington in January to give a briefing on the study at your Department of Transport. Once again I'm grateful to Charles Price for supplying a particularly apposite phrase which has now entered extensively into the lexicon of our campaign.

Having sat through the briefing, Charles described the findings as 'counter-intuitive'--a politically correct definition with which we totally concur! During February we got in touch with other community-based groups and also local authorities around the U.K.'s major airports and formed an alliance to fight these proposals. We lobbied politicians at both Westminster and Brussels, co-operated on press briefings and radio and TV coverage, too. We succeeded in getting questions asked in both Houses of Parliament, secured an adjournment debate in the House of Commons, obtained a private meeting with the Aviation Minister, Lord Caithness and ensured through a combination of leafleting and public meetings that more than 8,000 individual and group representations were sent to the Minister for Transport by the end of April.

We also co-operated financially and I went to Sweden at the end of April to start to put together an International Peer GroupReview team to work on the Sleep Disturbance Study. The Team comprises: Professor Birgina Berglund, University of Stockholm, Professor Ragnar Rylander and Doctor Evy Ohrstrom, University of Gothenburg, Professor Gerd Jansen, University of Dusseldorf, Doctor Michel Vallet and Alain Muzet, Institut National de Recherche sur les transports et leur Securite, Lyon, and Doctor Winni Hofman, University of Amsterdam.

Professor Berglund has produced an outline review of the Sleep Disturbance Study for us. In it, she states that the analysis of the research literature quoted by the study team is unsatisfactory as more than half of the items listed are so-called 'technical' reports that have not been peer-reviewed.

Professor Berglund also feels that the report, which is only considering outdoor noise levels should have looked at indoor exposures too--she considers this absolutely necessary for accurate prediction of sleep disturbance. In calculating such indoor exposures, both open and closed window measurements should be taken. The study also makes no mention of the links between night time noise exposure and day time levels, i.e. constant 24 hour exposure. During the day, reports of annoyance, communication, problems and various other adverse health effects will be at issue, independent of sleep disturbance and its after-effects appearing in day time.

The actimeter methodology, validated by EEC measurements is also questionable. The validation study is unfortunately very small, only governing 50 subjects at each of the 8 different study sites with different exposures.

The 6 'sleep EEG' cases were studied during 4 nights each, while the 50 actimeter cases were studied during 15 nights each. This means that the validation study only involved 6 subjects (four nights each) in each of the 8 different exposed areas. The statistical base is therefore very small indeed considering the presumed large intra--as well as inter--individual variance for both the EEG and the actimeter measurements. The definition of sleep disturbance used in the report is incompatible with the awakenings measured due to the low validity of the actimeter measurements of wrist-movement and their indication of awakenings.

The selection of the study sites is also questionable, considering that the aim of the study was to determine the relationship between outdoor wide exposure and the probability of noise disturbance. By selecting two areas at each airport a large portion of the exposure variance can be characterized as between airport variance rather than between exposure variance. In Professor Berglund's view, the choice of sites actually restricts the variance in wide exposure and this in turn affects the possibility of drawing conclusions about outdoor noise levels from aircraft activity.

The issue of control sites is vital one too. Professor Berglund strongly feels that control sites are necessary because phenomena such as habituation and adaptation to environmental exposure may have influenced the results. The exposure pattern at night as well as sound pressure levels varies substantially between sites -- a classification of sites according to exposure patterns would look quite different. 8 such different study sites really represents too multi-faceted a range of exposure conditions to be successful in forming good dose response relationships particularly when both the dose and the response have been integrated into an indicator based on uncertain assumptions.

The study populations were quota samples and were not selected to be representative slices of people living around airports and therefore it is impossible to draw conclusions about the reactions of the populations living around the four airports to aircraft noise at night. And in turn this also invalidates any action to control or even extend flight activities at night at these four airports. The report itself indicates a worry that the selection of volunteer subjects as well as excluding some subjects may have distorted the sample to include only the less susceptible. Professor Berglund is very concerned that the data treatment starts at a level of 60dB and that we don't know what happens at lower levels. The study only shows what happens between >60dB and <90dB and in her words, Professor Berglund views as highly suspicious the 'fact' that apparently sleep disturbance does not change between 60 and 90dB! The dose response model should perhaps have been more concerned with the exposure pattern during the night rather than outdoor noise level. Professor Berglund feels that more work looking at the additional variance contributed by the outdoor/indoor exposure relationship may shed some useful light on the findings.

So where should we go from here? To extend the work of our review team, we need money. We've contacted key charitable trusts who research into social and environmental issues, we've established contact with our Department of the Environment and we are hopeful of getting contributions from several local authorities. However, last week the Government finally announced the new Night Flight regime for London's airports.

The major change is the introduction of a '1/2' point level in the quota system.This means less exempt airplanes,which we welcome. And the quota budget at Heathrow has been kept as originally proposed. However,Gatwick and Stansted quotas have been increased by about 6% with now up to 10% 'flexibility' at the end of each season. These proposals can only mean more night flights and a consequent worsening of the night time environment around these airports.

I feel this shows the symbiotic relationship between the aviation industry, the Civil Aviation Authority and the Department of Transport which results in measures so patently and transparently one-sided that even our low expectation of the 'consultation' period was surpassed! We're afraid such a willful mixture of flawed research, a poorly confected and impossible to monitor night flight regime simply adds to the deep cynicism with which we view the whole saga. There can be no cure for the problem of night noise without accurate diagnosis--and our Minister seems unable to accept even the slightest criticism from any source.

John Meanan, who I know is here with us, announced in San Diego recently that the Department of Transport was open to criticism by commissioning controversial research and then using it to justify racheting up night flight numbers. In a very recent letter to a Manchester MP from Lord Caithness, the following paragraph shows our governments ability to twist the truth and present a view totally opposite from that intended by Mr. Meenan.

The choice we are left with now is between being wearily pessimistic or continuing to be angry and dismayed. This quote from Adlai Stevenson eloquently sums up the sheer impossibility of the Department of Transport and the Civil Aviation Authority ever being able to serve any master other than the Aviation industry.It's as if they are tied together in a permanent three-legged race -- and we, the public around the airports, are being trodden on in the rush towards the finishing line of the "Airlines and Airports special invitation 100 meter dash" in which all the prizes are awarded to themselves!

Thanks once again to NOISE for inviting me. I hope you've found this last half an hour interesting.--Thank You!.

Jeffery N. Gazzard.

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Date: Tue, 25 Jul 95
Databases searched for citations between 1991 and 1995:

1. **MEDLINE®**, a major medical database, is produced by the National Library of Medicine, Bethesda, Maryland. Citations used with the permission of the National Library of Medicine.

2.**INSPEC™**, a major scientific database, is produced by the Institution of Electrical Engineers (IEE), Stevenage, Herts., England. Citation used with permission.

3. **OCLC WorldCat®** is produced by the OCLC Online Computer Library Center. The citations, part of the FirstSearch Catalog, are used with permission. FirstSearch is a trademark of the OCLC Online Computer Library Center, Inc. The screens displayed are copyrighted by OCLC and/or its third-party database providers.

4. **University of Washington Library Online Catalog**, is produced by the University of Washington Libraries, University of Washington, Seattle, WA. Citations used with the permission of the University of Washington Libraries.

5. **PsycINFO®**, a major psychology database, is produced by the American Psychological Association, Arlington, VA. Citations used with permission.

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MEDLINE search 1:
Author : Babisch-W

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Document 5
Accession No.: 94071484.
Author: Babisch-W. Ising-H. Gallacher-J-E. Sharp-D-S. Baker-I-A.
Title: Traffic noise and cardiovascular risk: the Speedwell study, first phase. Outdoor noise levels end risk factors.
Source: Arch-Environ-Health. 1993 Nov-Dec. 48(6). P 401-5.
Journal Title: ARCHIVES OF ENVIRONMENTAL HEALTH.

Document 6

213

Document 6
Accession No.: 93212293.
Author: Stansfeld-S-A. Sharp-D. Gallacher-J. Babisch-W.
Title: Road traffic noise, noise sensitivity and psychological disorder.
Source: Schriftenr-Ver-Wasser-Boden-Lufthyg. 1993. 88. P 167-88.
Journal Title: SCHRIFTENREIHE DES VEREINS FUR WASSER-, BODEN-, UND LUFTHYGIENE.

Document 7
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Author: Babisch-W. Elwood-P-C. Ising-H. Kruppa-B.
Title: Traffic noise as a risk factor for myocardial infarction.
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Year : From 1991 To 1995

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Author: Kawabata-T.
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Source: Eur-J-Epidemiol. 1994 Oct. 10(5). P 549-54.
Journal Title: EUROPEAN JOURNAL OF EPIDEMIOLOGY.

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Title: [Evaluating the noise problem in regional town planning]
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Journal Title: SLEEP.

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Title: Prehospital blood pressures: inaccuracies caused by ambulance noise?
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Accession No.: 94287174.
Author: Ogunsola-O-J. Oluwole-A-F. Asubiojo-O-I. Durosinmi-M-A. Fatusi-A-O. Ruck-W.
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Author: Brenner-H. Oberacker-A. Kranig-W. Buchwalsky-R.
Title: A field study on the immediate effects of exposure to low-altitude flights on heart rate and arrhythmia in patients with cardiac diseases.
Source: Int-Arch-Occup-Environ-Health. 1993. 65(4). P 263-8.
Journal Title: INTERNATIONAL ARCHIVES OF OCCUPATIONAL AND ENVIRONMENTAL HEALTH.

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Author: Spreng-M.
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Author: de-Jong-R-G.
Title: Review: extraaural health effects of aircraft noise.
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Author: Rosenberg-J.
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Author: Horne-J-A. Pankhurst-F-L. Reyner-L-A. Hume-K. Diamond-I-D.
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Subject Major: NOISE: ae. SLEEP: ph. SLEEP-DISORDERS: pp.
Subject Minor: ADULT. AGED. AIRCRAFT. ELECTROENCEPHALOGRAPHY. FEMALE.
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Author: Pichot-P.
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Source: Bull-Acad-Natl-Med. 1992 Mar. 176(3). P 393-9; discussion 400.
Journal Title: BULLETIN DE L ACADEMIE NATIONALE DE MEDECINE.
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Subject Minor: ENGLISH-ABSTRACT. HUMAN.

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Author: Tubbs-R-L.
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Subject Minor: ADULT. AUDIOMETRY-PURE-TONE. FIRES. HEARING-LOSS-
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Author: Wai-W-T.
Title: Socioeconomic development and environmental pollution in Hong Kong--risks and opportunities.
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Journal Title: SCIENCE OF THE TOTAL ENVIRONMENT.
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MEDLINE Search 4: Subject Heading : Noise ae (Adverse effects of Noise)

Year : From 1991 To 1995

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Accession No.: 95242031.
Author: Morales-Su'arez-Varela-M-M. Llopis-Gonz'alez-A. Cotanda-
Guti'errez-P. Garc'ia-Garc'ia-A-M. Garc'ia-Rodr'iguez-A.
Title: [The evaluation of the effects of ambient noise on the residents of the historic center of Valencia (published erratum appears in Rev Sanid Hig Publica (Madr) 1993 May-Jun;67(3):239)]
Source: Rev-Sanid-Hig-Publica-Madr. 1992 May-Aug. 66(3-4). P 239-44.

Journal Title: REVISTA DE SANIDAD E HIGIENE PUBLICA.
Subject Major: ENVIRONMENTAL-EXPOSURE: ae. NOISE: ae. URBAN-
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Subject Minor: ADULT. AGED. ENGLISH-ABSTRACT. ENVIRONMENTAL-EXPOSURE: sn.
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Accession No.: 95210702.
Author: Kileny-P-R.
Title: Temporary threshold shift [letter; comment]
Source: J-Am-Acad-Audiol. 1995 Jan. 6(1). P 111.
Comment: Comment on: J-Am-Acad-Audiol. 1994 Sep. 5(5). P 343-8.
Journal Title: JOURNAL OF THE AMERICAN ACADEMY OF AUDIOLOGY.
Subject Major: AUDITORY-THRESHOLD. EXERCISE. HEARING. MUSIC.
Subject Minor: HUMAN. NOISE: ae.

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Accession No.: 95078472.
Author: Vittitow-M. Windmill-I-M. Yates-J-W. Cunningham-D-R.
Title: Effect of simultaneous exercise and noise exposure (music) on hearing [see comments]
Source: J-Am-Acad-Audiol. 1994 Sep. 5(5). P 343-8.
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Journal Title: JOURNAL OF THE AMERICAN ACADEMY OF AUDIOLOGY.
Subject Major: HEARING: ph. MUSIC. NOISE: ae.
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Accession No.: 95256144.
Author: McGinn-M-D. Faddis-B-T.
Title: Exposure to low frequency noise during rearing induces spongiform lesions in gerbil cochlear nucleus: high frequency exposure does not.
Source: Hear-Res. 1994 Dec. 81(1-2). P 57-65.
Journal Title: HEARING RESEARCH.
Subject Major: COCHLEAR-NUCLEUS: in. NOISE: ae.
Subject Minor: ACOUSTIC-STIMULATION. ANALYSIS-OF-VARIANCE. ANIMAL. AUDITORY-
THRESHOLD: ph. COCHLEAR-NUCLEUS: pa. COMPARATIVE-STUDY.
COMPUTER-SIMULATION. EVOKED-POTENTIALS-AUDITORY-BRAIN-STEM: ph.
GERBILLINAE. SUPPORT-US-GOVT-PHS.

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Author: Eisenberg-L-S. Dirks-D-D. Bell-T-S.
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Source: J-Speech-Hear-Res. 1995 Feb. 38(1). P 222-33.
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Subject Major: HEARING. HEARING-LOSS-SENSORINEURAL: di. NOISE. SPEECH-
PERCEPTION.
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STUDY. FEMALE. HUMAN. MALE. MIDDLE-AGE. NOISE: ae.
SUPPORT-US-GOVT-NON-PHS. SUPPORT-US-GOVT-PHS.

Document 7
Accession No.: 95187964.

Author: Petiot-J-C. Parrot-J. Smolik-H-J. Petiot-M-T. Lobreau-J-P.
Title: [Level of anxiety and effects of moderate noise on early auditory evoked potentials]
Source: C-R-Acad-Sci-III. 1994 Jul. 317(7). P 615-20.
Journal Title: COMPTES RENDUS DE L ACADEMIE DES SCIENCES. SERIE III, SCIENCES DE LA VIE.
Subject Major: ANXIETY: pp. EVOKED-POTENTIALS-AUDITORY-BRAIN-STEM. NOISE: ae.
Subject Minor: ADULT. ENGLISH-ABSTRACT. FEMALE. HUMAN. MALE. SEX-FACTORS. TIME-FACTORS.

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Accession No.: 94252484.
Author: Plomp-R.
Title: Noise, amplification, and compression: considerations of three main issues in hearing aid design [published erratum appears in Ear Hear 1994 Dec;15(6):following table of contents]
Source: Ear-Hear. 1994 Feb. 15(1). P 2-12.
Journal Title: EAR AND HEARING.
Subject Major: HEARING-AIDS. HEARING-DISORDERS: rh.
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Author: Hoehmann-D. Muller-S. Dornhoffer-J-L.
Title: Modulation of cochlear responses in the guinea pig by low-frequency, phase-shifted maskers following noise trauma.
Source: Eur-Arch-Otorhinolaryngol. 1995. 252(1). P S20-5.

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Subject Major: ACOUSTIC-STIMULATION. AUDITORY-THRESHOLD: ph. COCHLEA: pp. COCHLEAR-DISEASES: et. COCHLEAR-DISEASES: pp. NOISE: ae.
Subject Minor: ACTION-POTENTIALS: ph. ANIMAL. AUDIOMETRY-EVOKED-RESPONSE. COCHLEAR-MICROPHONIC-POTENTIALS: ph. COMPARATIVE-STUDY. DISEASE-MODELS-ANIMAL. FEMALE. GUINEA-PIGS. MALE. ORGAN-OF-CORTI: pp. REACTION-TIME. ROUND-WINDOW: pp.

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Accession No.: 95227211.
Author: Henley-C-M. Rybak-L-P.
Title: Ototoxicity in developing mammals.
Source: Brain-Res-Brain-Res-Rev. 1995 Jan. 20(1). P 68-90.
Journal Title: BRAIN RESEARCH. BRAIN RESEARCH REVIEWS.
Subject Major: ANIMALS-NEWBORN: gd. HEARING: ph. HEARING-LOSS-NOISE-INDUCED: pp. LABYRINTH: de.
Subject Minor: AGE-DISTRIBUTION. AGE-FACTORS. ANIMAL. COCHLEA: de. COCHLEA: pp. DEAFNESS: et. DIURETICS: ae. EVOKED-POTENTIALS. GENTAMICINS: ae. HEARING: de. HUMAN. HYPOTHYROIDISM: pp. INFANT-NEWBORN. KANAMYCIN: ae. LABYRINTH: gd. NOISE: ae. RATS. SUPPORT-US-GOVT-PHS.

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Accession No.: 95225874.
Author: Anttonen-H. Virokannas-H. Sorri-M.
Title: Noise and hearing loss in reindeer herders.

Source: Arctic-Med-Res. 1994. 53 Suppl 3. P 35-40.
Journal Title: ARCTIC MEDICAL RESEARCH.
Subject Major: ANIMAL-HUSBANDRY. HEARING-LOSS-NOISE-INDUCED: et. NOISE:
ae. OCCUPATIONAL-DISEASES: ep. REINDEER.
Subject Minor: ADULT. ANIMAL. FINLAND. HUMAN. MIDDLE-AGE. OFF-ROAD-MOTOR-
VEHICLES.

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Accession No.: 95217414.
Author: Raynor-E-M. Carrasco-V-N. Prazma-J. Pillsbury-H-C.
Title: An assessment of cochlear hair-cell loss in insulin-dependent diabetes mellitus diabetic and noise-exposed rats.
Source: Arch-Otolaryngol-Head-Neck-Surg. 1995 Apr. 121(4). P 452-6.
Journal Title: ARCHIVES OF OTOLARYNGOLOGY -- HEAD AND NECK SURGERY.
Subject Major: DIABETES-MELLITUS-EXPERIMENTAL: co. DIABETES-MELLITUS-INSULIN-
DEPENDENT: co. HAIR-CELLS-OUTER: pa. NOISE: ae.
Subject Minor: ANIMAL. DIABETES-MELLITUS-EXPERIMENTAL: pa. DIABETES-MELLITUS-
INSULIN-DEPENDENT: pa. HAIR-CELLS-INNER: pa. MALE. RATS.
RATS-SPRAGUE-DAWLEY. SUPPORT-NON-US-GOVT.

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Accession No.: 95206863.
Author: Kjellberg-A. Skoldstrom-B. Tesarz-M. Dallner-M.
Title: Facial EMG responses to noise.
Source: Percept-Mot-Skills. 1994 Dec. 79(3 Pt 1). P 1203-16.
Journal Title: PERCEPTUAL AND MOTOR SKILLS.
Subject Major: AROUSAL: ph. ELECTROMYOGRAPHY. FACIAL-MUSCLES: ph. NOISE: ae.
Subject Minor: ADULT. AFFECT: ph. ATTENTION: ph. FEMALE. GENDER-IDENTITY.

HUMAN. MALE. MIDDLE-AGE. PROBLEM-SOLVING: ph.
PSYCHOPHYSIOLOGY. REACTION-TIME: ph.

Document 14
Accession No.: 95201877.
Author: Terzano-M-G. Parrino-L.
Title: Effect of hypnotic drugs on sleep architecture.
Source: Pol-J-Pharmacol. 1994 Sep-Oct. 46(5). P 487-90.
Journal Title: POLISH JOURNAL OF PHARMACOLOGY.
Subject Major: HYPNOTICS-AND-SEDATIVES: pd. PYRIDINES: pd. SLEEP: de.
Subject Minor: ADULT. ANALYSIS-OF-VARIANCE. COMPARATIVE-STUDY. DOUBLE-BLIND-
METHOD. HUMAN. HYPNOTICS-AND-SEDATIVES: ad. HYPNOTICS-AND-
SEDATIVES: tu. INSOMNIA: di. INSOMNIA: dt. MIDDLE-AGE.
NOISE: ae. PYRIDINES: ad. PYRIDINES: tu. SLEEP-STAGES:
de.

Document 15
Accession No.: 95199510.
Author: File-S-E.
Title: Chronic exposure to noise modifies the anxiogenic response, but not the hypoactivity, detected on withdrawal from chronic ethanol treatment.
Source: Psychopharmacology-Berl. 1994 Nov. 116(3). P 369-72.
Journal Title: PSYCHOPHARMACOLOGY.
Subject Major: ALCOHOL-ETHYL: ae. ANXIETY: px. MOTOR-ACTIVITY: ph.
NOISE: ae. SUBSTANCE-WITHDRAWAL-SYNDROME: px.
Subject Minor: ALCOHOL-ETHYL: ad. ANIMAL. BEHAVIOR-ANIMAL: de. EXPLORATORY-

BEHAVIOR: de. MALE. RATS. SOCIAL-BEHAVIOR. SUPPORT-NON-US-
GOVT.

Document 16
Accession No.: 95184027.
Author: Wei-B-L. Tang-H. Kang-J. Qu-F. Nie-Z-W.
Title: [Changes of auditory brainstem response and auditory cortex response after exposure to intensive noise]
Source: Sheng-Li-Hsueh-Pao. 1994 Dec. 46(6). P 553-60.
Journal Title: SHENG LI HSUEH PAO [ACTA PHYSIOLOGICA SINICA].
Subject Major: AUDITORY-CORTEX: ph. EVOKED-POTENTIALS-AUDITORY-BRAIN-STEM.
NOISE: ae.
Subject Minor: ANIMAL. AUDITORY-FATIGUE. AUDITORY-THRESHOLD. COCHLEA: ul.
ENGLISH-ABSTRACT. GUINEA-PIGS. MALE. SUPPORT-NON-US-GOVT.

Document 17
Accession No.: 95183662.
Author: Van-Dijken-H-H. Tilders-F-J. Olivier-B. Mos-J.
Title: Effects of anxiolytic and antidepressant drugs on long lasting behavioural deficits resulting from one short stress experience in male rats.
Source: Psychopharmacology-Berl. 1992. 109(4). P 395-402.
Journal Title: PSYCHOPHARMACOLOGY.
Subject Major: ANTI-ANXIETY-AGENTS: pd. ANTIDEPRESSIVE-AGENTS: pd. BEHAVIOR-
ANIMAL: de. STRESS-PSYCHOLOGICAL: px.
Subject Minor: ANIMAL. DESIPRAMINE: pd. DIAZEPAM: pd. ELECTROSHOCK.
FLUVOXAMINE: pd. MALE. MOTOR-ACTIVITY: de. NOISE: ae.
PIPERAZINES: pd. RATS. RATS-WISTAR. SEROTONIN-AGONISTS: pd.

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Document 19
Accession No.: 95181678.
Author: Yund-E-W. Buckles-K-M.
Title: Multichannel compression hearing aids: effect of number of
channels on speech discrimination in noise.
Source: J-Acoust-Soc-Am. 1995 Feb. 97(2). P 1206-23.
Journal Title: JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA.
Subject Major: EQUIPMENT-DESIGN. HEARING-AIDS. HEARING-DISORDERS: rh.
NOISE: ae. SPEECH-PERCEPTION.
Subject Minor: AGED. FEMALE. HUMAN. MALE. MIDDLE-AGE. PHONETICS. SPEECH-
DISCRIMINATION-TESTS. SUPPORT-US-GOVT-NON-PHS.

Document 20
Accession No.: 95181677.
Author: Pearson-J-D. Morrell-C-H. Gordon-Salant-S. Brant-L-J.
Metter-E-J. Klein-L-L. Fozard-J-L.
Title: Gender differences in a longitudinal study of age-associated hearing loss.
Source: J-Acoust-Soc-Am. 1995 Feb. 97(2). P 1196-205.
Journal Title: JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA.
Subject Major: PRESBYCUSIS: di. SEX-FACTORS.
Subject Minor: ADULT. AGED. AUDIOMETRY-PURE-TONE. FEMALE. HUMAN.
LONGITUDINAL-STUDIES. MALE. MIDDLE-AGE. NOISE: ae.

Document 23
Accession No.: 95163703.
Author: Orlando-P. Perdelli-F. Cristina-M-L. Piromalli-W.
Title: Environmental and personal monitoring of exposure to urban noise and community response.
Source: Eur-J-Epidemiol. 1994 Oct. 10(5). P 549-54.

Journal Title: EUROPEAN JOURNAL OF EPIDEMIOLOGY.
Subject Major: ENVIRONMENTAL-MONITORING. NOISE: ae. URBAN-POPULATION.
Subject Minor: HUMAN. ITALY. NOISE-TRANSPORTATION: ae. SUPPORT-NON-US-GOVT.
TIME-FACTORS.

Document 24
Accession No.: 95155170.
Author: Quirk-W-S. Coleman-J-K. Hanesworth-J-M. Harding-J-W. Wright-J-W.
Title: Noise-induced elevations of plasma endothelin (ET-3).
Source: Hear-Res. 1994 Oct. 80(1). P 119-22.
Journal Title: HEARING RESEARCH.
Subject Major: ACOUSTIC-STIMULATION: ae. ENDOTHELINS: bl.
Subject Minor: ANALYSIS-OF-VARIANCE. ANIMAL. COMPARATIVE-STUDY.
HEMODYNAMICS: ph. NOISE: ae. RADIOIMMUNOASSAY. RATS.
RATS-INBRED-WKY. SUPPORT-NON-US-GOVT. SUPPORT-US-GOVT-PHS.

Document 25
Accession No.: 95150409.
Author: Foo-S-C. Lwin-S. Chia-S-E. Jeyaratnam-J.
Title: Chronic neurobehavioural effects in paint formulators exposed to solvents and noise.
Source: Ann-Acad-Med-Singapore. 1994 Sep. 23(5). P 650-4.
Journal Title: ANNALS OF THE ACADEMY OF MEDICINE, SINGAPORE.
Subject Major: NOISE: ae. OCCUPATIONAL-EXPOSURE: ae. PSYCHOMOTOR-
PERFORMANCE. SOLVENTS: ae.
Subject Minor: ADULT. CASE-CONTROL-STUDIES. CHEMICAL-INDUSTRY. HUMAN. MALE.
MIDDLE-AGE. NEUROPSYCHOLOGICAL-TESTS. SUPPORT-NON-US-GOVT.
TIME-FACTORS.

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Document 32
Accession No.: 95103137.
Author: Butkovskaia-Z-M. Egorova-N-M. Smirnov-V-V. Leinl-A-A. Kaidash-N-Ia.
Title: [Development of rational work schedules for tunnel workers of schist mines]
Source: Med-Tr-Prom-Ekol. 1994. (1). P 10-4.
Journal Title: MEDITSINA TRUDA I PROMYSHLENNAIA EKOLOGIIA.
Subject Major: ADAPTATION-PHYSIOLOGICAL. MINING. NOISE: ae.
OCCUPATIONAL-EXPOSURE. VIBRATION: ae. WORK-SCHEDULE-TOLERANCE.
Subject Minor: ENGLISH-ABSTRACT. HUMAN. MICROCLIMATE. TEMPERATURE. TIME-
FACTORS.

Document 33
Accession No.: 95090407.
Author: Ivarsson-U-S. Arlinger-S-D.
Title: Speech recognition in noise before and after a work-day's noise exposure.
Source: Scand-Audiol. 1994. 23(3). P 159-63.
Journal Title: SCANDINAVIAN AUDIOLOGY.
Subject Major: NOISE: ae. SPEECH-PERCEPTION. WORK.
Subject Minor: ADULT. AUDITORY-THRESHOLD. COMPARATIVE-STUDY. FATIGUE. HUMAN. LATERALITY. MIDDLE-AGE.

Document 35
Accession No.: 95079265.
Author: Parrot-J. Petiot-J-C. Smolik-H-J. Petiot-M-T. Lobreau-J-P.
Title: [Effects of moderate noises on early auditory evoked potentials in man, in relation to age]
Source: C-R-Acad-Sci-III. 1994 Jun. 317(6). P 505-10.

Journal Title: COMPTES RENDUS DE L ACADEMIE DES SCIENCES. SERIE III, SCIENCES
DE LA VIE.
Subject Major: EVOKED-POTENTIALS-AUDITORY-BRAIN-STEM: ph. NOISE: ae.
Subject Minor: ADOLESCENCE. ADULT. AGE-FACTORS. ENGLISH-ABSTRACT. FEMALE.
HUMAN. MALE. MIDDLE-AGE. SEX-FACTORS.

Document 36
Accession No.: 95074396.
Author: Schroder-A-C. Viemeister-N-F. Nelson-D-A.
Title: Intensity discrimination in normal-hearing and hearing-impaired listeners.
Source: J-Acoust-Soc-Am. 1994 Nov. 96(5 Pt 1). P 2683-93.
Journal Title: JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA.
Subject Major: AUDITORY-PERCEPTION. COCHLEA: pp. HEARING-LOSS-HIGH-FREQUENCY:pp.
Subject Minor: ACOUSTIC-NERVE: pp. AUDITORY-THRESHOLD. COMPARATIVE-STUDY. HUMAN. NOISE: ae. SUPPORT-US-GOVT-PHS.

Document 37
Accession No.: 95074395.
Author: Peters-R-W. Hall-J-W-3rd.
Title: Comodulation masking release for elderly listeners with relatively normal audiograms.
Source: J-Acoust-Soc-Am. 1994 Nov. 96(5 Pt 1). P 2674-82.
Journal Title: JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA.
Subject Major: AGED. AUDIOMETRY. AUDITORY-PERCEPTION. HEARING: ph.
PERCEPTUAL-MASKING.
Subject Minor: ADULT. AGE-FACTORS. AUDITORY-THRESHOLD. COMPARATIVE-STUDY.
HUMAN. MIDDLE-AGE. NOISE: ae. SUPPORT-US-GOVT-PHS.

Document 38
Accession No.: 95074393.
Author: Hellman-R-P.
Title: Relation between the growth of loudness and high-frequency excitation.
Source: J-Acoust-Soc-Am. 1994 Nov. 96(5 Pt 1). P 2655-63.
Journal Title: JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA.
Subject Major: COCHLEA: pp. HEARING-LOSS-HIGH-FREQUENCY: pp. LOUDNESS-PERCEPTION.
Subject Minor: ADULT. AGED. AUDITORY-THRESHOLD. HUMAN. MIDDLE-AGE. NOISE: ae. SUPPORT-US-GOVT-NON-PHS. SUPPORT-US-GOVT-PHS.

Document 39
Accession No.: 95071559.
Author: Suter-A-H.
Title: Communication and job performance in noise: a review.
Source: ASHA-Monogr. 1992 Nov. (28). P 1-84.
Journal Title: ASHA MONOGRAPHS.
Subject Major: COMMUNICATION. NOISE. WORK.
Subject Minor: AUDITORY-THRESHOLD. COCHLEA: pp. HEARING-LOSS-SENSORINEURAL:
pp. HUMAN. NOISE: ae. SIGNAL-DETECTION-PSYCHOLOGY.
SPEECH-PERCEPTION. TASK-PERFORMANCE-AND-ANALYSIS. TIME-
FACTORS.

Document 40
Accession No.: 95068015.
Author: Tomei-F. Papaleo-B. Baccolo-T-P. Persechino-B. Spano-G. Rosati-M-V.
Title: Noise and gastric secretion.
Source: Am-J-Ind-Med. 1994 Sep. 26(3). P 367-72.
Journal Title: AMERICAN JOURNAL OF INDUSTRIAL MEDICINE.

Subject Major: GASTRIC-ACID: se. GASTRIC-MUCOSA: se.
NOISE: ae.
Subject Minor: DYSPEPSIA: pp. FEMALE. HUMAN. MALE.
MIDDLE-AGE.

Document 42
Accession No.: 2049.
Author: Kompis-M. Dillier-N.
Title: Noise reduction for hearing aids: combining directional microphones with an adaptive beamformer [letter]
Source: J-Acoust-Soc-Am. 1994 Sep. 96(3). P 1910-3.
Journal Title: JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA.
Subject Major: EQUIPMENT-DESIGN. HEARING-AIDS. HEARING-DISORDERS: rh. NOISE: ae.
Subject Minor: HUMAN.

Document 43
Accession No.: 2044.
Author: Neuman-A-C. Bakke-M-H. Hellman-S. Levitt-H.
Title: Effect of compression ratio in a slow-acting compression hearing aid: paired-comparison judgments of quality.
Source: J-Acoust-Soc-Am. 1994 Sep. 96(3). P 1471-8.
Journal Title: JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA.
Subject Major: HEARING-AIDS. HEARING-LOSS-SENSORINEURAL: rh. SPEECH-PERCEPTION.
Subject Minor: ADOLESCENCE. ADULT. AGED. AUDIOMETRY-PURE-TONE. COCHLEA: pp. COMPARATIVE-STUDY. FEMALE. HEARING-LOSS-SENSORINEURAL: di. HEARING-LOSS-SENSORINEURAL: pp. HUMAN. LABYRINTH: pp. LOUDNESS-PERCEPTION. MALE. MIDDLE-AGE. NOISE: ae. SUPPORT-US-GOVT-PHS.

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Document 44
Accession No.: 2040.
Author: Lei-S-F. Ahroon-W-A. Hamernik-R-P.
Title: The application of frequency and time domain kurtosis to the assessment of hazardous noise exposures.
Source: J-Acoust-Soc-Am. 1994 Sep. 96(3). P 1435-44.
Journal Title: JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA.
Subject Major: AUDITORY-PERCEPTION. NOISE: ae.
Subject Minor: ANIMAL. AUDIOMETRY. AUDITORY-THRESHOLD. BASILAR-MEMBRANE: pp. CHINCHILLA. COMPARATIVE-STUDY. HEARING-LOSS-NOISE-INDUCED: di. HEARING-LOSS-NOISE-INDUCED: et. HEARING-LOSS-NOISE-INDUCED: pp. LABYRINTH: pp. SOUND-SPECTROGRAPHY. SUPPORT-US-GOVT-PHS.

Document 45
Accession No.: 95046994.
Author: Subramaniam-M. Henderson-D. Spongr-V.
Title: The relationship among distortion-product otoacoustic emissions, evoked potential thresholds, and outer hair cells following interrupted noise exposures.
Source: Ear-Hear. 1994 Aug. 15(4). P 299-309.
Journal Title: EAR AND HEARING.
Subject Major: COCHLEA: pp. HAIR-CELLS: pp. NOISE: ae.
Subject Minor: ACOUSTIC-STIMULATION. ANIMAL. CHINCHILLA. COCHLEA: ul. ELECTRIC-STIMULATION. EVOKED-POTENTIALS-AUDITORY. HAIR-CELLS: ul. PHOTOMICROGRAPHY. SUPPORT-NON-US-GOVT. SUPPORT-US-GOVT-PHS.

Document 46
Accession No.: 95036199.
Author: Irwin-J.

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Title: Noise-induced hearing loss and the 4 kHz dip.
Source: Occup-Med-Oxf. 1994 Sep. 44(4). P 222-3.
Journal Title: OCCUPATIONAL MEDICINE.
Subject Major: HEARING-LOSS-NOISE-INDUCED: pp. NOISE: ae.
Subject Minor: AUDIOMETRY-PURE-TONE. HUMAN.

Document 47
Accession No.: 95027888.
Author: Touma-J-B.
Title: Noise and hearing.
Source: W-V-Med-J. 1994 Aug. 90(8). P 327-9.
Journal Title: WEST VIRGINIA MEDICAL JOURNAL.
Subject Major: HEARING. NOISE: ae.
Subject Minor: HEARING-LOSS-NOISE-INDUCED: pc. HUMAN. NOISE-OCCUPATIONAL: ae.

Document 50
Accession No.: 94215597.
Author: Nakamura-H. Moroji-T. Nagase-H. Okazawa-T. Okada-A.
Title: Changes of cerebral vasoactive intestinal polypeptide- and somatostatin-like immunoreactivity induced by noise and whole-body vibration in the rat.
Source: Eur-J-Appl-Physiol. 1994. 68(1). P 62-7.
Journal Title: EUROPEAN JOURNAL OF APPLIED PHYSIOLOGY AND OCCUPATIONAL PHYSIOLOGY.
Subject Major: NOISE: ae. PEPTIDES: me. SOMATOSTATIN: me. VASOACTIVE-INTESTINAL-PEPTIDE: me. VIBRATION: ae.
Subject Minor: ANIMAL. BRAIN: me. IMMUNOENZYME-TECHNIQUES. IMMUNOHISTOCHEMISTRY. MALE. RATS. RATS-WISTAR. REPRODUCIBILITY-OF-RESULTS. TISSUE-DISTRIBUTION.

Document 51
Accession No.: 94367325.
Author: Barrenas-M-L.
Title: The influence of a melanin-binding drug on temporary threshold shift in humans.

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Source: Scand-Audiol. 1994. 23(2). P 93-8.
Journal Title: SCANDINAVIAN AUDIOLOGY.
Subject Major: AUDITORY-THRESHOLD: de. CHLOROQUINE: ae. CHLOROQUINE: pd. LABYRINTH: de. MELANINS: me. NOISE: ae.
Subject Minor: ADULT. AGE-FACTORS. FEMALE. FREE-RADICALS: me. HUMAN. MALE. MIDDLE-AGE. PIGMENTATION. SUPPORT-NON-US-GOVT.

Document 53
Accession No.: 94366177.
Author: Souza-P-E. Turner-C-W.
Title: Masking of speech in young and elderly listeners with hearing loss.
Source: J-Speech-Hear-Res. 1994 Jun. 37(3). P 655-61.
Journal Title: JOURNAL OF SPEECH AND HEARING RESEARCH.
Subject Major: HEARING. HEARING-LOSS-SENSORINEURAL: di. PERCEPTUAL-MASKING. SPEECH-PERCEPTION.
Subject Minor: ADULT. AGE-FACTORS. AGED. AGING. AUDIOMETRY-PURE-TONE. AUDITORY-THRESHOLD. FEMALE. HUMAN. MALE. MIDDLE-AGE. NOISE: ae. SOUND-SPECTROGRAPHY. SUPPORT-US-GOVT-PHS.

Document 54
Accession No.: 94361985.
Author: Haddock-J.
Title: Reducing the effects of noise in hospital.
Source: Nurs-Stand. 1994 Jul 20-26. 8(43). P 25-8.
Journal Title: NURSING STANDARD.
Subject Major: INPATIENTS. NOISE. SLEEP.
Subject Minor: CLINICAL-NURSING-RESEARCH. COMPARATIVE-STUDY. EAR-PROTECTIVE-DEVICES. FEMALE. HUMAN. NOISE: ae. NOISE: pc.

Document 55
Accession No.: 94361810.
Author: Sugisawa-T. Ishida-A. Hotta-S. Yamamura-K.

Title: The effect of 6 kHz tone exposure on inner ear function of the
guinea pig: relation to changes in cochlear microphonics, action potential, endocochlear potential and chemical potentials of K(+)-ions and Na(+)-ions, using a double-barrel
glass electrode.
Source: Eur-Arch-Otorhinolaryngol. 1994. 251(3). P 154-9.
Journal Title: EUROPEAN ARCHIVES OF OTO-RHINO-LARYNGOLOGY.
Subject Major: ACTION-POTENTIALS: ph. COCHLEA: pp. COCHLEAR-MICROPHONIC-
POTENTIALS: ph. ENDOLYMPH: ch. NOISE. POTASSIUM: an. SODIUM:
an.
Subject Minor: ANIMAL. ANOXIA: me. COCHLEAR-NERVE: pp. DIFFUSION.
ELECTRODES. ENDOLYMPH: me. GLASS. GUINEA-PIGS. MALE.
NOISE: ae. PERILYMPH: ch. PERILYMPH: me. REACTION-
TIME: ph. SUPPORT-NON-US-GOVT. TIME-FACTORS.

Document 56
Accession No.: 94352806.
Author: Weglel-A. Pigo'n-Weglel-A.
Title: [Plasma pancreatic glucagon during glucose tolerance test in workers exposed to vibration and noise]
Source: Pol-Arch-Med-Wewn. 1994 Apr. 91(4). P 263-6.
Journal Title: POLSKIE ARCHIWUM MEDYCYNY WEWNETRZNEJ.
Subject Major: GLUCAGON: bl. NOISE: ae. OCCUPATIONAL-EXPOSURE. VIBRATION: ae.
Subject Minor: ADULT. BLOOD-GLUCOSE: an. ENGLISH-ABSTRACT. GLUCOSE-TOLERANCE-TEST. HUMAN. METALLURGY. MIDDLE-AGE.

Document 57
Accession No.: 94350746.

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Author: Niemiec-A-J. Raphael-Y. Moody-D-B.
Title: Return of auditory function following structural regeneration
after acoustic trauma: behavioral measures from quail.
Source: Hear-Res. 1994 May. 75(1-2). P 209-24.
Journal Title: HEARING RESEARCH.
Subject Major: AUDITORY-THRESHOLD: ph. COCHLEA: ph. HAIR-CELLS: ph. NOISE: ae. REGENERATION.
Subject Minor: ANIMAL. AUDIOMETRY. BASILAR-MEMBRANE: cy. BASILAR-MEMBRANE:ph. BEHAVIOR-ANIMAL: ph. COCHLEA: cy. COHORT-STUDIES. COTURNIX. HAIR-CELLS: cy. SUPPORT-NON-US-GOVT. SUPPORT-US-GOVT-PHS.

Document 58
Accession No.: 94342607.
Author: Plomp-R.
Title: Comments on "Evaluating a speech-reception threshold model for hearing-impaired listeners" [J. Acoust. Soc. Am. 93, 2879-2885
(1993)] [letter; comment]
Source: J-Acoust-Soc-Am. 1994 Jul. 96(1). P 586-9.
Comment: Comment on: J-Acoust-Soc-Am. 1993 May. 93(5). P 2879-85.
Journal Title: JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA.
Subject Major: AUDITORY-THRESHOLD. HEARING-LOSS-SENSORINEURAL: rh. SPEECH-DISORDERS.
Subject Minor: AGED. COMPARATIVE-STUDY. HEARING. HEARING-AIDS. HUMAN. NOISE: ae.

Document 59
Accession No.: 94327288.
Author: Breschi-M-C. Scatizzi-R. Martinotti-E. Pellegrini-A.
Soldani-P. Paparelli-A.
Title: Morphofunctional changes in the noradrenergic innervation of the rat cardiovascular system after varying duration of noise
stress.

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Source: Int-J-Neurosci. 1994 Mar. 75(1-2). P 73-81.
Journal Title: INTERNATIONAL JOURNAL OF NEUROSCIENCE.
Subject Major: CARDIOVASCULAR-SYSTEM: ir. NOISE: ae. NOREPINEPHRINE: ph. STRESS-PSYCHOLOGICAL: pa. SYMPATHETIC-NERVOUS-SYSTEM: pa.
Subject Minor: ADRENAL-CORTEX: me. ADRENAL-CORTEX: ph. ANIMAL. AORTA-THORACIC: de. AORTA-THORACIC: pa. AORTA-THORACIC: pp. CARDIOVASCULAR-SYSTEM: pa. CARDIOVASCULAR-SYSTEM: pp. HEART-ATRIUM: pa. HEART-ATRIUM: pp. HISTOCYTOCHEMISTRY. LIPIDS: me. LIVER-GLYCOGEN: me. MALE. NERVE-FIBERS: ph. RATS. RATS-WISTAR. RECEPTORS-ADRENERGIC-ALPHA: de. RECEPTORS-ADRENERGIC-ALPHA: ph. RECEPTORS-ADRENERGIC-BETA: de. RECEPTORS-ADRENERGIC-BETA: ph. STRESS-PSYCHOLOGICAL: pp. SYMPATHETIC-NERVOUS-SYSTEM: pp.

Document 60
Accession No.: 94314673.
Author: Griffiths-S-K. Pierson-L-L. Gerhardt-K-J. Abrams-R-M. Peters-A-J.
Title: Noise induced hearing loss in fetal sheep.
Source: Hear-Res. 1994 Apr. 74(1-2). P 221-30.
Journal Title: HEARING RESEARCH.
Subject Major: FETAL-DISEASES: et. HEARING-LOSS-NOISE-INDUCED: et.
Subject Minor: ACOUSTIC-STIMULATION. ANIMAL. AUDITORY-THRESHOLD: ph. DISEASE-MODELS-ANIMAL. EVOKED-POTENTIALS-AUDITORY-BRAIN-STEM. FEMALE. FETAL-DISEASES: pp. HEARING-LOSS-NOISE-INDUCED: pp. NOISE: ae. PREGNANCY. SHEEP. SUPPORT-US-GOVT-PHS.

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Database #2:
INSPEC™ (International Information Services for the Physics and Engineering Communities), a major science database.

INSPEC Search 1: Subject Heading : noise-pollution
Year : From 1991 To 1995

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Document 1
Accession No.: 4968268.
Author: Tupov-V-B.
Author Affil.: Moscow Power Inst., Russia.
Title: The effect of noise from thermal power stations.
Source: Teploenergetika. vol.42, no.4. April 1995.
References: 9 refs.
Trans. Title: Thermal Engineering. vol.42, no.4. pp. 328-32. April 1995.
Language: eng.
Year: 1995.

Document 2
Accession No.: 4959606.
Author: Gjestland-T. Liasjo-K-H. Granoten-I-L-N.
Author Affil.: SINTEF DELAB, Trondheim Univ., Norway.
Title: Community response to noise from short-term military aircraft exercise.
Source: Journal of Sound and Vibration. vol.182, no.2. pp. 221-8. 27 April 1995.
References: 5 refs.
Year: 1995.

Document 3
Accession No.: 4958678.
Author: Vos-J.
Author Affil.: TNO Human Factors Res. Inst., Soesterberg, Netherlands.

Title: Technical note: on the comparability of community responses to noise from artillery and rifle ranges, as determined in two Australian studies.
Source: Noise Control Engineering Journal. vol.43, no.2. pp. 39-42. March-April 1995.
References: 9 refs.
Language: eng.
Year: 1995.

Document 4
Accession No.: 4956661.
Author: Cammarata-G. Cavalieri-S. Fichera-A. Marletta-L.
Author Affil.: Istituto di Macchine, Catania Univ., Italy.
Title: Self-organizing map to filter acoustic mapping survey in noise pollution analysis.
Source: Published by: IEEE. New York, NY, USA. 1993.
References: 8 refs.
Conf. Title: IJCNN '93-Nagoya. Proceedings of 1993 International Joint Conference on Neural Networks (Cat. No.93CH3353-0). Nagoya, Japan. pp. 2017-20 vol.2. Japanese Neural Network Soc. IEEE Neural Networks Council. Int. Neural Network Soc. European Neural Network Soc. Soc. Instrum. & Control Eng. IEICE. 25-29 Oct. 1993.
Language: eng.
Year: 1993.
Pub. Type: conference-proceeding (C).

Document 5
Accession No.: 4953138.
Author: Prokisch-G.
Title: Cooling system and noise protection for the locomotive 1014.
Source: Elin-Zeitschrift. vol.47, no.1-2. pp. 53-7. 1995.
Language: ger.
Year: 1995.
Pub. Country: Austria.

Document 6

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Accession No.: 4952976.
Author: Yifan-Gong.
Author Affil.: CRIN/CNRS, Inst. Nat. de Recherche en Inf. et Autom.-Lorraine, Nancy, France.
Title: Speech recognition in noisy environments: a survey.
Source: Speech Communication. vol.16, no.3. pp. 261-91. April 1995.
References: 225 refs.
Language: eng.
Year: 1995.
Pub. Country: Netherlands.

Document 7
Accession No.: 4952192.
Author: Crombie-D-H. Hothersall-D-C. Chandler-Wilde-S-N.
Author Affil.: Dept. of Civil Eng., Bradford Univ., UK.
Title: Multiple-edge noise barriers.
Source: Applied Acoustics. vol.44, no.4. pp. 353-67. 1995.
References: 10 refs.
Year: 1995.
Pub. Country: UK.

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Author: Weyna-S.
Author Affil.: Fac. of Maritime Technol., Tech. Univ. of Szczecin, Poland.
Title: The application of sound intensity technique in research on
noise abatement in ships.
Source: Applied Acoustics. vol.44, no.4. pp. 341-51. 1995.
References: 5 refs.
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Author: Cannelli-G-B. Santoboni-S.
Author Affil.: Istit. di Acustica, CNR, Rome, Italy.
Title: Algorithm for computing the physical descriptor of environmental impulsive sounds.
Source: Journal of the Acoustical Society of America. vol.97, no.4. pp. 2599-602. April 1995.
References: 4 refs.
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Accession No.: 4941611.
Author: Romanov-V-N.
Author Affil.: Krylov Central Res. Inst., St. Petersburg, Russia.
Title: Effect of interlayer ties on the propagation of an acoustic wave through a triple-layered plate.
Source: Akusticheskii Zhurnal. vol.41, no.2. pp. 286-90. March-April 1995.
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Year: 1995.
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Author: Chew-C-H.
Author Affil.: Dept. of Mech. & Production Eng., Nat. Univ. of Singapore, Singapore.
Title: The influence of inclined buildings on road traffic noise.
Source: Applied Acoustics. vol.45, no.1. pp. 29-46. 1995.
References: 2 refs.
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Year: 1995.
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Author: Heutschi-K.
Author Affil.: Swiss Federal Labs. for Mater. Testing & Res., Dubendorf, Switzerland.
Title: A simple method to evaluate the increase of traffic noise emission level due to buildings, for a long straight street.
Source: Applied Acoustics. vol.44, no.3. pp. 259-74. 1995.
References: 4 refs.
Language: eng.
Year: 1995.
Pub. Country: UK.

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Author: Fuchs-H-V. Zha-X.
Author Affil.: Fraunhofer-Inst. fur Bauphys., Stuttgart, Germany.
Title: The application of micro-perforated plates as sound absorbers with inherent damping.
Source: Acustica. vol.81, no.2. pp. 107-16. March-April 1995.
References: 22 refs.
Language: eng.
Year: 1995.
Pub. Country: Germany.
Class. Code: A4350. A4355. A4328.

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Author: Oshino-Y. Tsukui-K. Tachibana-H.
Author Affil.: Japan Automobile Res. Inst. Inc., Tsukuba, Japan.
Title: Prediction of road traffic noise taking account of transient running conditions of vehicles-2. Simulation of traffic flow and calculation of noise propagation.
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References: 13 refs.
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Author: Rumeau-M.
Author Affil.: Lab. Central de la Prefecture de Police de Paris, France.
Title: Evaluating annoyance of impulsive noise.
Source: Acta Acustica. vol.2, no.6. pp. 497-504. Dec. 1994.
References: 14 refs.
Language: fre.
Year: 1994.
Pub. Country: France.

Document 21
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Author: Mechel-F-P.
Title: The noise sluice.
Source: Acta Acustica. vol.2, no.6. pp. 491-6. Dec. 1994.
References: 2 refs.
Language: eng.
Year: 1994.
Pub. Country: France.

Document 23
Accession No.: 4926894.
Author: Traill-S.
Title: Too quiet an approach to quieter homes.
Source: Noise & Vibration Worldwide. vol.26, no.1. pp. 16-17. Jan. 1995.
Language: eng.
Year: 1995.
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Document 24
Accession No.: 4925889.
Author: Paulsen-R. Kastka-J.
Author Affil.: Med. Inst. of Environ. Hygiene, Dusseldorf Univ., Germany.

Title: Effects of combined noise and vibration on annoyance.
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Author: Clark-G.
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Year: 1994.
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Author: Dawn-T.
Title: Heathrow braces itself for noise complaints.
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Language: eng.
Year: 1994.
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Accession No.: 4915379.
Author: Ohta-M. Ikuta-A.
Author Affil.: Fac. of Eng., Kinki Univ., Higashihiroshima, Japan.
Title: Some new type regression analysis methods acoustic environmental system based on the introduction of multiplicative noise.
Source: IEICE Transactions on Fundamentals of Electronics, Communications and Computer Sciences. vol.E78-A, no.1. pp. 123-6. Jan. 1995.

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Author: Watts-G-R.
Author Affil.: Environ. Centre, Transport Res. Lab., Crowthorne, UK.
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References: 6 refs.
Language: eng.
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Accession No.: 4898921.
Author: Motylewski-J. Zmierczak-T. Nadolski-W. Wasala-T.
Author Affil.: Inst. of Fundamental Technol. Res., Polish Acad. of Sci.,
Warsaw, Poland.
Title: Infrasounds in residential area-a case study.
Source: Journal of Low Frequency Noise & Vibration. vol.13, no.2. pp. 65-70. 1994.
Language: eng.
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INSPEC Search 2:

Subject Heading : aircraft OR airports OR jets
Subject Heading : noise-abatement
Year : From 1991 To 1995

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Document 3
Accession No.: 4872264.

Author: Lancey-T-W.
Author Affil.: California State Univ., Fullerton, CA, USA.
Title: A quadrupole model for jet acoustical shielding.
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References: 19 refs.
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Accession No.: 4787257.
Author: Martin-V. Vignassa-P. Peseux-B.
Author Affil.: Lab. de Mecanique et d'Acoust., CNRS, Marseille, France.
Title: Numerical vibro-acoustic modelling of aircraft for the active acoustic control of interior noise.
Source: Journal of Sound and Vibration. vol.176, no.3. pp. 307-32. 22 Sept. 1994.
References: 18 refs.
Language: eng.
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Accession No.: 4672246.
Author: Smeatham-D. Wheeler-P-D. Kerry-G.
Author Affil.: Dept. of Appl. Acoust., Salford Univ., UK.
Title: Community response to noise from light aircraft.
Source: Acoustics Bulletin. vol.19, no.2. pp. 33, 35-6. March-April 1994.
References: 4 refs.
Language: eng.
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Document 7
Accession No.: 4620486.

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Author: Thomas-D-R. Nelson-P-A. Elliott-S-J. Pinnington-R-J.
Author Affil.: Inst. of Sound & Vibration Res., Southampton Univ., UK.
Title: An experimental investigation into the active control of sound transmission through stiff light composite panels.
Source: Noise Control Engineering Journal. vol.41, no.1. pp. 273-9. July-Aug. 1993.
References: 7 refs.
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Accession No.: 4620124.
Author: Chandra-R.
Author Affil.: Dept. of Aerosp. Eng., Maryland Univ., College Park, MD, USA.
Title: Active strain energy tuning of composite beams using shape memory alloy actuators (helicopter rotors).
Source: Proceedings of the SPIE - The International Society for Optical Engineering. vol.1917, no.1. pp. 267-84. 1993.
References: 12 refs.
Conf. Title: Smart Structures and Materials 1993. Smart Structures and Intelligent Systems. Albuquerque, NM, USA. SPIE. 1-4 Feb. 1993.
Language: eng.
Year: 1993.

Document 9
Accession No.: 4620123.
Author: Prasad-J-V-R. Sankar-L-N. Park-W-G.
Author Affil.: Sch. of Aerosp. Eng., Georgia Inst. of Technol., Atlanta, GA, USA.
Title: Active control of rotor noise.
Source: Proceedings of the SPIE - The International Society for Optical Engineering. vol.1917, no.1. pp. 255-66. 1993.
References: 12 refs.

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Language: eng.
Year: 1993.
Pub. Country: USA.

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Accession No.: 4620119.
Author: Park-C. Walz-C. Chopra-I.
Author Affil.: Dept. of Aerosp. Eng., Maryland Univ., College Park, MD, USA.
Title: Bending and torsion models of beams with induced strain actuators (for helicopters).
Source: Proceedings of the SPIE - The International Society for Optical Engineering. vol.1917, no.1. pp. 192-216. 1993.
References: 9 refs.
Conf. Title: Smart Structures and Materials 1993. Smart Structures and
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Language: eng.
Year: 1993.
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Document 11
Accession No.: 4619248.
Author: Wells-V-L. Huang-W.
Author Affil.: Dept. of Mech. & Aerosp. Eng., Arizona State Univ., Tempe, AZ, USA.
Title: Parametric evaluation of transmission characteristics in aircraft-like structures.
Source: Applied Acoustics. vol.41, no.3. pp. 247-64. 1994.
References: 6 refs.
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Year: 1994.
Pub. Country: UK.

Document 12
Accession No.: 4597164.
Author: Vlasov-E-V. Ginevskii-A-S. Pimshtein-V-G.
Author Affil.: N. E. Zhukovskii Central Aerohydrodynamics Inst., Moscow, Russia.
Title: Reduction of supersonic turbulent jet noise.
Source: Akusticheskii Zhurnal. vol.39, no.5. pp. 804-9. Sept.-Oct. 1993.
References: 9 refs.
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Language: eng.
Year: 1993.
Pub. Country: Russia. USA.

Document 13
Accession No.: 4535440.
Author: Belyakov-A-A. Maltsev-A-A. Medvedev-S-Yu. Cherepennikov-V-V.
Author Affil.: State Univ., Nizhegorod, Russia.
Title: Adaptive system for the active suppression of a wideband hydroacoustic noise field generated by a turbulent jet in a conduit.
Source: Akusticheskii Zhurnal. vol.39, no.3. pp. 433-8. May-June 1993.
References: 12 refs.
Trans. Title: Acoustical Physics. vol.39, no.3. pp. 226-8. May-June 1993.
Language: eng.
Year: 1993.
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Author: Thomas-D-R. Nelson-P-A. Elliot-S-J.
Author Affil.: Inst. of Sound & Vibration Res., Southampton Univ., UK.
Title: Active control of the transmission of sound through a thin cylindrical shell. Part II. The minimization of acoustic potential energy.
Source: Journal of Sound and Vibration. vol.167, no.1. pp. 113-28. 8 Oct. 1993.
References: 17 refs.
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Year: 1993.
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Accession No.: 4526537.
Author: Thomas-D-R. Nelson-P-A. Elliott-S-J.
Author Affil.: Inst. of Sound & Vibration Res., Southampton Univ., UK.
Title: Active control of the transmission of sound through a thin cylindrical shell. Part I. The minimization of vibrational energy.
Source: Journal of Sound and Vibration. vol.167, no.1. pp. 91-111. 8 Oct. 1993.
References: 23 refs.
Language: eng.
Year: 1993.
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Accession No.: 4432256.
Author: Oppenheim-A-V. Weinstein-E. Zangi-K-C. Feder-M. Gauger-D.
Author Affil.: MIT, Cambridge, MA, USA.
Title: Single sensor active noise cancellation based on the EM algorithm.
Source: Published by: IEEE. New York, NY, USA. 1992.
References: 6 refs.
Conf. Title: ICASSP-92: 1992 IEEE International Conference on Acoustics, Speech and Signal Processing (Cat. No.92CH3103-9). San Francisco, CA, USA. pp. 277-80 vol.1. IEEE. 23-26 March 1992.
Language: eng.

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Document 17
Accession No.: 4423292.
Author: Fuller-C-R. Snyder-S-D. Hansen-C-H. Silcox-R-J.
Author Affil.: Virginia Polytech. Inst. & State Univ., Blacksburg, VA, USA.
Title: Active control of interior noise in model aircraft fuselages using piezoceramic actuators.
Source: AIAA Journal. vol.30, no.11. pp. 2613-17. Nov. 1992.
References: 9 refs.
Language: eng.
Year: 1992.
Pub. Country: USA.

Document 18
Accession No.: 4316858.
Author: De-Vries-L.
Author Affil.: Fokker Aircraft bv Schiphol, Netherlands.
Title: Refinements to the power plant control systems in the Fokker 50 aircraft.
Source: Journal A. vol.33, no.3. pp. 127-30. Oct. 1992.
Language: eng.
Year: 1992.
Pub. Country: Belgium.

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Accession No.: 4047017.
Author: Fahy-F-J. Mason-J-M.
Author Affil.: Inst. of Sound & Vibration Res., Southampton Univ., UK.
Title: Measurements of the sound transmission characteristics of model aircraft fuselages using a reciprocity technique.
Source: Noise Control Engineering Journal. vol.37, no.1. pp. 19-29. July-Aug. 1991.
References: 5 refs.
Language: eng.

Year: 1991.
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Accession No.: 3995995.
Author: Silence-J-L.
Author Affil.: EAR Specialty Composites, Indianapolis, IN, USA.
Title: Meeting the noise control needs of today's aircraft.
Source: Noise & Vibration Worldwide. vol.22, no.7. pp. 14-16. July 1991.
Language: eng.
Year: 1991.
Pub. Country: UK.

Document 22
Accession No.: 3959635.
Author: Unruh-J-F.
Author Affil.: Div. of Mech. & Fluids Eng., Southwest Res. Inst., San Antonio, TX, USA.
Title: Simulation and control of propeller induced structure-borne noise.
Source: Noise Control Engineering Journal. vol.36, no.2. pp. 91-6. March-April 1991.
References: 7 refs.
Language: eng.
Year: 1991.
Pub. Country: USA.

Document 23
Accession No.: 3921424.
Author: Das-I-S. Dosanjh-D-S.
Author Affil.: Pennsylvania State Univ., Sharon, PA, USA.
Title: Short conical solid/perforated plug-nozzle as supersonic jet noise suppressor.
Source: Journal of Sound and Vibration. vol.146, no.3. pp. 391-406. 8 May 1991.
References: 26 refs.

Language: eng.
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INSPEC Search 3:
Subject Heading : acoustic noise measurement
Year : From 1991 To 1995

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Document 1
Accession No.: 4979994.
Author: Nakasako-N. Ohta-M. Mitani-Y.
Author Affil.: Hiroshima Inst. of Technol., Japan.
Title: An improvement of state estimation method based on correlation information with saturated noisy observations and its application to acoustic measurement.
Source: Published by: Soc. Instrum. & Control Eng. Tokyo, Japan. 1993.
References: 11 refs.
Conf. Title: SICE '93. Proceedings of the 32nd SICE Annual Conference. International Session (IEEE Cat. No.93 TH 0575-1). Kanazawa, Japan. pp. 1399-404. Soc. Instrum. & Control Eng. Ind. Electron. Soc. IEEE. IEEE Tokyo Sect. Korean Assoc. Autom. Control. Chinese Autom. Control Soc. 4-6 Aug. 1993.
Language: eng.
Year: 1993.
Pub. Country: Japan.

Document 2
Accession No.: 4969173.
Author: Jungbauer-D-E. Unruh-J-F. Rose-S. Pantermuehl-P-J.
Author Affil.: Southwest Res. Inst., San Antonio, TX, USA.
Title: Sound power and pressure level measurements in the inlet and outlet of an HRSG duct.
Source: Transactions of the ASME. Journal of Engineering for Gas Turbines and Power. vol.117, no.2. pp. 259-65. April 1995.
Language: eng.
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Document 3
Accession No.: 4964929.
Author: Johantgen-N.
Author Affil.: Oriental Motor USA Corp., Torrance, CA, USA.
Title: Microstepped 5-phase step motors cut vibration and audible noise.
Source: Powerconversion & Intelligent Motion. vol.21, no.5. pp. 49-53. May 1995.
Language: eng.
Year: 1995.
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Accession No.: 4960486.
Author: Ghosh-A. Bridges-J. Hussain-F.
Author Affil.: Dept. of Mech. Eng., Houston Univ., TX, USA.
Title: Instantaneous directivity in jet noise by multipole decomposition.
Source: Transactions of the ASME. Journal of Vibration and Acoustics. vol.117, no.2. pp. 172-9. April 1995.
References: 17 refs.
Language: eng.
Year: 1995.
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Document 5
Accession No.: 4956661.
Author: Cammarata-G. Cavalieri-S. Fichera-A. Marletta-L.
Author Affil.: Istituto di Macchine, Catania Univ., Italy.
Title: Self-organizing map to filter acoustic mapping survey in noise pollution analysis.
Source: Published by: IEEE. New York, NY, USA. 1993.
References: 8 refs.
Conf. Title: IJCNN '93-Nagoya. Proceedings of 1993 International JointConference on Neural Networks (Cat. No.93CH3353-0). Nagoya, Japan. pp. 2017-20 vol.2. Japanese Neural Network Soc. IEEE Neural Networks Council. Int. Neural Network Soc. European

Neural Network Soc. Soc. Instrum. & Control Eng. IEICE. 25-29 Oct. 1993.
Language: eng.
Year: 1993.
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Document 6
Accession No.: 4948778.
Author: Fuelhata-K. Yanagisawa-T.
Title: A new sound level meter possible to evaluate the psychological effects to noise.
Source: Journal of the Faculty of Engineering, Shinshu University. no.75. pp. 47-58. Feb. 1995.
References: 12 refs.
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Year: 1995.
Pub. Country: Japan.

Document 7
Accession No.: 4945683.
Author: Chiang-D. Fishbein-W. Sheppard-D. Edited by: Sanson-L-D.
Author Affil.: US Army Commun. & Electron. Command, USA.
Title: Acoustic aircraft detection sensor.
Source: Published by: IEEE. New York, NY, USA. 1993.
References: 4 refs.
Conf. Title: Proceedings. The Institute of Electrical and Electronics Engineers 1993 International Carnahan Conference on Security Technology: Security Technology (Cat. No.CH3372-0/93). Ottawa, Ont., Canada. pp. 127-33. IEEE Lexington Sect. IEEE Aerosp. & Electron. Syst. Soc. G. Levett & Associates. IEEE Ottawa Sect. Georgia Tech. Res. Inst. Chung Shan Inst. Sci. & Technol. Nat. Chiao-Tung Univ. 13-15 Oct. 1993.
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Accession No.: 4942875.
Author: Cannelli-G-B. Santoboni-S.
Author Affil.: Istit. di Acustica, CNR, Rome, Italy.
Title: Algorithm for computing the physical descriptor of environmental impulsive sounds.
Source: Journal of the Acoustical Society of America. vol.97, no.4. pp. 2599-602. April 1995.
References: 4 refs.
Language: eng.
Year: 1995.
Pub. Country: USA.

Document 9
Accession No.: 4932751.
Author: Payne-R-C.
Title: Effect of atmospheric pressure on measured aircraft noise levels.
Source: 52 pp. March 1994.
References: 11 refs.
Language: eng.
Year: 1994.
Report No.: RSA(EXT) 0048. Issuing organization: Nat. Phys. Lab.,
Teddington, UK.
Pub. Country: UK.

Document 10
Accession No.: 4921813.
Author: Muster-J. Budig-P-K. Belmans-R. Geysen-W. Sattler-P-K.
Author Affil.: Tech. Univ. Chemnitz, Germany.
Title: Audible noise in speed-controlled inverter-fed medium-sized induction motors.
Source: European Transactions on Electrical Power Engineering. Vol.5, no.1. pp. 5-13. Jan.-Feb. 1995.
References: 17 refs.
Language: eng.
Year: 1995.

Pub. Country: Germany.

Document 11
Accession No.: 4911639.
Author: Galinsky-G. Reader-G-T. Potter-I-J. Gustafson-R-W.
Author Affil.: Dept. of Mech. Eng., Calgary Univ., Alta., Canada.
Title: Effect of various working fluid compositions on combustion noise in diesel engines.
Source: Published by: AIAA. Washington, DC, USA. 1994.
References: 17 refs.
Conf. Title: Collection of Technical Papers. 29th Intersociety Energy Conversion Engineering Conference (IEEE Cat. No.94CH3478-5). Monterey, CA, USA. pp. 1157-62 vol.3. 7-11 Aug. 1994.
Language: eng.
Year: 1994.
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Document 12
Accession No.: 4900236.
Author: Watts-G-R.
Author Affil.: Environ. Centre, Transport Res. Lab., Crowthorne, UK.
Title: A comparison of noise measures for assessing vehicle noisiness.
Source: Journal of Sound and Vibration. vol.180, no.3. pp. 493-512. 23 Feb. 1995.
References: 6 refs.
Language: eng.
Year: 1995.
Pub. Country: UK.

Document 13
Accession No.: 4900229.
Author: Moorhouse-A-T. Gibbs-B-M.
Author Affil.: School of Archit. & Building Eng., Liverpool Univ., UK.
Title: Measurement of structure-borne sound emission from resiliently mounted machines in situ.
Source: Journal of Sound and Vibration. vol.180, no.1. pp. 143-61. 9 Feb. 1995.

References: 11 refs.
Language: eng.
Year: 1995.
Pub. Type: journal-article (J).
Pub. Country: UK.

Document 14
Accession No.: 4900228.
Author: Rowell-M-A. Oldham-D-J.
Author Affil.: Acoustics Res. Lab., Liverpool Univ., UK.
Title: Determination of the directivity of a planar noise source by means of near field acoustical holography. 2. Numerical simulation.
Source: Journal of Sound and Vibration. vol.180, no.1. pp. 119-42. 9 Feb. 1995.
References: 9 refs.
Language: eng.
Year: 1995.
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Document 15
Accession No.: 4900227.
Author: Rowell-M-A. Oldham-D-J.
Author Affil.: Acoustics Res. Unit., Liverpool Univ., UK.
Title: Determination of the directivity of a planar noise source by means of near field acoustical holography. 1. Theoretical background.
Source: Journal of Sound and Vibration. vol.180, no.1. pp. 99-118. 9 Feb. 1995.
References: 29 refs.
Language: eng.
Year: 1995.
Pub. Country: UK.

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Accession No.: 4888314.
Author: Chartier-V-L. Blair-D-E. Easley-D-M. Raczkowski-R-T.

Author Affil.: Div. of Lab., Bonnevile Power Adm., Vancouver, BC, Canada.
Title: Corona performance of a compact 230-kV line.
Source: IEEE Transactions on Power Delivery. vol.10, no.1. pp. 410-20. Jan. 1995.
References: 17 refs.
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Accession No.: 4888255.
Author: Tannaka-Y. Yamamoto-T.
Author Affil.: Hiroshima Inst. of Technol., Japan.
Title: Assessment system for compressor noises based on principal component analysis.
Source: Journal of the Acoustical Society of Japan (E). vol.15, no.6. pp. 403-6. Nov. 1994.
References: 4 refs.
Language: eng.
Year: 1994.
Pub. Country: Japan.

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Accession No.: 4881113.
Author: Ribeiro-Fonseca-J. Correia-L.
Author Affil.: Center of Intelligent Robotics, UNINOVA, Portugal.
Title: Identification of underwater acoustic noise.
Source: Published by: IEEE. New York, NY, USA. 1994.
References: 13 refs.
Conf. Title: OCEANS 94. Oceans Engineering for Today's Technology and
Tomorrow's Preservation. Proceedings (Cat. No.94CH3472-8). Brest, France. pp. II/597-602 vol.2. Oceanic Eng. Soc. IEEE. Soc. Electr. Electron. France. Communaute Urbaine de Brest. 13-16 Sept. 1994.
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Document 19
Accession No.: 4877394.
Author: Chi-Yao-Wu. Pollock-C.
Author Affil.: Dept. of Eng., Warwick Univ., Coventry, UK.
Title: Analysis and reduction of vibration and acoustic noise in the switched reluctance drive.
Source: IEEE Transactions on Industry Applications. vol.31, no.1. pp. 91-8. Jan.-Feb. 1995.
References: 7 refs.
Language: eng.
Year: 1995.
Pub. Country: USA.

Document 20
Accession No.: 4875688.
Author: Mio-N. Tsubono-K.
Author Affil.: Dept. of Phys., Tokyo Univ., Japan.
Title: Vibration transducer using an ultrashort Fabry-Perot cavity.
Source: Applied Optics. vol.34, no.1. pp. 186-9. 1 Jan. 1995.
References: 25 refs.
Language: eng.
Year: 1995.
Pub. Country: USA.

Document 21
Accession No.: 4861737.
Author: Ohta-M. Nakasako-N. Mitani-Y.
Author Affil.: Fac. of Eng., Kinki Univ., Higashi-Hiroshima, Japan.
Title: The transformation relationship of dual direction type among noise evaluation indices L/sub x/'s based on an improvement of the principal component analysis method.
Source: Journal of the Acoustical Society of Japan. vol.50, no.10. pp. 829-35. Oct. 1994.
References: 2 refs.
Language: jpn.

Year: 1994.
Pub. Country: Japan.

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Accession No.: 4857788.
Author: Jongens-A-W-D.
Author Affil.: Central Acoustics Lab., Cape Town Univ., Rondebosch, South Africa.
Title: Application of cepstrum techniques to the measurement of the normal incident sound absorption coefficient of road surfaces in-situ.
Source: Published by: IEEE. New York, NY, USA. Feb. 1994.
References: 4 refs.
Conf. Title: Proceedings of the 1993 IEEE South African Symposium on Communications and Signal Processing. Jan Smuts Airport, South Africa. pp. 25-31. IEEE. June 1908.
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Accession No.: 4852943.
Author: Uchino-E. Ohta-M.
Author Affil.: Dept. of Control Eng. & Sci., Kyushu Inst. of Technol., Fukuoka, Japan.
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Author: Pillay-P. Samudio-R. Ahmed-M. Patel-R.
Author Affil.: Dept. of Electr. Eng., New Orleans Univ., LA, USA.

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Author: Bracciali-A. Cluffi-L. Cluffi-R. Rissone-P.
Author Affil.: Dipartimento di Meccanica e Tecnol. Ind., Florence Univ., Italy.
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Author Affil.: Dept. of Electr. Eng., Zhejiang Univ., Hangzhou, China.
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Author Affil.: Hearing Section, Nat. Inst. of Health, Bethesda, MD, USA.
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Author: Somek-B. Krhen-M. Edited by: Vidmar-B.
Author Affil.: Elektrotehnicki, Fakultet, Zagreb, Croatia.
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Author: Davis-S-S.
Author Affil.: NASA Ames Res. Center, Moffett Field, CA, USA.
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Author Affil.: Dept. of Aerosp. Eng., Korea Adv. Inst. of Sci. & Technol., Taejon, South Korea.
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Author: Wu-S-F. Maestrello-L.
Author Affil.: Dept. of Mech. Eng., Wayne State Univ., Detroit, MI, USA.
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Author Affil.: Hamilton Standard Div., United Technol. Corp., East Hartford, CT, USA.
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Author Affil.: Dept. of Mech. Eng., Inst. of Sci., Bangalore, India.
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Author: Pimshtein-V-G.
Author Affil.: Central Aerohydrodynamic Inst., Moscow, Russia.
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Author: Hardin-J-C. Pope-D-S.
Author Affil.: NASA Langley Res. Center, Hampton, VA, USA.
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Author: Duck-P-W. Lasseigne-D-G. Hussaini-M-Y.
Author Affil.: Dept. of Math., Manchester Univ., UK.

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Author Affil.: Dept. of Acoust. Res., AT&T Bell Labs., Murray Hill, NJ, USA.
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Author Affil.: Dept. of Electr. Eng., California Univ., Los Angeles, CA, USA.
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Author Affil.: Dept. of Mech. Eng., Houston Univ., TX, USA.
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Author Affil.: Appl. Phys. Lab., Washington Univ., Seattle, WA, USA.
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Author: Sobolev-A-F.
Author Affil.: Zhukovskiy Inst. of Aerohydrodynamics, Russia.
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Author: Fuchs-H-V. Zha-X.
Author Affil.: Fraunhofer-Inst. fur Bauphys., Stuttgart, Germany.
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Author Affil.: Dept. of Mech. Eng., Houston Univ., TX, USA.
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Author Affil.: Coll. of Eng., Boston Univ., MA, USA.
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Author Affil.: George Washington Univ., Hampton, VA, USA.
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Author: San-Yih-Lin. Yan-Shin-Chin.
Author Affil.: Inst. of Aeronaut. & Astronaut., Nat. Cheng Kung Univ., Tainan, Taiwan.

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Author Affil.: North Carolina State Univ., Raleigh, NC, USA.
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Author: Vainshtein-P.
Author Affil.: Fac. of Mech. Eng., Technion-Israel Inst. of Technol., Haifa, Israel.
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Author Affil.: Dept. of Mech. Eng., Stanford Univ., CA, USA.
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Author Affil.: Dept. of Eng., Cambridge Univ., UK.
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Author Affil.: Dept. of Mech. Eng., Technion-Israel Inst. of Technol., Haifa, Israel.
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Author Affil.: Dept. of Mech. Eng., Houston Univ., TX, USA.
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Author Affil.: Sherbrooke Univ., Que., Canada.
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Author Affil.: Oddelk za fiziko, Ljubljana Univ., Slovenia.
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Author: Delfs-J.
Author Affil.: Inst. fur Stromungsmechanik, Tech. Univ. Braunschweig, Germany.
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Author Affil.: Dept. of Eng. Design & Manuf., Hull Univ., UK.
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Author: Bass-H-E. Raspet-R. Messer-J-O.
Author Affil.: Jamie Whitten Nat. Center for Phys. Acoust., Mississippi Univ., MS, USA.
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Author Affil.: Dept. of Mech. Eng., Houston Univ., TX, USA.
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Author: Lancey-T-W.
Author Affil.: California State Univ., Fullerton, CA, USA.
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Author: Attenborough-K. Taherzadeh-S. Bass-H-E. Di-X. Raspet-R. Becker-G-R. Gudesen-A. Chrestman-A. Daigle-G-A. LEsperance-A. Gabillet-Y. Gilbert-K-E. Li-Y-L. White-M-J. Naz-P. Noble-J-M. Van-hoof-H-A-J-M.
Author Affil.: Open Univ., Milton Keynes, UK.
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Author Affil.: Ultrasound Res. Lab., Univ. of Rochester Med. Center, NY, USA.
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Author Affil.: Naval Res. Lab., Washington, DC, USA.
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Author: Miura-H.
Author Affil.: Dept. of Electr. Eng., Nihon Univ., Tokyo, Japan.
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Author Affil.: Dept. of Theor. Astrophys., Space Res. Inst., Moscow, Russia.
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Author: Kurasawa-H. Obata-T.
Author Affil.: Nagano Nat. Coll. of Technol., Japan.
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Author: Raspet-R. Bass-H-E. Lixin-Yao. Boulanger-P. McBride-W-E.
Author Affil.: Phys. Acoust. Res. Group, Mississippi Univ., MS, USA.
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Author: Krane-M-H. Collorec-L.

Author Affil.: Lab. de Mecanique des Fluides et d'Acoustique, Ecole Centrale de Lyon, Ecully, France.
Title: Sound source decomposition for two-dimensional deformable vortices.
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Author: Bihhadi-A. Gervais-Y.
Author Affil.: Lab. d'Etudes Aerodynamiques, Poitiers, France.
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Author: Craig-D-W. Sabatier-J-M.
Author Affil.: Nat. Center for Phys. Acoust., Mississippi Univ., MS, USA.
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Author: Smolyakov-A-V.
Author Affil.: Krylov Shipbuilding Inst., St. Petersburg, Russia.
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Author Affil.: St. Petersburg State Univ., Russia.
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Author: Borisyuk-A-A.
Author Affil.: Inst. of Hydromech., Acad. of Sci., Kiev, Ukraine.
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Author: Putland-G-R.
Author Affil.: Dept. of Electr. & Comput. Eng., Queensland Univ., St. Lucia, Qld., Australia.
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Author: Raman-G. Rice-E-J. Reshotko-E.
Author Affil.: Exp. Fluid Dynamics Sect., NASA Lewis Res. Center, Cleveland, OH, USA.
Title: Mode spectra of natural disturbances in a circular jet and the effect of acoustic forcing.
Source: Experiments in Fluids. vol.17, no.6. pp. 415-26. Oct. 1994.
References: 34 refs.
Language: eng.
Year: 1994.
Pub. Type: journal-article (J).
Pub. Country: Germany.

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Accession No.: 4839202.
Author: Tarasov-S-B. Toleuov-G.
Title: Heat transfer processes in coherent structures in three-dimensional jets.
Source: Heat Transfer Research. vol.25, no.3. pp. 352-5. 1993.
Language: eng.
Year: 1993.
Pub. Type: journal-article (J).
Pub. Country: USA.

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Accession No.: 4831680.
Author: Bahar-E.
Author Affil.: Dapt. of Electr. Eng., Nebraska Univ., Lincoln, NE, USA.
Title: Green's functions for the full-wave acoustic radiation fields diffusely scattered by one- and two-dimensionally rough surfaces.
Source: Journal of the Acoustical Society of America. vol.96, no.5, pt.1. pp. 3106-14. Nov. 1994.
References: 27 refs.
Language: eng.
Year: 1994.
Pub. Type: journal-article (J).
Pub. Country: USA.

Document 58
Accession No.: 4831046.
Author: Maling-G-C-Jr.
Author Affil.: Empire State Software Syst. Ltd., Poughkeepsie, NY, USA.
Title: Historical developments in the control of noise generated by small air-moving devices.
Source: Noise Control Engineering Journal. vol.42, no.5. pp. 159-69. Sept.-Oct. 1994.
References: 153 refs.
Language: eng.

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Year: 1994.
Pub. Type: journal-article (J).
Pub. Country: USA.

Document 60
Accession No.: 4830016.
Author: Gabillet-Y. Daigle-G-A. LEsperance-A.
Author Affil.: Centre Sci. et Technique du Batiment, Saint-Martin-d'Heres, France.
Title: Sound propagation in a wind tunnel: comparison of experiments
with FFP and residue solution.
Source: Applied Acoustics. vol.43, no.4. pp. 321-31. 1994.
References: 6 refs.
Language: eng.
Year: 1994.
Pub. Type: journal-article (J).
Pub. Country: UK.

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INSPEC Search 5:
Subject Heading : vibrations
Subject Heading : airports or aircraft or jets
Year : From 1991 To 1995

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Document 1
Accession No.: 4815470.
Author: Viveash-J-P. Cable-A-N. King-S-K. Stott-J-R-R. Wright-R.
Author Affil.: Dept. of Aeromed. & Neurosci., Defence Res. Agency, Farnborough, UK.
Title: Aircraft vibration and the readability of an electronic flight instrument display.
Source: Displays. vol.15, no.2. pp. 76-82. April 1994.
References: 7 refs.
Language: eng.
Year: 1994.
Pub. Type: journal-article (J).
Pub. Country: UK.

Document 2
Accession No.: 4797583.
Author: Anders-J-T. Pearson-R.
Author Affil.: GEC Avionics Ltd., Rochester, UK.
Title: Applications of the 'START' vibratory gyroscope.
Source: GEC Review. vol.9, no.3. pp. 168-75. 1994.
References: 5 refs.
Language: eng.
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Pub. Type: journal-article (J).
Pub. Country: UK.

Document 4
Accession No.: 4746397.
Author: Caponero-M-A. De-Angelis-A. Filetti-V-R. Gammella-S.
Author Affil.: Dipartimento Sviluppo Tecnologie de Punta, ENEA, Rome, Italy.
Title: Structural analysis of an aircraft turbine blade prototype by use of holographic interferometry.
Source: Proceedings of the SPIE - The International Society for Optical Engineering. vol.2004. pp. 150-61. 1994.
Conf. Title: Interferometry VI: Applications. San Diego, CA, USA. SPIE. Soc. Exp. Mech. 14-15 July 1993.
Language: eng.
Year: 1994.
Pub. Type: conference-proceeding (C).
Pub. Country: USA.

Document 6
Accession No.: 4651187.
Author: Battis-J-C.
Author Affil.: Div. of Earth Sci., Air Force Mater. Command, Hanscom AFB, MA, USA.
Title: The effects of aircraft (B-52) overflights on ancient structures.
Source: Journal of Sound and Vibration. vol.171, no.2. pp. 267-83. 24 March 1994.

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References: 22 refs.
Language: eng.
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Pub. Country: UK.

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Accession No.: 4355225.
Author: Nowak-M.
Author Affil.: Inst. of Fundamental Technol. Res., Polish Acad. of Sci.,
Warsaw, Poland.
Title: Numerical procedures for determining characteristic roots in the aeroplane flutter problem at subsonic flight velocities. II.
Source: Bulletin of the Polish Academy of Sciences, Technical Sciences. vol.40, no.1. pp. 17-24. 1992.
References: 2 refs.
Language: eng.
Year: 1992.
Pub. Type: journal-article (J).
Pub. Country: Poland.

Document 8
Accession No.: 4355224.
Author: Nowak-M.
Author Affil.: Inst. of Fundamental Technol. Res., Polish Acad. of Sci.,
Warsaw, Poland.
Title: Numerical procedures for determining characteristic roots in the aeroplane flutter problem at subsonic flight velocities. I.
Source: Bulletin of the Polish Academy of Sciences, Technical Sciences. vol.40, no.1. pp. 7-15. 1992.
References: 7 refs.
Language: eng.
Year: 1992.
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Pub. Country: Poland.

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Author: Seals-J-D.
Title: Next-generation avionics packaging and cooling 'test results from a prototype system'.
Source: Published by: IEEE. New York, NY, USA. 1991.
Conf. Title: Proceedings. IEEE/AIAA 10th Digital Avionics Systems Conference (Cat. No.91CH3030-4). Los Angeles, CA, USA. pp. 164-9. IEEE. 14-17 Oct. 1991.
Language: eng.
Year: 1991.
Pub. Type: conference-proceeding (C).
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Document 11
Accession No.: 4042308.
Author: Giadi-A. Girgis-F.
Author Affil.: Dept. of Aeronaut., Al-Raya Al-Khadra Univ., Tripoli, Libya.
Title: Predicting most of the elasto-mechanical parameters by the use of electronic test equipments in ground resonance tests with application to airframe vehicles.
Source: Modelling, Simulation & Control B. vol.38, no.1. pp. 41-52. 1991.
References: 7 refs.
Language: eng.
Year: 1991.
Pub. Type: journal-article (J).
Pub. Country: France.
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INSPEC Search 6:
Subject Heading : noise measurement
Subject Heading : airports or aircraft or jets
Year : From 1991 To 1995
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Document 1
Accession No.: 4960486.

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Author: Ghosh-A. Bridges-J. Hussain-F.
Author Affil.: Dept. of Mech. Eng., Houston Univ., TX, USA.
Title: Instantaneous directivity in jet noise by multipole decomposition.
Source: Transactions of the ASME. Journal of Vibration and Acoustics. vol.117, no.2. pp. 172-9. April 1995.
References: 17 refs.
Language: eng.
Year: 1995.
Pub. Type: journal-article (J).
Pub. Country: USA.

Document 2
Accession No.: 4932751.
Author: Payne-R-C.
Title: Effect of atmospheric pressure on measured aircraft noise levels.
Source: 52 pp. March 1994.
References: 11 refs.
Language: eng.
Year: 1994.
Pub. Type: report (R).
Report No.: RSA(EXT) 0048. Issuing organization: Nat. Phys. Lab., Teddington, UK.
Pub. Country: UK.

Document 3
Accession No.: 4722123.
Author: Kelly-J-J. Wilson-M-R.
Author Affil.: Lockheed Eng. & Sci. Co., Hampton, VA, USA.
Title: Influence of source acceleration on sound-pressure signals.
Source: Noise Control Engineering Journal. vol.42, no.3. pp. 87-94. May-June 1994.
References: 13 refs.
Language: eng.
Year: 1994.
Pub. Type: journal-article (J).

Pub. Country: USA.

Document 4
Accession No.: 4503218.
Author: Payne-R-C.
Title: Experimental assessment of the use of ground-level microphones to measure the fly-over noise of jet-engined aircraft.
Source: 34 pp. Jan. 1993.
References: 18 refs.
Language: eng.
Year: 1993.
Pub. Type: report (R).
Report No.: NPL RSA(EXT) 0039. Issuing organization: Nat. Phys. Lab., Teddington, UK.
Pub. Country: UK.

Document 5
Accession No.: 4333873.
Author: Kazaryan-A-A.
Title: A highly sensitive thin-film capacitive pressure sensor.
Source: Izmeritel'naya Tekhnika. vol.34, no.12. pp. 47-8. Dec. 1991.
References: 4 refs.
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Pub. Country: Russia. USA.

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Accession No.: 4244372.
Author: Handy-W.
Title: Developing functional test methods to eliminate redundant receiver testing.
Source: Published by: Miller Freeman Expositions. Boston, MA, USA. 1991.
References: 2 refs.

Conf. Title: Work Smarter Not Harder. Proceedings ATE and Instrumentation Conference. Anaheim, CA, USA. pp. 23-8 supl. 13-16 Jan. 1992.
Language: eng.
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Accession No.: 4239510.
Author: Zacharias-R. Pennock-S. Poggio-A. Ray-S.
Author Affil.: Lawrence Livermore Nat. Lab., CA, USA.
Title: Tools and techniques for estimating high intensity RF effects.
Source: Published by: IEEE. New York, NY, USA. 1991.
References: 14 refs.
Conf. Title: Proceedings. IEEE/AIAA 10th Digital Avionics Systems Conference (Cat. No.91CH3030-4). Los Angeles, CA, USA. pp. 337-42. IEEE. 14-17 Oct. 1991.
Language: eng.
Year: 1991.
Pub. Type: conference-proceeding (C).
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Document 8
Accession No.: 4188309.
Author: Forrest-D. Waite-J-W.
Author Affil.: Hewlett-Packard Co., Everett, WA, USA.
Title: Digital signal processing improves aircraft noise measurements.
Source: Sound and Vibration. vol.26, no.3. pp. 24-9. March 1992.
References: 3 refs.
Language: eng.
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Document 9
Accession No.: 3974159.
Author: Smith-M-J-T.
Author Affil.: Rolls-Royco P/C, Derby, UK.
Title: Aircraft noise measurement: the case for rationalisation.
Source: Noise & Vibration Worldwide. vol.22, no.5. pp. 10-14. May 1991.
References: 5 refs.
Language: eng.
Year: 1991.
Pub. Type: journal-article (J).
Pub. Country: UK.
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INSPEC Search 7:
Subject Heading : acoustics or acoustic intensity
Subject Heading : airports or aircraft or jets
Year : From 1991 To 1995

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Document 2
Accession No.: 4883737.
Author: Chow-L-C. Cummins-R-J.
Author Affil.: British Aerosp. Airbus Ltd., Bristol, UK.
Title: Airbus aircraft acoustic fatigue certification.
Source: Acoustics Bulletin. vol.19, no.6. pp. 5-10. Nov.-Dec. 1994.
Language: eng.
Year: 1994.
Pub. Type: journal-article (J).
Pub. Country: UK.

Document 4
Accession No.: 4808090.
Author: Pimshtein-V-G.
Title: Disturbance generation in a subsonic turbulent jet under the influence of high-intensity sound.
Source: Izvestiya Akademii Nauk SSSR, Mekhanika Zhidkosti i Gaza. vol.29, no.2. pp. 104-11. March-April 1994.
References: 5 refs.

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Trans. Title: Fluid Dynamics. vol.29, no.2. pp. 238-43. March-April 1994.
Language: eng.
Year: 1994.
Pub. Type: journal-article (J).
Pub. Country: Russia. USA.

Document 5
Accession No.: 4619234.
Author: Yamamoto-K-J. Donelson-M-J.
Author Affil.: McDonnell Douglas Aerosp.-Transport Aircraft, Long Beach, CA, USA.
Title: Long distance propagation model and its application to aircraft en route noise prediction.
Source: AIAA Journal. vol.32, no.1. pp. 206-7. Jan. 1994.
References: 7 refs.
Language: eng.
Year: 1994.
Pub. Type: journal-article (J).
Pub. Country: USA.

Document 6
Accession No.: 4560958.
Author: Soreefan-I-S. Henry-R. Fave-C.
Author Affil.: Lab. d'Etudes Aerodynamiques-URA 91, Poitiers Univ., France.
Title: Self-sustained low-frequency tones generated by a confined jet impinging on an obstacle at low Mach number.
Source: Journal of Low Frequency Noise & Vibration. vol.12, no.2. pp. 30-5. 1993.
References: 15 refs.
Language: eng.
Year: 1993.
Pub. Type: journal-article (J).
Pub. Country: UK.

Document 7
Accession No.: 4560665.

Author: Ramesh-V. Vermeulen-P-J. Munjal-M-L.
Author Affil.: Dept. of Mech. Eng., Calgary Univ., Alta., Canada.
Title: Power measurement for an acoustically pulsed jet flow.
Source: Canadian Acoustics. vol.21, no.3. pp. 121-2. Sept. 1993.
References: 4 refs.
Conf. Title: Acoustics Week in Canada. Toronto, Ont., Canada. 4-8 Oct. 1993.
Language: eng.
Year: 1993.
Pub. Type: conference-proceeding (C).
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Document 9
Accession No.: 4543524.
Author: Shen-J. Meecham-W-C.
Author Affil.: Dept. of Mech. Aerosp. & Nucl. Eng., California Univ., Los Angeles, CA, USA.
Title: Quadrupole directivity of jet noise when impinging on a large rigid plate.
Source: Journal of the Acoustical Society of America. vol.94, no.3, pt.1. pp. 1415-24. Sept. 1993.
References: 40 refs.
Language: eng.
Year: 1993.
Pub. Type: journal-article (J).
Pub. Country: USA.

Document 12
Accession No.: 4238740.
Author: Galiullin-R-G. Permyakov-E-I.
Author Affil.: Pedagogical Inst., Kazan, Russia.
Title: Influence of turbulence on large-amplitude oscillations of a gas in a tube open at one end.
Source: Akusticheskii Zhurnal. vol.38, no.1. pp. 25-8. Jan.-Feb.
1992.
References: 13 refs.

Trans. Title: Soviet Physics - Acoustics. vol.38, no.1. pp. 11-13. Jan.-Feb. 1992.
Language: eng.
Year: 1992. 1992.
Pub. Type: journal-article (J).
Pub. Country: Russia. USA.

Document 13
Accession No.: 4184898.
Author: Vorobev-A-P.
Title: Effect of acoustic oscillations on the stability of a plane jet.
Source: Izvestiya Akademii Nauk SSSR, Mekhanika Zhidkosti i Gaza. vol.26, no.4. pp. 54-60. July-Aug. 1991.
References: 4 refs.
Trans. Title: Fluid Dynamics. vol.26, no.4. pp. 521-6. July-Aug. 1991.
Language: eng.
Year: 1991. 1991.
Pub. Type: journal-article (J).
Pub. Country: Russia. USA.

Document 15
Accession No.: 4025274.
Author: Cheng-L. Nicols-J.
Author Affil.: Dept. of Mech. Eng., Sherbrooke Univ., Que., Canada.
Title: Effect of the bulkhead fixing on the noise inside the airplane cabin.
Source: Canadian Acoustics. vol.19, no.4. pp. 11-12. Sept. 1991.
References: 2 refs.
Conf. Title: Canadian Acoustics Week 1991. Edmonton, Alta., Canada. Oct. 1991.
Language: eng.
Year: 1991.
Pub. Type: conference-proceeding (C).
Pub. Country: Canada.

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INSPEC Search 8:
Subject Heading : acoustic variables measurement
Subject Heading : airports or aircraft or jets
Year : From 1991 To 1995
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Document 1
Accession No.: 4807519.
Author: Deliverov-V-P. Lislenko-V-G. Neshcheret-P-A. Shlik-O-E.
Author Affil.: Dnepropetrovsk State Univ., Ukraine.
Title: The acoustic spectrum of a supersonic jet as a source of information about pulsational flow components.
Source: Akusticheskii Zhurnal. vol.40, no.5. pp. 787-93. Sept.-Oct. 1994.
References: 29 refs.
Trans. Title: Acoustical Physics. vol.40, no.5. pp. 697-702. Sept.-Oct. 1994.
Language: eng.
Year: 1994.
Pub. Type: journal-article (J).
Pub. Country: Russia. Russia.

Document 2
Accession No.: 4438663.
Author: Kelly-T.
Author Affil.: Transport Canada Aviation, Ottawa, Ont., Canada.
Title: Sound level data collection project in the vicinity of Toronto waterfront.
Source: Canadian Acoustics. vol.21, no.1. pp. 15-22. March 1993.
References: 1 refs.
Language: eng.
Year: 1993.
Pub. Type: journal-article (J).
Pub. Country: Canada.

Document 3

Accession No.: 4182234.
Author: Jacquet-B. Gely-D.
Author Affil.: ONERA, Chatillon, France.
Title: Study of noise produced by the impact of a hot supersonic jet on an obstacle.
Source: Journal de Physique IV (Colloque). vol.2, no.C1, pt.2. pp. 569-72 vol.2. April 1992.
References: 1 refs.
Conf. Title: Second French Conference on Acoustics. Arcachon, France. 14-17 April 1992.
Language: fre.
Year: 1992.
Pub. Type: conference-proceeding (C).
Pub. Country: France.
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INSPEC Search 9:
Author : Fidell-S
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Document 1
Accession No.: 4877536.
Author: Pearsons-K-S. Barber-D-S. Tabachnick-B-G. Fidell-S.
Author Affil.: BBN Syst. & Technol. Corp., Canoga Park, CA, USA.
Title: Predicting noise-induced sleep disturbance.
Source: Journal of the Acoustical Society of America. vol.97, no.1. pp. 331-8. Jan. 1995.
References: 28 refs.
Language: eng.
Year: 1995.
Pub. Type: journal-article (J).
Pub. Country: USA.

Document 2
Accession No.: 3837963.
Author: Fidell-S. Silvati-L.
Author Affil.: BBN Syst. & Technol. Corp., Canoga Park, CA, USA.
Title: An assessment of the effect of residential acoustic insulationon prevalence of annoyance in an airport community.

Source: Journal of the Acoustical Society of America. vol.89, no.1. pp. 244-7. Jan. 1991.
References: 8 refs.
Language: eng.
Year: 1991.
Pub. Type: journal-article (J).
Pub. Country: USA.

Document 3
Accession No.: 3837962.
Author: Green-D-M. Fidell-S.
Author Affil.: Dept. of Psychol., Florida Univ., Gainesville, FL, USA.
Title: Variability in the criterion for reporting annoyance in community noise surveys.
Source: Journal of the Acoustical Society of America. vol.89, no.1. pp. 234-43. Jan. 1991.
References: 7 refs.
Language: eng.
Year: 1991.
Pub. Type: journal-article (J).
Pub. Country: USA.

Document 4
Accession No.: 3837961.
Author: Fidell-S. Barber-D-S. Schultz-T-J.
Author Affil.: BBN Syst. & Technol. Corp., Canoga Park, CA, USA.
Title: Updating a dosage-effect relationship for the prevalence of annoyance due to general transportation noise.
Source: Journal of the Acoustical Society of America. vol.89, no.1. pp. 221-33. Jan. 1991.
References: 30 refs.
Language: eng.
Year: 1991.
Pub. Type: journal-article (J).
Pub. Country: USA.

Document 5
Accession No.: 3344396.

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Author: Fidell-S. Schultz-T. Green-D-M.
Author Affil.: BBN Syst. & Technol. Corp., Canoga Park, CA, USA.
Title: A theoretical interpretation of the prevalence rate of noise-induced annoyance in residential populations.
Source: Journal of the Acoustical Society of America. vol.84, no.6. pp. 2109-13. Dec. 1988.
References: 13 refs.
Language: eng.
Year: 1988.
Pub. Type: journal-article (J).
Treatment: THEORETICAL OR MATHEMATICAL (T).
Pub. Country: USA.

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INSPEC Search 10:
Author : Suter-A-H

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Document 1
Accession No.: 4126831.
Author: Suter-A-H.
Title: Noise sources and effects-a new look.
Source: Sound and Vibration. vol.26, no.1. pp. 18-34, 36, 38. Jan. 1992.
References: 241 refs.
Language: eng.
Year: 1992.
Pub. Type: journal-article (J).
Pub. Country: USA.

Document 2
Accession No.: 3690284.
Author: Suter-A-H. Lempert-B-L. Franks-J-R.
Author Affil.: US Dept. of Health & Human Services, Public Health Service, Cincinnatti, OH, USA.
Title: Real-ear attenuation of earmuffs in normal-hearing and hearing-impaired individuals.
Source: Journal of the Acoustical Society of America. vol.87, no.5. pp. 2114-17. May 1990.
References: 10 refs.

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Language: eng.
Year: 1990.
Pub. Type: journal-article (J).
Pub. Country: USA.

Document 3
Accession No.: 3623257.
Author: Suter-A-H.
Title: The need for and benefits of audiometric data base analysis.
Source: Sound and Vibration. vol.23, no.12. pp. 14-16. Dec. 1989.
References: 11 refs.
Language: eng.
Year: 1989.
Pub. Type: journal-article (J).
Pub. Country: USA.

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University of Washington Online Library Catalog, Seattle, WA
Subject Heading : Aircraft-noise OR Airport-noise OR Airplane-sounds OR Airplanes-Military--Noise--Congresses OR Airplanes--Noise OR Airplanes--Noise--Bibliography OR Airplanes--Noise--Congresses
Year : From 1991 To 1995

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Document 1
Author: Devenport, William J.
Title: Flow structure generated by perpendicular blade vortex interaction and implications for helicopter noise predictions [microform] / principle investigators: William J. Devenport, Stewart A.L. Glegg.
Pub. Info.: [Washington, DC : National Aeronautics and Space Administration ; Springfield, Va. : National Technical Information Service, distributor, 1994].
Phy Descript: 1 v.
Notes: Distributed to depository libraries in microfiche.
Shipping list no.: 94-0864-M.
Microfiche. [Washington, D.C. : National Aeronautics and Space Administration, 1994] 1 microfiche.
NASA Subject: Aeroacoustics.
Aircraft-noise.
Blade-vortex-interaction.
Noise-prediction.
Vortex-shedding.
Other Author: United States. National Aeronautics and Space Administration.
Series Info.: [NASA contractor report] ; NASA CR-195824.
Gov Doc Numb: Supt. of Docs. no.: NAS 1.26:195824.
Status: Engineering Microforms
N94-34207 CHECK THE SHELVES 1 fiche

Document 2
Author: Fields, James M.
Title: A review of an updated synthesis of noise/annoyance relationships [microform] / James M. Fields.
Pub. Info.: Hampton, Va. : Langley Research Center ; [Springfield, Va: National Technical Information Service, distributor, 1994].
Phy Descript: 1 v.
Notes: Distributed to depository libraries in microfiche.
Shipping list no.: 94-0862-M.
Microfiche. [Washington, D.C. : National Aeronautics and Space Administration, 1994] 1 microfiche.
NASA Subject: Aircraft-noise.
Human-reactions.
Noise-pollution.
Surveys.
Other Author: Langley Research Center.
Series Info.: NASA contractor report ; NASA CR-194950.
Gov Doc Numb: NAS 1.26:194950.
Status: Engineering Microforms
N94-34303 CHECK THE SHELVES 1 fiche

Document 3
Author: Ver, I. L. (Istvan L.), 1934-.
Title: Reciprocity-based experimental determination of dynamic forces and moments [microform] : a feasibility study / Istvan L. Ver and Michael S. Howe.
Pub. Info.: Hampton, Va. : National Aeronautics and Space Administration, Langley Research Center ; [Springfield, Va : National Technical Information Service, distributor, 1994].
Phy Descript: 1 v.
Notes: Distributed to depository libraries in microfiche.
Shipping list no.: 94-0861-M.
Microfiche. [Washington, D.C. : National Aeronautics and Space Administration, 1994] 1 microfiche.
NASA Subject: Aircraft-noise.
Dynamic-response.
Noise-propagation.
Prediction-analysis-techniques.
Structural-vibration.
Other Author: Howe, Michael S.

Langley Research Center.
Other Title: Reciprocity based experimental determination of dynamic
forces and moments.
Series Info.: NASA contractor report ; NASA CR-194905.
Gov Doc Numb: Supt. of Docs. no.: NAS 1.26:194905.
Status: Engineering Microforms
N94-33023 CHECK THE SHELVES 1 fiche

Document 4
Author: Garber, D. P. (Donald P.).
Title: En route noise levels from propfan test assessment airplane [microform] / Donald P. Garber and William L. Willshire, Jr.
Pub. Info.: Hampton, Va. : National Aeronautics and Space Administration, Langley Research Center ; [Springfield, Va : National Technical Information Service, distributor, 1994].
Phy Descript: 1 v.
Notes: Distributed to depository libraries in microfiche.
Shipping list no.: 95-0074-M.
Microfiche. [Washington, D.C. : National Aeronautics and Space Administration, 1994] 1 microfiche.
NASA Subject: Aeroacoustics.
Aerodynamic-noise.
Aircraft-noise.
Confidence-limits.
Noise-intensity.
Noise-propagation.
Prop-fan-technology.
Propeller-fans.
Sound-waves.
Other Author: Willshire, William L.
Langley Research Center.
Series Info.: NASA technical paper ; 3451.
Gov Doc Numb: Supt. of Docs. no.: NAS 1.60:3451.
Status: Engineering Microforms
N95-12341 CHECK THE SHELVES 1 fiche

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Document 5
Title: Potential impacts of advanced aerodynamic technology on air transportation system productivity [microform] / edited by Dennis M. Bushnell.
Pub. Info.: [Washington, DC] : National Aeronautics and Spaca Administration ; [Springfield, Va. : National Technical Information Service, distributor, 1994].
Phy Descript: 1 v.
Notes: Distributed to depository libraries in microfiche.
Shipping list no.: 95-0053-M.
Microfiche. [Washington, D.C. : National Aeronautics and Space Administration, 1994] 3 microfiches.
NASA Subject: Aerodynamics.
Air-transportation.
Aircraft-configurations.
Aircraft-noise.
Aircraft-structures.
Aircraft-wakes.
Airline-operations.
Flight-hazards.
Productivity.
Vortices.
Other Author: Bushnell, Dennis M.
United States. National Aeronautics and Space Administration.
Series Info.: NASA technical memorandum ; 109154.
Gov Doc Numb: Supt. of Docs. no.: NAS 1.15:109154.
Status: Engineering Microforms
N95-11489 CHECK THE SHELVES 3 fiche

Document 6
Author: SAE A-21 Committee.
Title: 1994 SAE aircraft noise handbook : aerospace standards, aerospace recommended practices, aerospace information reports /documents prepared by the SAE A-21 Committee.

Pub. Info.: Warrendale, Pa. : Society of Automotive Engineers, c1994-.
Phy Descript: 1 v. (loose-leaf) : ill. ; 30 cm.
Notes: Loose-leaf for updating.
Includes bibliographical references.
LC Subject: Airplanes -- Noise.
Other Author: Society of Automotive Engineers.
Other Title: SAE aircraft noise handbook.
1994 aircraft noise handbook.
Status: Engineering Reference
TL671.65 .S23 CHECK THE SHELVES LIBRARY USE ONLY

Document 7
Title: 101 digital sound effects [sound recording] : planes, trains and automobiles.
Pub. Info.: Santa Monica, CA : LaserLight, p1993.
Phy Descript: 1 sound disc : digital, stereo. ; 4 3/4 in.
Notes: Compact disc.
Analog recording; digitally remastered.
LC Subject: Sounds.
Airplane-sounds.
Railroad-sounds.
Automobile-sounds.
Other Title: Planes, trains and automobiles.
One hundred and one digital sound effects.
Publish Numb: LaserLight 12 147.
Status: UW-Tacoma Lib. Audio Visual Materials
Compact disc TAC-5 CHECK THE SHELVES

Document 8
Author: National Conference on Noise Control Engineering (12th : 1993 : Williamsburg, Va.).
Title: Noise-con 93 proceedings, 1993 National Conference on Noise Control Engineering : noise control in aeroacoustics / edited by

Harvey H. Hubbard.
Pub. Info.: New York, N.Y. : Noise Control Foundation, c1993.
Phy Descript: xx, 651 p. : ill. ; 23 cm.
Notes: Cover title: Proceedings of noise-con 93, noise control in aeroacoustics. "This is the proceedings of the twelfth in a series of National Conferences on Noise Control engineering, held at the Fort Magruder Inn and Conference Center, Williamsburg, Virginia on May 2-5, 1993. The theme of the conference was "Noise Control in Aeroacoustics" and it was co-sponsored by the NASA Langley Research Center and the Institute of Noise Control Engineering"--p. iii. Includes bibliographical references and index.
LC Subject: Aerodynamic-noise -- Congresses.
Airplanes -- Noise -- Congresses.
Noise-control -- Congresses.
Other Author: Hubbard, Harvey H.
Langley Research Center.
Institute of Noise Control Engineering.
Other Title: Noise control in aeroacoustics.
Status: Engineering General Stacks
TD891 .N33 1993 CHECK THE SHELVES

Document 9
Title: Seattle-Tacoma International Airport noise exposure map update, 1991.
Pub. Info.: Seattle, Wash. : Port of Seattle, [1993].
Phy Descript: 1 v. (various pagings) : ill., maps ; 28 cm.
Notes: Cover title.
"4/15/93.".
LC Subject: Airport-noise -- Washington-State -- Seattle-Tacoma-International-Airport -- Maps.
Noise-pollution -- Washington-State -- Seattle-Tacoma-International-Airport.
Seattle-Tacoma-International-Airport-Wash.
Other Author: Port of Seattle.
Other Title: Noise exposure map update, 1991.
Status: Suzzallo General Stacks

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TL725.3.N6 S52 1993 CHECK THE SHELVES

Document 10
Author: Propulsion and Energetics Panel Specialists' Meeting (78th (B) : 1991 : Bonn, Germany).
Title: Combat aircraft noise = le bruit genere par les avions de combat.
Pub. Info.: Neuilly sur Seine, France : Advisory Group for Aerospace
Research and Development, North Atlantic Treaty Organization, 1992.
Phy Descript: 1 v. (various pagings) : ill. ; 30 cm.
Notes: "Papers presented at the Propulsion and Energetics Panel
78th B Specialists' Meeting held in Bonn, Germany, 23rd-25th October 1991.".
Includes bibliographical references.
LC Subject: Airplanes-Military -- Noise -- Congresses.
Other Author: North Atlantic Treaty Organization. Advisory Group for Aerospace Research and Development. Propulsion and Energetics Panel.
Other Title: Bruit genere par les avions de combat.
Series Info.: AGARD conference proceedings ; no. 512.
Status: Engineering General Stacks
TL671.65 .P76 1991 CHECK THE SHELVES

Document 11
Author: Heller, H. (Hanno).
Title: Aircraft exterior noise measurement and analysis techniques / by Dr. H. Heller, Head, Technical Acoustics Division, German Aerospace Research Establishment.
Pub. Info.: Neuilly-sur-Seine, France : AGARD, c1991.
Phy Descript: xxi, 174 p. : ill., photos. ; 30 cm.
Notes: "Sponsored by the Flight Mechanics Panel of AGARD.".
"Published April 1991."--T.p. verso.
Preface in English and French.

213

Bibliography: p. 168-171.
LC Subject: Airplanes -- Noise.
Other Author: North Atlantic Treaty Organization. Advisory Group for Aerospace Research and Development. Flight Mechanics Panel.
Series Info.: AGARDograph ; no. 300, v. 9. AGARDograph. Flight test techniques series ; v. 9.
Status: Engineering General Stacks
629.1308 Ag15 no.300 v.9 CHECK THE SHELVES

Document 12
Title: Air transportation alternatives for the Puget Sound Region : public comment on the Options Subcommittee draft recommendations/ Puget Sound Air Transportation Committee (PSATC) Options Subcommittee.
Pub. Info.: Seattle, WA (216 1st Ave. S., Seattle 98104) : Puget Sound Council of Governments, [1991].
Phy Descript: 2 v. : ill. ; 28 cm.
Notes: Cover title: Public comment on the Options Subcommittee
draft recommendations.
"May 1991.".
Comments presented at the Pierce County Municipal Building, Snhomish [i.e. Snohomish] County Administrative Building, Sea-Tac Large Auditorium, at Mt. Rainier High School, Apr 3, 15, May 1-2, 1991.
LC Subject: Airport-noise -- Washington-State -- Puget-Sound-Region.
Airplanes -- Washington-State -- Puget-Sound-Region -- Noise. Seattle-Tacoma-International-Airport.
Other Author: Puget Sound Air Transportation Committee. Options Subcommittee.
Other Title: Options Subcommittee draft recommendations.
Public comment on the Options Subcommittee draft recommendations.
Status: Suzzallo General Stacks
TL726.4.S5 A36 1991 v.1 CHECK THE SHELVES
TL726.4.S5 A36 1991 v.2 CHECK THE SHELVES

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OCLC WorldCat

OCLC Search 1: Subject Heading : airport noise

Year : 1995 or 1994 or 1993 or 1992 or 1991

==

Author: Maryland Aviation Administration.
Title: Martin State Airport : airport noise zone
Pub. Info: [S.l.] : The Administration, 1995
Year: 1995
Physical Descr: 1 v. ; maps ; 61 x 89 cm.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Harris Miller Miller & Hanson Inc.
Language: eng
OCLC No: 32799299

Title: Sound solutions : F.A.R. part 150 noise compatibility study summary report
Pub. Info: [Indianapolis, Ind.?] : Indianapolis Airport Authority, 1992
Year: 1992
Physical Descr: 8 p. (some folded) : ill., map ; 26 cm.
Notes: Title from cover.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Indianapolis International Airport. Indianapolis Airport Authority.
Other Title: F.A.R. part 150 noise compatibility study summary report
Language: eng
OCLC No: 32457778

Author: Iowa. Dept. of Transportation.Planning Coordination Team.
Title: Land use planning and zoning in airport vicinities
Pub. Info: Des Moines, Iowa : The Dept., 1995
Year: 1995
Physical Descr: 41 p. : ill. ; 28 cm.
Notes: "PM 657 1-5-95."

Notes: PUBLICATION TYPE: Book
Language: eng
OCLC No: 32420950

Author: Reese Air Force Base.
Title: AICUZ study : citizen's brochure.
Pub. Info: Lubbock, Texas : United States Air Force, Reese Air Force Base, 1994
Year: 1994
Physical Descr: 8 p. : map ; 28 cm.
Notes: Cover title.
Notes: PUBLICATION TYPE: Book
Language: eng
OCLC No: 32362617

Author: Barrett, Douglas E.
Title: La Guardia Airport ground-noise abatement study
Pub. Info: 1994
Year: 1994
Physical Descr: p. 157-160 : ill. ; 28 cm.
Notes: Includes bibliographical references (p. 160)
Notes: PUBLICATION TYPE: Book
Other Author/Title: Menge, Christopher W.
Source: nnas Transportation research record. No. 1444 (1994)
(OCoLC)1259379
Language: eng
OCLC No: 32355313

Author: Norton, Paul. W.
Title: The National Noise Policy of 1990 : effects on the aviation industry
Pub. Info: 1994
Year: 1994
Physical Descr: 71 leaves : ill. ; 28 cm.
Notes: CCE618.
Notes: "A graduate research project presented to the College of Continuing Education in partial fulfillment of the

requirements for the degree of Master of Aeronautical Science.
Notes: Includes bibliographical references.
Notes: PUBLICATION TYPE: Book
Series: ERAU graduate research project ; 1994-279
Series: CCE graduate research project
Language: eng
OCLC No: 32286819

Author: Larson, Kate M. S.
Title: Noise compatibility program
Pub. Info: Burlington, Mass. : Harris Miller Miller & Hanson, Inc., 1994
Year: 1994
Physical Descr: 1 v. (various pagings) : ill., maps (some col.) ; 28 cm.
Notes: At head of title: Westover Metropolitan Airport / Air Reserve Base, FAR part 150 documentation.
Notes: "Prepared under Federal Aviation Regulations, part 150"
Notes: "October 1994"
Notes: Prepared by: Harris Miller Miller & Hanson, Inc. and: C&S Engineers, Inc.
Notes: Prepared for: Westover Metroplitan Development Corporation.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Miller, Robert L. Harris Miller Miller & Hanson, Inc. C & S Engineers, Inc. Westover Metropolitan Development Corporation.
Language: eng
OCLC No: 32234560

Title: Draft finding of no significant impact for proposed noise compatibility program actions at Cincinnati/Northern Kentucky International Airport / prepared for the Federal Aviation Administration by Landrum & Brown...[et.al].

Pub. Info: Cincinnati, Ohio : Landrum & Brown, 1995
Year: 1995
Physical Descr: 1 v. (various pagings) : maps ; 28 cm.
Notes: In loose-leaf binder.
Notes: PUBLICATION TYPE: Book
Language: eng
OCLC No: 32211395

Author: Maryland Aviation Administration.
Title: Baltimore/Washington International Airport airport noise zone
Pub. Info: [Baltimore?] : The Administration, 1994
Year: 1994
Physical Descr: 1 atlas (11 leaves) : maps ; 64 x 90 cm.
Notes: PUBLICATION TYPE: Map
Other Author/Title: Harris, Miller, Miller & Hanson, Inc.
Language: eng
OCLC No: 32143021

Title: AICUZ study
Pub. Info: McConnell Air Force Base, Kan. : The Base, 1994
Year: 1994
Physical Descr: 2 v. in 1 : maps ; 28 cm.
Notes: Cover title.
Notes: PUBLICATION TYPE: Book
Other Author/Title: McConnell Air Force Base. Air installation compatible use zone study.
Language: eng
OCLC No: 32127639

Author: Pereira Filho, Allemander J.
Title: Interpreting airport noise contours
Pub. Info: Washington, D.C. : Transportation Research Board, 1995
Year: 1995
Physical Descr: 26 p. : ill. ; 28 cm.

Notes: Paper no. 950212 prepared for presentation at the 74th annual meeting of the Transportation Research Board, Washington, D.C., Jan. 1995.
Notes: Includes bibliographical references (p. 26).
Notes: PUBLICATION TYPE: Book
Other Author/Title: Braaksma, John P. Phelan, Joseph J.
Language: eng
OCLC No: 32057001

Author: Kinsey, Kristin L.
Title: Aircraft noise abatement in the 1990's : a case study of methods utilized at Sacremento Metropolitan Airport, California
Pub. Info: 1994
Year: 1994
Physical Descr: 28 leaves : ill. ; 28 cm.
Notes: "A graduate research project presented to the College of Continuing Education in partial fulfillment of the requirements for the degree of Master of Aeronautical Science.
Notes: Includes bibliographical references.
Notes: PUBLICATION TYPE: Book
Series: ERAU graduate research project ; 1994-145
Series: CCE graduate research project
Language: eng
OCLC No: 31896249

Title: City of Ontario part 150 program
Edition: Video ed.
Pub. Info: Ontario (Calif.) : [The City], 1994
Year: 1994
Physical Descr: 1 videocassette (ca. 10 min.) : sd., col. ; 1/2 in.
Notes: VHS format.
Notes: Cover title: Ontario part 150 program.
Notes: Lists the program's goals and identifies recent progress.
Notes: PUBLICATION TYPE: Audiovisual
Other Author/Title: Ontario (Calif.) Ontario part 150 program.

Language: eng
OCLC No: 31893772

Title: Ciudad de Ontario el programa part 150
Edition: Video ed.
Pub. Info: Ontario (Calif.) : [The City], 1994
Year: 1994
Physical Descr: 1 videocassette (ca. 10 min.) : sd., col. ; 1/2 in.
Notes: VHS format.
Notes: In Spanish
Notes: Cover title: Ontario part 150 program
Notes: Spine title: Programa part 150 de Ontario
Notes: PUBLICATION TYPE: Audiovisual
Other Author/Title: Ontario (Calif.) Ontario part 150 program. Programa part 150 de Ontario.
Language: spa
OCLC No: 31893768

Title: Final environmental assessment : proposed commuter runway, Hartsfield Atlanta International Airport
Pub. Info: [Atlanta, GA] : City of Atlanta Department of Aviation :Federal Aviation Administration, 1994
Year: 1994
Physical Descr: 1 v. (various pagings) : ill., maps (some folded), tables; 28 cm.
Notes: "January 1994".
Notes: "This Environmental Assessment becomes a federal documentwhen evaluated and signed by the responsible FAA oficial."
Notes: Acronyms and abreviations -- 1.0 Purpose and need -- 2.0 Alternatives -- 3.0 Affected environment -- 4.0 Environmental consequences -- 5.0 List of preparers -- 6.0 Comments and coordination -- Bibliography -- Appendixes: A. Terms and methods for describing noise; B: Comparison of measured and modeled noise levels; C: Flight track data; D: Air quality emission data and calculations; E: Wildlife, plants and threatened and endangered species; F: Community facilities in the airport environs; G: Noise impacts by Census tract.
Notes: An environmental assessment prepared to provide a comprehensive evaluation of the potential consequences associated with a proposed commuter runway at the William B. Hartsfield Atlanta International Airport.
Notes: PUBLICATION TYPE: Book
Other Author/Title: CH2M Hill, Inc. United States. Federal Aviation Administration. Hawksley-Bell Associates, Inc. Harris Miller Miller & Hanson, Inc. Garrow & Associates, Inc. Duckett and Assocaites, Inc. B&E Jackson and Associates, Inc. Moreland Altobelli Associates, Inc. City of Atlanta Department of Aviation.
Language: eng
OCLC No: 31800432

Title: Expanded east coast plan : changes in aircraft flight patterns over the state of New Jersey : supplement to draft environmental impact statement
Pub. Info: Washington, DC : The Administration, 1994
Year: 1994
Physical Descr: 2 v. : ill., maps ; 28 cm.
Notes: Cover title: Supplement to draft environmental impact statement ; Expanded east coast plan : changes in aircraft flight patterns over the state of New Jersey.
Notes: [Vol. 1]: "Impact of the implementation of the Expanded east coast plan over the state of New Jersey" : p. [i].-- [Vol. 2]: "Appendix F, Noise levels by census block.
Notes: "Errata sheet" inserted.
Notes: Includes bibliographicalr references.
Notes: PUBLICATION TYPE: Book
Other Author/Title: United States. Federal Aviation Administration. Impact ofthe implementation of the Expanded east coast plan over the state of New Jersey. Supplement to draft environmental impact statement. Noise levels by census block. Changes in aircraft flight patterns over the state of New Jersey.

Language: eng
OCLC No: 31717015

Author: Sharp, Ben H.
Title: 25 years of airport sound insulation programs
Pub. Info: 1994
Year: 1994
Physical Descr: p. 641-648 : ill. ; 23 cm.
Notes: Includes bibliographical references (p. 646)
Notes: PUBLICATION TYPE: Book
Source: m2am National Conference on Noise Control Engineering (13th : 1994 : Fort Lauderdale, Fla.) Noise-Con 94. Poughkeepsie, NY : Noise Control Foundation, 1994. (OCoLC)30829555
Language: eng
OCLC No: 31706135

Author: Meara, Charles E.
Title: Testimony
Pub. Info: [New York, NY] : Port Authority of New York and New Jersey, 1994
Year: 1994
Physical Descr: 4 leaves ; 28 cm.
Notes: Cover title.
Notes: "October 14, 1994."
Notes: "City Council Transportation Committee Re: Res. #189, City Hall, New York."
Notes: PUBLICATION TYPE: Book
Other Author/Title: Port Authority of New York and New Jersey. New York (N.Y.) City Council.Committee on Transportation.
Language: eng
OCLC No: 31630706

Title: Geluidshinder rondom Schiphol : een vernieuwend bestuurskundig perspectief
Pub. Info: 's-Gravenhage : VUGA, 1991
Year: 1991

Physical Descr: 108 p. ; 22 cm.
Notes: "Geschreven in het kader van de toepassingsfase ... van de Nederlandse School voor Openbaar Bestuur"--P. 7.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Hoogeveen, J. P. Nederlandse School voor Openbaar Bestuur.
ISBN: 9052501548
Language: dut
OCLC No: 31510295

Author: Sutton, John W.
Title: Aviation noise: problems...solutions
Pub. Info: 1994
Year: 1994
Physical Descr: 23 leaves ; 28 cm.
Notes: "A graduate research project presented to the College of Continuing Education in partial fulfillment of the requirements for the degree of Master of Business Administration in Aviation.
Notes: Includes bibliographical references.
Notes: PUBLICATION TYPE: Book
Series: ERAU graduate research project ; 1994-94
Series: CCE graduate research project
Language: eng
OCLC No: 31415019

Title: 1993 school noise monitoring study : Minneapolis-St. Paul International Airport : MAC Aviation Noise Program.
Pub. Info: Minneapolis, Minn. : Metropolitan Airports Commission, 1994
Year: 1994
Physical Descr: 1 v. (various pagings) ; 28 cm.
Notes: Title from cover.
Notes: Includes bibliographical references.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Minneapolis-Saint Paul Metropolitan Airports Commission.
Language: eng

OCLC No: 31401189

Author: Simmons, Colin.
Title: Neighbourhood issues in the development of Manchester Airport, 1934-82
Pub. Info: 1994
Year: 1994
Physical Descr: p. [117]-143 : ill. ; 25 cm.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Caruana, Viv.
Source: nnas The Journal of transport history. Vol. 15, no. 2 (Sept. 1994) (OCoLC)1754849
Language: eng
OCLC No: 31296075

Title: Supplement to the draft environmental impact statement : impact of the implementation of the Expanded east coast plan over the state of New Jersey
Pub. Info: Washington, DC : The Administration, 1994
Year: 1994
Physical Descr: 2 v. : ill., maps ; 28 cm.
Notes: Cover title: Expanded east coast plan : changes in aircraft flight patterns over the state of New Jersey : supplement to draft environmental impact statement.
Notes: [Vol. 2]: Appendix F, Noise levels by census block.
Notes: "Errata sheet" inserted.
Notes: Includes bibliographicalr references.
Notes: PUBLICATION TYPE: Book
Other Author/Title: United States. Federal Aviation Administration. Impact of the implementation of the Expanded east coast plan over the state of New Jersey. Supplement to draft environmental impact statement. Expanded east coast plan.
Language: eng
OCLC No: 31271745

Title: MacGregor announces new night flying restrictions at Heathrow, Gatwick and Stanstead airports
Pub. Info: [London] : Dept. of Transport, 1993

Year: 1993
Physical Descr: [25] p. ; 30 cm.
Notes: Caption title.
Notes: "Date: 6 July 1994."
Notes: "Press notice no. 265."
Notes: Microfiche. Cambridge, UK : Chadwyck-Healey, Ltd., 1993.
1 microfiche : negative ; 11 x 15 cm. British official publications not published by HMSO ; 93.3809.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Great Britain. Dept. of Transport.
Language: eng
OCLC No: 31091075

Title: Night flights at Heathrow, Gatwick and Stansted airports proposals for revised restrictions a) for summer 1994 [and] b) winter 1994-95 to summer 1998 : consultation document
Pub. Info: [London] : Dept. of Transport, 1993
Year: 1993
Physical Descr: [15], 21 p. ; 30 cm.
Notes: Cover title.
Notes: "November 1993."
Notes: Microfiche. Cambridge, UK : Chadwyck-Healey, Ltd., 1993.
1 microfiche : negative ; 11 x 15 cm. British official publications not published by HMSO ; 93.4898.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Great Britain. Dept. of Transport.
Language: eng
OCLC No: 31091056

Author: Ausrotas, Raymond A.
Title: Impacts of technology on the capacity needs of the U.S. national airspace system

Pub. Info: [Washington, D.C.?] : National Aeronautics and Space Administration, Office of Management, Scientific and Technical Information Program, 1992
Year: 1992
Physical Descr: vii, 58 p. : ill., maps ; 28 cm.
Notes: Distributed to depository libraries in microfiche.
Notes: Shipping list no.: 93-0264-M.
Notes: Includes bibliographical references (p. 57).
Notes: Prepared for Langley Research Center.
Notes: Microfiche. [Washington, D.C.? : National Aeronautics and Space Administration, 1992] 1 microfiche : negative.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Simpson, Robert W. United States. National Aeronautics and Space Administration.Scientific and Technical Information Program.
Series: NASA contractor report ; 4470
Series: NASA contractor report ; NASA CR-4470.
Gov Pub No: 0830-H-14 (MF)
Govt Doc Number: NAS 1.26:4470
Language: eng
OCLC No: 31088501

Author: Woods, Robert V.
Title: San Antonio International : is a new airport needed?
Pub. Info: 1994
Year: 1994
Physical Descr: 52 leaves : ill. ; 28 cm.
Notes: "A graduate research project presented to the College of Continuing Education in partial fulfillment of the requirements for the degree of Master of Aeronautical Science.
Notes: Includes bibliographical references.
Notes: PUBLICATION TYPE: Book
Series: ERAU graduate research project ; 1994-57
Series: CCE graduate research project
Language: eng
OCLC No: 31073282

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Title: Syracuse Hancock International Airport : noise abatement program : relocation plan conceptual stage : Syracuse, New York.
Pub. Info: [Liverpool, NY] : Calocerinos & Spina, 1991
Year: 1991
Physical Descr: [7] p. ; 28 cm.
Notes: "Draft."
Notes: "November 1991."
Notes: Cover title.
Notes: PUBLICATION TYPE: Book
Language: eng
OCLC No: 31065810

Title: Runway Capacity to Serve the South East : Noise Sub Group report on the second stage assessments.
Pub. Info: [London] : Dept. of Transport, 1993
Year: 1993
Physical Descr: [127] p., [11] p. of folded plates : ill., maps.
Notes: Microfiche. Cambridge, UK : Chadwyck-Healey, Ltd., 1993. 2 microfiches : negative ; 11 x 15 cm. British official publications not published by HMSO ; 93.3811.
Notes: PUBLICATION TYPE: Book
Subject: Airport noise -- England.
Other Author/Title: Great Britain. Working Group on Runway Capacity to Serve the South East.Noise Sub Group. Great Britain. Dept. of
Transport.
Language: eng
OCLC No: 31058198

Title: Town of Islip part 150 noise study : noise compatibility program final report ; appendices C and D : Long Island MacArthur Airport, Ronkonkoma, New York.
Pub. Info: [Liverpool, NY] : Calocerinos & Spina, 1991
Year: 1991
Physical Descr: 1 v. (various pagings) : ill., folded maps ; 29 cm.
Notes: "September 1991."
Notes: Final report.

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Notes: PUBLICATION TYPE: Book
Other Author/Title: Calocerinos & Spina. Town of Islip part 150 noise study.
Language: eng
OCLC No: 31007209

Title: Town of Islip part 150 noise study : public information booklet : Long Island MacArthur Airport.
Pub. Info: Liverpool, NY : Calocerinos & Spina, 1991
Year: 1991
Physical Descr: 1 v. (various pagings) : ill., folded maps ; 29 cm.
Notes: "January 30, 1991."
Notes: "Draft."
Notes: PUBLICATION TYPE: Book
Other Author/Title: Calocerinos & Spina.
Language: eng
OCLC No: 30994374

Author: Great Britain.
Title: The Aeroplane Noise (Limitation on Operation of Aeroplanes) (Amendment) Regulations 1994
Pub. Info: [London : HMSO], 1994
Year: 1994
Physical Descr: 1 sheet ; 30 x 21 cm.
Notes: "Civil aviation."
Notes: "DET 7405."
Notes: PUBLICATION TYPE: Book
Other Author/Title: Great Britain. Laws, etc. (Statutory instruments) ; 1994, No. 1734 Great Britain. Dept. of Transport.
Series: Statutory Instruments ; 1994, No. 1734
ISBN: 0110447344
Language: eng
OCLC No: 30930174

Author: Chicago (Ill.). Dept. of Aviation.
Title: Striking a balance : the O'Hare International Airport Part 150 noise compatibility plan summary

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Pub. Info: Chicago, Ill. : The Department, 1994
Year: 1994
Physical Descr: 10 p. : ill. maps, ; 26 cm.
Notes: Title from cover.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Noise compatibility planning study. F.A.R. part 150 study. O'Hare International Airport.
Language: eng
OCLC No: 30905222

Author: Chicago (Ill.). Dept. of Aviation.
Title: Noise compatibility plan : executive summary
Pub. Info: Chicago, Ill. : The Department, 1994
Year: 1994
Physical Descr: 1 v. (various pagings) : ill., folded maps (some col.) ; 28 cm.
Notes: Title from cover.
Notes: At head of title: Chicago O'Hare International Airport Federal Aviation Regulation Part 150.
Notes: "July 1994"
Notes: PUBLICATION TYPE: Book
Other Author/Title: Landrum & Brown. O'Hare International Airport. F.A.R. part 150 study. Noise compatibility planning study.
Language: eng
OCLC No: 30905221

Author: Chicago (Ill.). Dept. of Aviation.
Title: Noise compatibility plan : Chicago O'Hare International Airport
Pub. Info: Chicago : The Department, 1994
Year: 1994
Physical Descr: 1 v. (various pagings) : ill., folded maps (some col.) ; 28 cm.
Notes: Title from cover.
Notes: At head of tilel: Chicago O'Hare International Airport Federal Aviation Regulation Part 150.
Notes: "July 1994" - cover.

Notes: "14 CFR 150"
Notes: PUBLICATION TYPE: Book
Other Author/Title: Landrum & Brown. F.A.R. part 150 study. O'Hare International Airport. Noise compatibility planning study.
Language: eng
OCLC No: 30905219

Title: Final environmental assessment for proposed development actions at Greater Rockford Airport
Pub. Info: Rockford, Ill. : Greater Rockford Airport, 1994
Year: 1994
Physical Descr: 1 v. (various pagings) : ill., maps ; 29 cm.
Notes: "This environmental assessment becomes a Federal document when evaluated and signed by the responsible FAA official." -- Cover.
Notes: Cover title: Draft environmental assessment for proposed development actions at Greater Rockford Airport, Rockford, Illinois.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Greater Rockford Airport Authority. Landrum & Brown. KEMRON Environmental Service. Skees Engineering. Draft environmental assessment for proposed development actions at Greater Rockford Airport, Rockford, Illinois. Proposed development actions at Greater Rockford Airport, Rockford, Illinois.
Language: eng
OCLC No: 30882937

Author: Levesque, Terrence J.
Title: Modelling the effects of airport noise on residential housing markets : a case study of Winnipeg International Airport
Pub. Info: 1994
Year: 1994
Physical Descr: p. 199-210 : ill. ; 25 cm.
Notes: Includes bibliographical references (p. 210)

Notes: PUBLICATION TYPE: Book
Source: nnas Journal of transport economics and policy. Vol. 28, no. 2 (May 1994) (OCoLC)856156
Language: eng
OCLC No: 30864704

Author: Garver, Peter G.
Title: Impact of aircraft noise
Pub. Info: 1994
Year: 1994
Physical Descr: ii, 64 leaves : ill. ; 28 cm.
Notes: "A graduate research project presented to the College of Continuing Education in partial fulfillment of the requirements for the degree of Master of Business Administration in Avialton.
Notes: Includes bibliographical references.
Notes: PUBLICATION TYPE: Book
Series: ERAU graduate research project ; 1994-10
Series: CCE graduate research project
Language: eng
OCLC No: 30856291

Author: Jenkins, John J.
Title: The Airport Noise and Capacity Act of 1990 : has Congress finally solved the aircraft noise problem?
Pub. Info: 1994
Year: 1994
Physical Descr: p. 1023-1055 ; 23 cm.
Notes: PUBLICATION TYPE: Book
Source: nnas Journal of air law and commerce. Vol. 59, no. 4 (May-June 1994) (OCoLC)1641887
Language: eng
OCLC No: 30798273

Title: Airport land use planning handbook
Pub. Info: [Berkeley, Calif.] : The Commission, 1993

Year: 1993
Physical Descr: 1 v. (various pagings) : ill., charts ; 28 cm.
Notes: "September 1993."
Notes: "Draft."
Notes: PUBLICATION TYPE: Book
Other Author/Title: California. Division of Aeronautics.
Language: eng
OCLC No: 30756409

Title: Dossier, environnement = environmental issues.
Pub. Info: Paris : Institut du transport aerien, 1992
Year: 1992
Physical Descr: VI, 66 p. : ill. ; 27 cm.
Notes: Parallel text in French and English.
Notes: Les nuisances sonores engendrees par le traffic aerien = Noise annoyance caused by air traffic / Michel Vallet -- Les nuisances sonores engendrees par les trains a grande vitesse = Noise annoyance caused by high-speed trains / Jacques Lambert -- Lattitude des aeroports face a la problematique de lenvironnement = How airports are coping with environmental problems / Hans Peter Staffelbach.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Vallet, Michel. Lambert, Jacques. Staffelbach, Hans. Institut du transport aerien.
Series: ITA etudes & documents = ITA studies & reports ; no. 92/2
Series: ITA etudes & documents ; no. 92/2.
Language: fre
OCLC No: 30752130

Author: Tsouka, Despina G.
Title: Noise prediction at new Athens Airport 'eleftherios Venezelos' by application of the integrated noise model, based on meteorologicla effects
Pub. Info: 1993
Year: 1993
Physical Descr: p. 161-164 : ill. ; 22 cm.

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Notes: Includes bibliographical references (p. 164)
Notes: PUBLICATION TYPE: Book
Other Author/Title: Meteorology in aeronautics.
Source: m2am International Conference on Noise Control Engineering (1993 : Leuven, Belgium). Inter-noise 93 : people versus noise. Poughkeepsie, N.Y. : Noise Control Foundation, 1993. Vol. 1. (OCoLC)29787828
Language: eng
OCLC No: 30699221

Author: Ploeg, F. D. van der.
Title: Recent developments with respect to aircraft noise and sleep disturbance
Pub. Info: 1993
Year: 1993
Physical Descr: p. 155-160 : ill. ; 22 cm.
Notes: Includes bibliographical references (p. 159-160)
Notes: PUBLICATION TYPE: Book
Other Author/Title: Schuller, W. M.
Source: m2am International Conference on Noise Control Engineering (1993 : Leuven, Belgium). Inter-noise 93 : people versus noise. Poughkeepsie, N.Y. : Noise Control Foundation, 1993. Vol. 1. (OCoLC)29787828
Language: eng
OCLC No: 30699213

Author: Looten, A.
Title: Fundamental inadequacies of standard noise measurements around airports to assess the annoyance to the communities
Pub. Info: 1993
Year: 1993
Physical Descr: p. 125-130 : ill. ; 22 cm.
Notes: Includes bibliographical references (p. 130)
Notes: PUBLICATION TYPE: Book
Source: m2am International Conference on Noise Control Engineering (1993 : Leuven, Belgium). Inter-noise 93 :

people versus noise. Poughkeepsie, N.Y. : Noise Control Foundation, 1993. Vol. 1. (OCoLC)29787828
Language: eng
OCLC No: 30699200

Author: Dickinson, Philip J.
Title: The making of an airport noise management standard
Pub. Info: 1993
Year: 1993
Physical Descr: p. 113-118 ; 22 cm.
Notes: Includes bibliographical references (p. 118)
Notes: PUBLICATION TYPE: Book
Source: m2am International Conference on Noise Control Engineering (1993 : Leuven, Belgium). Inter-noise 93 : people versus noise. Poughkeepsie, N.Y. : Noise Control Foundation, 1993. Vol. 1. (OCoLC)29787828
Language: eng
OCLC No: 30699184

Title: A guide to airport noise.
Pub. Info: [Phoenix, Ariz.] : Arizona Dept. of Transportation, Aeronautics Division, 1994
Year: 1994
Physical Descr: 1 folded sheet (6 p.) : ill. ; 22 x 10 cm.
Notes: Prepared by Barnard Dunkelberg & Company, Mestre Greve Associates.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Arizona. Aeronautics Division. Barnard Dunkelberg & Company. Mestre Greve Associates.
Govt Doc Number: TRT 3.8:G 84
Language: eng
OCLC No: 30652004

Author: Bragdon, Clifford R.
Title: Strategic planning for aircraft noise route impact analysis, a three dimensional approach

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Pub. Info: [Washington, DC] :[Springfield, Va. : National Aeronautics and Space Administration ;National Technical Information Service, distributor, 1993
Year: 1993
Physical Descr: 1 v.
Notes: Distributed to depository libraries in microfiche.
Notes: Shipping list no.: 94-0081-M.
Notes: Microfiche. [Washington, D.C. : National Aeronautics and Space Administration, 1993] 3 microfiches.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Rowan, M. J. Abuju, K. K. United States. National Aeronautics and Space Administration.
Series: NASA contractor report ; 191484
Series: NASA contractor report ; NASA CR-191484.
Gov Pub No: 0830-H-14 (MF)
Govt Doc Number: NAS 1.26:191484
Language: eng
OCLC No: 30535446

Author: Bragdon, Clifford R.
Title: Strategic planning for aircraft noise route impact analysis a three dimensional approach
Pub. Info: Atlanta, Ga. : Georgia Tech Research Institute, Georgia Institute of Technology, 1993
Year: 1993
Physical Descr: viii, 249 p. : ill. ; 28 cm.
Notes: Cover title.
Notes: Prepared for Langley Research Center, National Aeronautics and Space Administration.
Notes: "September 1993."
Notes: Includes bibliographical references (p. 245-249)
Notes: Microfiche. Springfield, Va. : National Technical Information Service, 1993. 3 microfiches : negative ; 11 x 15 cm.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Rowan, M. J. Ahuja, K. K. United States. National Aeronautics and Space Administration. Langley Research Center. Georgia Tech Research Institute.

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Series: NASA CR ; 191484
Series: NASA contrator report ; 191484.
Govt Doc Number: NAS 1.26:191484
Language: eng
OCLC No: 30332645

Title: Palm Springs Regional Airport, Palm Springs, California : F.A.R. part 150 noise compatibility study.
Pub. Info: Kansas City : Coffman Associates, 1994
Year: 1994
Physical Descr: 2 v. (various pagings) : ill. maps (some folded) ; 28 cm.
Notes: Prepared for the City of Palm Springs.
Notes: The study was conducted by the airport consulting firm of Coffman Associates, Inc., January 1994.
Notes: [v.1] F.A.R. part 150 noise compatibility study -- [v.2] F.A.R. part 150 noise compatibility study. Noise exposure maps.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Coffman Associates. FAR part 150 noise compatibility study. Noise compatibility study.
Language: eng
OCLC No: 30095892

Title: Kansai's offshore location addresses noise issue and facilitates round-the-clock operations.
Pub. Info: 1994
Year: 1994
Physical Descr: p. 13-14 : col. ill. ; 28 cm.
Notes: PUBLICATION TYPE: Book
Source: nnas ICAO Journal. Vol. 49, no. 1 (Jan.-Feb. 1994) (OCoLC)21967611
Language: eng
OCLC No: 30058223

Author: Edward K. Noda and Associates.
Title: Dillingham Airfield master plan and noise compatibility

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program
Pub. Info: [Honolulu : The Associates, 1993
Year: 1993
Physical Descr: 2 v. : ill., maps (some folded) ; 28 cm.
Notes: "State project no. AO2011-01."
Notes: "August 1993."
Notes: Includes bibliographies.
Notes: v.1. Master plan -- [v.2.] Executive summary.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Hawaii. Airports Division. Aries Consultants Ltd.
Language: eng
OCLC No: 30002902

Author: Fleming, Gregg G.
Title: HNM, Heliport noise model : version 2.2 user's guide
Pub. Info: Washington, DC :Springfield, VA : U.S. Dept. of Transportation, Federal Aviation Administration, Office of Environment and Energy ;Available through the National Technical Information Service, 1994
Year: 1994
Physical Descr: 94 p. in various pagings : ill. ; 28 cm.
Notes: Cover title.
Notes: "February 1994."
Notes: "DOT/FAA/EE/94/01."
Notes: "DOT-VNTSC-FAA-94-3."
Notes: Includes bibliographical references (p. 6-1/6-2)
Notes: Performed by the Volpe National Transportation Systems Center under funding no.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Rickley, Edward J. United States. Federal Aviation
Administration.Office of Environment and Energy. John A. Volpe National Transportation Systems Center (U.S.)
Govt Doc Number: TD 4.32/8:94/01
Tech Report No: DOT/FAA/EE/94/01DOT-VNTSC-FAA-94-3
Language: eng
OCLC No: 29971123

Author: United States. Federal Aviation Administration.
Title: ... progress report on the transition to quieter airplanes : report to Congress : report of the Secretary of Transportation to the United States Congress pursuant to Section 9308(g) of the Airport Noise and Capacity Act of 1990 (P.L. 101-508)
Pub. Info: Washington, D.C. : The Dept., The Administration, 1993 9999
Year: 1993
Physical Descr: v. ; 28 cm.
Frequency: Annual
Issues Pub: 1st report 1992 (August 1993)
Notes: Cover title.
Notes: PUBLICATION TYPE: Serial
Language: eng
OCLC No: 29933012

Author: Timmerman, Nancy S.
Title: Features of Massport's new noise monitoring system
Pub. Info: 1993
Year: 1993
Physical Descr: p. 425-428 ; 23 cm.
Notes: PUBLICATION TYPE: Book
Source: m2am National Conference on Noise Control Engineering (12th : 1993 : Williamsburg, Va.). Noise-Con 93 proceedings. Poughkeepsie, NY : Noise Control Foundation, 1993. (OCoLC)28590256
Language: eng
OCLC No: 29780424

Author: Merck, Harold L.
Title: Architectural glazing for sound attenuation at an airport hotel
Pub. Info: 1993
Year: 1993
Physical Descr: p. 333-338 : ill. ; 23 cm.

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Notes: PUBLICATION TYPE: Book
Source: m2am National Conference on Noise Control Engineering (12th : 1993 : Williamsburg, Va.). Noise-Con 93 proceedings. Poughkeepsie, NY : Noise Control Foundation, 1993. (OCoLC)28590256
Language: eng
OCLC No: 29780417

Author: Haboly, Edward F.
Title: Aircraft noise at a West Coast airport in the next century
Pub. Info: 1993
Year: 1993
Physical Descr: p. 85-90 ; 23 cm.
Notes: Includes bibliographical references (p. 90)
Notes: PUBLICATION TYPE: Book
Source: m2am National Conference on Noise Control Engineering (12th : 1993 : Williamsburg, Va.). Noise-Con 93 proceedings. Poughkeepsie, NY : Noise Control Foundation, 1993. (OCoLC)28590256
Language: eng
OCLC No: 29780413

Author: Rambalakos, Andreas J.
Title: Noise attenuaiton of a high speed civil transport with the use of high lift devices and reduced thrust setting at take-off
Pub. Info: 1993
Year: 1993
Physical Descr: x, 59 leaves : ill. ; 28 cm.
Notes: "A graduate research project submitted to the Department of Aerospace Engineering in partial fulfillment of the requirements of the degree of Master of Aerospace Engineering."
Notes: Includes bibliographical references.

Notes: PUBLICATION TYPE: Book
Series: ERAU graduate research project ; 1993-218
Language: eng
OCLC No: 29778697

Author: Gillen, David W.
Title: A socio-economic assessment of complaints about airport noise
Pub. Info: 1994
Year: 1994
Physical Descr: p. 45-55 : ill. ; 25 cm.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Levesque, Terrence J.
Source: nnas Transportation planning and technology. Vol. 18, no. 1 (1994) (OCoLC)1767712
Language: eng
OCLC No: 29759389

Title: F.A.R. Part 150 noise compatibility study : prepared for the Columbus Municipal Airport Authority
Pub. Info: [Columbus, Ohio] : Port Columbus International Airport, 1991 1993
Year: 1991
Physical Descr: 3 v. : ill., maps ; 28 cm.
Notes: "November 1991" on vol. 1; "October 1993" on vol. 2 and vol. 3.
Notes: Vol. 1. Noise exposure maps documentation, supporting information on project coordination and local consultation -- vol. 2. noise compatibility program update, supporting information on project coordination and local consultation -- vol. 3. Noise compatibility program update, public hearing information.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Coffman Associates. Noise compatibility program update.
Language: eng

OCLC No: 29757044

Title: F.A.R. Part 150 noise exposure maps and noise compatibility program update : prepared for the Columbus Municipal Airport Authority
Pub. Info: [Columbus, Ohio] : Port Columbus International Airport, 1993
Year: 1993
Physical Descr: 1 v. (various pagings) : ill., maps (some col.) ; 28 cm.
Notes: "October, 1993"
Notes: Cover title: Noise compatibility program.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Coffman Associates. Noise compatibility program.
Language: eng
OCLC No: 29757038

==

OCLC Search 2:
Subject Heading : transportation noise
Year : 1995 or 1994 or 1993 or 1992 or 1991

==

Author: Knoflacher, Hermann.
Title: Zur Harmonie von Stadt und Verkehr : Freiheit vom Zwang zum Autofahren
Pub. Info: Wien : Bohlau, 1993
Year: 1993
Physical Descr: 216 p. : ill., maps ; 24 cm.
Notes: Includes bibliographical references (p. 209-212).
Notes: PUBLICATION TYPE: Book
Series: Kulturstudien. Sonderband ; 16
ISBN: 3205054458
Language: ger
OCLC No: 32854549

Title: Potential impacts of advanced aerodynamic technology on air transportation system productivity

Pub. Info: [Washington, DC] :[Springfield, Va. : National Aeronautics and Space Administration ;National Technical Information Service, distributor, 1994
Year: 1994
Physical Descr: 1 v.
Notes: Distributed to depository libraries in microfiche.
Notes: Shipping list no.: 95-0053-M.
Notes: Microfiche. [Washington, D.C. : National Aeronautics and Space Administration, 1994] 3 microfiches.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Bushnell, Dennis M. United States. National Aeronautics and Space Administration.
Series: NASA technical memorandum ; 109154
Gov Pub No: 0830-D (MF)
Govt Doc Number: NAS 1.15:109154
Language: eng
OCLC No: 32246865

Title: Massnahmen und Losungswege gegen Abgase und Verkehrslarm
Pub. Info: Magdeburg : Das Ministerium fur Umwelt und Naturschutz, Referat Offentlichkeitsarbeit, 1993
Year: 1993
Physical Descr: 37, [1] p. : ill. ; 30 cm.
Notes: Includes bibliographical references (p. 38).
Notes: PUBLICATION TYPE: Book
Other Author/Title: Saxony-Anhalt (Germany). Ministerium fur Umwelt und Naturschutz.
Series: Umwelt und Verkehr
Language: ger
OCLC No: 32049639

Author: Clairbois, Jean-Pierre.
Title: Noise separation in a multisource environment (road, rail and air traffic) : the Villeneuve St. Georges survey
Pub. Info: 1993
Year: 1993
Physical Descr: p. 593-598 : ill. ; 22 cm.

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Notes: PUBLICATION TYPE: Book
Other Author/Title: Tisseyre, Alain.
Source: m2am International Conference on Noise Control Engineering (1993 : Leuven, Belgium). Inter-noise 93 : people versus noise. Poughkeepsie, N.Y. : Noise Control Foundation, 1993. Vol. 1. (OCoLC)29787828
Language: eng
OCLC No: 30699340

Author: Wyse, W. J.
Title: Transport noise pollution
Pub. Info: 1994
Year: 1994
Physical Descr: p. 65-69 : ill. (some col.) ; 30 cm.
Notes: PUBLICATION TYPE: Book
Source: nnas Light rail and modern tramway. Vol. 57, no. 675 (Mar. 1994) (OCoLC)26890269
Language: eng
OCLC No: 30321678

Title: Environmental analysis, air quality, noise, energy, and alternative fuels
Pub. Info: Washington, D.C. : National Academy Press, 1993
Year: 1993
Physical Descr: v, 130 p. : ill. ; 28 cm.
Notes: Includes bibliographical references.
Notes: PUBLICATION TYPE: Book
Other Author/Title: National Research Council (U.S.). Transportation Research Board.
Series: Transportation research record, 0361-1981 ; no. 1416
Series: Transportation research record ; 1416.
ISBN: 0309055636
Language: eng
OCLC No: 30130193

313

Author: Khairani bt. Hj. Alladin.
Title: Pengangkutan darat : kesannya terhadap alam sekitar : kajian kes di Kuala Lumpur Edition: Cet. 1.
Pub. Info: Kuala Lumpur : Dewan Bahasa dan Pustaka, Kementerian Pendidikan, Malaysia, 1993
Year: 1993
Physical Descr: xvii, 190 p. : ill. (some col.), maps ; 22 cm.
Notes: In Malay.
Notes: Includes bibliographical references (p. 181-186) and index.
Notes: Environmental impact of urban transportation system in Kuala Lumpur; study report.
Notes: PUBLICATION TYPE: Book
ISBN: 9836237321 :
Language: may
OCLC No: 30082372

Author: Ashaari, Y.
Title: Prediction and mitigation of traffic noise using ENM
Pub. Info: 1992
Year: 1992
Physical Descr: p. 71-87 : ill. ; 25 cm.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Bullen, R. B. (Robert B.)
Source: c2am Australian Road Research Board. Conference (16th :1992 : Perth, W.A.). Proceedings. Vol. 6. Vermont South, Vic. : Australian Road Research Board, 1992. (OCoLC)29865275
Language: eng
OCLC No: 29914870

Author: Kageson, Per, 1947-
Title: Getting the prices right : a European scheme for making transport pay its true costs
Pub. Info: Stockholm : European Federation for Transport and

Environment, 1993
Year: 1993
Physical Descr: 1 v. (various pagings) ; 25 cm.
Notes: "May 1993."
Notes: "T&E 93/6."
Notes: Includes bibliographical references.
Notes: PUBLICATION TYPE: Book
ISBN: 9155877214
Language: eng
OCLC No: 29696634

Author: Mason, Keith D.
Title: The UK Environmental Foresight Project
Pub. Info: London : H.M.S.O., 1993
Year; 1993
Physical Descr: 3 v. : ill. ; 30 cm.
Notes: Prepared by the Centre for Exploitation of Science and
Technology for the UK Environmental Foresight Project.
Notes: v. 2. Road transport and the environment : the future agenda in the UK : air pollution -- v. 3. The Future road transport noise agenda in the UK.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Centre for Exploitation of Science and Technology. UK
Environmental Foresight Project. Road transport and the
environment. The Future road transport noise agenda in the UK.
ISBN: 0117528838 (v.1) :0117528412 (v.2) :0117528846 (v.3) :
Language: eng
OCLC No: 29669504

Author: Ahn, Hoon M.
Title: The heart rate responses of dairy cows to two types of

disturbances - transportation and aircraft noises
Pub. Info: 1992
Year: 1992
Physical Descr: vii, 45 leaves : ill. ; 28 cm.
Notes: Includes bibliographical references (l. 37-39).
Notes: Thesis (M.S.) -- Utah State University. Dept. of Animal,
Dairy and Veterinary Sciences, 1992.
Notes: PUBLICATION TYPE: Book
Language: eng
OCLC No: 29540688

Author: Balachandran, Chetlur G.
Title: Traffic and transit noise challenges in the nineties
Pub. Info: 1992
Year: 1992
Physical Descr: p. 845-848 : ill. ; 23 cm.
Notes: Includes bibliographical references (p. 848)
Notes: PUBLICATION TYPE: Book
Source: m2am International Conference on Noise Control Engineering (1992 : Toronto, Ont.) Inter-noise 92. Vol. 2. New York : Noise Control Foundation, c1992. (OCoLC)27694389
Language: eng
OCLC No: 28205122

Author: Anderson, Grant S.
Title: Aircraft overflight study effect of aircraft altitude upon sound levels at the ground
Pub. Info: [Lakewood, CO] : National Park Service, 1992
Year: 1992
Physical Descr: xiv, 63 p. : ill. ; 28 cm.
Notes: Performing organization: Harris, Miller, Miller & Hanson,
Inc.

Notes: "March 1992."
Notes: "NPOA report no. 91-4."
Notes: Includes bibliographical references (p. 59-63).
Notes: Microfiche. Springfield, Va. : National Technical Information Service, 1993. 1 microfiche : negative ; 11 x 15 cm.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Horonjeff, Richard D. United States. National Park Service. Harris, Miller, Miller & Hanson, Inc. Effect of aircraft altitude upon sound levels at the ground.
Language: eng
OCLC No: 28168481

Title: Report to Congress, New York and Connecticut aircraft noise mitigation review.
Pub. Info: Washington, D.C. : The Administration, 1992
Year: 1992
Physical Descr: 53 p. : ill., maps ; 28 cm.
Notes: Transmittal letter by Thomas C. Richards, Adminstrator.
Notes: PUBLICATION TYPE: Book
Other Author/Title: United States. Dept. of Transportation. United States. Federal Aviation Admistration. New York and Connecticut aircraft noise mitigation review.
Language: eng
OCLC No: 27502021

Title: Transportation and the environment : an annotated bibliography
Pub. Info: [Washington, D.C.] : Federal Railroad Administration, Office of Policy, 1992
Year: 1992
Physical Descr: 52 p. ; 28 cm.
Notes: Cover title.
Notes: "December 1992."
Notes: PUBLICATION TYPE: Book

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Other Author/Title: United States. Federal Railroad Administration.Office of Policy.
Language: eng
OCLC No: 27160936

Author: Banoo, Shahana.
Title: Analysis of Federal Aviation Administration's integrated noise model deterministic noise predictions
Pub. Info: 1992
Year: 1992
Physical Descr: vi, 167 leaves : ill. ; 28 cm.
Notes: Typescript.
Notes: "A thesis [submitted] as partial fulfillment of the requirements of the Master of Science degree in Civil Engineering."
Notes: Bibliography: leaves 131-133.
Notes: Thesis (M.S.)--University of Toledo.
Notes: PUBLICATION TYPE: Book
Language: eng
OCLC No: 26442747

Author: Hygge, Staffan.
Title: Noise from aircraft, road traffic and railways : the effects on long-term learning in children aged 12-14 years
Pub. Info: 1991
Year: 1991
Physical Descr: p. 843-846 : charts ; 22 cm.
Notes: Includes bibliographical references (p. 846)
Notes: PUBLICATION TYPE: Book
Source: m2am International Conference on Noise Control Engineering (1991 : Sydney, N.S.W.). Inter-noise 91. Vol. 2 Sydney, Australia : Australian Acoustical Society ; Poughkeepsie, NY, USA : Noise Control Foundation, [1991?] (OCoLC)25414949
Language: eng

OCLC No: 26337785

Author: Job, R. F. S.
Title: Internal consistency and stability of measurements of community reaction to noise
Pub. Info: 1991
Year: 1991
Physical Descr: p. 101-108 : ill. ; 28 cm.
Notes: Includes bibliographical references (p. 107-108)
Notes: PUBLICATION TYPE: Book
Source: nnas Transportation research record. No. 1312 (1991) (OCoLC)1259379
Language: eng
OCLC No: 26185227

Author: Griffiths, Ian D.
Title: Les changements dans l'exposition au bruit de circulation
Pub. Info: 1991
Year: 1991
Physical Descr: p. 15-18 ; 30 cm.
Notes: Includes bibliographical references (p. 18)
Notes: PUBLICATION TYPE: Book
Other Author/Title: Raw, Gary J.
Other Title: Traffic noise and annoyance level. eng
Source: nnas Recherche-transports-securite. No 32 (dec. 1991) (OCoLC)10557190
Language: fre
OCLC No: 25567078

Author: Organisation for Economic Co-operation and Development.
Title: Fighting noise in the 1990s
Pub. Info: Paris : OECD, 1991
Year: 1991

213

Physical Descr: 120 p. : ill. ; 23 cm.
Notes: "The drafting of this report has been overseen by National Experts on noise from Member countries, assisted by Messrs Ariel Alexandre and Jean-Philippe Barde from the OECD Secretariat."-- p. 3.
Notes: Microfiche. Paris : OECD, 1991. 2 microfiches ; 11 x 15 cm.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Alexandre, Ariel. Barde, Jean-Phillippe.
Language: eng
OCLC No: 23916896

Author: Great Britain. Dept. of Transport.
Title: Railway noise and the insulation of dwellings : the report of the committee formed to recommend to the Secretary of State for Transport a national noise insulation standard for new railway lines
Pub. Info: London : H.M.S.O., 1991
Year: 1991
Physical Descr: 57 p. : ill. ; 30 cm.
Notes: Chairman : C.G.B. Mitchell.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Mitchell, C. G. B.
ISBN: 0115510125 (pbk.)
Language: eng
OCLC No: 23724656

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OCLC Search 3:
Subject Heading : transportation noise
Year : 1995 or 1994 or 1993 or 1992 or 1991

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Author: Knoflacher, Hermann.
Title: Zur Harmonie von Stadt und Verkehr : Freiheit vom Zwang zum Autofahren
Pub. Info: Wien : Bohlau, 1993
Year: 1993

Physical Descr: 216 p. : ill., maps ; 24 cm.
Notes: Includes bibliographical references (p. 209-212).
Notes: PUBLICATION TYPE: Book
Series: Kulturstudien. Sonderband ; 16
ISBN: 3205054458
Language: ger
OCLC No: 32854549

Title: Potential impacts of advanced aerodynamic technology on air transportation system productivity
Pub. Info: [Washington, DC] :[Springfield, Va. : National Aeronautics and Space Administration ;National Technical Information Service, distributor, 1994
Year: 1994
Physical Descr: 1 v.
Notes: Distributed to depository libraries in microfiche.
Notes: Shipping list no.: 95-0053-M.
Notes: Microfiche. [Washington, D.C. : National Aeronautics and Space Administration, 1994] 3 microfiches.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Bushnell, Dennis M. United States. National Aeronautics and Space Administration.
Series: NASA technical memorandum ; 109154
Gov Pub No: 0830-D (MF)
Govt Doc Number: NAS 1.15:109154
Language: eng
OCLC No: 32246865

Title: Massnahmen und Losungswege gegen Abgase und Verkehrslarm
Pub. Info: Magdeburg : Das Ministerium fur Umwelt und Naturschutz, Referat Offentlichkeitsarbeit, 1993
Year: 1993
Physical Descr: 37, [1] p. : ill. ; 30 cm.
Notes: Includes bibliographical references (p. 38).
Notes: PUBLICATION TYPE: Book

Other Author/Title: Saxony-Anhalt (Germany). Ministerium fur Umwelt und Naturschutz.
Series: Umwelt und Verkehr
Language: ger
OCLC No: 32049639

Author: Clairbois, Jean-Pierre.
Title: Noise separation in a multisource environment (road, rail and air traffic) : the Villeneuve St. Georges survey
Pub. Info: 1993
Year: 1993
Physical Descr: p. 593-598 : ill. ; 22 cm.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Tisseyre, Alain.
Source: m2am International Conference on Noise Control Engineering (1993 : Leuven, Belgium). Inter-noise 93 : people versus noise. Poughkeepsie, N.Y. : Noise Control Foundation, 1993. Vol. 1. (OCoLC)29787828
Language: eng
OCLC No: 30699340

Author: Wyse, W. J.
Title: Transport noise pollution
Pub. Info: 1994
Year: 1994
Physical Descr: p. 65-69 : ill. (some col.) ; 30 cm.
Notes: PUBLICATION TYPE: Book
Source: nnas Light rail and modern tramway. Vol. 57, no. 675 (Mar. 1994) (OCoLC)26890269
Language: eng
OCLC No: 30321678

Title: Environmental analysis, air quality, noise, energy, and alternative fuels
Pub. Info: Washington, D.C. : National Academy Press, 1993

Year: 1993
Physical Descr: v, 130 p. : ill. ; 28 cm.
Notes: Includes bibliographical references.
Notes: PUBLICATION TYPE: Book
Other Author/Title: National Research Council (U.S.). Transportation Research Board.
Series: Transportation research record, 0361-1981 ; no. 1416
Series: Transportation research record ; 1416.
ISBN: 0309055636
Language: eng
OCLC No: 30130193

Author: Khairani bt. Hj. Alladin.
Title: Pengangkutan darat : kesannya terhadap alam sekitar : kajian kes di Kuala Lumpur
Edition: Cet. 1.
Pub. Info: Kuala Lumpur : Dewan Bahasa dan Pustaka, Kementerian Pendidikan, Malaysia, 1993
Year: 1993
Physical Descr: xvii, 190 p. : ill. (some col.), maps ; 22 cm.
Notes: In Malay.
Notes: Includes bibliographical references (p. 181-186) and index.
Notes: Environmental impact of urban transportation system in Kuala Lumpur; study report.
Notes: PUBLICATION TYPE: Book
ISBN: 9836237321 :
Language: may
OCLC No: 30082372

Author: Ashaari, Y.
Title: Prediction and mitigation of traffic noise using ENM
Pub. Info: 1992
Year: 1992
Physical Descr: p. 71-87 : ill. ; 25 cm.
Notes: PUBLICATION TYPE: Book

Other Author/Title: Bullen, R. B. (Robert B.)
Source: c2am Australian Road Research Board. Conference (16th :1992 : Perth, W.A.). Proceedings. Vol. 6. Vermont South, Vic. : Australian Road Research Board, 1992. (OCoLC)29865275
Language: eng
OCLC No: 29914870

Author: Kageson, Per, 1947-
Title: Getting the prices right : a European scheme for making transport pay its true costs
Pub. Info: Stockholm : European Federation for Transport and Environment, 1993
Year: 1993
Physical Descr: 1 v. (various pagings) ; 25 cm.
Notes: "May 1993."
Notes: "T&E 93/6."
Notes: Includes bibliographical references.
Notes: PUBLICATION TYPE: Book
ISBN: 9155877214
Language: eng
OCLC No: 29696634

Author: Mason, Keith D.
Title: The UK Environmental Foresight Project
Pub. Info: London : H.M.S.O., 1993
Year: 1993
Physical Descr: 3 v. : ill. ; 30 cm.
Notes: Prepared by the Centre for Exploitation of Science and Technology for the UK Environmental Foresight Project.
Notes: v. 2. Road transport and the environment : the future agenda in the UK : air pollution -- v. 3. The Future road transport noise agenda in the UK.
Notes: PUBLICATION TYPE: Book

Other Author/Title: Centre for Exploitation of Science and Technology. UKEnvironmental Foresight Project. Road transport and the environment. The Future road transport noise agenda in the UK.
ISBN: 0117528838 (v.1) :0117528412 (v.2) :0117528846 (v.3) :
Language: eng
OCLC No: 29669504

Author: Ahn, Hoon M.
Title: The heart rate responses of dairy cows to two types of disturbances - transportation and aircraft noises
Pub. Info: 1992
Year: 1992
Physical Descr: vii, 45 leaves : ill. ; 28 cm.
Notes: Includes bibliographical references (l. 37-39).
Notes: Thesis (M.S.) -- Utah State University. Dept. of Animal, Dairy and Veterinary Sciences, 1992.
Notes: PUBLICATION TYPE: Book
Language: eng
OCLC No: 29540688

Author: Balachandran, Chetlur G.
Title: Traffic and transit noise challenges in the nineties
Pub. Info: 1992
Year: 1992
Physical Descr: p. 845-848 : ill. ; 23 cm.
Notes: Includes bibliographical references (p. 848)
Notes: PUBLICATION TYPE: Book
Source: m2am International Conference on Noise Control Engineering (1992 : Toronto, Ont.) Inter-noise 92. Vol. 2. New York : Noise Control Foundation, c1992. (OCoLC)27694389
Language: eng
OCLC No: 28205122

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Author: Anderson, Grant S.
Title: Aircraft overflight study effect of aircraft altitude upon sound levels at the ground
Pub. Info: [Lakewood, CO] : National Park Service, 1992
Year: 1992
Physical Descr: xiv, 63 p. : ill. ; 28 cm.
Notes: Performing organization: Harris, Miller, Miller & Hanson, Inc.
Notes: "March 1992."
Notes: "NPOA report no. 91-4."
Notes: Includes bibliographical references (p. 59-63).
Notes: Microfiche. Springfield, Va. : National Technical Information Service, 1993. 1 microfiche : negative ; 11 x 15 cm.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Horonjeff, Richard D. United States. National Park Service. Harris, Miller, Miller & Hanson, Inc. Effect of aircraft altitude upon sound levels at the ground.
Language: eng
OCLC No: 28168481

Title: Report to Congress, New York and Connecticut aircraft noise mitigation review.
Pub. Info: Washington, D.C. : The Administration, 1992
Year: 1992
Physical Descr: 53 p. : ill., maps ; 28 cm.
Notes: Transmittal letter by Thomas C. Richards, Adminstrator.
Notes: PUBLICATION TYPE: Book
Other Author/Title: United States. Dept. of Transportation. United States. Federal Aviation Admistration. New York and Connecticut aircraft noise mitigation review.
Language: eng
OCLC No: 27502021

Title: Transportation and the environment : an annotated bibliography
Pub. Info: [Washington, D.C.] : Federal Railroad Administration, Office of Policy, 1992
Year: 1992
Physical Descr: 52 p. ; 28 cm.
Notes: Cover title.
Notes: "December 1992."
Notes: PUBLICATION TYPE: Book
Other Author/Title: United States. Federal Railroad Administration.Office of Policy.
Language: eng
OCLC No: 27160936

Author: Banoo, Shahana.
Title: Analysis of Federal Aviation Administration's integrated noise model deterministic noise predictions
Pub. Info: 1992
Year: 1992
Physical Descr: vi, 167 leaves : ill. ; 28 cm.
Notes: Typescript.
Notes: "A thesis [submitted] as partial fulfillment of the requirements of the Master of Science degree in Civil Engineering."
Notes: Bibliography: leaves 131-133.
Notes: Thesis (M.S.)--University of Toledo.
Notes: PUBLICATION TYPE: Book
Language: eng
OCLC No: 26442747

Author: Hygge, Staffan.
Title: Noise from aircraft, road traffic and railways : the effects on long-term learning in children aged 12-14 years
Pub. Info: 1991

Year: 1991
Physical Descr: p. 843-846 : charts ; 22 cm.
Notes: Includes bibliographical references (p. 846)
Notes: PUBLICATION TYPE: Book
Source: m2am International Conference on Noise Control Engineering (1991 : Sydney, N.S.W.). Inter-noise 91. Vol. 2 Sydney, Australia : Australian Acoustical Society ; Poughkeepsie, NY, USA : Noise Control Foundation, [1991?] (OCoLC)25414949
Language: eng
OCLC No: 26337785

Author: Job, R. F. S.
Title: Internal consistency and stability of measurements of community reaction to noise
Pub. Info: 1991
Year: 1991
Physical Descr: p. 101-108 : ill. ; 28 cm.
Notes: Includes bibliographical references (p. 107-108)
Notes: PUBLICATION TYPE: Book
Source: nnas Transportation research record. No. 1312 (1991) (OCoLC)1259379
Language: eng
OCLC No: 26185227

Author: Griffiths, Ian D.
Title: Les changements dans l'exposition au bruit de circulation
Pub. Info: 1991
Year: 1991
Physical Descr: p. 15-18 ; 30 cm.
Notes: Includes bibliographical references (p. 18)
Notes: PUBLICATION TYPE: Book
Other Author/Title: Raw, Gary J.
Other Title: Traffic noise and annoyance level. eng

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Source: nnas Recherche-transports-securite. No 32 (dec. 1991) (OCoLC)10557190
Language: fre
OCLC No: 25567078

Author: Organisation for Economic Co-operation and Development.
Title: Fighting noise in the 1990s
Pub. Info: Paris : OECD, 1991
Year: 1991
Physical Descr: 120 p. : ill. ; 23 cm.
Notes: "The drafting of this report has been overseen by National Experts on noise from Member countries, assisted by Messrs Ariel Alexandre and Jean-Philippe Barde from the OECD Secretariat."-- p. 3.
Notes: Microfiche. Paris : OECD, 1991. 2 microfiches ; 11 x 15 cm.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Alexandre, Ariel. Barde, Jean-Phillippe.
Language: eng
OCLC No: 23916896

Author: Great Britain. Dept. of Transport.
Title: Railway noise and the insulation of dwellings : the report of the committee formed to recommend to the Secretary of State for Transport a national noise insulation standard for new railway lines
Pub. Info: London : H.M.S.O., 1991
Year: 1991
Physical Descr: 57 p. : ill. ; 30 cm.
Notes: Chairman : C.G.B. Mitchell.
Notes: PUBLICATION TYPE: Book
Other Author/Title: Mitchell, C. G. B.
ISBN: 0115510125 (pbk.)
Language: eng
OCLC No: 23724656

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OCLC Search 4:
Subject Heading : airplane noise
Year : 1995 or 1994 or 1993 or 1992 or 1991

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Author: AIAA Aeroacoustics Conference (15th : 1993 : Long Beach, Calif.)
Title: 15th AIAA Aeroacoustics Conference October 25-27, 1993, Long Beach, CA.
Pub. Info: New York : American Institute of Aeronautics and Astronautics, 1993 9999
Year: 1993
Physical Descr: microfiches : ill. ; 11 x 15 cm.
Notes: Includes bibliographical references.
Notes: PUBLICATION TYPE: Book
Other Author/Title: American Institute of Aeronautics and Astronautics. AIAA Aeroacoustics Conference. Aeroacoustics Conference. Fifteenth AIAA Aeroacoustics Conference.
Series: AIAA papers ; 93/4320-93/4450
Language: eng
OCLC No: 29904974

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PsycINFO

Search 1:
Subject Heading : Noise-Effects
Year : From 1991 To 1995

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Document 1
Accession No.: 28397 82-08.
Author: File-Sandra-E.
Author Affil.: U London, United Medical & Dental Schools of Guy's & St Thomas's Hosps, Div of Pharmacology, Psychopharmacology Research Unit, Guy's Hosp, England.
Title: Chronic exposure to noise modifies the anxiogenic response, but not the hypoactivity, detected on withdrawal from chronic ethanol treatment.
Source: Psychopharmacology. 1994 Nov Vol 116(3) 369-372.
Language: eng.
Pub. Type: journal-article.
Class. Code: 2580.
ISSN: 0033-3158.
Year: 1994.

Document 2
Accession No.: 28063 82-08.
Author: Pierson-Linda-L. Gerhardt-Kenneth-J. Abrams-Robert-M. Griffiths-Scott-K. et al.
Author Affil.: US Army Research Lab, Aberdeen Proving Ground, MD, US.
Title: Effect of impulse noise on the auditory brainstem response of the fetal sheep and the adult ewe: Case study.
Source: Military Medicine. 1994 Nov Vol 159(11) 676-680.
Language: eng.
Pub. Type: journal-article.
ISSN: 0026-4075.
Year: 1994.

Document 3
Accession No.: 27967 82-08.
Author: Lidor-Ronnie. Singer-R-N.
Author Affil.: Wingate Inst, Zinman Coll of Physical Education, Psychomotor Lab, Natanya, Israel.
Title: Motor skill acquisition, auditory distractors, and the encoding specificity hypothesis.
Source: Perceptual & Motor Skills. 1994 Dec Vol 79(3, Pt 2), SpecIssue 1579-1584.
Language: eng.
Pub. Type: journal-article.
ISSN: 0031-5125.
Year: 1994.

Document 4
Accession No.: 24408 82-07.
Author: Vera-Maria-Nieves. Vila-J. Godoy-J-F.
Author Affil.: U Granada Facultad de Filosofia y Letras, Departamento de Personalidad, Evaluation y Tratamiento Psicologico, Spain.
Title: Cardiovascular effects of traffic noise: The role of negative self-statements.
Source: Psychological Medicine. 1994 Nov Vol 24(4) 817-827.
Language: eng.
Pub. Type: journal-article.
ISSN: 0033-2917.
Year: 1994.

Document 5
Accession No.: 22180 82-06.
Author: Stollman-Martin-H-P. Kapteyn-Theo-S.
Author Affil.: Inst Sint Marie, Eindhoven, Netherlands.
Title: Effect of time scale modification of speech on the speech recognition threshold in noise for elderly listeners.
Source: Audiology. 1994 Sep-Oct Vol 33(5) 280-290.

213

Author Affil.: U Cambridge, Dept of Experimental Psychology, England.
Title: Effects of carrier frequency and background noise on the detection of mixed modulation.
Source: Journal of the Acoustical Society of America. 1994 Aug Vol 96(2, Pt 1) 741-751.
Language: eng.
Pub. Type: journal-article.
ISSN: 0001-4966.
Year: 1994.

Document 9
Accession No.: 16089 82-05.
Author: Ainsworth-W-A. Meyer-G-F.
Author Affil.: Keele U, Dept of Communication & Neuroscience, England.
Title: Recognition of plosive syllables in noise: Comparison of an
auditory model with human performance.
Source: Journal of the Acoustical Society of America. 1994 Aug Vol 96(2, Pt 1) 687-694.
Language: eng.
Pub. Type: journal-article.
ISSN: 0001-4966.
Year: 1994.

Document 10
Accession No.: 71780 32-05.
Author: Haas-Ellen-Carla.
Author Affil.: Virginia Polytechnic Inst & State U, US.
Title: The perceived urgency and detection time of multi-tone and frequency-modulated warning signals in broadband noise.
Source: Dissertation Abstracts International. 1993 Aug Vol 54(2-B) 1030.
Language: eng.
Pub. Type: dissertation.
ISSN: 0419-4217.

Year: 1993.

Document 11
Accession No.: 12417 82-04.
Author: Dimitrijevic-Mirjana. Laban-Olgica. Von-Hoersten-Stephen. Markovic-Branislav-M. et al.
Author Affil.: Immunology Research Ctr, Belgrade, Yugoslavia.
Title: Neonatal sound stress and development of experimental allergic encephalomyelitis in Lewis and DA rats.
Source: International Journal of Neuroscience. 1994 Sep Vol 78(1-2) 135-143.
Language: eng.
Pub. Type: journal-article.
ISSN: 0020-7454.
Year: 1994.

Document 12
Accession No.: 12258 82-04.
Author: Geringer-John-M.
Author Affil.: U Texas, Dept of Music, Austin, US.
Title: Loudness estimations of noise, synthesizer, and music excerpts by musicians and nonmusicians.
Source: Psychomusicology. 1993 Spr Vol 12(1) 22-30.
Language: eng.
Pub. Type: journal-article.
ISSN: 0275-3987.
Year: 1993.

Document 13
Accession No.: 12109 82-04.
Author: Santisteban-Carmen. Cobo-Pedro. Santiago-J-Salvador.
Author Affil.: U Complutense de Madrid, Inst Pluridisciplinar de Investigacion, Spain.
Title: Influence of windowing in the analysis of sounds used in experiments about the effects of noise on human behaviour.

Source: Psicologica. 1994 Vol 15(2) 239-254.
Language: eng.
Pub. Type: journal-article.
ISSN: 0211-2159.
Year: 1994.

Document 14
Accession No.: 11719 82-03.
Author: Hopkins-Jeffrey.
Author Affil.: U Western Ontario, London, Canada.
Title: Orchestrating an indoor city: Ambient noise inside a mega-mall.
Source: Environment & Behavior. 1994 Nov Vol 26(6) 785-812.
Language: eng.
Pub. Type: journal-article.
ISSN: 0013-9165.
Year: 1994.

Document 15
Accession No.: 8688 82-03.
Author: Dugue-Benoit. Leppanen-Esa. Grasbeck-Ralph.
Author Affil.: Minerva Foundation Inst for Medical Research, Helsinki, Finland.
Title: Preanalytical factors and standardized specimen collection: The effects of industrial noise.
Source: Stress Medicine. 1994 Jul Vol 10(3) 185-189.
Language: eng.
Pub. Type: journal-article.
ISSN: 0748-8386.
Year: 1994.

Document 16
Accession No.: 7805 82-02.
Author: Ruddell-Edward-J. Gramann-James-H.
Author Affil.: U Utah, Dept of Recreation & Leisure, Salt Lake City, US.
Title: Goal orientation, norms, and noise-induced conflict among recreation area users.

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Source: Leisure Sciences. 1994 Apr-Jun Vol 16(2) 93-104.
Language: eng.
Pub. Type: journal-article.
ISSN: 0149-0400.
Year: 1994.

Document 17
Accession No.: 6182 82-02.
Author: Carter-N-L. Hunyor-S-N. Crawford-G. Kelly-D. et al.
Author Affil.: National Acoustic Labs, Sydney, NSW, Australia.
Title: Environmental noise and sleep: A study of arousals, cardiac arrhythmia and urinary catecholamines.
Source: Sleep. 1994 Jun Vol 17(4) 298-307.
Language: eng.
Pub. Type: journal-article.
ISSN: 0161-8105.
Year: 1994.

Document 18
Accession No.: 459 82-01.
Author: Hall-Howard. Bienvenue-Gordon. Martin-James.
Author Affil.: Rainbow Babies & Childrens Hosp, Cleveland, OH, US.
Title: The impact of relaxation/imagery on high level noise exposure: A pilot study. Special Issue: Dreams.
Source: International Journal of Psychosomatics. 1993 Vol 40(1-4) 60-67.
Language: eng.
Pub. Type: journal-article.
ISSN: 0884-8297.
Year: 1993.

Document 19
Accession No.: 70070 32-01.
Author: Phelps-Brady-Justin.
Author Affil.: Utah State U, US.
Title: An examination of operant-respondent interaction in the development of tolerance to ethanol.

213

Source: Dissertation Abstracts International. 1993 Jun Vol 53(12-B) 6535.
Language: eng.
Pub. Type: dissertation.
ISSN: 0419-4217.
Year: 1993.

Document 20
Accession No.: 43774 81-12.
Author: Matsunaga-Atsuko. Maruyama-Kinya. Kudoh-Nobuo.
Author Affil.: Tohoku U Faculty of Arts & Letters, Dept of Psychology, Sendai, Japan.
Title: An analysis of noise effects in listening to music: I.
Source: Tohoku Psychologica Folia. 1992 Vol 51 45-58.
Language: eng.
Pub. Type: journal-article.
ISSN: 0040-8743.
Year: 1992.

Document 21
Accession No.: 43762 81-12.
Author: Baer-Thomas. Moore-Brian-C-J.
Author Affil.: U Cambridge, Dept of Experimental Psychology, England.
Title: Effects of spectral smearing on the intelligibility of sentences in the presence of interfering speech.
Source: Journal of the Acoustical Society of America. 1994 Apr Vol 95(4) 2277-2280.
Language: eng.
Pub. Type: journal-article.
ISSN: 0001-4966.
Year: 1994.

Document 22
Accession No.: 43753 81-12.
Author: Washburn-David-A.
Author Affil.: Georgia State U Dept of Psychology, Sonny Carter Life Sciences Lab, Atlanta, US.

Title: Human factors with nonhumans: Factors that affect computer-task performance.
Source: International Journal of Comparative Psychology. 1992 Sum Vol 5(4) 191-204.
Language: eng.
Pub. Type: journal-article.
ISSN: 0889-3667.
Year: 1992.

Document 23
Accession No.: 39935 81-11.
Author: Horne-J-A. Pankhurst-F-L. Reyner-L-A. Hume-K. et al.
Author Affil.: Loughborough U of Technology, Dept of Human Sciences, England.
Title: A field study of sleep disturbance: Effects of aircraft noise and other factors on 5,742 nights of actimetrically monitored sleep in a large subject sample.
Source: Sleep. 1994 Mar Vol 17(2) 146-159.
Language: eng.
Pub. Type: journal-article.
ISSN: 0161-8105.
Year: 1994.

Document 24
Accession No.: 39920 81-11.
Author: Starnes-William-R. Loeb-Roger-C.
Author Affil.: U Michigan, Dept of Behavioral Sciences, Dearborn, US.
Title: Locus of control differences in memory recall strategies when confronted with noise.
Source: Journal of General Psychology. 1993 Oct Vol 120(4) 463-471.
Language: eng.
Pub. Type: journal-article.
Class. Code: 2343.
ISSN: 0022-1309.
Year: 1993.

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Document 25
Accession No.: 88245 31-11.
Author: Usai-Maria-C. Umilta-Carlo.
Author Affil.: U degli Studi Genova, Italy.
Title: Effetti del rumore sul controllo del fuoco dell'attenzione. (The effects of noise on the control of attentional focus.).
Source: Giornale Italiano di Psicologia. 1994 Apr Vol 21(2) 221-241.
Language: ita.
Pub. Type: journal-article.
ISSN: 0390-5349.
Year: 1994.

Document 26
Accession No.: 74608 31-11.
Author: Ballard-Joan-Carol.
Author Affil.: Emory U, GA, US.
Title: Effects of task demand, noise, and pretest anxiety on vigilance performance and changes in anxiety state.
Source: Dissertation Abstracts International. 1993 May Vol 53(11-B) 5965-5966.
Language: eng.
Pub. Type: dissertation.
ISSN: 0419-4217.
Year: 1993.

Document 27
Accession No.: 36004 81-10.
Author: Lankford-James-E. West-Denise-M.
Author Affil.: Northern Illinois U, Coll of Professional Studies, Office of the Dean, De Kalb, US.
Title: A study of noise exposure and hearing sensitivity in a high school woodworking class.
Source: Language, Speech, & Hearing Services in Schools. 1993 Jul Vol 24(3) 167-173.
Language: eng.

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Pub. Type: journal-article.
ISSN: 0161-1461.
Year: 1993.

Document 28
Accession No.: 33154 81-09.
Author: Humes-Larry-E. Watson-Betty-U. Christensen-Laurel-A. Cokely-Carol-G. et al.
Author Affil.: Indiana U, Dept of Speech & Hearing Sciences, Bloomington, US.
Title: Factors associated with individual differences in clinical measures of speech recognition among the elderly.
Source: Journal of Speech & Hearing Research. 1994 Apr Vol 37(2) 465-474.
Language: eng.
Pub. Type: journal-article.
ISSN: 0022-4685.
Year: 1994.

Document 30
Accession No.: 31751 81-08.
Author: Hetu-Raymond.
Author Affil.: U Montreal, Group d'Acoustique, PQ, Canada.
Title: Mismatches between auditory demands and capacities in the industrial work environment.
Source: Audiology. 1994 Jan-Feb Vol 33(1) 1-14.
Language: eng.
Pub. Type: journal-article.
ISSN: 0020-6091.
Year: 1994.

Document 31
Accession No.: 28739 81-08.
Author: Hanson-E-K-S. Schellekens-J-M-H. Veldman-J-B-P. Mulder-L-J-M.
Author Affil.: Dept of Clinical Psychology & Health Psychology, Utrecht, Netherlands.

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Title: Psychomotor and cardiovascular consequences of mental effort and noise.
Source: Human Movement Science. 1993 Dec Vol 12(6) 607-626.
Language: eng.
Pub. Type: journal-article.
ISSN: 0167-9457.
Year: 1993.

Document 32
Accession No.: 28218 81-08.
Author: Alcantara-Joseph-I. Dooley-Gary-J. Blamey-Peter-J. Seligman-Peter-M.
Author Affil.: U Melbourne, Human Communication Research Ctr, Vict, Australia.
Title: Preliminary evaluation of a formant enhancement algorithm on the perception of speech in noise for normally hearing listeners.
Source: Audiology. 1994 Jan-Feb Vol 33(1) 15-27.
Language: eng.
Pub. Type: journal-article.
ISSN: 0020-6091.
Year: 1994.

Document 33
Accession No.: 24510 81-07.
Author: Fernandes-Cathy. File-Sandra-E.
Author Affil.: U London, United Medical & Dental Schools of Guy's & St Thomas's Hosps Psychopharmacology Research Unit, England.
Title: Beware the builders: Construction noise changes (-sup-1-sup-4C)GABA release and uptake from amygdaloid and hippocampal slices in the rat.
Source: Neuropharmacology. 1993 Dec Vol 32(12) 1333-1336.
Language: eng.
Pub. Type: journal-article.
ISSN: 0028-3908.
Year: 1993.

Document 34
Accession No.: 24266 81-07.
Author: Baker-Mary-Anne. Holding-Dennis-H.
Author Affil.: Indiana U Southeast, Dept of Psychology, New Albany, US.
Title: The effects of noise and speech on cognitive task performance.
Source: Journal of General Psychology. 1993 Jul Vol 120(3) 339-355.
Language: eng.
Pub. Type: journal-article.
ISSN: 0022-1309.
Year: 1993.

Document 35
Accession No.: 21492 81-06.
Author: Stansfeld-Stephen-A. Sharp-Dan-S. Gallacher-John. Babisch-Wolfgang. et al.
Author Affil.: U London, University Coll & Middlesex Hosp School of Medicine, England.
Title: Road traffic noise, noise sensitivity and psychological disorder.
Source: Psychological Medicine. 1993 Nov Vol 23(4) 977-985.
Language: eng.
Pub. Type: journal-article.
ISSN: 0033-2917.
Year: 1993.

Document 36
Accession No.: 20753 81-06.
Author: Mollenauer-Sandra. Bryson-Rebecca. Robison-Molly. Sardo-James. et al.
Author Affil.: San Diego State U, CA, US.
Title: EtOH self-administration in anticipation of noise stress in C57BL/6J mice.
Source: Pharmacology, Biochemistry & Behavior. 1993 Sep Vol 46(1) 35-38.
Language: eng.

Pub. Type: journal-article.
ISSN: 0091-3057.
Year: 1993.

Document 37
Accession No.: 20619 81-06.
Author: Tassi-Patricia. Nicolas-A. Seegmuller-C. Dewasmes-G. et al.
Author Affil.: Lab de Physiologie et de Psychologie Environnementales, Strasbourg, France.
Title: Interaction of the alerting effect of noise with partial sleep deprivation and circadian rhythmicity of vigilance.
Source: Perceptual & Motor Skills. 1993 Dec Vol 77(3, Pt 2) 1239-1248.
Language: eng.
Pub. Type: journal-article.
ISSN: 0031-5125.
Year: 1993.

Document 38
Accession No.: 20192 81-06.
Author: Zust-Hansjorg. Tschopp-Kurt.
Author Affil.: U Basel, Dept of Otolaryngology, Switzerland.
Title: Influence of context on speech understanding ability using German sentence test materials.
Source: Scandinavian Audiology. 1993 Vol 22(4) 251-255.
Language: eng.
Pub. Type: journal-article.
ISSN: 0105-0397.
Year: 1993.

Document 39
Accession No.: 20183 81-06.
Author: Keidser-Gitte.
Author Affil.: National Acoustic Labs, Chatswood, NSW, Australia.
Title: Normative data in quiet and in noise for "DANTALE": A Danish speech material.
Source: Scandinavian Audiology. 1993 Vol 22(4) 231-236.

Language: eng.
Pub. Type: journal-article.
ISSN: 0105-0397.
Year: 1993.

Document 40
Accession No.: 16841 81-05.
Author: Laver-John.
Author Affil.: U Edinburgh Ctr for Speech Technology Research, Scotland.
Title: Repetition and re-start strategies for prosody in text-to-speech conversion systems.
Source: Speech Communication. 1993 Oct Vol 13(1-2), Spec Issue 75-85.
Language: eng.
Pub. Type: journal-article.
ISSN: 0167-6393.
Year: 1993.

Document 41
Accession No.: 12307 81-04.
Author: Kaernbach-Christian.
Author Affil.: Ruhr-U Bochum, Inst fur Neuroinformatik, Germany.
Title: Temporal and spectral basis of the features perceived in repeated noise.
Source: Journal of the Acoustical Society of America. 1993 Jul Vol 94(1) 91-97.
Language: eng.
Pub. Type: journal-article.
ISSN: 0001-4966.
Year: 1993.

Document 43
Accession No.: 71355 31-03.
Author: Moryl-Colleen-M.
Author Affil.: U California, Santa Barbara, US.
Title: Effects of contralateral stimulation on evoked otoacoustic emissions.

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Source: Dissertation Abstracts International. 1993 Jan Vol 53(7-B) 3384-3385.
Language: eng.
Pub. Type: dissertation.
ISSN: 0419-4217.
Year: 1993.

Document 44
Accession No.: 71226 31-03.
Author: Heller-Laurie-M.
Author Affil.: U Pennsylvania, US.
Title: Across-frequency influences in lateralization for interaural time and level differences.
Source: Dissertation Abstracts International. 1993 Jan Vol 53(7-B) 3814.
Language: eng.
Pub. Type: dissertation.
ISSN: 0419-4217.
Year: 1993.

Document 45
Accession No.: 70979 31-03.
Author: Whitmore-Mihriban.
Author Affil.: Wichita State U, KS, US.
Title: Quantitative assessment of human performance in cockpit-related systems.
Source: Dissertation Abstracts International. 1993 Jan Vol 53(7-B) 3703.
Language: eng.
Pub. Type: dissertation.
ISSN: 0419-4217.
Year: 1993.

Document 46
Accession No.: 85399 31-02.
Author: Biassoni-de-Serra-Ester-C.
Author Affil.: U Nacional de Cordoba, Ctr de Investigaciones Acusticas y Luminotecnicas, Argentina.

Title: Avances en el estudio sobre contaminacion sonora y comprension del lenguaje oral en escolares. (Advances in the study of the effect of urban noise on verbal speech comprehension in schoolchildren.).
Source: Interdisciplinaria. 1992 Vol 11(1) 1-20.
Language: spa.
Pub. Type: journal-article.
ISSN: 0325-8203.
Year: 1992.

Document 48
Accession No.: 47538 80-12.
Author: Nivison-Mary-E. Endresen-Inger-M.
Author Affil.: Dept of Biological & Medical Psychology, Div of Physiological Psychology, Bergen, Norway.
Title: An analysis of relationships among environmental noise, annoyance and sensitivity to noise, and the consequences for health and sleep.
Source: Journal of Behavioral Medicine. 1993 Jun Vol 16(3) 257-276.
Language: eng.
Pub. Type: journal-article.
ISSN: 0160-7715.
Year: 1993.

Document 49
Accession No.: 47535 80-12.
Author: Bronzaft-Arline-L.
Author Affil.: City U New York, Lehman Coll, Bronx, US.
Title: Architects, engineers and planners as anti-noise advocates.
Source: Journal of Architectural & Planning Research. 1993 Sum Vol 10(2) 146-159.
Language: eng.
Pub. Type: journal-article.
ISSN: 0738-0895.
Year: 1993.

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Document 50
Accession No.: 88711 30-12.
Author: Naemura-Aki. Tsuda-Kenroku. Suzuki-Naoto.
Author Affil.: Osaka Juvenile Classification Home, Sakai, Japan.
Title: / Effects of loud noise on nasal skin temperature.
Source: Japanese Journal of Psychology. 1993 Apr Vol 64(1) 51-54.
Language: jpn.
Pub. Type: journal-article.
ISSN: 0021-5236.
Year: 1993.

Document 51
Accession No.: 40044 80-11.
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Author Affil.: Linkoping U, Sweden.
Title: The effects of background noise and working memory capacity on speechreading performance.
Source: Scandinavian Audiology. 1993 Vol 22(2) 67-70.
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Author Affil.: Ohio State U, US.
Title: Preservation of intelligibility and acoustical characteristics in partial laryngectomees and normal laryngeal speakers produced under conditions of competing noise.
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Author: Greider-Thomas.
Author Affil.: U Kentucky, Coll of Agriculture, US.
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Author: Biassoni-de-Serra-Ester-C.
Author Affil.: U Nacional de Cordoba, Ctr de Investigaciones Acusticas y Luminotecnicas, Argentina.
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Author Affil.: U Maryland, College Park, US.
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Author Affil.: University Hosp Rotterdam, Dept of Otorhinolaryngology, Netherlands.
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Author Affil.: Massachusetts Inst of Technology, US.
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Author Affil.: U Goteborg, Sweden.
Title: Coping strategies used by middle-aged males with noise-induced hearing loss, with and without tinnitus.

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Author Affil.: U London, University Coll & Middlesex School of Medicine, England.
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Author Affil.: Free U, Medical Faculty, Amsterdam, Netherlands.
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Author Affil.: U Pittsburgh, PA, US.
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Author Affil.: U Minnesota, Minneapolis, US.
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Author Affil.: U Bourgogne, Faculte des Sciences Lab de Psychophysiologie Humaine Appliquee, Dijon, France.
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Author Affil.: Ft Hays State U, Hays, KS, US.
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Author Affil.: INSERM Unite 299 Lab d'Audiologie Experimentale, U Bordeaux II, France.
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Author Affil.: Netherlands Organization for Applied Scientific Research, Inst for Perception, Soesterberg, Netherlands.
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Author Affil.: Tokushima U, Coll of Integrated Arts & Sciences, Japan.
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Author Affil.: Franklin & Marshall Coll, Lancaster, PA, US.
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Author Affil.: Yale U School of Medicine, New Haven, CT, US.
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Author Affil.: Showa Women's U, Tokyo, Japan.
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Author Affil.: Baylor Coll of Medicine, Houston, TX, US.
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Author Affil.: U Auckland, New Zealand.
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Author Affil.: Universitetssjukhuset, Linkoping, Sweden.
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Author Affil.: Inst Medycyny Pracy w Przemysle Weglowym i Hutniczym, Sosnowiec, Poland.
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Author Affil.: U Colorado School of Nursing, Health Sciences Ctr, Denver, US.
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Author Affil.: U Wales; University Coll of North Wales, Bangor, Wales.
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Author Affil.: Retina Foundation of the Southwest, Dallas, TX, US.
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Author Affil.: U Granada Facultad de Filosofia y Letras, Spain.
Title: Physiological and subjective effects of traffic noise: The role of negative self-statements.
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Author Affil.: Free U Medical Faculty, Amsterdam, Netherlands.
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Author Affil.: Dept of Veterans Affairs Medical Ctr, Dept of Psychiatry, San Diego, CA, US.
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Author Affil.: U Keele, England.
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Author Affil.: U British Columbia, Vancouver, Canada.
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Author Affil.: Yeshiva U Albert Einstein Coll of Medicine, Long Island Jewish Medical Ctr, NY, US.
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Author Affil.: Open U, Brain & Behaviour Research Group, Milton Keynes, England.
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Author Affil.: Maharshi Dayanand U, Rohtak, India.
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Author Affil.: Lab de Psychologie de l'Environnement, Paris, France.
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Author Affil.: U Wisconsin, School of Nursing, Madison, US.
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Author Affil.: U Wisconsin, Madison, US.
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PsycINFO search 2:

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Year : From 1991 To 1995

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Accession No.: 28397 82-08.
Author: File-Sandra-E.
Author Affil.: U London, United Medical & Dental Schools of Guy's & St Thomas's Hosps, Div of Pharmacology, Psychopharmacology Research Unit, Guy's Hosp, England.
Title: Chronic exposure to noise modifies the anxiogenic response, but not the hypoactivity, detected on withdrawal from chronic ethanol treatment.
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Author Affil.: US Army Research Lab, Aberdeen Proving Ground, MD, US.
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Author: Lidor-Ronnie. Singer-R-N.
Author Affil.: Wingate Inst, Zinman Coll of Physical Education, Psychomotor Lab, Natanya, Israel.
Title: Motor skill acquisition, auditory distractors, and the encoding specificity hypothesis.
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Accession No.: 24408 82-07.
Author: Vera-Maria-Nieves. Vila-J. Godoy-J-F.

Author Affil.: U Granada Facultad de Filosofia y Letras, Departamento de Personalidad, Evaluation y Tratamiento Psicologico, Spain.
Title: Cardiovascular effects of traffic noise: The role of negative self-statements.
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Author: Stollman-Martin-H-P. Kapteyn-Theo-S.
Author Affil.: Inst Sint Marie, Eindhoven, Netherlands.
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Author Affil.: Laurentian U of Sudbury, ON, Canada.
Title: Geophysical variables and behavior: LXXVII. Increased geomagnetic activity and decreased pleasantness of spontaneous narratives for percipients but not agents.
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Author Affil.: Vanderbilt U, Dept of Psychology, Nashville, TN, US.
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Author: Moore-Brian-C-J. Sek-Aleksander.
Author Affil.: U Cambridge, Dept of Experimental Psychology, England.
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Author: Ainsworth-W-A. Meyer-G-F.
Author Affil.: Keele U, Dept of Communication & Neuroscience, England.
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Author Affil.: Virginia Polytechnic Inst & State U, US.
Title: The perceived urgency and detection time of multi-tone and frequency-modulated warning signals in broadband noise.
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Author Affil.: Immunology Research Ctr, Belgrade, Yugoslavia.
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Author Affil.: U Texas, Dept of Music, Austin, US.

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Author Affil.: U Complutense de Madrid, Inst Pluridisciplinar de Investigacion, Spain.
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Author Affil.: U Western Ontario, London, Canada.
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Author Affil.: Minerva Foundation Inst for Medical Research, Helsinki, Finland.
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Author: Ruddell-Edward-J. Gramann-James-H.
Author Affil.: U Utah, Dept of Recreation & Leisure, Salt Lake City, US.
Title: Goal orientation, norms, and noise-induced conflict among recreation area users.
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Author Affil.: National Acoustic Labs, Sydney, NSW, Australia.
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Author Affil.: Rainbow Babies & Childrens Hosp, Cleveland, OH, US.
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Author: Phelps-Brady-Justin.
Author Affil.: Utah State U, US.
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Author: Matsunaga-Atsuko. Maruyama-Kinya. Kudoh-Nobuo.
Author Affil.: Tohoku U Faculty of Arts & Letters, Dept of Psychology, Sendai, Japan.
Title: An analysis of noise effects in listening to music: I.
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Author Affil.: U Cambridge, Dept of Experimental Psychology, England.
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Author Affil.: Georgia State U Dept of Psychology, Sonny Carter Life Sciences Lab, Atlanta, US.
Title: Human factors with nonhumans: Factors that affect computer-task performance.
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Author Affil.: Loughborough U of Technology, Dept of Human Sciences, England.
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Author Affil.: U Michigan, Dept of Behavioral Sciences, Dearborn, US.
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Source: Journal of General Psychology. 1993 Oct Vol 120(4) 463-471.
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Author: Usai-Maria-C. Umilta-Carlo.
Author Affil.: U degli Studi Genova, Italy.
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Author Affil.: Emory U, GA, US.
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Author Affil.: Northern Illinois U, Coll of Professional Studies, Office of
the Dean, De Kalb, US.
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Author Affil.: Dept of Clinical Psychology & Health Psychology, Utrecht, Netherlands.
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Author Affil.: U Melbourne, Human Communication Research Ctr, Vict, Australia.
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Author Affil.: U London, United Medical & Dental Schools of Guy's & St Thomas's Hosps Psychopharmacology Research Unit, England.
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Author Affil.: Indiana U Southeast, Dept of Psychology, New Albany, US.
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Author Affil.: U London, University Coll & Middlesex Hosp School of Medicine,England.
Title: Road traffic noise, noise sensitivity and psychological disorder.
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Author Affil.: San Diego State U, CA, US.
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Author Affil.: Lab de Physiologie et de Psychologie Environnementales,

Strasbourg, France.
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Author Affil.: U Basel, Dept of Otolaryngology, Switzerland.
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Author Affil.: National Acoustic Labs, Chatswood, NSW, Australia.
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Author Affil.: U Edinburgh Ctr for Speech Technology Research, Scotland.
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Author: Kaernbach-Christian.
Author Affil.: Ruhr-U Bochum, Inst fur Neuroinformatik, Germany.
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Author Affil.: U California School of Medicine, Borun Ctr for Gerontological Research, Los Angeles, US.
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Author Affil.: U California, Santa Barbara, US.
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Author Affil.: U Pennsylvania, US.
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Author Affil.: Wichita State U, KS, US.
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Author Affil.: U Nacional de Cordoba, Ctr de Investigaciones Acusticas y Luminotecnicas, Argentina.
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Author Affil.: NRCC, Inst for Research in Construction, Ottawa, ON, Canada.
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Author Affil.: Dept of Biological & Medical Psychology, Div of Physiological Psychology, Bergen, Norway.

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Author Affil.: City U New York, Lehman Coll, Bronx, US.
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Author Affil.: Osaka Juvenile Classification Home, Sakai, Japan.
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Author Affil.: Ohio State U, US.
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Author Affil.: U Kentucky, Coll of Agriculture, US.
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Author Affil.: U Nacional de Cordoba, Ctr de Investigaciones Acusticas y
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Author Affil.: U Maryland, College Park, US.
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Author Affil.: University Hosp Rotterdam, Dept of Otorhinolaryngology, Netherlands.
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Author Affil.: Massachusetts Inst of Technology, US.
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Author Affil.: U Goteborg, Sweden.
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Author Affil.: U London, University Coll & Middlesex School of Medicine, England.
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Author Affil.: Free U, Medical Faculty, Amsterdam, Netherlands.
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Author Affil.: U Pittsburgh, PA, US.
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Author Affil.: U Minnesota, Minneapolis, US.

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Author Affil.: U Bourgogne, Faculte des Sciences Lab de Psychophysiologie Humaine Appliquee, Dijon, France.
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Author Affil.: Ft Hays State U, Hays, KS, US.
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Author Affil.: INSERM Unite 299 Lab d'Audiologie Experimentale, U Bordeaux II, France.
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Author Affil.: Netherlands Organization for Applied Scientific Research, Inst for Perception, Soesterberg, Netherlands.
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Author Affil.: Franklin & Marshall Coll, Lancaster, PA, US.
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Author Affil.: Showa Women's U, Tokyo, Japan.
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Author Affil.: Baylor Coll of Medicine, Houston, TX, US.
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Author Affil.: U Auckland, New Zealand.
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Author Affil.: Inst Medycyny Pracy w Przemysle Weglowym I Hutniczym, Sosnowiec, Poland.
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Author Affil.: U Colorado School of Nursing, Health Sciences Ctr, Denver, US.
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Author Affil.: U Wales, University Coll of North Wales, Bangor, Wales.
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Author Affil.: Retina Foundation of the Southwest, Dallas, TX, US.
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Author Affil.: U Granada Facultad de Filosofia y Letras, Spain.
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Author Affil.: Free U Medical Faculty, Amsterdam, Netherlands.
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Author Affil.: Dept of Veterans Affairs Medical Ctr, Dept of Psychiatry, San Diego, CA, US.
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Author Affil.: U Keele, England.
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Author Affil.: U British Columbia, Vancouver, Canada.
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Author Affil.: Yeshiva U Albert Einstein Coll of Medicine, Long Island Jewish Medical Ctr, NY, US.
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Author: Sandi-Carmen. Cambronero-Juan-C. Borrell-Jose. Guaza-Carmen.

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Author Affil.: Open U, Brain & Behaviour Research Group, Milton Keynes, England.
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Author: Bhatia-P. Shipra. Muhar-I-S.
Author Affil.: Maharshi Dayanand U, Rohtak, India.
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Author: Martin-Dominique.
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Author: McCarthy-Donna-O. Oulmet-Mary-E. Daun-Jane-M.
Author Affil.: U Wisconsin, School of Nursing, Madison, US.
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Author: Kluender-Keith-R. Jenison-Rick-L.
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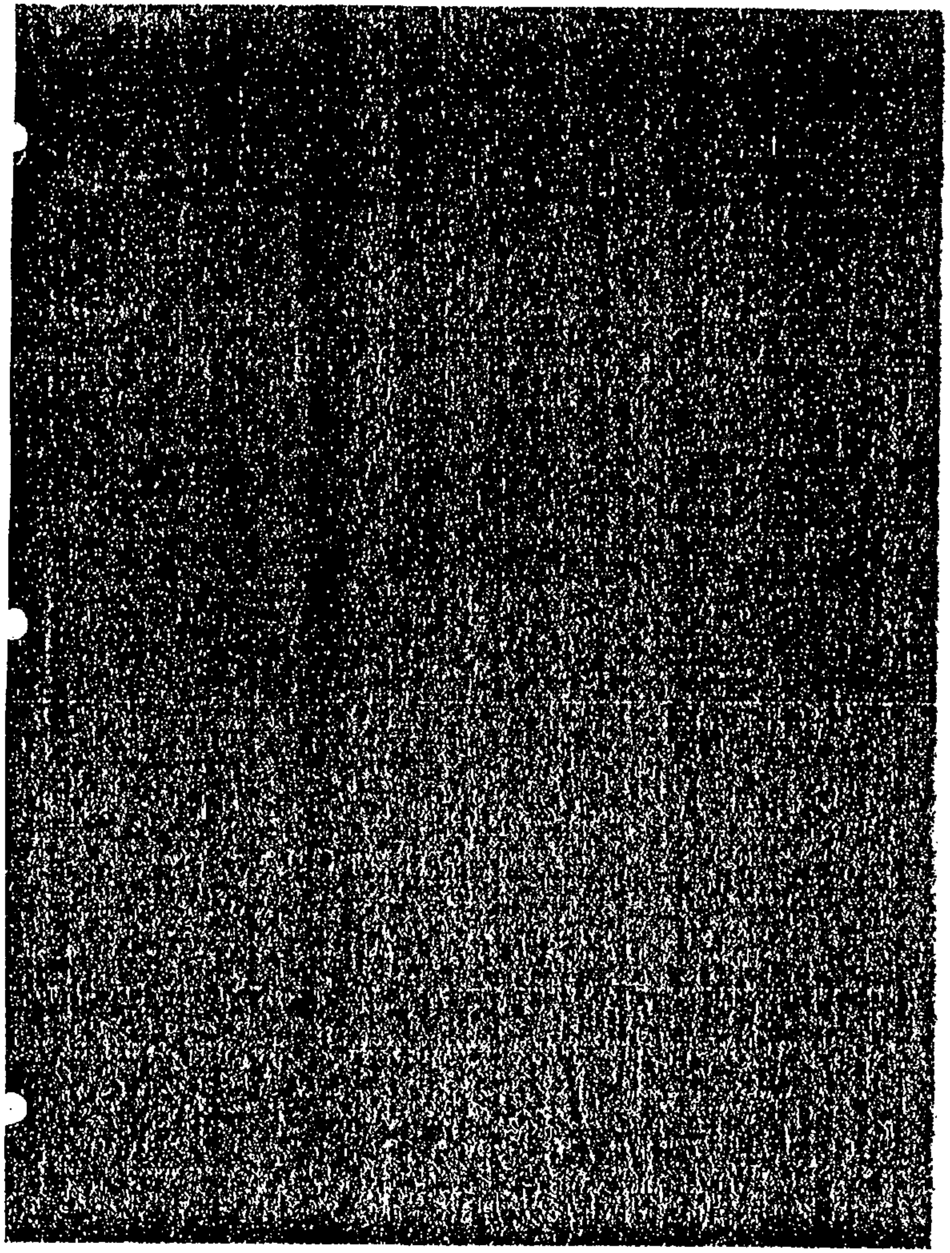

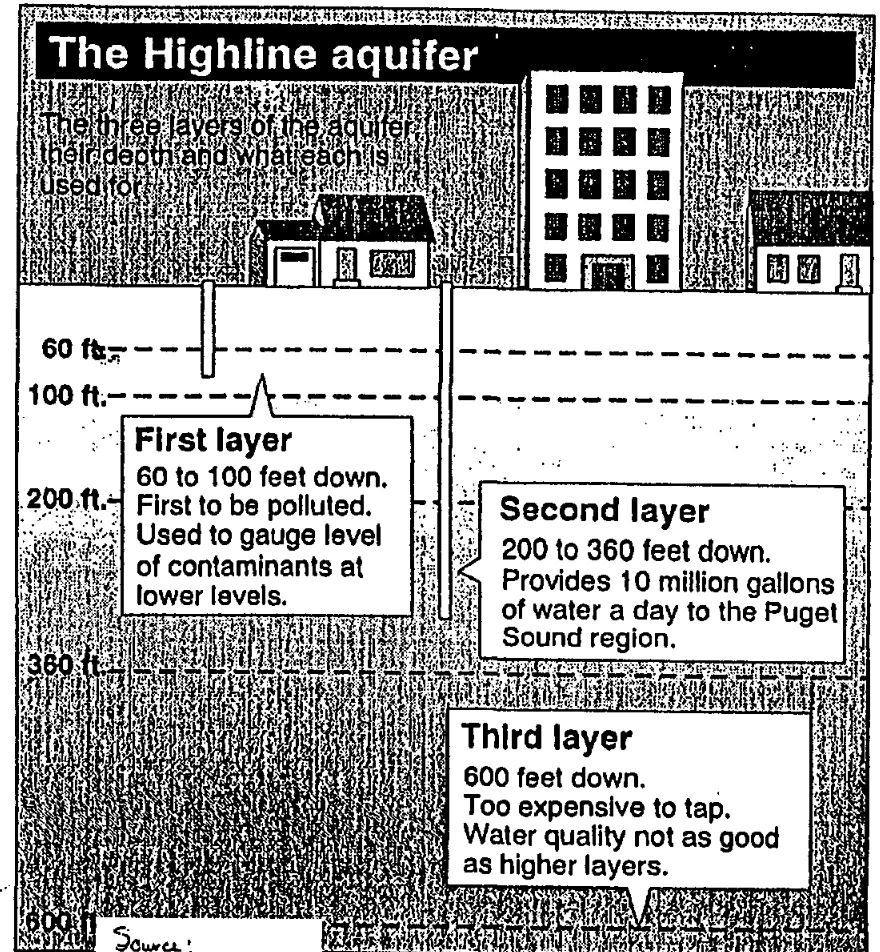

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Office of Noise
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November 1978
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Protective Noise Levels

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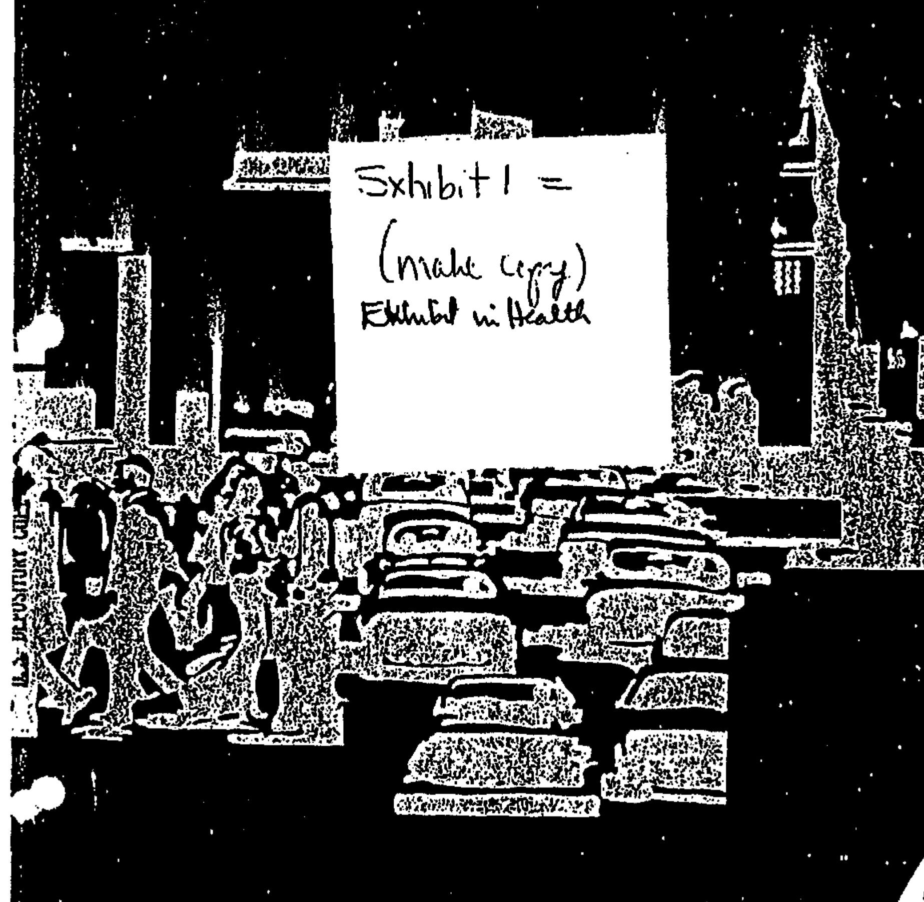
Condensed Version of EPA Levels Document



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PURPOSE

This publication is intended to complement the EPA's "Levels Document,"* the 1974 report examining levels of environmental noise necessary to protect public health and welfare. It interprets the contents of the Levels Document in less technical terms for people who wish to better understand the concepts presented there, and how the protective levels were identified. In that sense, this publication may serve as an introduction, or a supplement, to the Levels Document.

*"Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," EPA/ONAC 550/9-74-004, March, 1974.

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INTRODUCTION

During the last 20 years there has been increasing concern with the quality of the environment. Along with air and water contaminants, noise has been recognized as a serious pollutant. As noise levels have risen, the effects of noise have become pervasive and more apparent.

Noise is defined as "unwanted sound." In the context of protecting the public health and welfare, noise implies adverse effects on people and the environment. Noise causes hearing loss, interferes with human activities at home and work, and is in various ways injurious to people's health and well-being. Although hearing loss is the most clearly measurable health hazard, noise is also linked to other physiological and psychological problems.

Noise annoys, awakens, angers and frustrates people. It disrupts communication and individual thoughts, and affects performance capability. Noise is one of the biological stressors associated with everyday life. Thus, the numerous effects of noise combine to detract from the quality of people's lives and the environment.

Noise emanates from many different sources. Transportation noise, industrial noise, construction noise, household noise, and people and animal noise are all large-scale offenders. It is important, then, to examine the total range and combination of noise sources and not to focus unduly on any one source.

Through the Noise Control Act of 1972, Congress directed the Environmental Protection Agency (EPA) to publish scientific information about the kind and extent of all identifiable effects of different qualities and quantities of noise. EPA was also directed to define acceptable levels under various conditions which would protect public health and welfare with an adequate margin of safety. The EPA collaborated with other Federal agencies and the scientific community to publish a "Levels Document,"* which would fulfill these requirements in the Noise Control Act.

Initial public reaction was quite favorable, but it was discovered that the document was too complex, too technical, and too long for some audiences. This summary presents the contents of the Levels Document in less technical terms. It defines the basic measurement of noise, analyzes noise exposure, and presents the best understood effects of noise — hearing damage, speech interference, and annoyance — using information contained in the Levels Document. The identified protective levels are then summarized, followed by a number of often-asked questions and answers about the Levels Document.

No attempt has been made here to incorporate recent research findings pertaining to effects of noise on people. Considerable new information has developed since initial publication of the Levels Document, including new findings on community response to noise, sleep disruption, and speech interference. Summaries and analyses of some recent information on noise effects are available through EPA and other agencies.

*"Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety", EPA 550/9-74-004, March, 1974, U.S. Environmental Protection Agency, Washington, D.C. 20460.

ABOUT SOUND

The sound we hear is the result of a sound source inducing vibration in the air. The vibration produces alternating band of relatively dense and sparse particles of air, spreading outward from the source in the same way as ripples do on water after a stone is thrown into it. The result of the movement of the particles is a fluctuation in the normal atmospheric pressure, or sound waves. These waves radiate in all directions from the source and may be reflected and scattered or, like other wave actions, may turn corners. When the source stops vibrating, the sound waves disappear almost instantaneously, and the sound ceases. The ear is extremely sensitive to sound pressure fluctuations, which are converted into auditory sensations.

Sound may be described in terms of three variables:

1. Amplitude (perceived as loudness)
2. Frequency (perceived as pitch)
3. Time pattern

Amplitude

Sound pressure is the amplitude or measure of the difference between atmospheric pressure (with no sound present) and the total pressure (with sound present). Although there are other measures of sound amplitude, sound pressure is the fundamental measure and is the basic ingredient of the various measurement descriptors in the next section, "Measurement of Environmental Noise."

The unit of sound pressure is the decibel (dB); thus it is said that a sound pressure level is a certain number of decibels. The decibel scale is a logarithmic scale, not a linear one such as the scale of length. A logarithmic scale is used because the range of sound intensities is so great that it is convenient to compress the scale to encompass all the sounds that need to be measured. The human ear has an extremely wide range of response to sound amplitude. Sharply painful sound is 10 million times greater in sound pressure than the least audible sound. In decibels, this 10 million to 1 ratio is simplified logarithmically to 140 dB.

Another unusual property of the decibel scale is that the sound pressure levels of two separate sounds are not directly (that is, arithmetically) additive. For example, if a sound of 70 dB is added to another sound of 70 dB, the total is only a 3-decibel increase (to 73 dB), not a doubling to 140 dB. Furthermore, if two sounds are of different levels, the lower level adds less to the higher as the difference increases. If the difference is as much as 10 dB, the lower level adds almost nothing to the higher level. In other words, adding a 60 decibel sound to a 70 decibel sound only increases the total sound pressure level less than one-half decibel.

Frequency

The rate at which a sound source vibrates, or makes the air vibrate, determines frequency. The unit of time is usually one second and the term "Hertz" (after an early investigator of the physics of sound) is used to designate the number of cycles per second.

The human ear and that of most animals has a wide range of response. Humans can identify sounds with frequencies from about 16 Hz (Hertz) to 20,000 Hz. Because pure tones are relatively rare in real-life situations, most sounds consist instead of a complex mixture of many frequencies.

Time Pattern

The temporal nature of sound may be described in terms of its pattern of time and level: continuity, fluctuation, impulsiveness, intermittency. Continuous sounds are those produced for relatively long periods at a constant level, such as the noise of a waterfall. Intermittent sounds are those which are produced for short periods, such as the ringing of a telephone or aircraft take-offs and landings. Impulse noises are sounds which are produced in an extremely short span of time, such as a pistol shot or a hand clap. Fluctuating sounds vary in level over time, such as the loudness of traffic sounds at a busy intersection.

MEASUREMENT OF ENVIRONMENTAL NOISE: SOUND DESCRIPTORS

EPA has adopted a system of four "sound descriptors" to summarize how people hear sound and to determine the impact of environmental noise on public health and welfare. These four descriptors are: the A-weighted Sound Level, A-weighted Sound Exposure Level, Equivalent Sound Level, and Day-Night

Sound Level. They are related but each is most useful for a particular type of measurement. The descriptors and some examples of their uses are described below.

A-weighted Sound Level

One's ability to hear a sound depends greatly on the frequency composition of the sound. People hear sounds most readily when the predominant sound energy occurs at frequencies between 1000 and 6000 Hertz (cycles per second). Sounds at frequencies above 10,000 Hertz (such as high-pitched hissing) are much more difficult to hear, as are sounds at frequencies below about 100 Hz (such as a low rumble). To measure sound on a scale that approximates the way it is heard by people, more weight must be given to the frequencies that people hear more easily.

A method for weighting the frequency spectrum to mimic the human ear has been sought for years. Many different scales of sound measurement, including A-weighted sound level (and also B, C, D, and E-weighted sound levels) have evolved in this search. A-weighting was recommended by EPA to describe environmental noise because it is convenient to use, accurate for most purposes, and is used extensively throughout the world. Figure 1 shows the A-weighted levels of some environmental noises. Note that these ranges of measured values are the maximum sound levels.

The A-weighting of frequency also is used in the three descriptors discussed below. When used by itself, an A-weighted decibel value denotes either a sound level at a given instant, a maximum level, or a steady-state level. The following three descriptors are used to summarize those levels which vary over time.

Sound Exposure Level

Since the levels of many sounds change from moment to moment, this variation must also be accounted for when measuring environmental noise. One method for measuring the changing magnitude of sound levels is to trace a line on a sheet of moving paper, so that the movement of the pen is proportional to the sound level in decibels. Figure 2 illustrates such a recording, about which several features are noteworthy. First, the sound level varies with time over a range of about 30 dB. Second, the sound appears to be characterized by a fairly steady-state lower level, upon which are superimposed sound levels associated with individual events. This fairly constant lower level is often called the background ambient sound level.

Each single event in Figure 2 may be partially characterized by its maximum level. It may also be partially characterized by its time pattern. In the example, the sound level of the aircraft is above that of the background ambient level for about a minute, whereas the sound levels from cars are above the background level for much less time.

The duration of sounds with levels that vary from moment to moment is more difficult to characterize. One way is to combine the maximum sound level with the length of time during which the sound level is greater than a certain number of decibels below the maximum level — for example, the number of seconds that the sound rises from 10 dB below maximum, as in Figure 3.

Using this procedure one can measure the total energy of the sound by summing the intensity during the exposure duration. This procedure produces the second measurement descriptor, *sound exposure level* (L_s), referred to in the Levels Document as the single event noise exposure level (SENEL).

Equivalent Sound Level

Yet another method of quantifying the noise environment is to determine the value of a steady-state sound which has the same A-weighted sound energy as that contained in the time-varying sound. This is the third measurement descriptor, termed the *Equivalent Sound Level* (L_{eq}). The Equivalent Sound Level is a single value of sound level for any desired duration, which includes *all* of the time-varying sound energy in the measurement period. In Figure 2, for example, the L_{eq} equals about 58 dB, indicating that the amount of sound energy in all the peaks and valleys in the figure is equivalent to the energy in a continuous sound of 58 dB.

The major virtue of the Equivalent Sound Level is that it correlates reasonably well with the effects of noise on people, even for wide variations in environmental sound levels and time patterns. It is used when only the durations and levels of sound, and not their times of occurrence (day or night), are relevant. It is easily measurable by available equipment. It also is the basis of a fourth and final measurement descriptor of the total outdoor noise environment, the *Day-Night Sound Level* (L_{dn}).

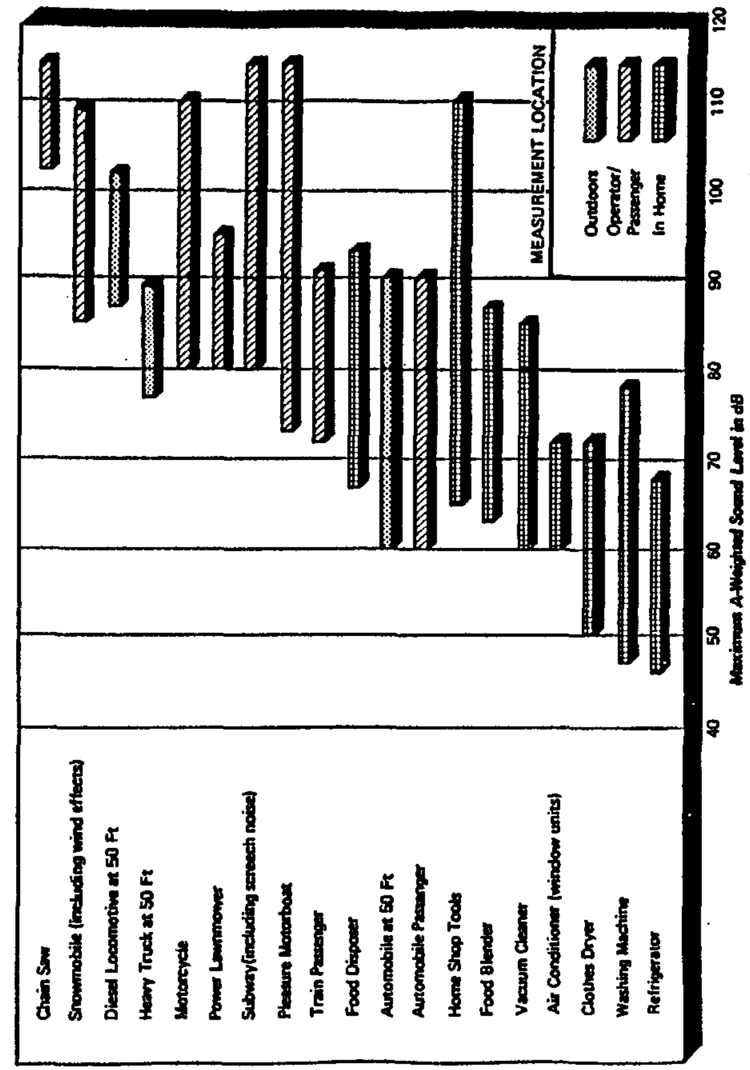

FIGURE 1. TYPICAL RANGE OF COMMON SOUNDS

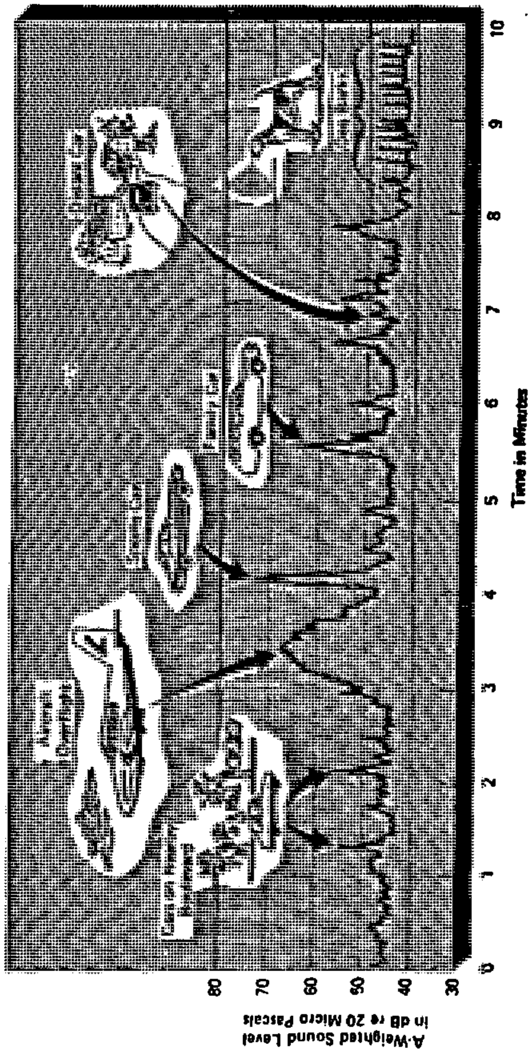

FIGURE 2. TYPICAL OUTDOOR SOUND MEASURED ON A QUIET SUBURBAN STREET

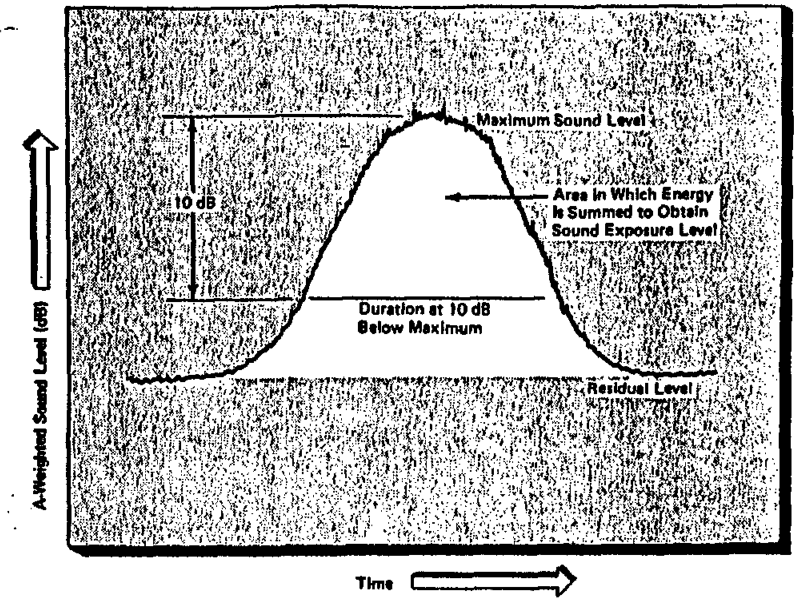

FIGURE 3. DESCRIPTION OF THE SOUND OF A SINGLE EVENT

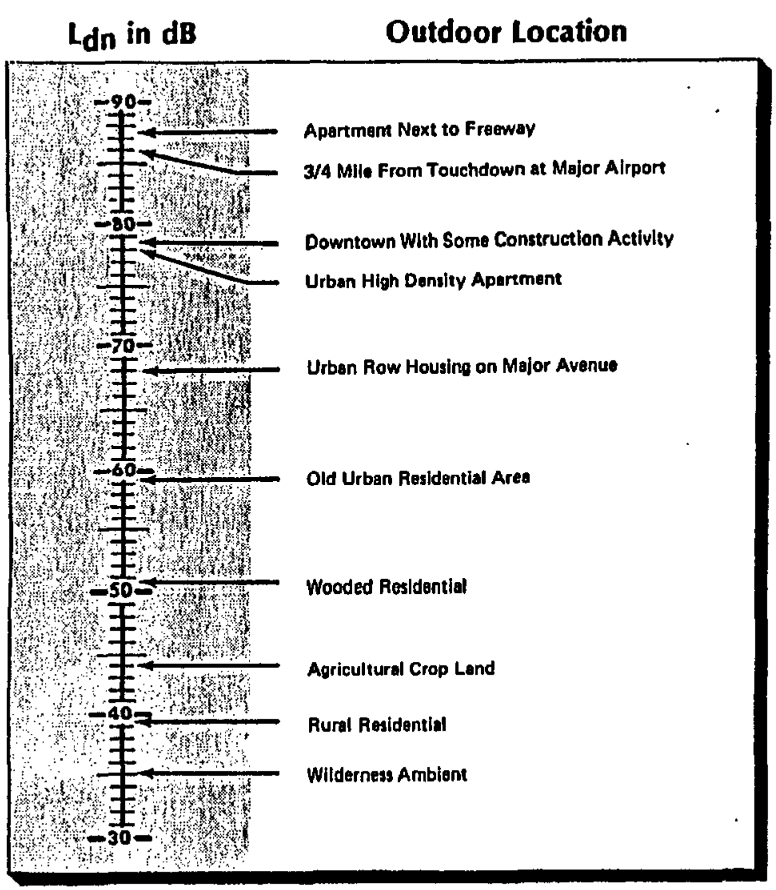

FIGURE 4. EXAMPLES OF OUTDOOR DAY-NIGHT AVERAGE SOUND LEVELS IN dB MEASURED AT VARIOUS LOCATIONS

Day-Night Sound Level

The Day-Night Sound Level is the A-weighted equivalent sound level for a 24-hour period with an additional 10 dB weighting imposed on the equivalent sound levels occurring during nighttime hours (10 pm to 7 am). Hence, an environment that has a measured daytime equivalent sound level of 60 dB and a measured nighttime equivalent sound level of 50 dB, can be said to have a weighted nighttime sound level of 60 dB (50 + 10) and an L_{dn} of 60 dB. Examples of measured L_{dn} values are shown in Figure 4. Table I summarizes the use of the four sound descriptors used by EPA.

Table I. Descriptors of Sound*

TYPICAL USE	NAME OF DESCRIPTOR	NATURE OF DESCRIPTOR
To describe steady airconditioning sound in a room or measure maximum sound level during a vehicle passby with a simple sound level meter.	A-weighted Sound Level	The momentary magnitude of sound weighted to approximate the ear's frequency sensitivity.
To describe noise from a moving source such as an airplane, train, or truck.	A-weighted Sound Exposure Level	A summation of the energy of the momentary magnitudes of sound associated with a single event to measure the total sound energy of the event.
To measure average environmental noise levels to which people are exposed.	Equivalent Sound Level	The A-weighted sound level that is "equivalent" to an actual time varying sound level, in the sense that it has the same total energy for the duration of the sound.
characterize average sound levels in sidential areas throughout the day and night.	Day-Night Sound Level	The A-weighted equivalent sound level for a 24-hour period with 10 decibels added to nighttime sounds (10 pm - 7 am).

*The unit for all descriptors is the decibel.

LEVELS OF ENVIRONMENTAL NOISE IN THE UNITED STATES

In residential areas of the United States, major contributions to outdoor noise come from transportation, industrial, construction, human and animal sources. Inside homes, appliances, radio and television, as well as people and animals, are predominant noise sources. On the job, workplace equipment can create moderate to extremely high levels of noise. The daily noise exposure of people depends on how much time they spend in different outdoor and indoor locations and on the noise environments in these places. Typical daily exposure patterns are discussed in this section, following short descriptions of outdoor and indoor levels of environmental noise throughout the United States.

Outdoor Levels

The noise environment outside residences in the United States can be highly variable. As seen in Figure 4, outdoor Day-Night Sound Levels in different areas vary over a range of 60 dB. Levels occur as low as L_{dn} = 30 to 40 dB in wilderness areas and as high as L_{dn} = 85 to 90 dB in urban areas.

Most Americans live in areas with a much smaller range of outdoor noise levels. Figure 5 shows that for urban dwellers (roughly 135 million people, more than half the U.S. population), 87% live in areas of L_{dn} = 48 and higher from traffic noise alone. Most of the other 13% of the urban population experience lower noise levels than those of Figure 5. Figure 5 also shows that nearly half of the urban population live in areas exposed to traffic sounds that range over only 5 dB (L_{dn} = 55 to 60 dB). Rural populations enjoy average outdoor sound levels generally lower than L_{dn} = 50 dB.

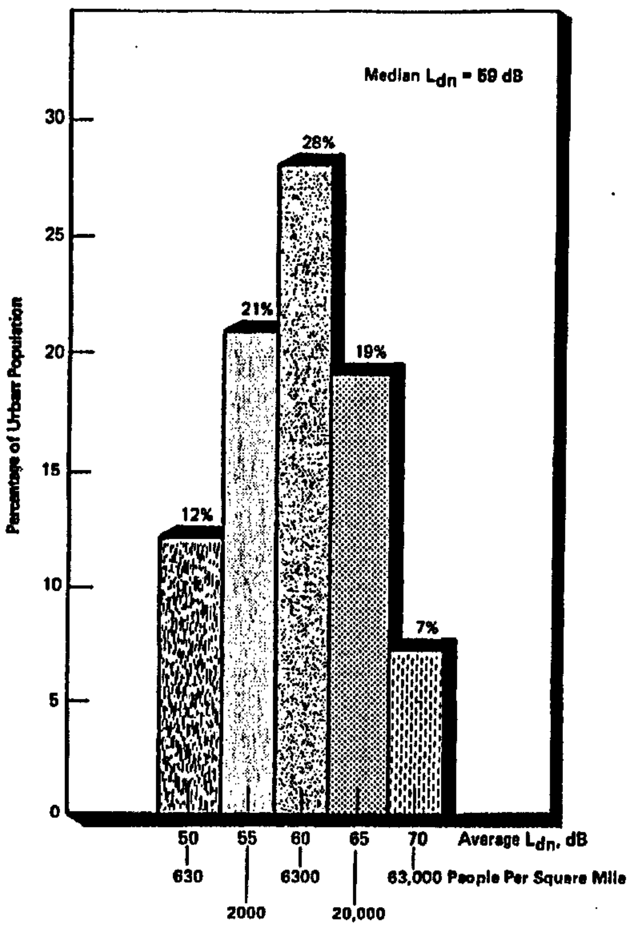

FIGURE 5. ESTIMATED PERCENTAGE OF URBAN POPULATION EXPOSED TO OUTDOOR DAY-NIGHT SOUND LEVELS DUE TO TRAFFIC

It is useful to know the number of people living in areas characterized by different levels of environmental noise. Figure 6 presents estimates for urban traffic, freeway traffic, and aircraft noise. The figure shows that urban traffic noise is much more widespread than either aircraft or freeway noise, but the figures are not strictly additive, because many of the people counted in one category are also exposed to another category of noise. Fifty-nine million people live in areas with urban traffic noise of L_{dn} = 60 dB or higher, in contrast to only 16 million and 3.1 million people who live in areas with outdoor levels of L_{dn} = 60 dB or higher for aircraft and freeway noise, respectively. On the other hand, more people are exposed to higher levels of noise from freeway and aircraft operations than from urban traffic: about 300,000 people live in areas exposed to levels of L_{dn} = 60 dB or higher from freeway traffic; 200,000 from aircraft operations; and 100,000 from urban traffic. Bear in mind, however, that there may be differences between individual at-ear exposure levels and outdoor levels, because people move from place to place for varying amounts of time.

Relationship Between Indoor and Outdoor Levels

The contribution of outdoor noise to indoor noise levels is usually small. That part of a sound level within a building caused by an outdoor source obviously depends on the source's intensity and the sound level reduction afforded by the building. Although the sound level reduction provided by different buildings differs greatly, dwellings can be categorized into two broad classes—those built in warm climates and those built in cold climates. Further, the sound level reduction of a building is largely determined by whether its windows are open or closed. Table II shows typical sound level reductions for these categories of buildings and window conditions, as well as an approximate national average sound level reduction.

Table II
Typical Sound Level Reductions of Buildings

	Windows Opened	Windows Closed
Warm Climate	12 dB	24 dB
Cold Climate	17 dB	27 dB
Approximate National Average	15 dB	25 dB

Sample measurements of outdoor and indoor noise levels during 24-hour periods are depicted in Figure 7. Despite the sound level reduction of buildings, indoor levels are often comparable to or higher than levels measured outside. Thus, indoor levels often are influenced primarily by internal noise sources such as appliances, radio and television, heating ane ventilating equipment, and people. However, many outdoor noises may still annoy people in their homes more than indoor noises do. Indeed, people sometimes turn on indoor sources to mask the noise coming from outdoors.

An example of the range of hourly sound levels measured inside living areas in plotted for each hour of the day in Figure 8. The figure shows the median levels and the range of levels observed for 80% of the data. During late night hours the typical hourly sound level was approximately 36 dB. This level was probably dominated by outdoor noise. However, during the day, the hourly average levels ranged from about 40 to 70 dB, indicating the wide range of activities in which people engage.

INDIVIDUAL NOISE EXPOSURE PATTERNS

During a 24-hour period, people are exposed to a wide range of noises, including noise at home, work, school, places of recreation, shopping establishments, and while enroute to these or other locations. Clearly, no single exposure pattern can be typical of all people, or even of those people who follow a common life style. Figure 9 shows hypothetical exposure patterns for broad classes of people. From these levels and some assumptions about the hours spent at different daytime activities, 24-hour average sound levels can be estimated for factory and office workers, housewives, and preschool and school-age children. Estimates based on these assumptions are found in Table III.

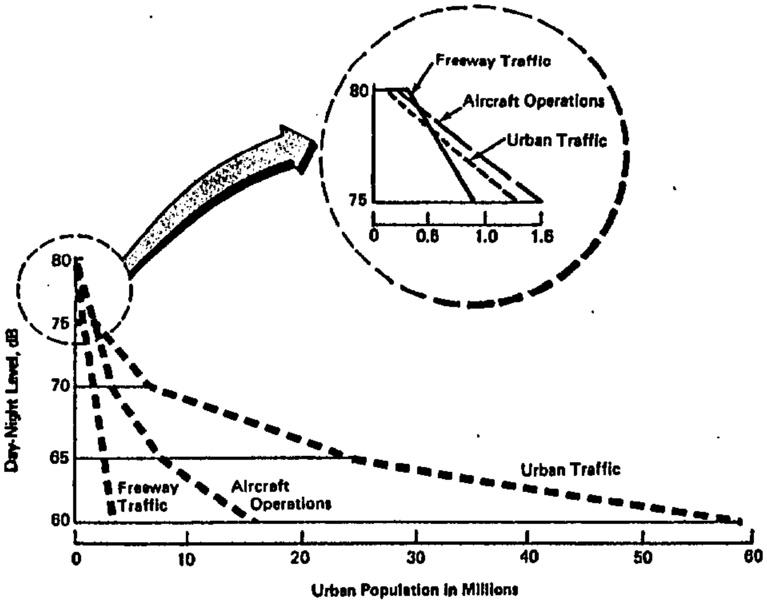

FIGURE 6. CUMULATIVE NUMBER OF PEOPLE IN URBAN AREAS EXPOSED TO OUTDOOR DAY-NIGHT AVERAGE SOUND LEVELS FROM DIFFERENT SOURCES

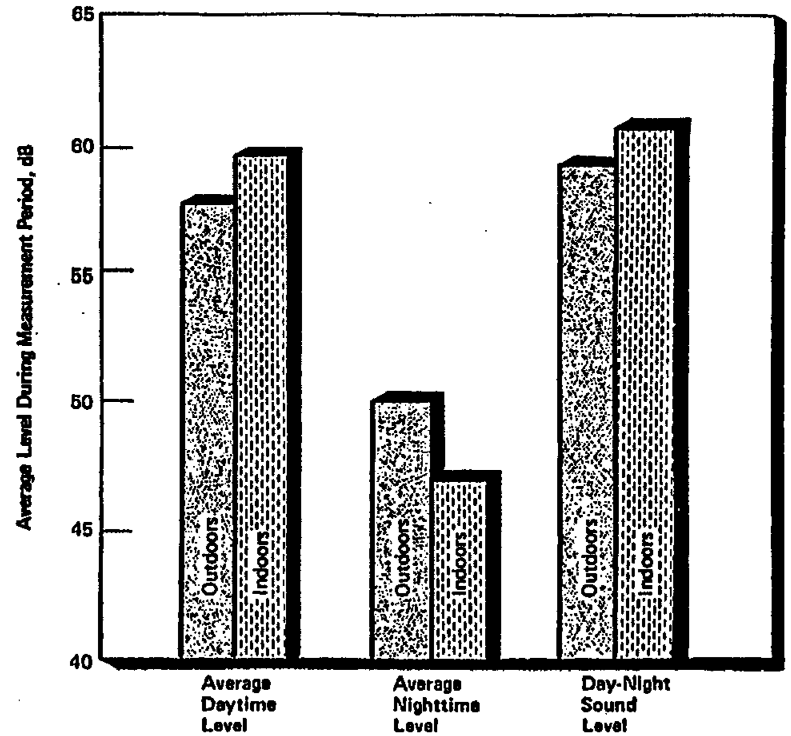

FIGURE 7. COMPARISON OF SAMPLE OUTDOOR AND INDOOR AVERAGE RESIDENTIAL SOUND LEVELS

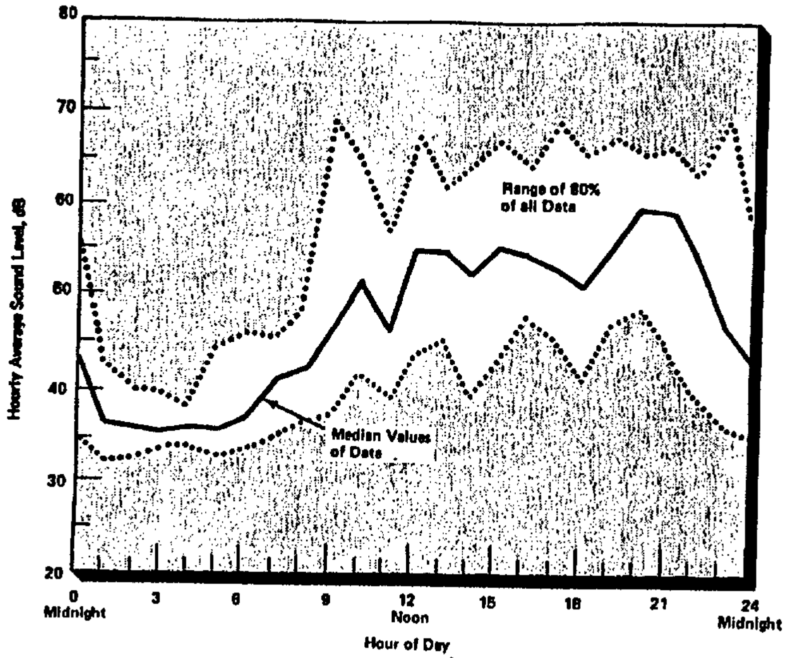

FIGURE 8. TIME PATTERN OF HOURLY INDOOR RESIDENTIAL SOUND LEVELS

For most people, nighttime noises do not contribute significantly to the 24-hour average. For many, the 24-hour average is determined primarily by the noise exposure of a single activity, frequently occurring for a short period of time.

Table III
Hypothetical Examples of Noise Exposures of Individuals

Individual	24-Hour Average Sound Level, dB Suburban Environment	Urban Environment
Factory Worker	87	87
Office Worker	72	70
Housewife	64	67
School Child	77	77

HEARING DAMAGE FROM ENVIRONMENTAL NOISE

There is no question that exposure to certain levels of noise can damage hearing. However, determining exposure levels that protect hearing with an adequate margin of safety is a complicated matter.

This is because hearing is a complex ability that cannot be summarized by a single number in the way an individual's height or weight can be described. In fact, sizeable differences exist between individuals' hearing abilities. Hearing acuity tends to change progressively with age. Also, environmental noise exposure may vary considerably from moment to moment, so that specification of protective levels should include dynamic considerations. Further, relationships between hearing damage and noise exposure must be inferred, since available scientific information was gathered from groups of people who differed not only in noise exposure, but also in other important ways. Finally, individual and group noise exposures (especially over a working lifetime) are rarely known with precision.

In reaching conclusions about hearing loss, then, one must rely to a degree on assumptions, hypotheses, and extrapolations from existing data. Since complete agreement within the scientific community on these matters is lacking, an attempt was made in the Levels Document to consider alternative assumptions and hypotheses to ensure that the methods used to derive protective levels were based on the most defensible practice. As new data become available these levels may change slightly.

Basic Premises Involved in Determining Protective Levels

1. Changes in ability to hear in the region of 4000 Hz are the most important signs of irreversible hearing loss, indicating actual physiological destruction within the hearing mechanism. This frequency is usually the first frequency affected when the ear is damaged by exposure to noise. Furthermore, the protection of hearing acuity at this frequency is critical for understanding of speech and appreciation of music and other sounds.

2. Changes in individual hearing level, like changes in height or weight, are only significant if they are sizeable. Changes smaller than 5 dB are considered insignificant.

3. At all ages, it is assumed that hearing acuity cannot be damaged by sounds that cannot be heard. This may be important in that aging and other causes may produce appreciable shifts in hearing.

4. Because hearing ability varies from person to person, recommendations must be made in terms of a critical percentage of the population, ranked with superior hearing over the remainder. EPA's recommendations were based on the 96th percentile—that is, on providing protection for 96% of the people. It is assumed that people with poorer hearing than the 96th percentile are not affected by noise of typical levels (see 3 above), so that the recommendations protect virtually the entire population.

5. An individual's total noise exposure is evaluated by an "equal energy" rule: two noise exposures are expected to produce equal hearing loss if the product of exposure intensity and exposure time are equal. This rule allows a 3-dB decrease in sound pressure level (expressed in dB) for each doubling of the duration. Thus an exposure of 76 dB for one hour is equivalent to 73 dB for two hours, or 70 dB for four hours. This procedure is probably accurate for exposures of 30 minutes or more. It is also more protective for very short exposures and for noise that fluctuates greatly in level.

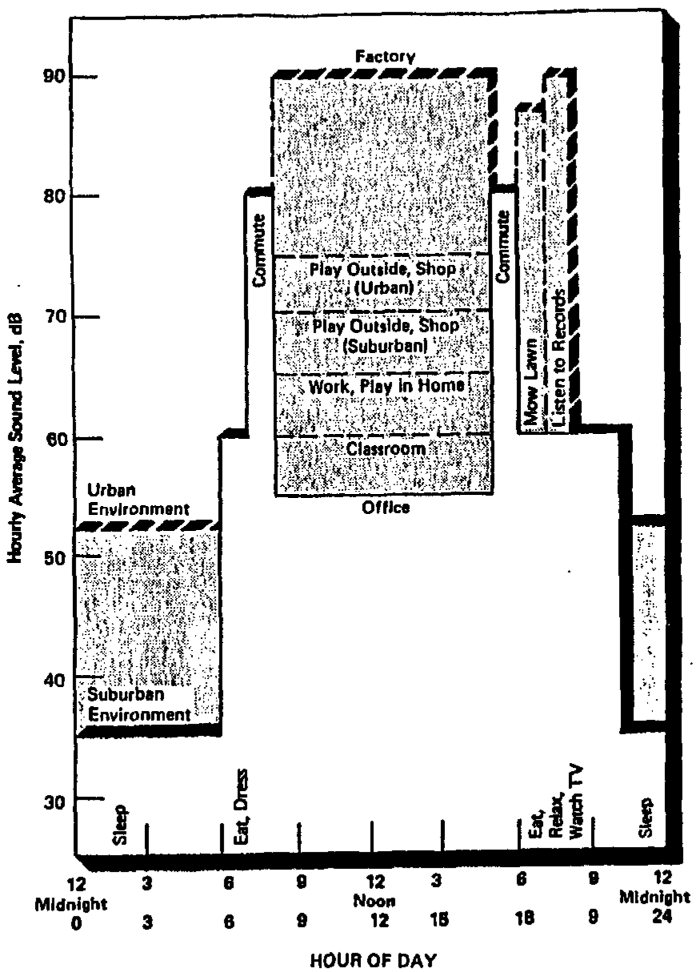

FIGURE 9. GENERALIZED INDIVIDUAL NOISE EXPOSURE PATTERNS

6. Intermittent noise produces less hearing damage than the "equal energy" rule would predict. To be considered intermittent for this purpose, a noise must fall below 65 dB for 10% of each hour and have peaks that exceed the background level by 5 to 15 dB. Intermittent noise is assumed to produce 5 dB less effect than does continuous noise of the same average level.

Calculation of the Maximum Allowable Noise Exposure

Three major scientific studies have attempted to assess hearing damage for various noise exposures. All are based on a comparison of groups of noise-exposed people and comparable non-exposed groups. All three studies attempted to predict hearing loss as a function of noise exposure of a certain percentage of people. Because these studies were of exposure to high-level noise, extrapolations of the data were necessary to estimate the protective exposure level that would produce minimal hearing loss: less than 5 dB at 4000 Hz for 96% of the people.

Forty years of exposure (250 working days per year) to a noise level of 73 dB for 8 hours per day was calculated to produce a hearing loss smaller than 5 dB for 96% of the people. This is the basic datum used to calculate hearing-protective levels of noise exposure. To use it in specific situations, certain corrections must be applied. One correction is to determine the yearly (rather than working day) level (250 to 365 days). This consideration amounts to a reduction 1.6 dB. Another correction, based on exposure on a 24-hour rather than 8-hour basis, produces an additional reduction of 5 dB.

Table IV contains at-ear noise exposure levels that produce negligible hearing losses for both 8-hour and 24-hour exposure on a yearly and working day basis. The 8-hour calculation assumes the remaining 16 hours of the day are spent in relative quiet.

Since an individual often experiences intense noise exposure outside of working hours (for example, while using noisy appliances or pursuing noisy recreation), protection on a 24-hour basis 365 days per year requires exposure of an intermittent variety at an equivalent level of less than 71.4 dB. This value is rounded to 70 dB to provide a slight margin of safety. Exposure to greater levels would produce more than 5 dB hearing loss in at least some of the population.

Table IV
(At-Ear) Exposure Levels that Produce No More Than
5 dB Noise-Induced Hearing Damage Over a 40-Year Period

		Steady (Continuous) Noise	Intermittent Noise	With Margin of Safety
L_{eq}, 8 hour	250 day/year	73	78	
	365 day/year	71.4	76.4	75
L_{eq}, 24 hour	250 day/year	68	73	
	365 day/year	66.4	71.4	70

Discussion of Assumptions

Several assumptions have been made in calculating the 24-hour yearly hearing-protective level of 70 dB. It is reasonable to ask how alternative assumptions would affect this level, and what the range of error might be.

Q. How would the recommended level be affected by a change in the percentage of the population protected?

A. Reducing the 96th percentile value to the 50th percentile (i.e., protecting half the population) would increase the protective level value from 70 dB to 77 dB.

Q. Since agreement on the value of the intermittency correction is imperfect, what other values might be used?

A. The estimated intermittency correction used in the Levels Document is 5 dB. The true intermittency correction is probably within the range 0 to 15 dB.

Q. How accurate is the equal energy assumption?

A. The equal energy assumption when applied to the long times (8 hours to 24, or 250 to 365 days) is fairly accurate. It may be subject to error when applied to short exposures of extreme level.

Q. How meaningful are the basic studies of hearing damage risk?

A. The probable errors of estimates in the three basic studies cannot be stated with absolute accuracy. There are a number of problems in extrapolating percentages of the population damaged from relatively high exposure levels to the protective level. Also, there is the problem of determining the amount of hearing damage when the control (non-exposed) population is subject to high levels of non-occupational noise. Thus, the 70 dB protective level is simply the best present estimate, subject to change if better data become available.

SPEECH COMMUNICATION

Communication is an essential element of human society, and speech is its most convenient form of expression. Interference with speech can degrade living directly, by disturbing normal social and work-related activities, and indirectly, by causing annoyance and stress. Sometimes the communications disturbed by noise are of vital importance, such as warning signals or cries for assistance. Prolonged speech interference and resulting annoyance are clearly not consistent with public health and welfare.

Speech interference from environmental noise can occur at home, at work, during recreation, inside vehicles, and in many other settings. Of chief concern for current purposes are the effects of noise on face-to-face conversations (indoors and outdoors), telephone conversations, and radio or television use.

The degree to which noise disturbs speech depends not only on physical factors (such as noise levels, vocal effort, distances between talkers and listeners, and room acoustics), but also on non-physical factors. The latter include the speaker's enunciation, the familiarity of the listener with the speaker's vocabulary and accent, the topic of conversation, the listener's motivation, and the hearing acuity of the listener. Years of research on speech intelligibility have produced considerable information about how these factors interact. Accurate predictions of speech intelligibility can be based on average noise levels and distances between speakers and listeners.

Speech Interference Indoors

The solid line in Figure 10 shows the effects of steady masking noise on sentence intelligibility for persons with normal hearing in a typical living room. At distances greater than about one meter from the speaker, the level of speech is fairly constant throughout the room.

The highest noise level that permits relaxed conversation with 100% sentence intelligibility throughout the room is 45 dB. People tend to raise their voices when the background noise exceeds 45-50 dB.

Speech Interference Outdoors

The sound level of speech outdoors decreases with increasing distance between speaker and listener. Table V shows distances between speaker and listener for satisfactory outdoor speech intelligibility at two levels of vocal effort in steady background noise levels.

The levels for normal and raised-voice "satisfactory conversation" shown in Table V permit sentence intelligibility of 95% at each distance. Ninety-five percent sentence intelligibility usually permits reliable communication because of the redundancy in normal conversation.

If the noise levels in Table V are exceeded, the speaker and listener must either move closer together or expect reduced intelligibility. For example, consider a conversation at normal vocal effort at a distance of three meters in a steady background noise of 56 dB. If the background level increases to 66 dB, the speakers either will have to move closer (to one meter apart) to maintain the same intelligibility, or alternatively, raise their voices appreciably. If they remain three meters apart without raising their voices, speech intelligibility would drop considerably.

Table V
Steady A-weighted Sound Levels That Allow Communication with 95 Percent Sentence Intelligibility Over Various Distances Outdoors for Different Voice Levels

VOICE LEVEL	COMMUNICATION DISTANCE (meters)					
	0.5	1	2	3	4	5
Normal Voice (dB)	72	66	60	56	54	52
Raised Voice (dB)	78	72	66	62	60	58

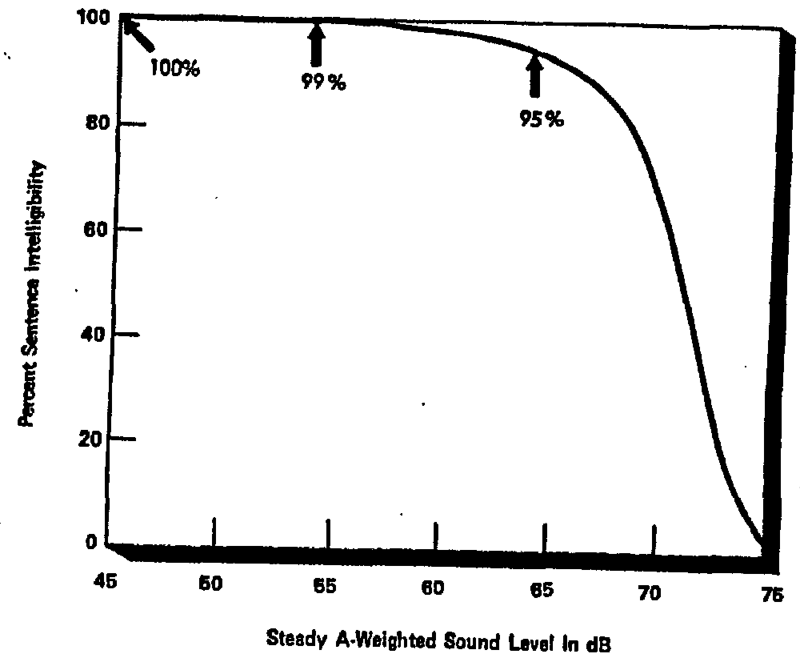

FIGURE 10. INDOOR SENTENCE INTELLIGIBILITY

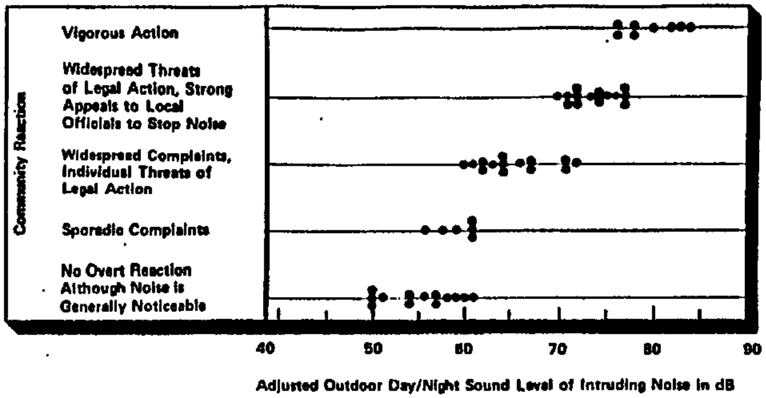

FIGURE 11. COMBINED DATA FROM COMMUNITY CASE STUDIES ADJUSTED FOR CONDITIONS OF EXPOSURE

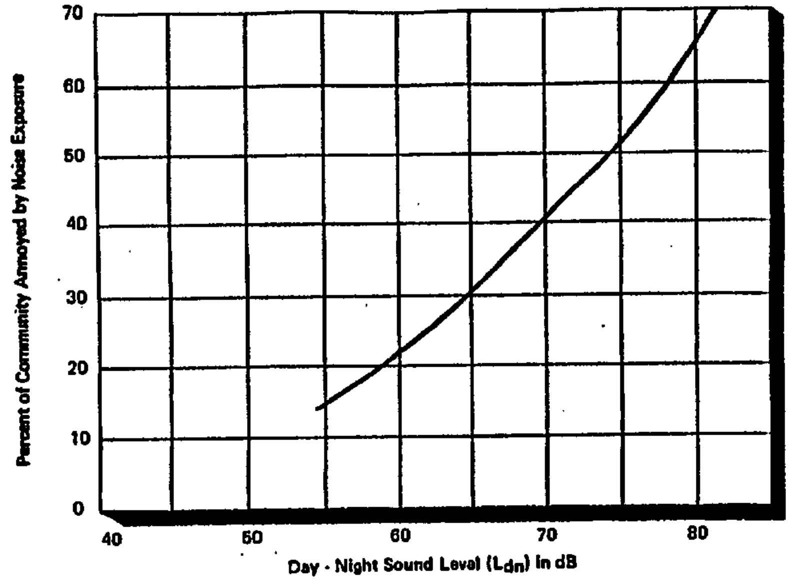

FIGURE 12. PERCENTAGE OF POPULATION ANNOYED BY COMMUNITY NOISE (HEATHROW AIRPORT STUDY)

Q. How is the margin of safety for annoyance applied?

A. The identified indoor level of L_{dn} = 45 incorporates a margin of safety for 100% protection of speech perception which is used as a surrogate for annoyance. The outdoor identified level of 55 L_{dn} protects speec. outdoors to a level of 95% intelligibility at up to 2 meters, while incorporating a 5 dB margin of safety for speech, and giving added weight to the range of adverse effects.

Q. Why is the nighttime penalty 10 decibels?

A. The 10 dB nighttime weighting had two bases: first, this weighting value has been applied successfully here and in other countries; secondly, in quiet environments, the natural drop in level from day to night is about 10 dB.

SUMMARY

On the basis of its interpretation of available scientific information, EPA has identified a range of yearly Day-Night Sound Levels sufficient to protect public health and welfare from the effects of environmental noise. It is very important that these noise levels, summarized in Table VIII, not be misconstrued. Since the protective levels were derived without concern for technical or economic feasibility, and contain a margin of safety to insure their protective value, they must not be viewed as standards, criteria, regulations, or goals. Rather, they should be viewed as levels below which there is no reason to suspect that the general population will be at risk from any of the identified effects of noise.

Table VIII
Yearly L_{dn} Values That Protect Public Health and Welfare with a Margin of Safety

EFFECT	LEVEL	AREA
Hearing	$L_{eq(24)} \leq 70$ dB	All areas (at the ear)
Outdoor activity interference and annoyance	$L_{dn} \leq 55$ dB	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	$L_{eq(24)} \leq 55$ dB	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	$L_{dn} \leq 45$ dB	Indoor residential areas
	$L_{eq(24)} \leq 45$ dB	Other indoor areas with human activities such as schools, etc.

Outdoor yearly levels on the L_{dn} scale are sufficient to protect public health and welfare if they do not exceed 55 dB in sensitive areas (residences, schools, and hospitals). Inside buildings, yearly levels on the L_{dn} scale are sufficient to protect public health and welfare if they do not exceed 45 dB. Maintaining 55 L_{dn} outdoors should ensure adequate protection for indoor living. To protect against hearing damage, one's 24-hour noise exposure at the ear should not exceed 70 dB.

MISUSES, MISUNDERSTANDINGS, AND QUESTIONS

Perhaps the most fundamental misuse of the Levels Document is treatment of the identified levels as regulatory goals. They are *not* regulatory goals; they are levels defined by a negotiated scientific consensus. These levels were developed without concern for economic and technological feasibility, are intentionally conservative to protect the most sensitive portion of the American population, and include an additional margin of safety. In short, the levels in Table VIII are neither more nor less than what Congress re-

quired them to be: levels of environmental noise requisite to protect the public health and welfare with an adequate margin of safety.

Q. Why doesn't the Levels Document explicity say how much noise is too much noise?

A. Decisions about how much noise is too much noise for whom, for how long, and under what conditions demand consideration of economic, political, and technological matters far beyond the intent of the Levels Document. Such decisions are properly embodied in formal regulations, not informational publications such as the Levels Document.

Q. How do I use this information for local purposes?

A. This question reflects the need to reconcile local economic and political realities with scientific information. People who formulate local noise abatement programs cannot escape the responsibility of making such economic and political compromises for their constituencies. The Levels Document does not impose arbitrary Federal decisions about the appropriateness of noise environments upon any level of government, nor is it a source of prescriptions for solving local noise problems. It is best viewed as a technical aid to local decision makers who seek to balance scientific information about effects of noise on people with other considerations, such as cost and technical feasibility.

Q. If the identified noise levels are indeed sufficient to protect public health and welfare, shouldn't they be considered to be long-range regulatory goals?

A. Attainment of the identified levels of environmental noise can only be considered idealized goals. Pragmatically, it is unlikely that local, state, or Federal regulatory strategies will seek to attain such levels for all situations in the near future.

Q. Why isn't the Levels Document more definite about specific effects associated with various noise exposure conditions?

A. Available knowledge about the effects of noise would not support more precise statements. Increasingly specific statements will be incorporated in future informational publications as they are justified by increasing knowledge of human response to noise exposure.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

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4. TITLE AND SUBTITLE Protective Noise Levels Condensed Version of EPA Levels Document		5. REPORT DATE November 1978 6. PERFORMING ORGANIZATION CODE ONAC
7. AUTHOR(S) EPA Office of Scientific Assistant to DAA/Noise		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS EPA/ONAC		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Environmental Protection Agency Office of Noise Abatement & Control (ANR-471) 401 M Street, S.W. Washington, D.C. 20460		13. TYPE OF REPORT AND PERIOD COVERED 14. SPONSORING AGENCY CODE EPA/ONAC
15. SUPPLEMENTARY NOTES		

16. ABSTRACT

This publication is intended to promote understanding of EPA's findings about levels of environmental noise that protect public health and welfare. It seeks to clarify the proper use of the 1974 "Levels Document" by interpreting its contents in less technical terms. The manual deals with measurement descriptors of environmental noise. Also addressed are the best understood effects of noise on people (hearing damage, speech interference and annoyance). Protective levels are summarized.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Environmental noise levels, indoor and outdoor levels, measurement descriptors, noise exposure patterns, hearing damage, speech interference, annoyance, protective noise exposures		

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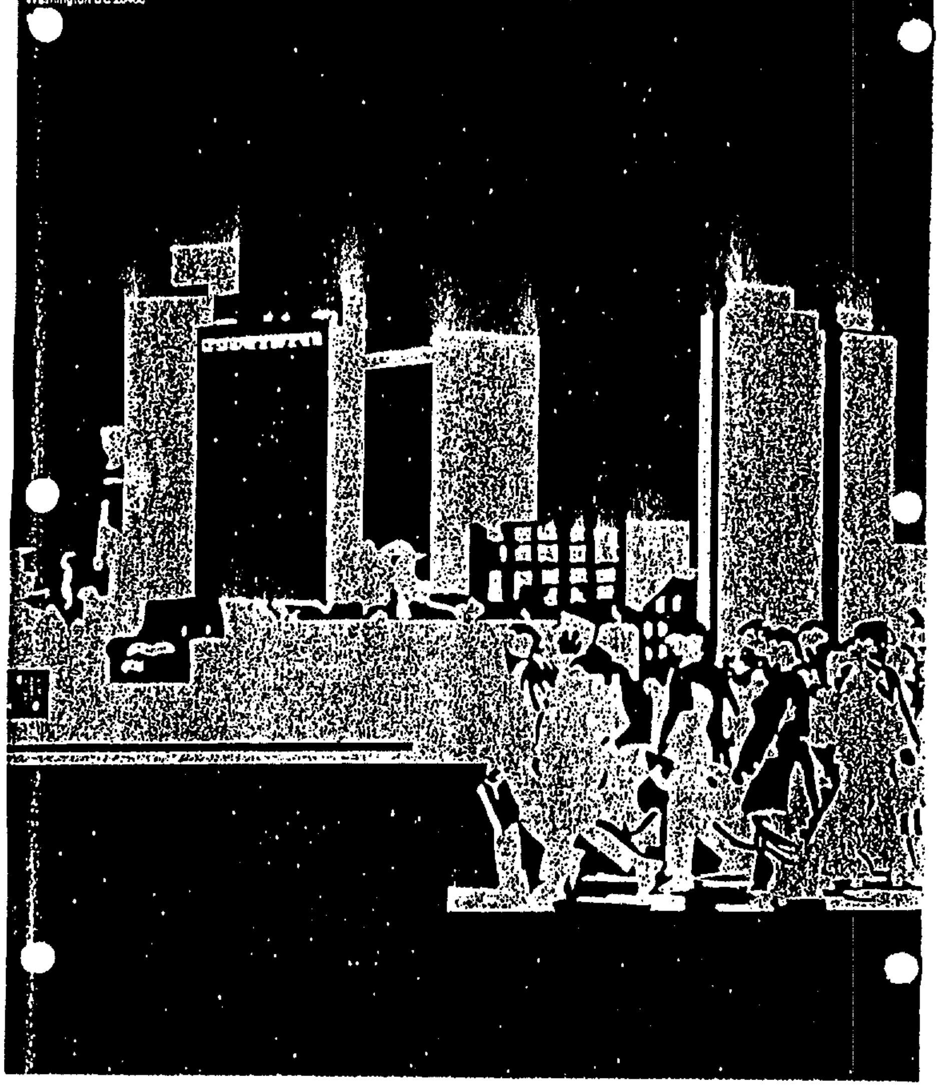

regression analysis procedure to develop a logistic[3] fit equation describing the relationship between DNL and %HA based on the updated data. A comparison of the logistic fit equations based on the original (161 data points) and the updated (400 points) data indicates that the predicted values are so similar (within about 1 percent) that no advantage would be obtained by replacing the original equation for describing the relationship (Fidell 1989).

The relationship is an invaluable aid in assessing community response as it relates the response to increases in both sound intensity and frequency of occurrence. Although the predicted annoyance, in terms of absolute levels, may vary among different communities, the Schultz curve can reliably indicate changes in level of annoyance for defined ranges of sound exposure for any given community.

2.4.2 Health Effects

Regarding public health effects, the "Levels Document" stated, "At this time there is insufficient scientific evidence that non-auditory diseases are caused by noise levels lower than those that cause noise-induced hearing loss." The "Levels Document" identified an $L_{eq(8)}$ not exceeding 70 dB (i.e. 8 hours per day) over a 40-year period for protection against noise-induced hearing loss (U.S. Environmental Protection Agency 1974). In 1981, the National Academy of Sciences, Committee on Hearing, Bioacoustics and Biomechanics (CHABA) was asked by the National Institute for Occupational Safety and Health (NIOSH) to consider research that might be performed to examine the effects on human health from long-term exposure to noise. The CHABA (Working Group 81), in their report, The Effects on Human Health From Long-Term Exposure to Noise, concluded that "evidence from available research is suggestive, but it does not provide definitive answers to the question of health effects other than to the auditory system of the long-term exposure to noise" (National Academy of Sciences 1981). Consequently, the issue of whether significant non-auditory health effects results from aircraft noise still remains and requires additional research.

2.5 Land Use Compatibility

Federal guidelines for compatible land use that take into account the impact of aviation noise have been devised for land near airports. They were derived through an iterative process that started before 1972. Independent efforts by the FAA, HUD, USAF, USN, EPA and other Federal agencies to develop compatible land use criteria were melded into a single effort by the Federal Interagency Committee on Urban Noise in 1979, and resulted in the FICUN Guidelines document (1980). The Guidelines document adopted DNL as its standard noise descriptor, and the Standard Land Use Coding Manual (SLUCM) as its standard descriptor for land uses. The noise-to-land use relationships were then expanded for FAA's advisory circular Airport-Land Use Compatibility Planning. The current individual agency compatible land use criteria have been, for the most part,

[3] A logistic fit equation is recommended in preference to the polynomial fit equations recommended in the Guidelines because it gives essentially the same predicted values in the range of interest (45 to 75 dB) and does not predict values of less than 0 or more than 100 percent.

AIR POLLUTION:
A STUDY
WITH PARTICULAR REFERENCE TO
SEATTLE-TACOMA INTERNATIONAL AIRPORT

BY
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Chairwoman
Environment Committee
REGIONAL COMMISSION ON AIRPORT AFFAIRS

November 8, 1992

Air Pollution:
A Study
With particular reference to
Sea-Tac International Airport

Air, noise and water pollution are associated with major population centers. Environmentally, all three combine to affect the biosphere, but only air pollution impacts every aspect of the environment. Air pollution damages the water quality of streams, rivers, fresh and salt water bodies. The earth's soil becomes saturated with the elements of air pollutants and becomes poisoned as well. It is the most frequent cause of biospheric environmental damage. Air pollution is also the most frequent cause of upper respiratory diseases. These pollution caused diseases result in severe economic losses to area businesses. This paper will concentrate on the adverse effects of air pollution as it applies to the region served by Seattle-Tacoma International Airport and twenty-eight other airports.

Air pollution, as we know it today, began during the agricultural revolution. Deforestation and burning to increase food production resulted in some soil erosion and particulate matter being emitted into the atmosphere. Overgrazing of grasslands and poor farming methods increased soil erosion. The industrial revolution compounded and intensified the original problems and created new ones. We are now confronted with pollutants in our soil, in the air and in the water. The accumulation of hazardous and radioactive wastes and long lived chemical and toxic substances in the air, on the land and in the waters is forcing us to review and attempt to understand how we have impaired our own ability to survive.

During the Apollo Flight, one of the astronauts said that the most disturbing part of the flight was the grayish haze over every land mass on earth. This ugly blanket (a thick, grayish brown pall) is smog -- a mixture of hundreds of different chemicals and pollutants. This is what we must deal with in our outdoor environment.

Our creation of agents of pollution such as chlorofluorocarbons has resulted in by-products which are destructive to the beneficial ozone layer of the stratosphere.[1] This beneficial ozone layer protects all forms of life from the harmful ultraviolet B (UV_b) rays of the sun. Excess UV_b radiation can cause cataracts, mutations in DNA which lead to skin cancers (including the often deadly melanoma). Excess UV_b rays can also threaten the yield of the world's basic crops. UV_b rays penetrate below the surface of the oceans, killing phytoplankton and krill which nourish larger fish and ultimately humans.[2] The United Nations Environment Program predicts a 26% increase in the incidence of nonmelanoma skin cancers worldwide if ozone (O_3) levels drop by 10%.[3] Furthermore, excess UV_b radiation affects the body's immune system, although to what extent has not been determined.

Trophospheric ozone is an air contaminant and must be controlled.[4] It is produced in two different ways: Noncatalytic reactions involving nitrogen dioxide (NO_2) and light, and by catalytic production involving hydrocarbons.[5]

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1 Pgs. 60 - 68, Lemonick, Michael D., The Ozone Vanishes, TIME, February 17, 1992

2 Pg. 61, IBID

3 Pg. 61 IBID

4 Pg. 4-26, Flight Plan Project, Final Programmatic EIS, Puget Sound Regional Council and the Port of Seattle, 1992

5 Pg. 3, AIR QUALITY ANALYSIS, Revised October, 1990, Puget Sound Council of Governments

The Seattle-Tacoma International Airport is the focus of debate because of the perceived need to expand. Sea-Tac is located on 2500 acres in King County which contains 2130.9 square miles[6] and 640 acres equals one square mile.[7] Simple computation shows that Sea-Tac occupies a mere 0.18% of the land in King County -- or less than 1/5 of 1%.[8]

What is the airport's contribution to air pollution in King County? This tiny pinpoint of land "contributes 8% of the carbon monoxide and 5% of the nitrogen oxide emissions in King County".[9] This concentration of air pollutants, reflected in the study requested by State Representative Greg Fisher, (D, 33rd District) has not been followed up by the staff at Seattle Tacoma International Airport. Airport staff is still "looking into" the problem. Staff has not yet determined what process to use to study air quality at the airport.

The October 2, 1992 editions of the *Seattle Times* and the *Post Intelligencer* carried a story about the Center for Disease Control's (Atlanta, Ga.) investigation into the increase of deaths from asthma. Air pollution is one of the factors under indictment as a cause of asthma. In a talk with community

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[6] Pg. 170, Washington's Almanac 1986, Evergreen Publishing Co., Seattle, Wa.

[7] Pg. 13, RANDOM HOUSE DICTIONARY OF THE ENGLISH LANGUAGE, Unabridged Edition, Random House, New York

[8] 2130.9 x 640 = 1,363,776 2500 ÷ 1,363,776 = 0.18%

[9] Pg. 15, Seattle Tacoma International Airport: Air Pollutant Contribution, May 1991, Department of Ecology

members on September 10, 1992, Dr. Gordon Baker, an allergist practicing in Burien, Washington said he found 34% of his patients with asthma residing in 4% of zip codes closest to Seattle Tacoma International Airport.

What cumulative effect occurs from all known sources of air pollution in the Puget Sound region, between the Cascade Mountains and Puget Sound? This region is severely impacted by many sources of pollutants. These sources include but are not limited to: shipping, air transportation, ground transportation, freight -- trucks and rail -- personal wood burning (indoors and outdoors), construction burns, logging burns, as well as commercial and industrial emissions and all kinds of leisure activity equipment and tools which utilize petroleum products.

Many of these sources of pollutants, such as aircraft, are included in a difficult to measure category because they are mobile sources. The Department of Ecology has certain specified regions in Washington State where accumulations of air pollutants can be ascertained and evaluated geographically. These mobile sources of pollutants are included in the category of "other sources"[10] but there are no documented cumulative and compounded effects of these mobile sources.

This paper will concentrate on pollutants registered in six counties of Western Washington in regions identified by the Washington State Department of Ecology: Snohomish, King, and

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[10] Pgs. 8 - 9, 1989-1990 ANNUAL REPORT, Air Quality Program, Washington State Department of Ecology, July 1991

Pierce Counties in the Puget Sound Region and Thurston, Whatcom and Skagit Counties in the Olympic-Northwest Region.[11]

Air pollution is commonly divided into two major categories:

CRITERIA AND TOXIC POLLUTANTS

Criteria pollutants consist primarily of the following elements: Total suspended particulates (TSP), particulate matter (PM_{10}), carbon monoxide, oxides of sulfur, oxides of nitrogen, hydrocarbons, ozone and lead (Pb). These criteria pollutants are constantly monitored 365 days per year by the Department of Ecology (DOE).

TOXIC POLLUTANTS

Toxic air pollutants are colorless and odorless. Unfortunately, toxic air pollutants are not yet regulated. Among the hundreds of chemicals are phenyl, benzene, dioxin, toluene, manganese, xylene, formaldehyde and chloroform. Not only are these pollutants toxic, many are known carcinogens. However, increasing attention is being given to them because of the potential effect to human health. In 1988, DOE began the process to regulate air toxins. In 1990, DOE started the laborious task of identifying and evaluating various toxic control strategies.

CRITERIA POLLUTANTS

Criteria pollutants -- carbon monoxide, nitrogen dioxide, sulphur dioxide, ozone, particulates, hydrocarbons and lead -- are common air pollutants and have been shown to be harmful to

[11] Pgs. 8 - 9, 1989-1990 ANNUAL REPORT, Air Quality Program, Washington State Department of Ecology, July 1991

human health and welfare.[12] Criteria pollutants are regulated according to federal and state levels. Monitoring of criteria pollutants is constant.

Carbon monoxide (CO) is deadly in high concentrations. It is the cause of many deaths. CO is a colorless, odorless gas and is the most frequently monitored component of air pollution. CO binds to the hemoglobin in the bloodstream and replaces the oxygen molecules reducing the blood's potential to carry oxygen throughout the body. This reduction in the body's ability to transport oxygen throughout the body has been found to cause heart difficulties in people with chronic diseases. It also reduces lung capacity which may aggravate arteriosclerosis.[13] Lack of oxygen has also been found to be a cause of impairment to mental abilities.[14]

Mobile sources which emit carbon monoxide and other pollutants are not fully monitored. Personal and business vehicles which rely on gasoline are monitored in much of the Puget Sound region and during the colder months of the year are required to run on oxygenated gas. Vehicles which use diesel fuel are not as stringently monitored. Jet aircraft are under

[12] Pg. 2, Seattle Tacoma International Airport: Air Pollution Contribution, May 1991, Department of Ecology

[13] Pg. 1, Air Quality Analysis, Revised, October, 1990, Puget Sound Regional Council and the Port of Seattle, 1991

[14] Pg. 1 and 4-27, IBID

the jurisdiction of the FAA and are beyond Washington State's demanding regulations.

The primary standard for CO is 35 parts per million (ppm) for one hour and 9 ppm for 8 hours. The Puget Sound region and the Southwest Region exceeded those standards in 1989 six times in four months. In 1990, standards were exceeded four times in three months.[15] The Puget Sound region is in nonattainment for carbon monoxide, particulate matter and ozone.[16] Nonattainment is defined as exceeding the standards set by Washington State.

Particulates are classified in two ways: total suspended particulates (TSP) which are composed of particles of 10 microns (about the size of a human hair) or less in diameter and particulate matter (PM_{10}) which consists of tiny particles of dust, sand, cinders, soot, asbestos, smoke and liquids found in the atmosphere. Suspended particles aggravate chronic disease and heart and lung disease symptoms. TSP amd PM_{10} often transport toxic elements such as lead, cadmium, antimony, arsenic, nickel, vinyl chloride, asbestos and benzene compounds throughout the body, often ending up in the respiratory, digestive and lymphatic systems.[17]

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[15] Pgs. 98-99, 1989-1990 ANNUAL REPORT, Air Quality Program, Washington State Department of Ecology, July, 1991

[16] Pg. 2, IBID

[17] Pg. 1, Air Quality Analysis, Revised 1990, Puget Sound Council of Governments

Adverse effects of both TSP and PM_{10} are the aggravation of "chronic diseases and heart and lung disease symptoms."[18] In the Puget Sound and Olympic-Northwest Regions TSP and PM_{10} come from many different sources: roads, fields, construction sites, factories, power plants, fireplaces, wood-burning stoves, windblown dust, diesel and car exhaust, ferry traffic, shipping and the region's numerous (two dozen plus) airports.

King County has begun regulating particulates from several sources: outdoor burning at all times; restricting the use of wood-burning stoves and fireplaces during specific weather conditions; and requiring gasoline powered automobiles to have emission tests every two years in order to be relicensed. Unfortunately many sources of criteria pollutants remain unaffected from such stringent requirements: aircraft, diesel-fuel burning vehicles, shipping, ferry traffic, off-road vehicles such as snomobiles and all kinds of other leisure-activity equipment including jet-skis, lawn mowers, blowers, etc.

Washington State has set standards for TSP at 60 micrograms per cubic meter.[19] In the regions being assessed, TSP standards were exceeded in the following months of 1990: February, April, May, July, September, October, November and

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[18] Pg. 1, AIR QUALITY ANALYSIS, Revised 1990, Puget Sound Council of Governments

[19] Pg. 29, 1989-1990 ANNUAL REPORT, Air Quality Report, Washington State Department of Ecology, July 1991

December. Fortunately, the amounts of TSP appear to be decreasing since monitoring in the regions began.[20]

The Puget Sound region (Everett-Seattle-Tacoma) is designated as a "non attainment" area for carbon monoxide, ozone, particulate matter (PM_{10}) and total suspended particulates.[21]

Oxides of sulphur (SO_2 and SO_3) become acidic by reacting with the moisture in the atmosphere. This creates a mist (acid rain) which damages the leaves and needles of trees and eventually kills the forests. Sulphur dioxide is known for its pungent, irritating odor and suffocating quality.

The oxides in the air we breathe must be filtered from the air to protect our respiratory system. Our sinuses are the filters of our bodies and they are working overtime.

Sulphur dioxide particles and other inorganic sulphates penetrate the mucosal lining and are intensely irritating to the bronchial mucosa, damaging the cilia and initiating bronchitis, producing asthma which decreases human respiratory function both at the acute and chronic levels. Exacerbation of other lung diseases also occurs.[22] SO_2 also aggravates symptoms of heart disease.

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[20] Pg. 88, <u>1989-1990 ANNUAL REPORT, Air Quality Report</u>, Washington State Department of Ecology, July 1991. See also, Pg. 3, <u>AIR QUALITY ANALYSIS, Revised October 1990</u>, Puget Sound Council of Governments

[21] Pg. 4-25, <u>FLIGHT PLAN PROJECT, Final Programmatic EIS</u>, Puget Sound Regional Council and Port of Seattle 1992

[22] Pg. 12, Dr. Ivker, Robert S., <u>SINUS SURVIVAL, Revised</u>, Tarcher/Perigee, 1992

SO_2 standards set by Washington State are 0.02 ppm as an annual average, 0.10ppm 24 hour average and a 0.40 ppm for one hour.[23] <u>According to the DOE, annual standards are never to be exceeded and short term standards are not to be exceeded more than once per year unless noted.</u> There were no documented exceedences during 1990 in the parts of the regions reviewed for this paper.

Nitrogen oxides provide color to the cloud of air pollution. They result from the high temperature oxidation of the nitrogen present in the air. Nitrogen oxides form particulates by coalescing into larger segments which reduces visibility and contributes to acid deposition. Nitrogen dioxide (NO_2) is the most prevalent of the nitrogen oxides.

NO_2 is a yellowish brown, highly poisonous reactive gas. NO_2 forms when fuel is burned at high temperatures. It is used as an intermediate in the manufacturing of nitric and sulferic acids. Internal combustion engines (automobiles and aircraft) and stationary fuel combustion sources are the two major sources of nitrogen oxide. NO_2 has a primary standard of 0.05 ppm.[24]

NO_2 increases the incidence of chronic bronchitis because it is a bronchoconstrictor.[25] NO_2 causes lung irritations resulting in ciliary paralysis, bronchitis and pneumonia. NO_2

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[23] Pg. 29, <u>1989-1990 ANNUAL REPORT, Air Quality Program</u>, Washington State Department of Ecology, July 1991

[24] Pg. 29, <u>IBID</u>

[25] Pg. 12, Dr. Ivker, Robert S., <u>SINUS SURVIVAL, Revised</u>, Tarcher/Perigee, 1992

exacerbates influenza by impairing the body's immune defenses against bacterial and viral infection.[26] Nitrogen oxides are also factors in the generation of secondary pollutants such as ozone. Both ozone and NO_2 impair humans in very similar ways. This is why the air pollution equation of compounding and cumulative effects of these pollutants needs to be thoroughly researched before more pollutants are added.

Hydrocarbons result from the release of unburned fuel or incomplete combustion of fuel. Internal combustion engines (automobiles and aircraft) are a primary source of hydrocarbons which play an important role in determining air quality. Other sources of HC emissions are the result of industrial processes, industrial and household solvents and fuel transfers.

Fuel misting by aircraft occurs mostly during takeoff and landing. This is because aircraft emit small quantities of unburned fuel containing hydrocarbons and particulates from the exhaust ports of jet engines. There is an intense odor when these episodes occur. "These emissions occur during take-off and landing and are most notable near the ends of the runways."[27] Fuel venting occurs mostly during an emergency, when fuel is jettisoned.

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[26] Pg. 12, Dr. Ivker, Robert S., SINUS SURVIVAL, Revised, Tarcher/Perigee, 1992

[27] Pg. 4-26, FLIGHT PLAN PROJECT, Final Environmental Impact Statement, Puget Sound Regional Council and Port of Seattle, October 1992.

Hydrocarbons mix with oxides of nitrogen in the presence of sunlight to form both ozone and NO_2. The amounts of hydrocarbons released increase ozone levels more than any other pollutant.[28] Hydrocarbons are highly irritating to the mucous membrane and make a generous contribution to upper respiratory distress.[29]

The compounding effects of NO_2, ozone and hydrocarbons on the entire earth's system must be researched. Each individual pollutant may not be harmful in small doses, but the compounding of all these pollutants and the cumulative effects are basically unknown because each is studied independently.

Ozone is found in two regions of the earth's atmosphere: the troposphere and the stratosphere. Ozone in the lower, breathable part of the atmosphere (troposphere) is produced when sunlight acts upon nitrogen oxides and hydrocarbons, producing NO_2 and ozone. This ozone is highly toxic and is regulated and monitored. Exposure to ozone "results in eye irritation and damage to lung tissues, reduces resistance to colds and pneumonia, aggravates heart disease, asthma, bronchitis and emphysema."[30] Stratospheric ozone is beneficial because of its protection against the UV_b rays of the sun.

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[28] Pg. 4, Appendix 2, Working Paper 12B, "Air Quality Assessment", The Flight Plan Project, 1992 Puget Sound Air Transportation Committee

[29] Pg. 13, Dr. Ivker, Robert S., SINUS SURVIVAL, Revised 1992, Tarcher/Perigee

[30] Pg. 4-26, FLIGHT PLAN PROJECT: Final Environmental Impact Statement, Puget Sound Regional Council, Port of Seattle, 1992

The beneficial ozone is attacked by chlorine atoms from the chlorofluorcarbons (CFC's). CFC's take one oxygen atom away from the ozone to form chlorine monoxide.[31] The chlorine monoxide then combines with another oxygen atom to form a new oxygen molecule and a chlorine atom. This process can go on indefinitely. In fact, "each atom of chlorine . . . could destroy up to 100,000 molecules of ozone."[32] This results in the destruction of the beneficial stratospheric layer of O_3 and leads to global warming. Human health effects due to the breakdown of the stratospheric layer of O_3 include increased mortality in the elderly and very young populations due to heat stress, increased preterm and prenatal births and increased diseases carried by fleas, ticks and mosquitoes.[33]

The newly formed oxygen molecules do not block the ultraviolet light, but allow it to penetrate to the surface of the earth where it is harmful to human and animal health, crops and forests. Although ozone is the air contaminant for which standards are set, its precursors (HC and NO_x) are the pollutants which must be controlled."[34]

Areas with the worst ozone pollution are also those areas with the largest populations and served by the largest airports:

[31] Pg. 63, Lemonick, Michael D., The Ozone Vanishes, TIME, February 17, 1992

[32] Pg. 62, IBID

[33] Pg. 4, AIR QUALITY ANALYSIS, Revised October 1990, Puget Sound Council of Governments

[34] Pg 1, IBID

Southern California, the Northeast, Texas Gulf Coast and Chicago-Milwaukee. Cities in California with the worst ozone pollution are Los Angeles-Long Beach, Riverside-San Bernardino and Anaheim-Santa Ana.[35]

The Seattle-Tacoma-Everett area with major shipping ports, a major international airport and over two dozen smaller airports, heavy road traffic, industry, large and small businesses has exceeded the primary standards for ozone levels of 0.12 ppm for a one-hour period in 1990 (two days in July and two days in August.)[36] The same area was declared as an Ozone Nonattainment Area in 1988. Ozone standards were exceeded in 1990 on three separate days at the monitoring site in Enumclaw. Because of these exceedences, the area will not be able to comply with the standard before late 1993 or early 1994. This assumes that the average of the three years is less than one exceedance per year. The Seattle-Tacoma-Everett area must attain the ozone standard no later than November 15, 1993.[37] (see attachment)

Growing scientific evidence indicates that ozone is a significant risk to human health. It appears to affect healthy as well as impaired respiratory systems in children and adults. Although no direct research on ozone and the sinuses has been done, the Air Pollution Health Effects Laboratory, University of

[35] Pg. 13, Dr. Ivker, Robert S., SINUS SURVIVAL, Revised, Tarcher/Perigee, 1992

[36] Pg. 33, 1989-1990 ANNUAL REPORT, Air Quality Program, Washington State Department of Ecology

[37] Summary Information, Seattle Ozone Nonattainment

California, Irvine has studied the effects of ozone on the nasal cavities of rats. Their findings of significant damage to the mucous membrane surrounding the opening to the maxillary sinuses as a result of inhaling ozone lends substance to the theory that ozone also damages the sinuses.[38] A recent study of ten and eleven year olds in Los Angeles shows lung capacity has diminished 17% compared to the normal range.[39] Autopsies performed by a pathologist at the University of Southern California on accidentally killed children show a "disturbing frequency of emphysematous changes previously seen only in adult lungs."[40] "Ozone can also cause shortness of breath and coughing during exercise in healthy adults and more serious effects in the young, old and infirm".[41]

Lead is an abundant metal. It is not readily excreted and therefore accumulates in the body within the blood, bones and soft tissue. Lead affects the kidneys, nervous system and blood-forming organs. Excessive exposure may cause nervous system impairments: seizures, mental retardation, behavioral disorders, miscarriages, stillbirths and defects of the newborn. Lead may

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[38] Pg. 14, Ivker, Dr. Robert S. SINUS SURVIVAL, Revised, Tarcher/Perigee, 1992

[39] Pg. 14, IBID

[40] Pg. 14, IBID

[41] Pg. 14, IBID

also contribute to high blood pressure and subsequent heart disease.[42]

Standards to protect the public health have been set by the Federal Clean Air Act. These standards use conclusive scientific and technical information available at the time the standards are set. They are set to provide a reasonable degree of protection from hazards that scientists may not have identified.

Air pollutants which affect the biota can also accelerate the deterioration of property, cause changes in economic values and become a threat to the quality of life.[43] Because air pollutants drift downward and settle in the soil, even those who buy "organic" food are impacted by chemicals. The food chain contains many chemicals which are harmful to our bodies. The food we eat may contain minute levels of toxic chemicals, but the compounding effect of all these chemicals can be disastrous.

Researchers (Falck, et al) analyzed fatty tissue from the breasts of 40 women, 20 of whom had cancerous lumps and 20 had benign lumps. In the fatty tissue from the breasts, Falck, et. al., found significantly higher levels of the extremely long lived and stable chemicals DDT, DDE and PCBs. Their conclusion is that the chemicals in the food and animal fat (fish, fowl and meat) accumulate in the fatty tissue.[44]

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[42] Pg.5, 1989-1990 ANNUAL REPORT, Air Quality Program, Washington State Department of Ecology, 1991

[43] Pg. 2, IBID

[44] Pg. 24 - 26, Michael Castleman, Telltale Tissue, SIERRA, November/December 1992

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Because of the implication that criteria air pollutants jeopardize human health, ongoing studies must continue. Sea-Tac Airport staff must be forced to begin the process of monitoring its own air pollution.

TOXIC POLLUTANTS

Toxic pollutants have generally not been subjected to rigorous scientific studies and are not highly regulated at this time. However, increasing attention is being given to them because of the potential effects on human health. These include but are not limited to the following toxic pollutants: phenyl, benzene, dioxins, toluene, manganese, xylene, chloroform and formaldehyde.[45] The Department of Ecology is concerned about existing toxic air pollutant sources. These sources generate complex control issues and pose great health risks to the general population.

Many of the toxic pollutants are known carcinogens with no set standards for an "acceptable level" to human, animal or plant health; however, there are industrial standards set for products which contain hydrocarbons and toxins.

Benzene is one of the more dangerous toxic pollutants. It is a known carcinogen. It is about 4% of hydrocarbon emissions. In 1984, the Radian Corporation estimated that roughly 12.7 tons of benzene were emitted at the airport.[46] Further estimates by

[45] Pg. 2, 1990 ANNUAL REPORT, Air Quality Program, Washington State Department of Ecology, July, 1991

[46] Pg. 7, SEATTLE TACOMA INTERNATIONAL AIRPORT: Air Pollutant Contribution, Department of Ecology, 1991

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the Radian Corporation are that the hourly average contribution of benzene at Sea-Tac airport is about 0.16 parts per million (or an average of 24,000 parts per trillion annually).[47] New WAC 173-460 proposes the acceptable impact levels for benzene at 0.083 parts per trillion.[48] How will the airport manage to reduce benzene to acceptable level?

At the airport, toxic pollutants are measured in metric tons per day, but a published baseline for 1992 is hard to find (if it exists.) A metric ton is 2204.62 avoirdupois pounds which is equivalent to 1000 kilograms.[49]

The Flight Plan Project Final Environmental Impact Statement projections for these toxic pollutants begins with the year 2000 and goes through 2010 to 2020. Where is the 1992 baseline for toxic pollutants in the Puget Sound region?

Anecdotal evidence points to a greater frequency of many kinds of cancers in residents close to Sea-Tac Airport. Therefore, in the words of Dr. Michael Horgan, hired as a consultant to the Flight Plan committee:

> "THE CLAIM OF CANCER CASES AT HIGHER THAN EXPECTED FREQUENCIES AROUND AIRPORTS CANNOT BE DISMISSED WITHOUT SYSTEMATIC INVESTIGATION."[50]

[47] Pg. 21, SEATTLE TACOMA INTERNATIONAL AIRPORT: Air Pollutant Contribution, Department of Ecology, 1991

[48] Pg. 21, IBID

[49] Pg. 903, RANDOM HOUSE DICTIONARY OF THE ENGLISH LANGUAGE, Unabridged Edition, New York

[50] Pg. 4-29, FLIGHT PLAN PROJECT FINAL EIS, Puget Sound Regional Council and Port of Seattle 1992

In 1987, Swedish scientists studied persons who had worked at an airport at some time in their adult lives. These workers had a greater frequency of brain cancers than persons matched for characteristics other than brain cancer.[51] Toxic air pollution emissions in the entire Puget Sound Region must be determined on a cumulative and compounded level.

There seems to be no plan to diminish criteria and toxic air pollutants from mobile sources other than internal combustion engines which are fueled by gasoline. Diesel and jet fuel sources are immune from these regulations. The contribution of emissions from the airport is viewed as inconsequential. Unfortunately, jet aircraft emissions permeate the atmosphere and leave residue on residential and business properties, in our lungs, on the ground and in the water.

QUANTITY OF EMISSIONS THROUGHOUT THE REGION

The Flight Plan Project was charged with identifying the amounts of emissions of air pollutants for the three airport system. This effort failed to take into consideration the CUMULATIVE AND COMPOUNDED effect of all emissions on the entire region. It is difficult to extrapolate from the information given in the Flight Plan Final Programmatic EIS how severely the region would be affected by any of the alternatives.[52] Sea-Tac is a "major indirect source of carbon monoxide, hydrocarbons,

[51] Pg. 4-29, FLIGHT PLAN PROJECT FINAL ENVIRONMENTAL IMPACT STATEMENT, Puget Sound Regional Council, Port of Seattle, 1992.

[52] Tables 4-6, 4-7, 4-8, 4-9A, 4-9B and 4-10, IBID

fine particulates and nitrogen oxides most of which are generated by aircraft operations and motor vehicle traffic".[53] Aircraft emission standards are implemented by the FAA. Washington State and the Environmental Protection Agency have no ability to apply standards to the airport or the aircraft.[54]

The Department of Ecology (DOE) has determined that carbon monoxide and hydrocarbon emissions generated by aircraft at Sea-Tac Airport occur in significant numbers when aircraft queue for take off and in taxiing in and out. The standard used by DOE for determining the amount of emissions is in metric tons. A metric ton (2204.62) is over 10% more than commonly used 2000 pound ton.

Carbon monoxide emissions total 1800 metric tons per year; hydrocarbon emissions are about 800 metric tons per year.[55] Climb and approach figures for CO and HC are 400 and 100 metric tons per year respectively.[56]

Nitrogen oxide emissions are 1200+ metric tons per year for climb and approach, 500 metric tons/year for takeoffs, 175 metric tons/year for queues and 100 metric tons/year for taxiing in and out.[57] Nitrogen oxides in aircraft exhaust generally oxidize to NO_2 and disperse over a wide area, reducing concentrations

[53] Pg. iv, SEATTLE TACOMA INTERNATIONAL AIRPORT: Air Pollutant Contribution, Air Quality Program, Department of Ecology, May 1991

[54] Pg. iv, IBID

[55] Pg. 18, Figures 4 and 5, IBID

[56] Pg. 18, Figures 4 AND 5, IBID

[57] Pg. 18, Figure 8, IBID

around the airport. It is probable that other pollutants disperse as well.

Sulphur oxide emissions are 900 metric tons/year when aircraft are in climb and approach, 40 metric tons/year while in a queue, 20 metric tons/year on takeoff and 20 metric tons/year taxiing in and out.[58]

Particulate emissions are 34 metric tons/year in climb and approach, 13 metric tons/year in queues, ten metric tons/year on takeoff and 9+ metric tons/year taxiing.[59] These numbers must be added together to find the true impact of air pollutants generated by Seattle-Tacoma International Airport's business.

Aircraft at Sea-Tac produce 3,050 metric tons per year of carbon monoxide emissions, 1300 metric tons/year of hydrocarbon emissions, 1950 metric tons/year of nitrogen oxide, 175 metric tons/year of sulfur oxide and 68 metric tons/year of particulate emissions. Compare these figures with motor vehicle emissions at the airport of less than 600 metric tons/year of all pollutants combined. (Figures have been totalled by estimation from graphs presented on pages 18 and 19, figures 4 - 8, SEATTLE TACOMA INTERNATIONAL AIRPORT: Air Pollutant Contribution.) Add 10% more to each of these figures to determine the impact: 6555.70 metric tons or 7211.27 tons per year.

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[58] Pg. 19, Figure 7, SEATTLE TACOMA INTERNATIONAL AIRPORT: Pollutant Contribution, Air Quality Program, Department ofEcology, May 1991

[59] Pg. 19, Figure 8, IBID

It is difficult to address all factors of air pollution with limits to amount of time and resources. I have not addressed the geophysical attributes nor weather patterns in this paper. However, both are important factors in air pollution monitoring. The region lies between two mountain ranges, contains large bodies of both salt and fresh water and has smaller plateaus and valleys. All these physical characteristics play an important part in air movement. Wind, rain, sun, snow, fog or the lack of these also impacts how, when or if the pollutants disperse and to where. Dispersal does not mean the pollutants disappear. Many of them remain with us far too long.

"Our environment is not infinitely resilient" and neither are we. "For too long we have assumed dominion over the environment and have failed to understand that the earth does not belong to us, but we to the earth."[60]

CONCLUSION

We must remember that chemical pollution threatens all forms of life. The serious effects of air pollution to this planet must be considered. We cannot always wait until there is indisputable evidence that serious damage is occurring before we try to halt the damage. The cumulative and compounded effects of air pollution is just one of the many dangers which can be avoided if there are monitoring safeguards for all forms of polluters. Aircraft and diesel burners (trucks, ships, cars,

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[60] Jeyanayagam, Samuel S., Ph.D, Daily Journal of Commerce, September 30, 1992

furnaces, etc.) must have regulations which provide for the capture and safe destruction of pollutants thereby preventing contaminants from being released into the air.

Automobiles which use gasoline are regulated and monitored. We must do the same for all other emission producers. It is not enough to point the finger at only one part of the problem, such as private vehicles, forcing these owners to comply with regulations when other sources are allowed to continue to pollute. All sources must be required to be clean. Special attention must be given to relatively small areas like Seattle-Tacoma International Airport with unacceptably high pollutant concentrations. We must be assured that such areas grow no worse as time progresses.

IT IS IMPERATIVE THAT THE STAFF AT SEATTLE-TACOMA INTERNATIONAL AIRPORT BEGINS TO DOCUMENT THE AIRPORTS AIR QUALITY WITH THE BEST AVAILABLE TECHNOLOGY, NOT THE LEAST EXPENSIVE.

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Draft - December 19, 1991

STATUTORY AFFECT OF DESIGNATING THE SEATTLE AREA AS AN OZONE NONATTAINMENT AREA UNDER THE ACT

Background

- The Seattle-Tacoma area was designated as a nonattainment area for ozone on March 3, 1978. This designation triggered the requirement to adopt and implement a Part D control strategy by January 1, 1979.

- The Part D control strategy for ozone was approved by EPA on June 5, 1980, and amendments were subsequently approved on September 14, 1981 and February 28, 1983. The strategy included Ecology and PSAPCA Part D new source review programs (LAER and offsets) and RACT regulations for existing stationary sources of VOC (all CTG's and all other major sources such as aerospace coatings).

- A maintenance plan was approved and the area was redesignated as an attainment area for ozone on January 2, 1987. The maintenance plan expanded the applicability of PSAPCA's RACT regulations to all of King, Snohomish, Pierce, and Kitsap counties.

Act Requirements for a New Marginal Ozone Nonattainment Designation

- The ozone standard must be attained by no later than November 15, 1993.

- A new Part D control strategy (or a revision to the existing strategy) must be submitted to EPA by no later than November 15, 1992. This submittal must include:

  - a comprehensive, accurate, and current emission inventory;

  - RACT corrections (by July 6, 1992, if not already submitted);

  - revisions to the vehicle inspection and maintenance program;

  - revisions to the Part D permit program (including an offset ratio of at least 1.1 to 1); and

  - provisions for periodic submittal of a revised emissions inventory, including a requirement for sources to submit annual emissions statements.

Implications for the Seattle-Tacoma-Everett Area

- There are already EPA-approved Part D control measures for ozone nonattainment areas which will go into effect immediately upon final designation of the Seattle-Tacoma-Everett area as an ozone nonattainment area (specifically, Ecology's and PSAPCA's RACT rules and Part D NSR provisions).

- Under the EPA-approved Ecology and PSAPCA permit rules, LAER will automatically become a requirement for new and/or modified major sources (those with the potential to emit more than 100 tons per year of VOC) which are permitted after January 6, 1992. Such new and/or modified major sources would have previously been only subject to BACT.
- A current emission inventory must be developed and submitted. This requirement impacts only the air agencies, not the sources.
- The required corrections to Ecology RACT regulations have already been adopted and submitted. However, PSAPCA will need to revise its rules to be consistent with the State's. Since PSAPCA's RACT rules have been in effect all along, this will have only minor impacts on existing sources.
- The State's vehicle I/M program must be revised and submitted. Since the I/M program needed to be revised to meet the carbon monoxide nonattainment area requirements, this will have no impact.
- The Ecology and PSAPCA Part D permit programs must be revised and submitted. The Act only requires minor changes to permit program requirements for marginal ozone nonattainment areas. However, Ecology/PSAPCA will have to decide whether or not to extend their Part D permit programs to major sources of nitrogen oxides.
- The periodic emissions inventory system must be established. Ecology and PSAPCA already require annual emissions reports; so this will have no impact.

Specific Provisions Not Required for a Marginal Ozone Nonattainment Area

- No new control measures are required by the federal Clean Air Act for marginal ozone nonattainment areas. The new control programs required by the Clean Air Washington Act of 1991 would be acceptable to EPA as elements of a revised Part D control strategy and as elements of a maintenance plan as well.
- No modeling analyses or other demonstrations are required to support a new or revised Part D control strategy.
- There is no requirement to adopt RACT regulations for new Control Technology Guidelines issued by EPA after the passage of the Clean Air Act Amendments of 1990.
- There is no requirement to lower the major source size cutoffs for the Part D NSR program. The size threshold for a major source remains at 100 tons per year, and for a major modification remains at 40 tons per year net increase.

SUMMARY INFORMATION

SEATTLE OZONE NONATTAINMENT

STANDARD: The level of the ozone standard is 0.12 ppm averaged over a one hour period. Areas are allowed to exceed the standard an average of once per year. The standard is measured over a three year period. In the simplest case, where an area has a complete data record from their monitoring sites, the standard can be exceeded no more than three times over a three year period.

Each area has an official ozone monitoring season. If the data record is not 100% complete for the entire season then some adjustment to the number of measured exceedances must be made to account for the possibility that exceedances occurred on days for which data are not available.

SEATTLE SITUATION: The maximum ozone monitoring site for the Seattle-Tacoma area is the Weyerhaeuser site in Enumclaw. This site measured exceedances of the ozone standard on three separate days in 1990. Since 21% of the days during the official season reported no values, the three exceedances were adjusted to account for the data gaps. The resulting number of exceedances ("expected exceedances") was 3.8 for 1990.

To determine compliance with the standard, the expected exceedances for each year over a three year period are averaged. If the average value is greater than 1.05, the standard is violated. Since 1990 includes a expected exceedance of 3.8, any three year average which includes 1990 will be greater than 1.05 (i.e. average of 3.8, 0.0, and 0.0 is 1.27 which is greater than 1.05).

WHEN CAN SEATTLE SHOW ATTAINMENT? Since any three years which include 1990 will violate the standard, the earliest that Seattle could show attainment is after 1991, 1992, and 1993 data are collected. The earliest attainment showing would be very late 1993, or early 1994. This assumes that the three years average less than one exceedance per year.

PROCESS FOR SEATTLE TO REDESIGNATE: State must 1) obtain three years of data which show attainment. 2) Determine emission inventory and project emissions into future years. 3) Demonstrate that the standard will be maintained into the future while considering economic and population growth. 4) Develop and submit plan to EPA requesting redesignation. 5) EPA reviews and approves maintenance plan and redesignation. The maintenance plan becomes an amendment to the state air implementation plan.

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Draft - December 19, 1991
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- There is no requirement to lower the major source size cutoffs for the Part D NSR program. The size threshold for a major source remains at 100 tons per year, and for a major modification remains at 40 tons per year net increase.

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Report on Planning by the Port of Seattle for Upcoming "Air Quality" Studies In and Around Sea Tac Airport

This reporter is a pathologist on the medical staff at Highline Community Hospital (HCH) and a member of the Health Subcommittee of the Environmental Committee regarding Sea Tac Airport expansion.

At the request of Mark Benedum (our subcommittee chairman) and at the invitation of the Port of Seattle (POS), I attended the "Airport Air Quality Working Group meeting" held at Sea Tac Airport on 8/24/92. The meeting was chaired by Michael Feldman (POS). As shown on the attached attendance list, multiple parties were represented including Department of Ecology (WA), EPA (Region 10), FAA, Puget Sound Air Pollution Control Agency (PSAPCA), U.W. Department of Environmental Health, Sea Tac Office Center, City of Sea Tac and, of course, POS. POS hopes that use of the air quality working group will lend credibility to any analysis performed. They profess to want real credibility and reliability of the studies.

Mr. Feldman stated that the meeting and pending studies had evolved because of multiple factors including (1) concerns raised from the 1991 Department of Ecology study using an "EDMS model" suggesting a significant potential impact of Sea Tac Airport on regional pollution (with particular reference to possible benzene "hot spots"), (2) A letter of concern written by the Medical Staff of HCH to PSATC, (3) Recent newspaper articles citing citizen concerns about possible relationships between Sea Tac Airport and cases of cancer in the adjacent neighborhoods, and (4) various comments made at the regional PSATC hearings regarding citizen concerns about air pollution and fuel dumping.

It was made clear that the POS wishes to perform "air quality" and emission studies to evaluate the situation and hopefully to allay various concerns or to enable the POS to mitigate problems which might exist. The clear reference was made by Mr. Feldman that if pollution problems are found, that a "more efficient" airport including a third runway might actually improve the situation (no mention being made of added motor vehicle traffic and 100,000 or more added flights per year!!). Mr. Feldman said that the POS has a 1992 budget of up to $50,000 for initial (pilot) studies. Multiple bids from several accredited local or regional testing laboratories had been obtained (ranging from about $35,000 to 55,000). The bids involving badge sampling (via passive diffusion) were favored by POS because that type of testing is about 25% less expensive than using evacuated canister sampling (or charcoal filter active sampling) followed by liquid or gas chromatography. Badge equipment would be less bulky and more easily and more safely placed in and around the airfield than would canister systems, according to Feldman.

A map of Sea Tac Airport was presented with about 10 sites proposed for testing on Airport property. The POS clearly wants to do a quick pilot study in 9/92 (using badges) to gather initial data. The implication was clear that if a decision is made to proceed with planning for a third Runway that more funds would be made available for more comprehensive and complete studies. September was felt to be a good month for sampling because of wind and weather conditions, and various committee members agreed.

Input from the group was welcomed by Mr. Feldman and included the following:

1. Dr. Sanders was concerned that the POS might only study one or two analytes including benzene and recommended doing a comprehensive analysis including benzene, hydrocarbons, carbon monoxide, nitrous oxide, sulfur dioxide, particulates, formaldehyde, etc.. Mr. Feldman stated that more than just one or two compounds would be studied but cited high costs of studying a large number of pollutants.

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2. Marsha Lee (EPA) was concerned that badge (passive diffusion) monitoring was not as accurate or sensitive or as established as using evacuated canisters or active sampling of known volumes of air over set periods of time. Canister methods can detect down to 1-2 parts per billion. Michael Morgan (an industrial hygienist from UW Department of Environmental Health disagreed in part and felt that badge testing was useful if accurately standardized. However, Ms. Lee stated that EPA has tried to avoid passive sampling in almost all of their previous studies. EPA recommends time-integrated active sampling methods. After much discussion and further input from Gerry Pade (PSAPCA), a consensus was reached that the gold standard for studies would be the very expensive use of on site gas chromatography. The next best method (next most established by previous studies and also acceptable to the EPA) would be to use evacuated canister sampling or active sampling of known air volumes over charcoal filters). The least preferred or established method would be using badges (passive diffusion). Mr. Feldman will discuss these issues further with EPA. Mr. Pade felt that active canister samplers could be readily anchored on the field and that such methods would add credibility to the studies.
3. A final important suggestion made by Mr. Pade (PSAPCA) and seconded by Dr. Sanders was that the POS should also include some sampling at remote sites off airport property in order to provide some comparative data re: pollution levels. Sites suggested included U.W. Campus, Bellevue, etc.. POS representatives seemed interested in doing some off site testing at some point but it wasn't clear if that would be part of a pilot study. POS said it might test at one of the Highline Schools, corner of 188th and Pacific Highway etc.. but timing was uncertain.

Conclusions and Recommendations:

Local citizens, RCAA and Rick Arambaru, et. al. should monitor the pending studies and data very carefully. If the POS uses only badge monitoring without parallel canister/active monitoring, questions of validity could be raised, especially in view of the concerns raised by the EPA and PSAPC representatives. Also, if a significant number of types of pollutants from both motor vehicles and airplanes in and around Sea Tac Airport are not measured, the study would be less than thorough or comprehensive. Also, if enough off-site comparison locations are not studied, the needed comparative data would be missing or at least incomplete. Finally, we must be aware that if pollution problems (and/or fuel dumping problems) are identified by any of the pending studies, then POS will probably use those findings to support building a "more efficient" airport including a third runway as a means of reducing rather than increasing air pollution.

Respectfully submitted,
Lee A. Sanders MD, PhD
8/26/92

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THE ADVERSE HEALTH IMPACTS OF AIRPORT EXPANSION
WITH PARTICULAR REFERENCE TO
SEA-TAC INTERNATIONAL AIRPORT

From the Health Subcommittee of the Environmental Impact Committee of the Regional Coalition on Airport Affairs

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10/5/92

SUMMARY OF ADVERSE HEALTH EFFECTS OF AIRPORTS

Fiction:
Airport noise is a minor annoyance and people living near the airport should be "good sports" and learn to ignore it.

Fact:
Airport noise results in a significant increase in community use of tranquilizers and sleeping pills. Airport communities have an increased rate of alcoholism, and admissions to psychiatric hospitals. Airport-related noise can literally drive people mad.

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Fiction:
Communities near the airport offer affordable housing and would be suitable for young families.
Fact:
Infants born to mothers living under the flight path have lower birth weights and higher likelihood of prematurity. There is some experimental evidence to suggest that serious birth defects are more likely when the mother is exposed to high noise levels during pregnancy. Airport communities are unsafe for pregnant women and their children.

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Fiction:
Although it is annoying, airport noise will not affect your physical health.

Fact:
Excessive noise has been positively associated with the development of hypertension, high cholesterol, and high

blood sugar, all of which place people at increased risk of heart disease and stroke.

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Fiction:
Sea-Tac airport has become so quiet in recent years that it no longer impacts learning in our schools.

Fact:
Speech and communication are affected when noise levels exceed 60 decibels. Excessively noisy schools have been shown to adversely affect the ability to solve simple problems as well as to learn mathematics and reading. Actual noise measurements in several Highline Schools in 1992 exceeded 85 decibels in the class room and 100 decibels in the school yard. Since the beginning of jet traffic at Sea-Tac airport, standardized test scores in the Highline School District have fallen from among the highest in the state to the third from the bottom.

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Fiction:
Airport-related noise is merely an annoyance to neighboring citizens and has minimal impact on sleep patterns or sense of well-being.

Fact:
On a typical recent weeknight at Sea Tac Airport, at least 110 planes including more than 70 jets took off or landed between 10:00pm and 7:00am. The level of noise produced severely impacts thousands of people in South King County. Disturbance of sleep is one of the most significant sources of distress caused by airport noise. Airport noise causes difficulty in attaining deep sleep, shortened REM sleep, and

premature arousal from sleep. Both deep and REM sleep are thought to be physiologically important. Sleep deprivation leads to impaired reaction times, fatigue, lethargy, decreased efficiency, anxiety and desire to be left alone.

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Fiction:
Sea Tac Airport is only a minor contributor to regional air pollution.

Fact:
A 1991 State Department of Ecology study indicated that Sea Tac Airport operations generate up to 5% of all air pollution in King County. The bulk of this pollution occurs over a relatively very small area (less than 0.25% of the area of King County) leading to relatively high and potentially damaging concentrations of various pollutants and particulates.

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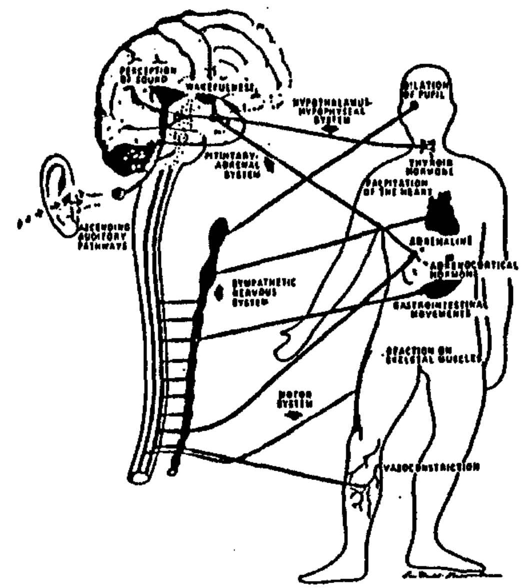
Fiction:
Detailed studies indicate no increased risk for development of cancer in communities nearest the airport.

Fact:
The study of cancer and its causes is highly complex. To date, no detailed comparative studies of actual cancer incidences have been performed to address this crucial question. 1990 U.S. Census Tract data programs necessary for beginning such studies will not be available to the Fred Hutchinson Cancer Research Center until early in 1993.

NOISE- GENERAL EFFECTS

Noise is considered to be a non-specific biologic stressor, eliciting a response that prepares the body for "fight or flight". The physiologic mechanism thought to be responsible for this reaction is the stimulation by noise of the brain's reticular activation system[1]. Neural impulses spread from the reticular system to the higher cortex and throughout the central nervous system. By means of the autonomic nervous system, noise can influence perceptual, motor, cognitive, behavioral, glandular, cardiovascular, and gastrointestinal function. "Noise promotes stress and anxiety, disrupts sleep and is a major threat to human health"[2].



(Figure 1)

Mental Health

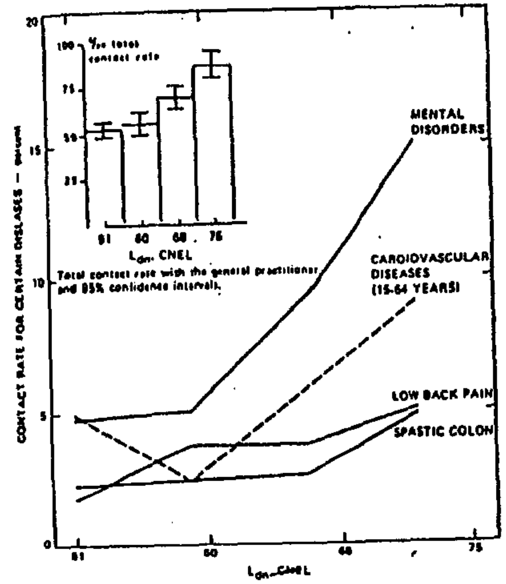
Over 60% of people in heavily noise-impacted areas complain of moderate to severe annoyance with airport noise. Chronic annoyance results in increased need for and use of sedative hypnotic medications and an increase in the frequency of nervous breakdowns. Studies have shown a marked increase in the use of tranquilizers and sedatives around jet airports [3,4], and an increase in the rate of alcoholism and its associated medical problems [5]. Experts have said that noise heightens aggressive behavior and dampens helpful impulses, which may in part explain an increased incidence of crime and domestic violence in airport communities[6]. Many studies have shown an increased number of psychiatric admissions from noise-impacted neighborhoods around jet airports [7,8,9,19,11]. More than simply being annoying, airport noise can have a measurable impact on mental health (see Figure 2).

Cardiovascular Disease

Cardiovascular disease is the number one cause of death in this country. Hypertension is second only to smoking as a cause of cardiovascular morbidity and mortality. Workplace noise of 85 to 95 dBA produces sustained hypertension in monkeys, even after the stimulus is withdrawn [12]. Systolic and diastolic hypertension has been produced experimentally in elderly people exposed to recorded aircraft noise [13]. Hypertension has also been demonstrated in school children under a jet flight path [14]. Prescriptions for antihypertensive medications gradually doubled in one airport community after the building of a new jet runway [15]. Similar observations have been made in other communities [16]. The result of excess hypertension in airport noise-impacted communities may well be an increase in heart disease and strokes. A study of 6000 noise-impacted people near the Amsterdam Airport found an increase in the use of

cardiovascular drugs, an increase in the medical treatment of heart disease, and an increase in pathological heart shape on x-ray in people exposed to aircraft noise[17]. One author has reported a 15% increase in the incidence of stroke near the L.A. International Airport compared to quieter communities[18]. Another study has failed to substantiate this finding [19].

In addition to raising blood pressure, noise can affect at least two other important risk factors for cardiovascular disease. A large epidemiologic study on road noise found that noise-exposed people had higher blood cholesterol levels, and higher blood glucose levels, both of which are associated with heart disease and stroke. The public health implications of these findings in a noise-exposed, urban population could be enormous[20]. Note the striking effects of increasing noise levels on mental and cardiovascular disease (Figure 2).



Pregnancy and Birth Defects

Heavily noise-impacted areas around jet airports are probably unsafe for pregnant women. Several studies have shown reduced birthweights and a higher rate of preterm labor and premature births in airport communities[21,22,23]. Studies have shown decreased fertility rates and increased birth defects when laboratory animals were exposed to loud noises during pregnancy [24]. One study has found an increase in the rates of neural tube defects (spina bifida and anencephaly) in children born to women living under the flight path of a large international airport [25]. Another study found a similar increase but felt it was statistically insignificant [26].

Gastrointestinal Disease

The effects of chronic noise exposure are not limited to the cardiovascular system. The Environmental Protection Agency (E.P.A.) has reported that people working in noisy areas have 5 times as many stomach and duodenal ulcers as the general population[27]. One study found that prescriptions for antacids, commonly used to treat ulcers and related acid peptic problems, nearly doubled in a community after the building of a new jet runway [28]. Another author found a 100% increase in the rate of cirrhosis of the liver related to alcoholism around a large international airport [29].

Immunology

Experts have also claimed that loud and disturbing noises trigger changes in circulating hormones and may lower resistance to disease and infection[30].

Learning Disabilities

Several Highline schools (up to 6000 students) are located in heavily noise-impacted areas. Sound measurements done in schools in the Highline district in 1992 recorded levels of 85 dBA in the classrooms[31]. Noise levels outside the schools reached 100 dBA. Noise begins to interfere with speech and learning when it exceeds 60 dBA. Although airport authorities would prefer to describe the noise as a day-night average (LDN) of 65 to 75 decibels, the actual effect in the classroom is similar to starting a gasoline lawn mower or running a food blender every 2 to 3 minutes. Studies have shown that students in noisy classrooms are more likely to read at least 1 year below grade level compared to students in quiet classrooms [32]. Another study found that children in schools exposed to airport noise were more likely to give up on a task, and less likely to succeed at simple problem solving compared to students in quiet schools. These effects were most marked in students who had been attending the noisy school the longest[33].

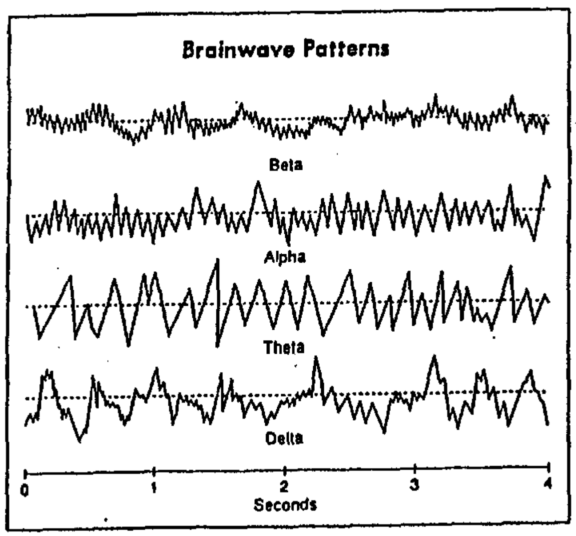
Mathematics testing was carried out in the Highline School District during the 1970's by Dr. Breysse of the University of Washington. He found that students in the noisiest schools did significantly worse on standard mathematics testing when compared to students studying in quieter schools in the same district. Highline School District M.A.T scores have fallen from among the best in the state to the 3rd lowest in the state concomitantly with the growth of jet aircraft traffic at Sea-Tac airport. For many students, the noise is not limited to the school environment. Many students live in homes impacted by aircraft noise. They arrive at school tired and inattentive from sleep disturbance and are expected to listen and concentrate in class rooms where noise levels significantly interfere with their education[31].

Sleep and Speech Disruption

Electrical brain activity as measured by the electroencephalogram (E.E.G.) indicates four states of consciousness according to certain brainwave patterns[34]:

BETA	>13 hz	Normal state of alertness, stress, anxiety
ALPHA	8-12 hz	State of light relaxation, super learning, positive thinking
THETA	4-7 hz	Deep relaxation, meditation, increased memory and focus
DELTA	1-3 hz	Deep sleep, lucid dreaming

(Figure 3)



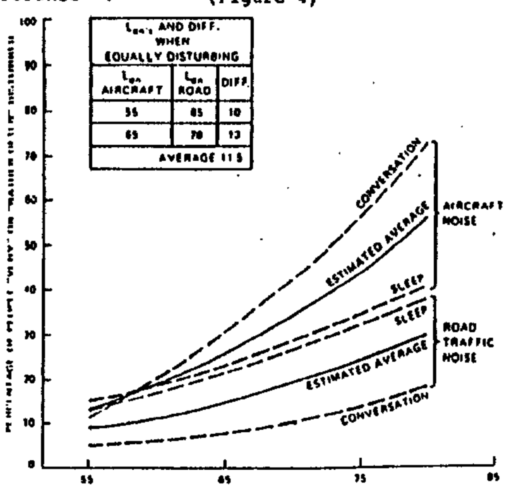
Sleep researchers described the drowsy period just preceding Stage 1 sleep as being characterized by a slowing of the alpha rhythm (8-12 hz) accompanied by slow rolling eye movements (SEM). As Stage 1 sleep is attained, the slowed alpha rhythm begins to break up and is replaced predominantly by an even slower, smaller amplitude (lower voltage) theta rhythm (4-7 hz) associated with unconsciousness. Deep sleep and lucid dreaming (Stages 3 and 4 Sleep) follow in association with rapid eye movements (REM) and a delta rhythm (1-3 hz)[34,35].

Disturbance of sleep is probably the most widespread source of distress caused by noise. Indoor threshold for falling asleep is 35 - 40 dBA. The indoor threshold for arousal from deep sleep is 70 dBA. Children are less susceptible and the elderly are more susceptible. Disruptions of sleep lead to symptoms of fatigue, lethargy, decreased efficiency, anxiety, and desire to be left alone [36].

According to one sleep study, 10% of people living 19 kilometers from Kennedy Airport reported difficulty sleeping compared with 60% of those within 6 kilometers of the airport. Falling asleep takes considerably longer with peak levels of 60 dBA and ambient levels of 50 dBA. Forty to 50 dBA are capable of changing the stage of sleep without producing complete awakening. The threshold for complete awakening is variable but violently fluctuating noise is the worst. Complete awakening can be seen with an increase of only 10 dBA over baseline. A study in a community in France done before and after the opening of a new noisy road found that noise levels of 40 +/- 3 dBA and peaks of only 55 +/-5 dBA caused people to take 16 minutes longer to fall asleep. Since deep and REM sleep are thought to be physiologically important, sleep impairment may well be damaging.

People living in very noisy houses did worse in measurements of unprepared reaction time after noisy nights and showed improvement after simple sound insulation. This research supports the recommendation that night time noise levels not exceed 35 dBA[36].

Ldn 55 from aircraft noise is equivalent to 50 daily episodes of aircraft noise with a peak level of 81 dBA. Noise can interfere with sleep at or above 40 dBA and will interfere with speech communication at or above 50 dBA. Each disruption lasts for about 1 minute, and there are at least 25 million U.S. citizens exposed to Ldn 55 or higher. At Dallas Fort Worth airport, Ldn 55 is not reached until 6 miles from the end of the runway. Intermittent noise such as aircraft noise is much more annoying and disruptive than continuous noise such as noise generated from traffic. Aircraft noise at an Ldn of 55 could cause interference with sleep and communication whereas Ldn 55 automobile noise would be below the threshold levels capable of such interference[37]. (Figure 4)



Additional information regarding sleep disturbance and its impacts appeared in the 3/15/92 edition of the Seattle Times in Bob Ortega's article entitled "Life Beneath the Roar -- Escaping Jet Noise Means Sleeping in the Basement and Turning on the Radio" The following is a brief excerpt from "Life Beneath the Roar"[31]:

> "If you change the quality of sleep on a chronic basis, in the long run it will affect your health," says Peter Breysse, professor emeritus of environmental health at the University of Washington. Even when people aren't awakened, he said, noise can disrupt the dream and deep-sleep cycles.
>
> On a typical recent week night, at least 110 aircraft, including more than 70 jets, landed or took off from Sea-Tac between 10:00pm and 7:00am. According to Port records, among them were at least 24 Boeing 727s and other louder, older jets.
>
> Within two miles of the airport, consultants to the port have measured peak noise from older jets reaching 100 decibels - about as loud as a diesel locomotive trundling directly across the street.
>
> "People believe they get used to night-time noise," said Alice Suter, a Cincinnati-based research audiologist. But studies show that even after five years of exposure to aircraft noise, physical responses - higher blood pressure, higher stress levels - continue..."

asthma, decreased lung function and capacity, emphysema, sinusitis, rhinitis, sore throat, chest congestion, wheezing and runny eyes or ocular (eye) burning.

In spite of the significant concerns long-raised by local citizens and by the 1991 Department of Ecology Study, the Port of Seattle (P.O.S.) currently "has no data" regarding its emission levels (quoting P.O.S. representative Michael Feldmann during the Air Quality Study meeting of 8/24/92; see Appendix I). However, the Port is planning to perform "Pilot Studies" of "Air Quality" -- probably beginning in the near future (possibly in Fall, 1992).

At the recent planning meeting for the upcoming "Air Quality Studies", there seemed to be considerable initial differences of opinion between Port officials and the representatives from both the E.P.A. and the Puget Sound Air Pollution Control Agency over whether to use badge monitoring (passive diffusion) or the more expensive but more generally accepted evacuated canister sampling methods. Please refer to the report of that planning meeting included as Appendix I for further details.

CANCER

"Cancer" implies malignant neoplasm (new growth). Most cancers have the capability of killing their host either by direct spread from their site of origin or by metastasis to distant body sites via the blood or lymphatic systems. The study of cancer is highly complex in part because there are so many types of cancers for each human organ system. In addition, the causes of cancer seem to be multifactorial -- often involving multiple different physiologic insults working cooperatively through repeated exposures over a long period of time.

Among the known causes of cancer (carcinogens) are the following: ionizing radiation (X-rays, gamma-rays), viruses (Human papilloma virus with cervical cancer, Epstein Barr virus with nasopharyngeal cancer and with lymphoma, etc.), chemicals (benzene with leukemia, aniline dyes with bladder cancer, hydrocarbons in soot with scrotal cancer in chimney sweeps, etc.), ultraviolet light with various skin cancers, tobacco smoke with lung cancer, asbestos with malignant mesothelioma, etc.

Due to the long latency period between exposure to chemicals such as benzene and the development of disease, it may not be possible to detect an increased incidence of cancer in airport communities. The problem is compounded by the fact that thousands of people with previous lengthy exposures have left the Sea Tac area over the past 20 years. (1200 families were moved out of the immediate Sea Tac community north end between about 1973 - 1978 according to Ms. Rose Clark, (personal communication). None of these people will show in any current epidemiologic studies).

Dr. Lee Sanders has requested the Fred Hutchinson Cancer Research Center (F.H.C.R.C.) to conduct preliminary studies to determine the relative proportions of breast cancer, colorectal cancer, lung cancer, leukemia and lymphoma in the areas surrounding the airport. In these initial studies, there were no definite increases in the ratios of one cancer compared to another, suggesting that at least the relative proportions of these diseases are no different near the airport than in non-airport-impacted communities.

The study of proportional variations of various cancers is a useful but relatively crude screening tool. David B. Thomas, M.D., Dr. P.H., of the University of Washington Division of Public Health Sciences and head of the Epidemiology Program at the F.H.C.R.C. states that more complete study would involve significant time and resources. In order to study possible relationships between airport pollution and cancer, the denominators (number of people by sex and age) in each census tract or an appropriate group of census tracts around Sea Tac Airport would need to be evaluated for various cancer types and then proper comparisons of actual incidences of each cancer type could be made to the incidences encountered in the surrounding 13 county area. The F.H.C.R.C. Epidemiology Department will not have the necessary 1990 census data programs to begin such a study until about February, 1993. Such studies should probably be provided by and funded by the Port of Seattle as part of any complete environmental impact statement, and ideally include an attempt to track the already-evacuated populace.

The potential inability to document increased cancer incidence does not necessarily mean that it does not exist. The estimated concentrations of benzene in some airport communities (although not measured) may at times exceed 24,000 parts per trillion. The acceptable source impact level for new sources proposed by WAC is 0.63 parts per trillion. Out of interest, Hartfield airport in Atlanta is in Clayton County. Clayton County had more than twice the national rate of lung cancer. A grand jury has been charged with conducting studies of the increased cancer risks[38].

CONCLUSION

This paper is not intended to be an exhaustive review of the literature regarding airport-related health issues. Many additional small studies can be cited supporting our conclusions and there are a few that do not. Small studies often lack the sensitivity required to demonstrate an effect (Beta or Type 2 statistical errors) and should not be used to refute a cause and effect relationship between airports

and public health. Even relatively small effects of airport noise and pollution on public health may be significant when large numbers of people are exposed. The weight of scientific evidence overwhelmingly supports the conclusion that airports are harmful to the health of people in surrounding communities. The health problems related to airport proximity are greatly compounded at Sea-Tac due to its relatively small size. Compared to most other airports with similar freight and passenger traffic, Sea-Tac has only one-fifth the land area, and there are a disproportionate number of schools and homes in heavily noise-impacted areas. Put simply, citizens around Sea-Tac are more likely to have airport-related health problems because the airport has an inadequate clear zone. Money earmarked for expansion of Sea-Tac would be better spent on alleviating the noise and pollution effects already felt by airport neighbors from existing operations. Cost estimates of further expansion of Sea-Tac must include more than the prices of fill dirt, concrete and construction. The additional numerous impacts of airport expansion on human health should be considered carefully before any decision is made to build. When these impacts and other community-borne costs are thoroughly considered along with the actual construction costs, expansion of Sea-Tac airport probably will not be financially feasible or ethically reasonable.

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REFERENCES FOR FIGURES IN TEXT

Fig. 1. NASA Reference Publication 1115, 1984, p. 391

Fig. 2. NASA Reference Publication 1115, 1984 p. 495

Fig. 3. ref. 34 above

Fig. 4. NASA Reference Publication 1115, 1984, p. 553

CHAPTER IV
ENVIRONMENTAL IMPACTS
SECTION 8 - INDUCED
SOCIO-ECONOMIC IMPACTS

Chapter IV, Section 8: Induced Socio-Economic Effects

Introduction to Comments on Chapter IV, 8. Our comments on this section of Chapter IV are in two groups. In the first group, Comments IV.8-A through IV.8-C we include studies of certain issues included within the scope of the section; these studies present materials, data, findings, & analyses not included in the DEIS, which should be addressed in the FEIS. In the second group, Comments IV.8-1 through IV.8- n are our comments on particular points raised in the DEIS or suggested by it.

Listing of items included as Comments IV-8-A - IV-8:

Comment IV-8-A: Letter of Dr. Lynn Michaelis responding to Flightplan DEIS.

Comment IV-8-B: Summary of M. Frankel Survey of Property Values, Richard Zerbe, Ph.D. and Andrea Hambly, M.S.

Comment IV-8-1: The DEIS, p. IV.8-1, reports that construction of the project will result in creation of a huge number of construction jobs' (45,500).

(a) The FEIS might advise the reader that the 'jobs' involved, except for those of POS & FAA bureaucrats, are only temporary, not full-time, long-term employment in the usual sense of the word job. The FEIS might reasonably address the question whether these temporary positions will be filled by local people or by the usual crews of boomers from Texas.

(b) We find no estimate of the dollar amount of the wages to be paid to those holding such 'jobs'; if there is such an estimate, may we suggest that in the FEIS the number of 'jobs' & the wages from those 'jobs' be discussed in the same place?

c) The FEIS might reasonably state with clarity that any (i) direct, (ii) indirect, or (iii) induced economic benefits to the local economy from the overall expenditure for the project would be approximately the same for any other project of the same magnitude. If there is a local benefit, it is not because the project is an airport project but because it is a big project. The FEIS might also reasonably state that

R-4-5

the same general principle is true for wages paid construction crews for this project and for any other project (or collection of smaller projects) of the same magnitude, (plus or minus a percentage point here or there, depending on the wage levels of the various trades & crafts involved). In fact, the FEIS might candidly reveal that the benefits would be the same if the sponsoring agency simply distributed to the inhabitants of the Central Puget Sound region checks totalling the amount projected as the cost of the third runway - - an economic boost that would have no adverse environmental consequences.

R-4-5

Comment IV-8-2. -- Economic Impact-- Sales Tax. The FEIS should clarify the expression 'sales tax revenue generated by people directly employed at the airport', p. IV.8-1, col. 2. The reader wonders, Sales taxes on what transactions?

R-4-10

Comment IV-8-3 --- Economic impacts of airport activity -- generally. The DEIS presents conclusions as to the number of jobs, earnings, &c., directly attributable to Sea-Tac Airport. See unlabelled box, p. IV.8-1, col. 1, & Table IV.8-1, p. IV.8-3.

(a) The totals seem grotesquely large. It is hard to visualize, for example, 78,000 people working at the airport (see cited Table). One wonders where they all park. But the reader may learn, not from the text but by perusal of Table IV.8-2, p. IV.8-10A, that the DEIS is actually claiming only 13,806 jobs at the Airport at present. The rest of the claimed jobs, some 65,000, are somewhere else, who knows where.

(b) Is it the DEIS' assumption that every visitor to the area arrives by air, & that anything a visitor purchases, any money spent by a visitor, is attributable to the airport? If so, then measuring economic impacts must be a chancy art, for some other investigat might say that a purchase made by a visitor at a hotel shop was attributable to the hotel industory, or to the publishing industry (if the purchase were a book) or to agriculture (or to candy manufacturing) if the purchase were a box of Aplets or Cotlets -- or to law-enforcement, if the visitor were an attendee at a police conference. And so on. How good are these numbers cited in the DEIS?

(c) And what happens to these curious numbers if the visitor were

R-4-1C

to travel in the future not by air but by rail? Are the dollars spent by vistors diverted to other transportation modes less worthy than those spent by air travellers? One would assume that the money all spends the same, & that it is a bit presumptuous to attribute visitor expenitures to the Airport. The FEIS should give cleaned-up, more realistic, numbers.

(d) Unfortunately, the reader cannot follow up on the issues raised here, for the one cited source, The Local and Regional Impacts of the Port of Seattle (1994) is not a published work, & the publisher or author(s), Martin O'Connell Associates, is/are unknown to libraries or book stores. This is yet another of the numerous instances in which this DEIS relies on semi-secret documents as authority for dubious sweeping generalities.

Comment IV-8-4 -- Economic Impacts -- methodology (p. IV.8-1). The methodology is based, we are told on published (but uncited) reports (reports by whom?), and on consultation with the Port of Seattle, State agencies (naming two), & employees of local jurisdictions (only King County actually named). This is yet another, & particularly egregious, example of the stealth method of citation of authorities in which this DEIS so often engages. R-8-15

(a) The FEIS should list each consultation, tell us who was consulted (including official position), & what each consultee contributed to the total methodology.

(b) If the preparers used any standard texts on econometrics, or consulted any professional economists (none are listed in the chart of preparers in DEIS ch. VI), the texts should be properly cited (with page references) & the economist(s), if any, fully identified.

Comment IV-8-5 -- Economic Impacts -- This comment addresses subsection (2) Existing conditions, at p. IV, 8-3. In the absence of any real information as to how the preparers guessed at the numbers presented in this Section, commenters can say very little about them. Some may agree, others may think (as we do) that they seem inflated.

Comment IV-8-6 -- Economic Impacts -- general. See FEIS IV.8-4, paragraph (3)(A) 1. Do-nothing alternative. It is interesting that the

preparers believe that the employment levels at (or directly attributable to) the Airport at future benchmark dates will be the same under all Alternatives, including do-nothing (no third runway). This appears to be a retreat from the assertions in prior justifications for the project that failure to construct the third runway would have severe adverse impacts on the local economy. The adverse economic impacts predicted by the DEIS are only the projected costs of delay to be felt by certain airlines. See paragraph (3)(A) 2, & parallel discussion in DEIS ch. II. R-8-16

Comment IV-*8-7 -- Economic Impacts -- costs allocation to beneficiaries. It would be revealing ifn the FEIS were to report the economic impacts, were the cost of this project to be borne by the parties benefiting. It is the consistent position of the DEIS that the sole purpose of the project is to enable more intense use of the Airport doing poor-weather conditions. As is established elsewhere in our comments, the need for that more intense use is directly attributable to the very substantial overuse of landing & take-off capacity by commuter airlines. If the Airport were run in an rational manner (in economic terms), the commuter opoerators would either be diverted to a more appropriate airfield or would be charged fees commensurate with the true value of the resource that they are using inefficiently. So, it is fair to day that the beneficiaries of this project, as the need is presented in the DEIS, are those commuter airlines who are not bearing the true cost of their wasteful operations. Do these entities have the resources to pay for this project? If not, why should anyone else pay for something that is for the benefit of these benefits?

Comment IV-8-8 -- Economic Impacts -- passengar benefits. From another point of view, the true beneficiaries of the proposed expansion are those individual persons who fly the commuter airlines. The FEIS would do well to reveal how many enplanements of commuters are involved per annum, & also how many discrete individuals are involved. This might best be done with a distribution curve, reporting annual enplanements by frequency. The public has been led to believe that some people are making very large numbers of trips per time period. What would ticket prices look like if these people were required to pay for the third runway, being proposed in truth for their benefit? What would true-cost pricing do the comparative attractiveness of various transportation modes? R-18-2

Comment IV-8-9 -- Economic impacts -- diminution of property values. Section 8 of Chapter IV contains no discussion of the issue of diminution of real-property values as a result of noise & other adverse impacts from airport operations & aircraft overflight. This is a matter of very serious concern to numerous property owners in areas throughout the western portions of Pierce, King, & Snohomish Counties, but it is entirely ignored as a socio-economic consequence of aircraft activity.

Comment IV-8-10 -- Economic impacts -- diminution of property values. There is some scant discussion of this issue buried in obscurity at p.IV.7-4, as a mental-health issue, as if diminution in property values is of no concern unless it can be shown to have caused mental stress. The discussion of depression of real-property values belongs in Section 8. R-16-32

Comment IV-8-11 -- Economic impacts -- diminution of property values. The misplaced discussion at p. IV.7-4 once again relies on bald assertions, unsupported by authorities, except for a quotation from one improperly cited (unpublished?) F.A.A. report from 1985, which appears to be a report on the authors' examination of other people's work, done in 1960 and in the period 1967-1970. It is entirely unclear who did that work 25 to 35 years ago, where, with what methodology. It is abundantly clear that they did not, unless they had working time machines, study the impacts of the commercial aircraft of today. The cited report gives no reason why the work done so long ago should be relied on as a useful indicator of conditions to be expected today or when the third runway comes into operation. R-16-38

Comment IV-8-12 -- Economic impacts -- diminution of property values.

(a) The psychology section of Section 7, Chapter 4, states that "[r]ecent comparisons" of appreciation rates of "residential property bear Sea-Tac" with rates elsewhere in King County found "no impact attributable to proximity to Sea-Tac". No study is cited for these comparisons, so presumably they are unpublished. Lack of citation leads this commenter to suggest that the comparisons were likely R-16-30

R-16-9

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done by, or at the behest of, the co-lead agencies, as a part of this present effort to promote the third runway. We suggest that no independent reader should give any credence to alleged comparisons of such uncertain origin.

(b) Further questions arises:

(1) Can it be that aircraft impacts are depressing property values widely over King County?

(2) May it be that in the most noise-impacted areas there very few significant sales of existing homes?

3) Perhaps such sales as are made are sales to those hoping for re-zoning from residential use, being made less & less suitable by overflight noise, to more intense use, which would support the costs of insulation. But who knows, when the alleged studies are cloaked in secrecy.

R-16-29

Comment IV-8-13 -- Economic impacts -- diminution of property values -- There is, we fear, another group of socio-economic effects of noise on real-property values other than simple depression of price. We suggest that the FEIS should look at this carefully. Noise from aircraft using Sea-Tac has very noticeably increased in volume & areas of impact over the last decade, as one can detect by study of the records of calls to the POS noise hotline, & as organizations concerned with airport impacts can tell by the ever-increasing levels of concern brought to them by ordinary citizens, farther & farther removed from Sea-Tac. There are more aircraft, they are very noisy, they no longer seem to fly with any concern for the noise endured by people below. R-4-1A One of the lead agencies, at the behest of the other, has altered flight paths for Sea-Tac traffic so as to bring planes over many parts of the three-county area that previously were nearly immune from overflight noise & air pollution. These great changes have certainly disappointed the reasonable expectations of thousands of occupants they had wisely chosen places to live away from Sea-Tac impacts. Many of these occupants do not particularly want to move; many had thought that they had purchased their last homes when they moved into their present residences; people such as this have put vast work & millions upon millions of dollars into improvement of their properties. Even if in their maturity they wished to pull up their roots to escape aircraft noise, can they recapture their investments? What will be the impact of their moving expenses if thousands of these citizens, many of them on fixed

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incomes, were to decide to move to noise-free areas? Will the proceeds of their sales (reduced by the costs of sale) be sufficient to permit them to acquire comparable housing elsewhere (with the costs increased by the costs of moving & purchase), using the funds received from their former, noise-impacted homes? And where will they be able to go? The co-lead agencies, in part through their paid spokesperson, AirWashington, argue that these people foolishly moved "down by the airport" & so are getting the noise that they deserve. We & such householders disagree, as do the people far North in Seattle, & in Gig Harbor, & Maple Valley, & Issaquah, & Medina, & numerous other places that are receiving Sea-Tac noise thanks to the four-post plan.

But let the FEIS directly answer the question: Where are such people to move in order to escape the present & the future noise? To answer that question, the FEIS must consider & discuss what the future flight paths will be, when the fourth runway will be built, what the noise impacts will be of the unregulated aircraft from East Asia that the Port is so assiduously seeking to bring here in ever-larger numbers, what sorts of noise are to be expected from the aircraft of the foreseeable future. Let us suggest one answer, which the FEIS should address: persons displaced by Sea-Tac noise will no longer rely on Port & F.A.A. assurances that there will be no greater noise impacts; they will not move a few neighborhoods farther away. They will not be able to find comparable housing in King County, especially now that growth-management legislation has essentially restricted further residential development to the Sea-Tac noise zone, the low-lying Western part of the county. The displaced persons will be looking farther afield -- Bellingham, Olympia, Vancouver Island, the Oregon Coast. This commenter believes that the process is already underway, & is likely to become very pronounced as people begin to lose hope on the subject of Sea-Tac. Profound socio-economic consequences may take place, as this stable, mature, salt-of-the-earth type of population leaves. Who comes in, if anyone? What is the impact on a community when it loses this group of residents? R-8-1

Comment IV-8-14: -- Economic Impacts -- Diminution of Property Values -- A viable method of examining the effects of airport noise on housing values at the national level, called "the neighborhood,, pair model," was recently studied in a report prepared by Booz, Allen & Hamilton Inc. for the Federal Aviation Administration. (Comment IV-8-C) The procedure consists of three R-16-4

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steps:

1. Identification by a local Realtor of two neighborhoods that have similar characteristics except for the noise level;

2. Selection of a sample of houses from each neighborhood with reasonably similar individual housing characteristics;

3. Use of a modified appraisal process by a local appraiser and statistical modeling to compare the housing values in the two neighborhoods.

Subjective inputs by local appraisers and Realtors are explicitly incorporated in the neighborhood and home selection process and are useful in interpreting the modeling results, the report notes. Conversely, asking the appraiser to normalize the sales prices of the selected homes to account for differences in house characteristics make the appraisal procedure much more quantitative compared to conventional appraisals, the report states. *"Hence, the analytical approach was designed to minimize the effects of local conditions by using local expertise and a combination of quantitative and qualitative techniques that complement each other, and seeks to overcome the shortcomings of previous studies that exclusively used one technique or the other."*

A series of studies was done around four major airports: Baltimore-Washington International, Los Angles International, and New York LaGuardia and Kennedy International Airports to determine whether the procedure was repeatable and verifiable, to see if any distinct trends could be observed, and to determine if any inferences could be made at the national level regarding the impact of airport noise on housing value.

Booz Allen researchers concluded that the results of the studies indicated that the neighborhood pair model is viable and helps establish the boundaries of the effect that airport noise has on housing values at a given airport. "The observed trends are consistent, showing that the noise impact is more pronounced in higher-priced areas and is hard to detect in relatively lowpriced neighborhoods," the report concludes. R-16-4

For instance, in the study around Los Angles International Airport, they found that, in moderately priced areas, the adjusted appraised value of homes suggested en average $60,873 (18.6 percent) higher property value in the quiet neighborhoods, or $4,348 (1.33 percent) per dB of "additional quiet." The FEIS should evaluate the effects of noise under the alternatives on home values in existing "quiet neighborhoods located in Normandy Park, Federal Way, and Mercer Island, for example On the other hand, the results in the low-priced areas were much more modest - $1,268 (0.8 percent) higher property value in the quiet neighborhood.

A later study in the New York area confirmed this finding. As was observed in the LAX study, the results in the low-priced areas indicate virtually no ($733, *0.5* percent) difference in property values between the quiet and noisy neighborhoods. In the moderately-priced areas, the adjusted appraised values suggested an average $10,700 (4.9 percent) higher property value in the quiet neighborhood, or $1,070 (0.5 percent) per dB of additional quiet. In high-priced areas, the adjusted appraised value suggested an average $22,367 (5.7 percent) higher property value in the quiet neighborhood, or $5,474 (1.4 percent) per dB of additional quiet. R-16-4

The report concludes that the magnitude of the impact of noise on property values cannot be estimated at the national level at this time, since the results varied across a wide range for the airports studied, and only a small sample of airports was considered. However, the primary goal of the study was to assess the feasibility of the neighborhood pair model to examine the effects of airport noise on property values, and the findings indicated that the methodology is viable and "reasonably economical," the report concludes.

The results of a national study could help decision makers in formulating national policy and would enable local airport authorities to better deal with airport noise impact, the report noted. The FAA must perform extensive cost-benefit analysis before implementing proposed changes in the national noise related policies. The report concludes that the aspect of noise impact which needs to be better understood is its economic impact. The DEIS makes no reference to this and other current studies evaluating the effects of airport noise on

property values. The FEIS should include a detailed analysis of all properties impacted by noise levels exceeding 65 DNL, listing the current level of property value diminution caused by existing noise levels, as well as the total number, location and amount of loss of property value caused by the noise levels associated with the alternatives.

Comment IV-8-15: -- Economic Impacts --Homeowner damages -- The Port of Seattle is currently being sued by approximately 120 homeowners residing in the cities of Burien, Des Moines, and SeaTac who are allegedly impacted by the noise of aircraft operations at SeaTac airport. These property owners are claiming the Port of Seattle's aircraft operations of SeaTac have caused diminution of property values, loss of quiet use and enjoyment, and trespass of their property. The FEIS should review these homeowners claims, the potential liability of the airport operator due to all similarly impacted homeowners, and the monetary amount of legal fees and costs which have been paid thus far in this case and will likely be incurred in the process of defending, settling, and paying property and nuisance damage claims caused by SeaTac airports present operations, as well as the amounts likely to be paid under each of the proposed alternatives. R-16-10

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APPENDIX
SUMMARY OF MARVIN FRANKEL'S SURVEY AND OTHER STUDIES

Richard O. Zerbe Jr.
Andrea Hambly

Population Surveyed

200 realtors and 70 appraisers from 40 suburban communities surrounding O'Hare Airport were asked to fill out a survey with greater emphasis given to individuals located in about 20 communities closest to the airport. The response rate was about 50%. 85% of the realtors and two thirds of the appraisers reportedly spend at least 30 hours per week practicing their specialty. (pp.2)

Factors Affecting Residential Property Values

Quality of other dwellings in the neighborhood, proximity to schools and the amount of property taxes were ranked as the three primary concerns out of a list of twelve. Conversely, proximity to jobs at the airport and related activities and access to the airport ranked eleventh and twelfth on that list, implying that prospective home owners assign these amenities a rather low value. (pp. 8)

How Well Informed Are Buyers?

Two thirds of the realtors thought that buyers were at least moderately well informed and approximately half of the appraisers thought the same. (pp.10)

Buyer and Seller Behavior Toward Noise Affected Properties

A clear desire to avoid such properties was expressed by 42.2% occasionally and by 49.1% frequently. 38% of sellers occasionally put their homes on the market wholly or primarily because of noise and 8.8% do so frequently. Lower than listed prices were sought specifically because of noise by 42.3% of buyers occasionally and by 17.1% frequently. (pp.12)

III. and IV. above indicate a thinner market on the buying side for noisy properties. The presence of noise is used a s a bargaining chip shows that there is a willingness to accept compensation via a lower purchasing price for such disamenities as aircraft noise. (p. 13)

Property Turn-Over And Selling Time

While 53.8% of the realtors and 68.4% of the appraisers thought that the turn-over of noisy properties was about average, the remaining interviewees pretty well split down the middle with respect to below and above average turn-over time. Thus, 21.8% of the realtors and 15.8% of the appraisers thought the turn-over time was below average and 24.4% of the realtors and 15.8% of the appraisers believed the turn-over time to be above average. Clearly, the results are inconclusive regarding the effect of noise on the turn-over time of properties.

Concerning selling time, however, the results indicate that it takes longer for noisy properties to clear the market than for quiet ones. In fact, 75% of the realtors (appraisers were not asked this question) believed that the selling time for noisy properties was above average. 22.5% of them thought it took an appreciably greater amount of time to sell such properties.

To recap, the real estate market is affected by aircraft noise primarily in the following ways:

1) Sellers are pressured into reducing their asking price to compensate buyers for the disamenity of aircraft noise.
2) Demand is weakened because some prospective buyers do not want to live in noisy surroundings.
3) Greater selling time is required to move such properties.
4) Supply could outstrip demand because people want to move out of the area to escape the noise and buyers do not want to move into the area for the same reason resulting in a weaker market for that category of residential real estate.

Impact Of Noise On Property Values

The survey also asked the realtors' and appraisers' opinion on how much in percentage terms the value of a property might be discounted for being exposed to low, moderate, substantial, and severe noise. First, they were to choose from a set of percentage figures and draw on their past experience in dealing with such properties. Secondly, they were asked to define properties they knew about that were exposed to moderate, substantial, and severe noise levels and assign their own percentage discount to these properties. This was done for single-family housing in the first case and for single and multi-family dwellings in the second case.

In the first case, the median % discount (pp. 18) ranged from 1.6% to 21.6% for the realtors and 1.2% to 16.5% for the appraisers. In the second case, the mean reduction in value was judged by the realtors to lay between 3.9% and 6.5%--the low-noise level was not included in this portion of the survey--and by appraisers between 2.7% and 12.7% for single-family homes. Multi-family dwellings were assigned a median discount between 2.6% and 12.9% by realtors

and 2.0% and 9.7% by appraisers. Appraisers assigned a discount consistently lower than did the realtors but the pattern for both groups is the same. Also worth noting is the fact that multi-family housing was discounted less by both groups reflecting perhaps the greater mobility and a higher turn-over rate of these residents. There is no long-term commitment to stay in the area; i.e., if the noise becomes unbearable one can quite easily move to a quieter area and these residents do not engage in the risk of losing on their investment should property values fall as a result of increased aircraft noise. (See the tables below)

ESTIMATED REDUCTIONS IN PROPERTY VALUES
DUE TO AIRCRAFT NOISE

<u>Based on Past Experience with Similar Properties</u>

	MEDIAN REDUCTION	
Noise Level	*Realtors*	*Appraisers*
Low	1.6%	1.2%
Moderate	5.5%	3.0%
Substantial	13.0%	10.0%
Severe	21.6%	16.5%
Sample Size	199	69

<u>Based on Identifiable Properties</u>
(figures in parentheses are standard errors)

MEAN REDUCTION			
Noise Level	*Moderate*	*Substantial*	*Severe*
Realtors			
a. Single-Family	3.9% (0.29)	9.6% (0.47)	16.4% (0.81)
b. Multi-Family	2.6% (0.48)	6.8% (0.60)	12.9% (0.90)
Appraisers			
a. Single-Family	2.7% (0.34)	6.3% (0.57)	12.7% (0.98)
b. Multi-Family	2.0% (0.41)	4.1% (0.62)	9.7% (1.21)

The low, moderate, substantial, and severe noise levels were then related to L_{dn} levels of 62.5, 67.5, 72.5, 77.5 L_{dn} respectively to draw a comparison between the survey results and the results of existing hedonic measures (refers to the use of the Property Value Method which regresses the price of a home on its various characteristics and neighborhood and environmental characteristics) of noise impact on property values. However, these measures stem from studies of airports other than O'Hare Airport. A hedonic approach had not been taken yet with respect to O'Hare Airport. The table below compares these results.

TYPE OF STUDY	NOISE LEVEL (LDN)			
	Low	*Moderate*	*Substantial*	*Severe*
Case I (Median Values)				
Realtors	1.6%	5.5%	13.0%	21.6%
Appraisers	1.2%	3.0%	10.0%	16.5%
Case II				
Realtors				
Single Family		3.9%	9.6%	16.4%
Multi Family		2.6%	6.8%	12.9%
Appraisers				
Single Family		2.7%	6.3%	12.7%
Multi Family		2.0%	4.1%	9.7%
Hedonic Regression Studies				
Single Family (0.58% reduction per decibel increase in the noise level over 60 L_{dn}	1.4%	4.8%	7.2%	10.2%

Ableson mentions a survey of households in Rockdale and Marrickville that found that "80% of households underestimated aircraft noise before they moved into the area and 20% positively regretted buying their house because of the noise, which is strong

evidence that the adverse effects of aircraft noise are not always fully reflected in house prices." This could also go the other way in that noise paranoia may induce a greater, perhaps excessive, property depreciation. Ableson offers other reasons for inefficiency in the real estate market with respect to internalizing the disamenity of aircraft noise such as:

1) Increased costs to home owners when the market is in disequilibrium after land-use changes. Some households will be living in an environment no longer suitable to their needs.
2) Hedonic prices do not capture indirect or dynamic secondary effects of amenities such as decreases in home and land property maintenance because homeowners try to avoid exposure to noise. This results in additional devaluation of the property.

Distribution of Benefits and Costs

The construction or expansion of an airport affects homeowners and renters differently depending on when they settled in the area surrounding the airport. While one could argue that the residential real estate market internalizes a negative externality such as aircraft noise via lower property values, this is only true for that portion of the population which moved into the area after the airport was constructed or expanded. Hence, these buyers and renters were compensated through lower real estate prices and rents. One might expect, however,--and the survey seems to confirm this--that not all buyers and renters are equally well informed about the true extent of the aircraft noise and thus might not have been fully compensated for this disamenity. A lack of information or misinformation leads to inefficiencies in the market as the prices do not reflect the true value of a commodity, in this case, real estate. On the other hand, homeowners who settled in the area prior to the airport's construction or expansion not only incur a financial loss as the value of their properties, and thus their home equity, falls but also must adjust to an environment that no longer represents their preferences. What value might be assigned to the loss of control over the enjoyment of one's home?

Land Use And Demographic Changes

The table below summarizes the results of several studies, all except J.F. Gautrin's employing regression analysis. The R-squared values range from .50 to .90 with most of them greater than .65. Gautrin used a modified Moehring Model rather than a regression analysis. (For description, see J.F. Gautrin (1975)) According to these studies, properties exposed to noise take a discount in value ranging from 0.40% to 2.09% per NEF. Paik's result of a 2.09% discount per NEF seems a bit high. Nelson reran that regression which yielded an even higher discount, namely 2.2%. However, Nelson feels that this merely reflects a much greater concern about aircraft noise stemming from lack of information at that time remembering that the study used 1960 data. Disregarding this study would give a range of discount of 0.4% to 1.3% per decibel above the threshold level of 20 - 25 NEF. In 1990, Uyeno et al. conducted a property value study of Vancouver Airport to measure the impact of noise on property values. Their result of a 0.65% discount falls well within the range of figures of the earlier studies which seems to indicate that the amount of noise discount has not changed over time. The results also are similar for airports in diverse geographical locations. Taking a simple average of the noise discount in all these studies, one arrives at 0.65% Therefore, it's reasonable to assume that the results of these studies may be applied to Sea-Tac airport for a simple approximation of noise impact on property values in the area surrounding the airport.

The following example will illustrate how in the aggregate the economic loss via depressed property values due to aircraft noise can be immense while seemingly small when looking at an individual property.

Take one hundred thousand homes valued at $100,000 each situated in the 65 Ldn zone. Apply first a .4% per decibel (above 55 Ldn) and then a 1.3% per decibel.

100,000 homes X $100,000 X .4%X 10 dB = 400,000,000

100,000 homes X $100,000 X 1.3% X 10 dB = 1,300,000,000

Thus, the economic loss, in this case, ranges from $400 million to $1.3 billion. The loss to the individual home owner ranges from $4,000 to $13,000.

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General Comments on the

draft environmental impact statement (DEIS)

By Dr. Lynn O. Michaelis

March 22, 1992

Introduction

Because of my professional background, I will limit my comments on the EIS to my professional area. I am a professional economist, working for the Weyerhaeuser Co. and am President of the National Association of Business Economists. The comments and criticisms in this statement do not reflect the position or concerns of either organization. Rather, they reflect my concerns as a resident of Marine Hills in Federal Way and for the future quality of life in the city of Seattle.

I also want to be clear, that the concerns being raised are not to be interpreted as being anti-port, anti-business or anti-growth. Growth is a fact of life and should be encouraged. However, if not correctly channeled growth can destroy. The purpose of having government oversight of the growth process is that sometimes business and the market do not capture the indirect costs imposed on some members of society . The other perspective government brings that is sometimes lost in the market is the long term socially optimal solution. Because of the way businesses make investment decisions, the near term dominates the long term consequences. The environmental assessment process is meant to remedy that deficiency of the free market system.

Businesses in which I work have for years been forced to recognize external pollution problems and have been forced to internalize those costs through pollution equipment. The result is cleaner air and water, but at a higher cost in the production of the product. But clearly the result is socially desirable, even if the regulatory approaches taken can be inefficient. The product reflects the true cost of the product to society. Then society can choose how much it demands at a price that reflects the true cost to society. I can not understand why an airport that produces air travel and noise pollution should not be subject to the same rules.

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This at the heart of my concern and the focus of additional work before the EIS can be complete. First, the criteria being used for selection are flawed and the data being used are inadequate to reach the correct solution on the long term optimal solution for Seattle. Second, the data currently being presented on costs and benefits is one sided and extremely biased. I hope to demonstrate that if the full costs are taken into account, then the "capacity problem" will disappear. Third, the data creates a sense of urgency that is misplaced, if the pricing problem is corrected. Because of the pricing system being used, scarcity is not being allocated correctly. Rather, the pricing system is creating an artifical shortage. Fourth, more work has to be done on assessing the long term impact on downtown Seattle, if the airport expansion continues at SeaTac rather than at a remote airport.

Criteria being used is not correct

It appears the primary criteria for site selection is minimize first time exposure to airplane noise. This is a political and not an economic criteria. This criteria implies that max. exposure of people already exposed to aircraft noise is the desirable alternative. This criteria has to be reassessed. A recent article in the Seattle Times makes it clear that serious health problems can develop, even after long term exposure to aircraft noise. They cited a study done recently that shows that "even after five years of exposure to aircraft noise, physical responses (higher blood pressure, higher stress levels) continues." In economic terms, more frequent and sustained exposure to aircraft comes at higher and higher cost to an individual not less cost.

Where an occasional flight is a nuisance, sustained and continuous aircraft noise has major consequences on lifestyle and residential property characteristics. Outside entertainment becomes nearly impossible. Educational activities can be seriously impaired. Health can be affected, not only because of sleep interruptions, but also because of higher stress induced by noise beyond your control. When taken together, sustained noise levels will eventually force those that have an option to move away from the noise shadow of a major airport will do so. More importantly, if people looking for a home come to believe these risks are possible, they will attach a stigma to the properties. A number of recent studies have assessed how stigma and pollution can affect property values.

Rather than first time exposed, THE CRITERIA SHOULD BE: WHICH SITE HAS THE LOWEST OVERALL SOCIAL COST WITH THE HIGHEST LONG TERM SOCIAL BENEFITS. This assessment is possible only if realistic and complete economic data is available.

Develop realistic and complete economic impact information

To be able to use an economic or financial criteria, a more complete set of economic information has to be developed. The data prepared so far is woefully inadequate. Only part of the costs associated with expanding the existing airport are considered. The process used to estimate benefits needs to be revised, because they are seriously biased to the high side.

1. There has been no information developed on the costs being imposed on surrounding communities and residents from the aircraft noise. Insulation of schools and offices are not captured in the cost estimate. Declining property values have not even been considered. The Port of Seattle has been willing to purchase properties required for expansion, but does not compensate others that are adversely affected. I believe a careful assessment of adverse effects on home values in the South End in the Noise Shadow needs to be done. Data will show there has already been significant erosion in relative values as a consequence of the airport growth. With values of $800,000 to $2,000,000 per acre, given home values in some areas, I believe a 10% loss in relative appreciation over the next ten years will cost homeowners in the Southend at least $800,000,000 dollars in opportunity cost.(This has to be refined. I assumed 21.5 sq. miles were adversely affect, which could be too small.) For some areas the likely decline could be significantly more than 10%.

An estimate of insulation and school construction costs have to be developed as well. Part of the final approval needs a more complete compensation scheme for affected indivuals and communities. Highline School district has already submitted its estimates of costs associated with insulating existing schools. They have also estimated the higher costs required for newer schools to make them compatable with aircraft noise. Other school districs need to be solicited for their input and potential costs.

An actual on site noise audit also is required to truly dimension the area adversely affected. Computer simulations are inadequate given the change to the four post pattern and due to the variability in actual take-off patterns.

2. Benefits listed in Working Paper #8 are biased for several reasons. First, the projected increase in traffic is high. Second, the assumption of visitor share is questionable, given the high level of commuter traffic. Third, it fails to recognize that an airport also allows more people to leave the area, thus draining sales dollars. Fourth, most of the growth could occur without an additional runway if the existing one were just used more efficiently. The true net benefit to the expansion would be significantly lower, even if the optimistic assumptions on traffic and visitors were correct.

3. Develop a set of scenarios on potential passenger traffic growth at the airport. Long term economic forecasts are risky at best. In fact, forecasting the next decade based on the last has been shown to be incorrect. To reflect the uncertainty of long term forecasts, a number of scenarios need to be developed considering the following developments. (I will submit more details on the following if requested to do so.)

. Overall economic growth will be significantly lower in the next 20 years than in the last 20 years due to demographic and productivity trends.
. Benefits of airline deregulation have been captured
    Real cost of travel will not decline as fast (according to Boeing)
. An oil shock/shortage could significantly alter air travel
. Growing restraints on airports will limit the number of airplanes
. Northwest growth was uniquely strong in 1980s, much slower in 1990s
    Boeing growth will be reversed
    Resource industries, fishing and timber, are declining
. Consumer surge of 1980s was unique due to policy and demographics
    . Aging population implies higher savings rate
    . Debt leverage and tax cuts of 1980s being reversed
. Technology will reduce business travel in 1990s
    . Video conference lowers business costs (recent WSJ)
    . Business traveler crucial to lower fares for tourists
    . Forces higher travel cost and lower growth for tourist trade

IF CORRECTLY DONE, A FEW SCENARIOS WOULD HELP TO ASSESS ALTERNATIVES AND THE SENSE OF URGENCY OF THE EXPANSION. Growth will occur, but if the likely growth is to 30 million by 2020, rather than 45 million. The estimating procedure used by KPMG Peat Marwick did not consider the above factors, but appears only to have used population and income. If so, the approach is woefully inadequate.

4. Net Benefits to Local Government have to be reassessed. The drop in property values will lower tax revenue in affected communities and to King Co. Further, the government needs to estimate the cost of building the support infrastructure for the airport. Similar to approaches being used with residential developers, the Port should have to fund part of the infrastructure cost to feed its development. This is important for two reasons. First, it will insure that the operating cost of the airport and the price of airplane operation correctly reflects the true operating cost of the airport. Second, it will make the trade-off between an urban airport and rural airport more soundly based on economic costs rather than on emotional appeals, such as "protects open spaces, sensitive areas, and farm lands". This is currently viewed as an unfeasible alternative and too costly, only because the full costs at SeaTac are not capture in the DEIS.

5. Reassess Overall benefits of airport to Seattle and South End Business. The focus was strictly on Airport related and Visitor related benefits (Working Paper #8). They failed to take into account the second order affects. As people migrate away from the Noise Shadow, average income will drop and retail sales will drop. Expenditures on remodeling and maintaining the housing base will drop as well. Eventually, the property use will change as the economic value for residential use declines.

An assessment of migration away from the airport noise needs to be included. For instance, a careful assessment of the suburban blight that has already developed around the airport and how it might spread if the airport grows further has to be included in the EIS. The impact is likely to be quite large in light of the four post pattern. This will include parts of Seattle plus the south end. Migration will be away from the noise. For South End residents the migration will be into Pierce Co. (Gig Harbor and Puyallup) or East (Enumclaw, Kent Highlands). For Seattle, the migration will be to Bellevue/east or further north.

6. Incorporate the true cost estimates in estimating the demand for operations (landings and take-offs) at SeaTac. The study has gone to great lengths in defining the capacity of the airport and in showing that based on optimistic demand growth we will be out of capacity by the year 2000. The study contends that jobs will be lost and international competitiveness will be lost if we fail to act. The study however fails to address the crucial issue that is creating the "shortage", the pricing mechanics at the airport. The airport prices landings on a per pound basis.

Under current pricing schemes there is no procedure for allocating space based on time of day or for more efficient operations to bid for landing space as in the open market. This approach is only possible in a government operation where costs are heavily subsidized. Like in the BPA fiasco of WPPS, low prices of energy were used to forecast shortages and immanent doom for the Northwest unless we built a nuclear power system. Those projections also failed to take into account a variety of pricing schemes that would have dealt with the problem more efficiently, such as peak our pricing.

BPA also failed to discuss the extremely low rates being offered to aluminum producers. Such is the case here as well. All the growth at SeaTac has been in commuter traffic. Because of the extremely low cost of operations (about $80 for a round trip-takeoff and landing), they can operate small planes inefficiently. In fact, the pricing scheme encourages small inefficient plane operation. To demonstrate this fact, United Express and Horizon accounted for 35% of passenger operations in 1990, but only 8.7% of the passengers. In fact the average operation of a United Express carried less than 10 passengers, while a Horizon operation carried about 12 people. I was recently on a flight from Portland with only 3 people on a United Express flight. The benefits estimates treat all operations of equal value. Further, the pricing scheme encourages inefficient operations just to hold an operating time slot.

This pricing scheme does not penalize for night time flights. These operations create extremely high costs for residents around an airport. If FAA restricts such pricing, then the rule needs to be changed. Heathrow airport prices night time flights at a very high level. Result: very few operations.

WHAT NEEDS TO BE DONE: Estimate demand for take-off and landings at various price levels. Also, implement a peak hour pricing system. If these methods are used, the shortage will not be as critical and will allow time to consider other alternatives with more complete information. For instance, ask how many commuter operations there would be at $500 per landing or at $1000 per landing or $4800 (high enough to generate an 8% return on $600 million).

7. Do a realistic pro forma financial return on the third runway to help understand the true economics of the third runway versus other alternatives.

First, consider the capital cost of $600 million versus the revenue being generated. If the third runway is being built to enable 100,000 commuter aircraft which carry only 1 million passengers to continue operation at SeaTac, then we are spending society's capital on a project that will generate less than $4 million in revenue, or less than a 1% return on capital. Since the runway requires operating expenses, the return would be far less than 1%. At a time that our society is trying to find solutions to our deficit and other social nees, such as better schools, diverting money to a project that can not even pay minimum rates of return is a serious issue.

Second, the indirect costs have to be included as well. Community costs to insulate schools and potential lost revenue from declining property values. The infrastructure costs in an area with high land values have to be calculated. Finally, the implicit property value loss of current home in the SouthEnd have to be included. If this is done, the true overall cost of the Third Runway could be found to approach $2 billion.

When this is done, and only then, can a fair comparison to long term social costs of alternatives be made. Right now that is not possible, given the information and data included in the EIS. Using current data, there is only one conclusion possible: build the third runway at an existing airport. But this could be a serious strategic error. Other major cities have been moving airport noise and growth away from the center of the city or capping the operations (Miami). By using limited information and a short term focus, Seattle could make a serious mistake. We had an opportunity to make a truly long term move in the 1970s and chose to expand SeaTac. We should be careful to not make the same mistake in the 1990s.

8. Revisit the question of how much of the estimated benefits could be captured by the existing capacity, if it were used more efficiently. If the average number of passengers per airplane rose to 80 and the operating efficiency improves due to new landing equipment, then the airport runways as currently configured could handle 32 million passengers, without adding the third runway. Other infrastructure costs would be required, however. It might mean commuter flights would be restricted. If they could not compete against more efficient flight and those that bring the greatest economic benefit, then they should be eliminated, just like other inefficient businesses or operations are eliminated in the real business world. Arguments concerning the need to provide frequent service to small towns just don't make economic sense. Similar arguments were used to stop the railroads from dropping inefficient rail lines. Eventually, they had to since the government was not subsidizing the industry operations any longer.

9. A different set of questions need to be asked in assessing community interest in supporting the expansion of the airport. As any market researcher knows, the way a question is asked can lead to what ever answer you want.

So far, the information provided to the business community has been limited. When asked, "Would you support a third runway that costs you nothing and will create jobs and encourage growth and international competitiveness?" They answer yes. When the broader community is told that they will face two hour delays without a third runway, they clearly would support it, again if the cost is zero. But what if we asked the following set of questions:

Would the City of Seattle support a bond levy of $800 million to pay affected homeowners in the Southend?

Would Business vote for a new tax of $80 million per year to pay taxes on affected home owners and to fix the schools?

What airplane operations would be economic at $5,000 per landing and takeoff?

How would people south end feel about expansion if you said their property taxes would be lowered (potentially even be negative get a check from the county) depending on number of flights, noise level, time of day of flight?

CONCLUDING COMMENTS/CONCERNS, PLUS MY SUGGESTED ALTERNATIVE

Because there is so much at stake for the long term economic health of Seattle and the South King County area, the economic data has to be fundamentally reworked. It has to be developed to include all costs, direct and indirect. The short term impacts and benefits have to be balanced with the longer term benefits. **The airport has to internalize the cost of the pollution it is generating just like the rest of the manufacturing businesses.**

Only when this is done, will we know the true demand for the product. Just like when a sawmill was free to burn its waste, neighbors bore the cost. Environmental regulation made us stop and find a way of disposing of the waste differently. In a similar vein, the airport takes as a free good, its right to generate flight operations and the associated noise pollution. The cost associated with those operations have been shifted to the neighboring residents and communities. This has resulted in the price being set too low for airplane operations and has created excess demand.

At a time that the Federal Government is running huge deficits, it is also imperative, that we truly decide what is socially required. Using $600 million of America's scarce savings on a project that can not even generate 1% return on investment is clearly not in societies near term interest. But more important, building an ever bigger airport next to the heart of your city, probably is not even desirable in the longer term.

I BELIEVE A CAREFUL LOOK AT THE ECONOMIC COSTS AND BENEFITS COULD LEAD TO THE FOLLOWING CONCLUSION:

1. Eventually, transform SeaTac into a commuter airport, with primary service to the west coast cities. The airport would be closed from 11 pm to 6 am.

2. Build another remote airport for International, cross continental flights and for cargo operations (Boeing field might be optimal for cargo, esp. if SeaTac were transformed to a commuter airport).

3. Link these operations with a light rail or bus service

4. Work with Portland and Vancouver in developing a broad Northwest regional strategy to avoid duplication. Shifting some flight activity to Portland might be in Seattle's best interest, given the location of the Portland airport. We can no longer afford to use narrow economic interests.

It is crucial that a more imaginative approach be taken than just taking one more step in a direction that entrenches the existing airport as our only alternative. Failure to do so will leave future generations wondering why we did what we did. Why we took some of the most beautiful areas around the sound and turned them into slums and warehouse. We accelerated the retreat of the population from the city core, with all of the negative consequences seen in other major cities. We have time to consider the economic issues carefully. The decision and the consequences are too important to be rushed by inadequate and biased economic information.

[signature]
3/23/92

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DISCUSSION DRAFT REPORT

September 17, 1992

Project Ib: Cost and Effects of Air Capacity Constraints

AIRTRAC

Washington State Air Transportation Commission

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VI. COSTS AND EFFECTS OF AIR TRANSPORTATION CAPACITY CONSTRAINTS

Executive Summary

This executive Summary highlights the results from case study analysis of the costs and effects of air capacity constraints. A case study approach was taken to identify the costs and effects of air capacity constraints and their implications for Washington. The following are the key findings in the case study areas.

- There are direct economic costs arising from capacity constraints. These costs are the additional operational costs incurred by airlines as a result of delay. They also include the value of passengers' time lost due to delays.
- Currently, there is little evidence of wider economic costs associated with existing air capacity constraints. However, there is an expectation that at some time in the future capacity constraints will have economic costs.
- There is little evidence of wider economic effects upon the location and expansion decisions of business and hence upon economic development. Air capacity is a consideration for industrial location and expansion. However, it is one among many factors influencing economic development.
- Airports and airlines work around capacity constraints to increase passenger throughput. There is evidence that congestion at San Francisco International has resulted in displacement of service to other regional airports.
- Airports have made specific operational adjustments in response to congestion. They are also engaged in extensive planning efforts to identify options for increasing capacity.

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Source: Dye Management Group, Cost and Effects of Air Capacity Constraints; Draft Report to Washington State Air Transportation

- At Vancouver International and Boston Logan the frequency of service provided by the commercial scheduled airlines is largely unaffected by the capacity constraints. Typically, if there is a market for more service it is added.

- The bulk of general aviation operations have been effectively relocated to other airports in the vicinity to address capacity constraints.

- Access to a major airport from regional areas by air does not appear to have been adversely impacted by current capacity constraints.

Introduction

This section examines the potential costs and effects for Washington's economy that might arise from a shortfall in air transportation capacity in central Puget Sound. Rather than attempt to "model" any economic costs arising from an air capacity shortfall, the analysis describes the expected effects of a capacity shortage and draws conclusions about their likely impacts on the wider economy.

The assessment draws on the technical analysis presented in the preceding sections of this report and from additional case study research.

The section is organized as follows:

- The nature of air transportation capacity constraints.

- Expected consequences of air capacity constraints.

- Case study analysis of the effects of capacity constraints.

The Nature of Air Capacity Constraints

Air Transportation Capacity is Not Fixed

In simplest terms air capacity constraints occur when the demand for air travel cannot be accommodated by the available airport facilities and airspace. AIRTRAC's analysis of demand and capacity (Project II) has defined air capacity as "how many aircraft operations can be handled over a period of time." [1] This analysis also notes that air capacity could be viewed as the ability to move passengers.

For analyzing economic and social effects, what is important is the capacity of the air transportation system, air and landside, to move people and goods in a timely fashion. Typically, demand is more likely to exceed supply at peak hours and at particular times of the year such as holiday weekends. In reality, in the case of airports "capacity" is not a fixed ceiling. Many of the demand management strategies being explored nationwide are specifically designed to increase the utilization of existing airport facilities and hence increase capacity.

Nature of Capacity Constraints

As discussed in other AIRTRAC projects[2], an airport's capacity is difficult to determine because it is dependent upon many factors which are subject to change. These factors include: the mix of aircraft used, scheduling, air capacity control, weather conditions - to list a few. Consequently, air transportation capacity is not a fixed ceiling. In practice, airports operate in excess of capacity.

To accommodate the demands of the business commuter or to offer better connections for passengers, airlines' flights tend to arrive and depart in batches close together. When airports are at, or close to capacity, this causes delays which tend to spread out the arrival and departure of flights by making them late. In this way airports operate at and beyond their capacity. The nature and extent of any capacity constraints in Washington will influence the costs and effects of the constraint.

The analysis of current and future capacity constraints in Washington and their implications for the efficient operation of the air transportation system are addressed in other AIRTRAC work. However, it is important for the reader to have an overview of the nature of capacity constraints when considering the costs and effects of an air capacity shortage.

The following are the types of constraints which affect the capacity of air transportation systems:

- **Runway and taxiway capacity.** The capacity of existing runways is not fixed and is subject to change. It is dependent upon air traffic control rules, weather, airport operating hours, and the type and mix of aircraft using the runway among other variables.

- **Terminal capacity.** Terminal capacity is the physical constraints upon the arrival and departure of people and goods through an airport. At many airports terminal capacity is constrained by the number of gates. Again, the capacity is variable depending upon type of aircraft and scheduling among other factors.

- **Landside infrastructure capacity.** Constrained access to airports due to surface traffic congestion and other infrastructure shortfalls is an air transportation capacity constraint. Landside infrastructure capacity affects the intermodal connections that enable people, goods, and support services to access the airport. Efficient access to airports is, from the perspective of airport users, extremely important. In the case of citizens in Puget Sound, focus group analysis reported earlier, indicated that landside capacity limitations is their preeminent air transportation capacity concern.

- **Airspace capacity.** Air space capacity constraints arise from the fixed physical requirements due to safety requirements. Again, these change with the adoption of technological innovations.

- **Air traffic control center capacity.** The ability of air traffic control centers to manage air transportation demand, particularly at peak periods, is a capacity constraint. This changes over time depending upon operating roles and use of technology.

The Expected Consequences of Air Transportation Capacity Constraints

Why Constraints Are of Direct Economic Concern

The discussion of air transportation capacity constraints is usually in terms of delayed operations or average delay per flight. The economic effects of any future air capacity constraints in Washington will depend not just on delay but upon the extent to which a capacity shortfall impedes the efficient mobility of people and goods. From the perspective of the transportation user and provider, the concept of level of service can provide an important indicator of the efficiency of air transportation mobility.

Level of service is captured not only by delay, but also frequency of flight, ease of connections, as well as landside access and other intermodal connections. It is through adverse impacts upon level of air transportation services due to air transportation capacity constraints that any economic costs will be experienced in Washington. Nationwide there have been few attempts to assess, much less quantify, these types of economic costs.

The following discussion highlights some of the expected direct economic consequences of air capacity constraints:

- **Delay.** Delay is the measure most commonly used to indicate whether or not demand can be met by existing capacity. Airport specific economic analyses frequently generate estimates of the direct economic costs arising from delays. Typically, economic costs are calculated by estimating the additional operating costs for the airlines (fuel consumption, equipment costs and staff costs), estimating the value of passenger time lost, and calculating other direct costs. These figures can result in quite large numbers.

For example, it is estimated that the annual costs of delay at Sea-Tac in 2020 will be around $232 million.[3]

- **Frequency of Service.** In the current absence of demand management or slot rationing, as long as there is demand for the service, there is nothing to stop a commuter airline from adding additional service to Pullman or any other location. Therefore, a capacity constraint need not necessarily affect the frequency of service. However, capacity constraints will, as noted above, increase the costs of operating a particular flight and the length of journey time if the flight is scheduled to leave or arrive during peak periods.

- **Prices.** If the demand for airport capacity exceeds supply one would expect the price to rise. Therefore an expected cost of capacity constraints would be an increase in the cost of air transportation. The current practices of the scheduled air carriers indicate that this would be manifested by fewer seats allocated to those with discounted coach fares. In this way, flights would be filled in the first instance by full fare paying business passengers. Consequently, passengers would be paying more irrespective of whether prices rise. This will make it harder for business and non-business travellers alike to travel on discounted trips. This increases the cost of doing business, and thus would have a negative economic impact.

As noted earlier, nationwide there is a policy trend towards using the price mechanism to manage the demand for and meet transportation infrastructure costs. In the case of air transportation this will likely result in a future situation in which capacity constraints could influence the frequency of service. In an environment in which federal policy allows capacity constrained airports to ration access by price, long haul scheduled commercial aircraft are likely to secure access over commuter and general aviation operations. This could have a direct impact on the frequency and convenience of service between commuter destinations and also impact access from rural communities to destinations world wide.

- **Response of the Industry to the Constraint.** One of the largest determinants of the economic costs of air transportation constraints will be the reaction of the air transportation industry itself. As discussed above, the industry response would be to adjust prices. Service levels would be affected if airlines believed that the costs of operating at a congested airport outweighed the benefits and that the service could more efficiently be provided at another less congested location.

Broader Economic Concerns

The earlier sections of this report identified the important role which air transportation plays as an infrastructure facilitating economic development. Conversely, the absence of adequate air transportation capacity will impede economic development in the state. These wider economic costs are highlighted below (as a caveat it is important to emphasize that economic costs arise from inadequate air capacity).

- **Lost Economic Development Opportunities.** Access to the national and international air transportation system for the movement of people and goods is an important factor influencing the location of new and the expansion of existing businesses. However, air transportation access is just one among a number of factors influencing location. At what point air capacity constraints impede economic development is not clear. In many respects, air capacity constraints could be viewed as the consequence of a successful economy that generates increasing demand for air transportation services.

- **Lost Opportunities for Economic Development.** Elsewhere in North America (Raleigh Durham, Dallas Fort Worth, Atlanta, the Province of Alberta, and Vancouver, British Columbia) air transportation facilities and services have been used to promote economic development. As the experience of these regions indicates, there are opportunities for increasing direct air transportation industry employment and attracting industries that place great value on air transportation.

- **Loss Competitive Position with Other Airports and Regions.** The volume of people and goods using air transportation services in Washington has direct benefits to the state's economy as outlined in previous sections of this report. One of the long-term costs arising from air capacity constraints would be an erosion of state's competitiveness as an international gateway and as a national entry-point to the Pacific Northwest. However, capacity alone does not determine whether or not Washington is an international gateway. Instead, it is determined by bilateral agreements, the origin and destination market in Washington, and the national organization of the industry.

Washington is now bordered by several well-positioned, competing airports. Perhaps the greatest concern is potential competition from Portland and Vancouver. With respect to Portland International, the airport has ample capacity but has a much smaller origin and destination market than Washington's. Vancouver International Airport is aggressively expanding, and air transportation is being used explicitly as part of the city's economic development strategy. Portland has been selected by Delta to be its Transpacific Gateway. It is also one of the few airports on the West Coast with land available for development. Denver's new airport, which will be the largest in the world when completed, begins operation at the end of 1993. Vancouver International Airport has environmental approval for a parallel runway. As it stands now, Seattle as a West Coast international gateway is a distant fourth to Los Angeles, San Francisco and Vancouver. At the same time, longer-range aircraft like the Boeing 747-400 will allow carriers to bypass traditional West Coast gateways and fly on to dominant inland hubs: Chicago, Dallas, Minneapolis, and Atlanta to name just a few.

Case Study Analysis of the Effects of Capacity Constraints

Case studies were undertaken to provide empirical insight into the cost and effects of air transportation capacity constraints in central Puget Sound. The objective of the case study research was to draw conclusions for Washington from an assessment of the effects of the capacity constraints experienced at particularly congested airports and regions.

The case studies focus on:

- Boston, General Edward Lawrence Logan International Airport (Boston Logan),
- San Francisco International Airport, and
- Vancouver International Airport, British Columbia.

The results are drawn from secondary materials collected in the different regions and from a series of telephone interviews with airport managers, industry representatives, and business citizen interests. Appendix C outlines the case study selection criteria the approach, and a lis of the individuals contacted.

BOSTON LOGAN CASE STUDY

Key Findings

- There is strong indication that passengers are more concerned about ground access to Boston Logen Airport than delays caused by airside capacity constraints.
- Other regional airports, such as Manchester or Providence, have grown in recent years as Logan has become congested. This is due to growth in the areas surrounding these airports, and difficulties of accessing Logan by service transportation.
- Despite stagnant passenger growth and congestion, there has been a significant increase in commuter flights at Logan.
- Access problems at Logan, delays, and the availability of service from other airports have led potential passengers from outlying areas to use alternate airports. It should be noted, however, that only 20 percent of Logan's passengers come from outlying areas.
- There is little indication that current delays have had a negative impact on New England's economy. However, there is a concern that they will in the future.

BOSTON LOGAN INTERNATIONAL AIRPORT AND AIR TRANSPORTATION IN NEW ENGLAND

Boston Logan International Airport is the major regional airport in New England. It is primarily an airport serving origin and destination travel. Only 11 percent of passengers are on connecting flights.

Since deregulation, a number of other air carrier airports in the region, Portland, Bangor, Manchester, Worchester, Windsor Locks/Bradley, Providence, and Burlington have grown rapidly. The location of major airports in New England is shown in Exhibit VI-1.

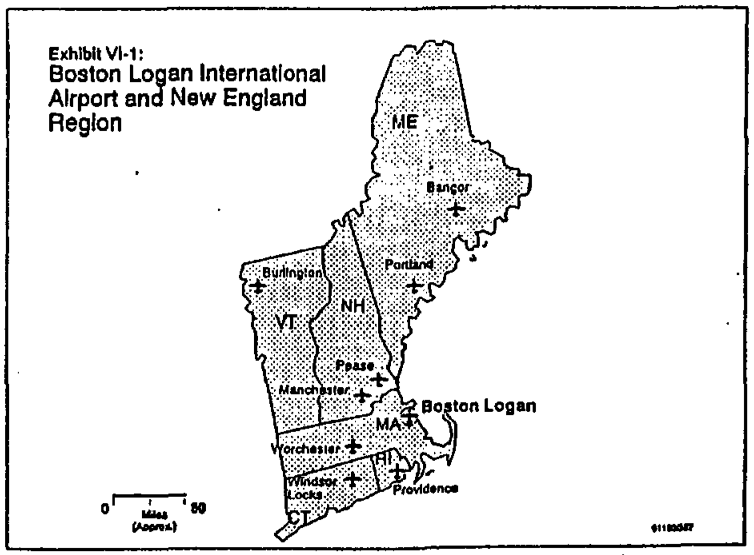

Exhibit VI-1: Boston Logan International Airport and New England Region

Despite their recent growth, they still provide only very limited access to the region. Together, these airports serve about 30 percent of the regional demand for commercial scheduled air services.[4]

In 1991, Boston Logan airport served over 22 million passengers, an increase of about 40 percent since 1982. Passenger numbers stagnated in the late 1980s due to the recession in the regional economy. Over the past decade, Boston Logan has experienced an increase of almost 60 percent in air cargo. In the late 1980s air cargo growth halted due to the downturn in the region's economy.

Like Sea-Tac, a high proportion of operations at Boston Logan airport are commuter flights, some 36 percent in recent years. The high proportion of commuter flights, which has increased significantly in recent years has led to an increase in the number of operations although the number of passengers has remained constant. An indication of the importance of the commuter market is that Business Express, the largest commuter carrier serving Boston Logan, carries out 50 percent more operations than the largest national carrier.

General Aviation. General aviation activity at Boston Logan comprises about five percent of operations. Hanscom Field, Massport's general aviation airport, handles most general aviation demand serving the needs of private and corporate aircraft.

EFFECTS OF CAPACITY CONSTRAINTS ON THE AIR TRANSPORTATION SYSTEM

Boston Logan has a relatively severe capacity constraint. The airport is one of 23 airports in the U.S. exceeding 20,000 hours of airline flight delay in 1991. Since 1986, 4.4 percent of all flights at Logan airport were delayed for 15 minutes or more. Like many other airports, Boston Logan airport experiences severe delays under adverse weather conditions requiring Instrument Flight Rules (IFR). IFR conditions reduce the runway capacity for arrivals to one aircraft. Boston Logan airport operates under IFR conditions 10 to 15 percent of the time.

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The Nature of the Capacity Constraints

Physical Constraints. The airport is located three miles from downtown Boston at the edge of Boston Harbor on infill. It is surrounded by water on three sides and borders the residential and commercial community of East Boston on the fourth side. Since the 1970s, community sensitivity to noise and the inability to make changes the coastline without enabling state legislation have prevented any expansion of airside capacity at Boston Logan International.

Airside Constraints. Adverse weather and wind conditions can reduce the airside capacity of the airport to about 50 percent of the current peak-hour demand.

Landside Constraints. Boston Logan faces a serious ground access problem, impacting both passengers and cargo. Ground access problems are exacerbated because the airport is surrounded by water.

Future Constraints. Currently, Boston Logan faces delays during peak hours and under adverse weather or wind conditions. Present demand levels allow the airport to dissolve backups without seriously impacting flights scheduled outside of the peak-periods. There is growing concern, that Boston Logan may be unable to meet demand for passenger services at some point after the year 2000. A study conducted by the New England Council in 1990 has identified a potential shortfall of between 8 and 19 million passengers by the year 2010, and that at least 15 percent of the expected demand would be unmet.

Response of the Air Transportation System

Airports. After failed efforts to improve airside capacity through runway expansion in the 1970s and a landing fee program in the mid-eighties, Boston Logan airport is concentrating its efforts on improving the landside capacity. To help address landside constraints, current plans for improvement to the ground access Boston Logan involve construction of a third tunnel. However, this may reduce the amount of land available for cargo operations on site. Land availability is a limiting factor for cargo operations, and there is concern that the future cargo

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handling capacity of the airport will not meet future demand. One study argues that up to 60 percent of the air cargo demand at Boston Logan may not be met in 2010.[3]

Currently, Boston Logan is in the process of instituting LAMP, Logan's Airport Modernization Program in response to capacity constraints. This program assumes that passenger growth on the airside will be accommodated through the use of larger aircraft, a reduction in the proportion of operations by smaller commuter aircraft, flattening demand peaks, and progress in air traffic control technology.[4] As part of the program, there are planned improvements to landside capacity and ground access to the airport through: construction of a third tunnel, renovation and expansion of gate capacity, improvements in the processing capacity of international passengers, and a variety of other structural improvements.

Other airports in the region have grown rapidly in recent years and increased both passenger and carrier operations. Several airports, including Bradley, Manchester, Pease (a former air force base), and Worchester are in the process of expanding their landside capacities or are planning to do so. All existing airports are limited in their ability to expand their operations because of constraints in their ability to expand airside capacity.

Attempted Demand Management. In the 1980s demand management was introduced at Boston Logan in an effort to reduce the high proportion of commuter and general aviation aircraft. The demand management initiative was known as the Program for Airport Capacity Efficiency (PACE). The planned demand management program had two phases:

- In the first phase, the airport established a landing fee based on a combination of an operations and a weight fee.
- The second phase consisted of a peak-based fee.

Boston Logan was taken to court by general aviation and business interests over PACE and won the case in court. However, the United States Department of Transportation (USDOT), required Boston Logan to remove the operation based fee in order not to loose their Airport Improvement

Program entitlement. At the same time, USDOT encouraged Boston Logan to look into a peak-hour based fee. The USDOT have since drafted guidelines regarding peak-hour based landing fees. The guidelines are currently under review by the Office of Management and Budget (OMB). Boston Logan representatives are currently awaiting their decision. If peak based landing fees are authorized, they will most likely be used as part of a strategy to address the delays arising from capacity constraints.

Many in the business community believed that PACE would be detrimental to economic development but airport representatives did not expect any adverse impacts. A study commissioned by the airport before the implementation of PACE predicted that no market would lose service and that only marginal flights in markets with high service levels would be eliminated.[7] An airport official confirmed that during the nine months in which the program was actually in place, only marginal flights were lost. A representative of Banger Airport believed that Bangor passengers, using Boston Logan as a hub, lost commuter service as a result of PACE.

Passenger adapt

Passengers. Passengers using Boston Logan have experienced delays for the last 20 years, as have many airports on the east coast. The delays for passengers are inconvenient, according to an airport official, but do not result in missed flights, this is because Logan service is mainly origin and destination travel. Passengers are accustomed to the delays, they absorb the cost, and consider the potential for delay in their choice of flight. Ground access to the airport, however, is a major concern for passengers. Passengers from outlying areas who would have accessed the airport by car are now beginning to use other airports in the region, such as Manchester or Providence. This tendency has been accentuated by an increase in service at other airports and increasing ground access problems at Boston Logan.

Effects on Airlines. Despite increasing delay problems, the number of flights scheduled at Boston Logan has increased in recent years. Airlines continue to focus their activities on Boston Logan and schedule flights despite the delays, and the costs of the delay that they incur.

The airline industry recognizes the capacity problems at Boston Logan and would therefore like to see a commuter runway be built. Consequently, the Air Transportation Association is currently in the process of putting together a plan for the operation of this runway that would account for community concerns. The airline representative interviewed saw neither the use of existing airports, all of which have capacity constraints preventing them from taking over a significant portion of Logan's traffic, nor the construction of a second new airport as a solution.

Effects on Cargo. Cargo operations at Boston Logan are not significantly impacted by the airside capacity constraints. According to an airport official, only the belly freight portion of the airport's cargo operations leaving during peak periods is affected by current delay. However, ground access problems are a difficulty for freight forwarders. According to an airport official and an FAA representative, all other air cargo shipments involve heavy freight or packages which are scheduled to leave outside of peak hours. Other airports in the region have significantly increased their cargo operations in recent years. This is in particular true for Manchester, Portland, and Providence.

WIDER ECONOMIC EFFECTS

Economic Impact. No conclusive evidence exists that current delays at Boston Logan impact New England's economy negatively. There is acute concern that the projected future gap between capacity and demand will have negative implications for the future economic development.

The study prepared by the New England Council cited above makes an attempt to assess the potential economic impacts of future capacity constraints at Logan airport. A cursory estimate of the capacity gap indicates that it may produce economic losses of between $7.2 and 16.8 billion and between 54,000 and 125,000 person years of employment between 1995 and 2010. This is based on estimates of lost air transportation industry business.

San Francisco International Airport Case Study

Key Findings

- San Francisco International airport is the dominant airport in the Bay area; however, growth around Oakland and San Jose airports has enabled these airports to increase both the size of their operations and their share of operations in the region.

- San Francisco provides the bulk of domestic and international long distance destinations. Oakland and San Jose serve a substantial portion of the "California Corridor" market and other short distance destinations.

- At present, existing delays and congestion at San Francisco International airport do not appear to be adversely impacting the economy in the Bay area.

- There is a belief that in the near future capacity constraints will reach a point where they have negative economic impact on the Bay area.

- In response to the delays caused by congestion, a small number of airlines have just started to move California Corridor and commuter shuttle service out of San Francisco International.

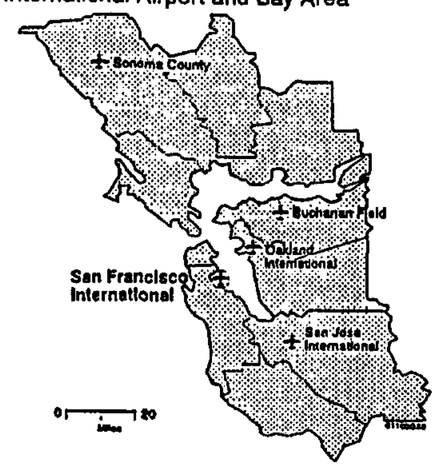
- The business community is more concerned about ground access problems than delays arising from air capacity constraints at San Francisco International.

- In response to ground access problems at San Francisco International, passengers have started to use the other regional airports for commuter service needs.

Air Transportation in the Bay Area

San Francisco International Airport is the major commercial airport for the San Francisco Bay area and northern California. It is owned and operated by the City and County of San Francisco, and is located 14 miles south of downtown San Francisco in an unincorporated area

Exhibit VI-2:
San Francisco International Airport and Bay Area



of San Mateo County (see Exhibit VI-2). The area has access to two other commercial airports, Oakland International Airport and San Jose International Airport, as well as to two smaller airports serving both commercial and general aviation needs, Sonoma County, and Buchanan Field/Concord.

Historically, San Francisco International has been the dominant airport in the region. Airports in the region have experienced strong growth in passenger traffic over the past decade with Oakland and San Jose growing fastest. In 1970, San Francisco International's market share of the region's domestic origin and destination passengers was slightly over 90 percent, with Oakland and San Jose at six and three percent, respectively. In 1990, it served 71 percent of the region's domestic origin and destination passengers. Oakland's share was 13 percent, San Jose's 16 percent, and Buchanan Field/Concord and Sonoma County each served less than 0.5 percent of passengers.

In recent years, the Bay area has experienced marked increase in the share of short-haul domestic flights (up to 600 miles), serving the California corridor. Oakland and San Jose serve an increasing proportion of this market. Airport representatives and the business community believe that these two airports serve distinct regional commuter markets.. For the most part, the increase in the regional shares for the two airports reflects an increase in population and economic activities in the areas surrounding the two airports as opposed to competitive gains over San Francisco.

San Francisco International has retained its regional importance for serving long-haul domestic flights, mainly the transcontinental market, and the international market for the entire region. San Francisco serves 90 percent of the region's international passengers and is the region's international gateway. Oakland and San Jose serve mostly the southern California market; 90 percent of scheduled service from Oakland is to southern California. Despite that, San Francisco still serves a large share of the short haul commuter market in the region. Oakland and San Jose provide limited international service but expect to increase this service segment in the future.

San Francisco International is also the major cargo airport for the region. It is the sixth largest cargo airport in the U.S., although only about 10 percent of its cargo operations are cargo-only. During the last decade, air cargo tonnage at the airport increased by about 40 percent to over 580,000 metric tons in 1991. It should be noted that the increase in air cargo activity is almost exclusively due to an increase in international air cargo shipments. San Francisco currently

handles 68 percent of the air cargo in the region, Oakland 26 percent, and San Jose about six percent. While cargo operations in San Francisco concentrate on belly and to some extent on traditional air cargo, Oakland serves overnight small package cargo operations.

San Francisco International has only very limited capacity to accommodate general aviation demand. It ceased meeting general aviation needs almost a decade ago. In addition to smaller airports such as Buchanan Field/Concord and Sonoma County, Oakland and San Jose meet a portion of general aviation needs.

Effects of Capacity Constraints on the System

Nature of Capacity Constraints

Effects of Airside Capacity Constraints. San Francisco International is one of the most heavily congested airports in the nation and exceeded 20,000 annual hours of delay in 1990. In both 1985 and 1988, the average delay per operation exceeded eight minutes. As at many major airports, serious delays occur under Instrument Flight Rules conditions when the airport has to shut down dual arrivals on parallel runways and looses 50 percent of its airside capacity. This situation applies 6 to 7 percent of the time.

Effects of Physical Constraints. The location of San Francisco International not only limits the expansion capacity of the airport but also creates major ground access problems. San Francisco airport is situated on San Francisco Bay infill, surrounded by water, residential, and commercial development and thus cannot expand the land area it covers without Bay infill. Its location, in a densely populated large metropolitan area with limited freeway access also makes ground access a major problem for passengers.

Response of the Air Transportation System

Effects on Airports. In response to capacity constraints, San Francisco International has made a number of operational adjustments but no attempt to increase its runway capacity. Past and planned capacity improvements focus on increasing the landside capacity of the airport. Operational adjustment have involved reducing certain general aviation activities at the airport in order to make room for scheduled carrier and cargo operations.

In the last decade, landside capacity improvements included: the construction of a new north terminal, the renovation of both existing terminals to provide a total of 80 gates, with 48 of them able to serve wide-body jets. In addition, the airport expanded its parking facilities and constructed an additional passenger tunnel.

The airport's proposed master-plan attempts to address future demand for services at the airport. It calls for the construction of an additional terminal to serve international flights with 20 gates for wide-bodied planes, six gates for conventional sized planes, and a customs facility capable of handling 5,000 passengers per hour. The plan also includes a ground transportation center with parking and staging facilities and an automated people mover system to connect the terminals with the ground transportation center and remote parking facilities.

Strong opposition from the environmental community as well as the communities surrounding the airport has prevented the airport from increasing its airside capacity through an expansion of its runway facilities in the past. The current airport master-plan also reflects this reality and does not contain any physical expansion of existing runway capacity.

San Francisco airport officials also point to existing developments in the industry that, in their opinion, will help the airport to meet future demand:

(1) ■ The number of airlines using the airport is declining and will continue to decline due to industry trends. (This assumption will only apply if there is no increase in hubbing activities.)

(2) ■ Airlines will attempt to increase their efficiencies, reduce the number of unprofitable flights, and increase load factors.

(3) ■ Airlines will move to using larger planes in particular on international flights and thus be able to serve more people with the same runway activity.

Effects on passengers. Passengers are more concerned about ground access to the airport rather than delays at the airport itself. Despite capacity constraints, passengers prefer to use San Francisco International over regional alternatives because of the frequency of service and fare structure.

A survey of air passengers conducted regularly by San Francisco International Airport shows an overall airport rating of over four (out of five) for San Francisco during the last five years. This evidence suggests that air passengers do not perceive the delays as excessive.[5] A focus group of frequent flyers living in the Bay area conducted as part of the regional airport system plan indicates that congestion at the airport and congested ground access to the airport gives the airport a negative image. The participants were particularly concerned about congested roadways, expensive parking, and poor customer service.

Capacity constraints have adversely affected San Francisco International's image among passengers in comparison to Oakland and San Jose, which are perceived as much friendlier because of their smaller size. Despite this, passengers continue to use San Francisco. The reasons for this decision lie in the higher frequency of flights available at San Francisco and in the lower prices that the larger market there offers. In addition, participants perceived ground access problems at both Oakland and San Jose as an impediment to using these alternatives as well.

Effects on Airlines. Airlines continue to provide good service into San Francisco International despite congestion. A small number of airlines have adjusted their services in response to congestion.

The airline industry considers San Francisco International as the main airport for the San Francisco region and will continue to schedule new service at that airport. There is recognition that the region's aviation system is overcrowded and not meeting current demand at San

Francisco during peak hours. In a focus group meeting, airline representatives stated problems with access, air traffic and congestion at the gates at San Francisco.

Some airlines have recently moved services elsewhere in the region in response to congestion at San Francisco. A representative from American Airlines observed that they have stopped service between San Francisco International and Los Angeles because of the congestion problems at San Francisco. This cancellation of 18 flights to Los Angeles was accommodated by increasing service from San Jose. It appears that at least one other airline is considering a similar move.

Effects on Cargo. To date, cargo has not been significantly impacted by delays at San Francisco. However, runway and ground capacity constraints preclude San Francisco International from marketing air cargo facilities. There appears to be a trend towards decentralization of cargo facilities in response to capacity constraints.

Cargo operations in the Bay area have already experienced a trend towards decentralization. This is a response to the increases in both domestic and international traffic at San Francisco International. The increasing global market for air cargo generated growth in international cargo operations in the region. Growth in cargo has been particularly strong at Oakland. Oakland actively pursues the cargo market segment and tries to attract more operations. San Jose is also attempting to gain a larger market share.

Effects on General Aviation. Most general aviation activity relocated from San Francisco International over a decade ago. Currently, it serves a limited number of general aviation operations, mostly corporate jets.

Oakland and San Jose have significant general aviation activity. San Jose is likely to start considering limiting general aviation activities by not improving or updating existing facilities. The airport has limited runway capacity, and currently 50 percent of that capacity is taken up by general aviation activity. San Jose expects to continue to serve the general aviation market segment and has just completed construction of a corporate jet terminal.

Focus group research indicates that members of the general aviation community are concerned that future development at Oakland will displace general aviation especially for corporate jets.[9] There is clear concern that reducing general aviation capacity in the region would, over time, have a significant negative effect on the business community.

Social Impact. There is no apparent negative social impact as a result of congestion at San Francisco airport beyond increased journey times. The region is well served by the other two major commercial airports and residents of the communities surrounding these airports use them at least for short-haul flights. Despite the ground access problem and congestion at the airport itself, Bay area residents continue to use San Francisco in particular for long-haul and international flights. Presently, the higher frequency of flights to desired destinations and the lower prices San Francisco offers still offset the negative impacts of congestion at and around the airport.

Wider Economic Effects

There is little evidence that the wider economy is adversely effected by delays at San Francisco International. There are specific concerns about ground access difficulties at the airport. There appears to be a growing sense that the gap between air transportation demand and capacity may soon reach a point where it starts to have a negative impact on the region's economy. However, no evidence has been assembled to date.

The business community in the Bay area presently believes that it receives good service from San Francisco International and the other airports in the Bay area. None of those interviewed in either air transportation industry or industry in general believed that congestion at San Francisco has had a negative impact on the economy in region. The focus of the business community's concern is on ground access to the airport for both passengers and cargo rather than on congestion at the airport itself. For that reason, there is support for a better market segmentation among the three major airports and for more decentralization of cargo operations. Thus, a movement of both cargo and passenger operations away from San Francisco with its congested ground access system is seen as economically beneficial rather than damaging.

There is concern that the potential future reduction in general aviation activity due to increased use of Oakland and San Jose by scheduled will have adverse economic effects.

VANCOUVER INTERNATIONAL AIRPORT CASE STUDY

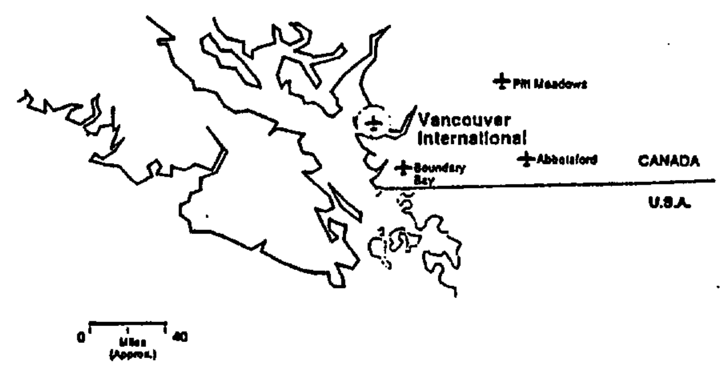
Key Findings

- There are direct costs associated with delays estimated at an average of $800,000 per month. These are borne by the air transportation industry and exclude placing a value on passengers' time.
- There is no conclusive evidence of wider economic costs arising from existing delays at Vancouver International Airport on the regional economy.
- Capacity constraints do not appear to impact the level of service. Since the mid-eighties, Vancouver International has seen a steady increase in commercial operations despite increasing levels of delay.
- Access to communities across British Columbia has not been adversely impacted. The most rapidly growing segment of demand over the past decade has been regional and commuter service. They have grown at a rate of over 100 percent per year.
- Service to Pacific Rim countries has grown rapidly in recent years.
- For regional passengers, service has actually increased despite increasing delays because of the higher frequency of available flights.
- Passengers, including those coming from outlying areas, prefer the concentration of air service at Vancouver International because it provides them with a higher frequency of service and a larger number of destinations than service split among different airports in the region. It is also more economical for the airlines.

VANCOUVER INTERNATIONAL AND BRITISH COLUMBIA'S AIR TRANSPORTATION SYSTEM

Vancouver International Airport is the major hub for British Columbia. Vancouver International is situated eight miles south of downtown Vancouver, located close to the most densely populated areas of the greater Vancouver metropolitan area. It is situated on Sea Island in the

Exhibit VI-3:
Vancouver International Airport and Region



Fraser River estuary (see Exhibit VI-3). British Columbia is served by four other airports in the Vancouver area, Boundary Bay, Pitt Meadows, Langley, and Abbotsford. General aviation activity is particularly high at Boundary Bay, it is the third busiest general aviation airport in Canada.

Vancouver International Airport is British Columbia's major airport. It is the connecting point for most major carrier operations and commuter services in British Columbia and western

Canada. Vancouver International provides air service to the rest of Canada and is Canada's West Coast international gateway for scheduled service to the Pacific Rim.

In recent years, regional services have increased dramatically, rising by about 100 percent per year. In addition, service to Pacific Rim countries has grown significantly. Operations at Vancouver International increased by almost 50 percent, between 1977 and 1989, despite an economic downturn in the early eighties. During the same time period, the number of passengers served by the airport increased by 80 percent to over nine million passengers per year.

During the 1980s, both the number and the composition of operations at Vancouver International changed dramatically. In particular, the airport experienced an over 300 percent increase in turbo-prop aircraft in the mid-eighties, reflecting a trend to smaller aircraft and more frequent regional service. Vancouver International has a diversity of scheduled and general aviation operations. Corporate and private aircraft accounted for 12 percent of all movements in 1988.

Vancouver International plays an important role in providing cargo services for the region. Currently, it handles about 140,000 tons per year. Eighty to 90 percent of all cargo leaving Vancouver International is belly freight.[10]

EFFECTS OF CAPACITY CONSTRAINTS ON THE AIR TRANSPORTATION SYSTEM

The Nature of the Capacity Constraints.

Growth Demand. Vancouver International experiences delays because demand exceeds runway capacity. The main factors are increasing traffic volumes, in particular on regional and Pacific Rim routes and a diverse mix of aircraft rather than adverse weather or wind conditions. Demand exceeded the operational runway capacity for the existing mix of operations at Vancouver International in 1988 by 10,000 movements, causing an estimated 40,200 hours of delay. Delays at the airport averaged 8.4 minutes. On average, 40 percent of all departures were delayed, although less than 10 percent experienced delays of more than 15 minutes.[11]

Congestion and delay at Vancouver International is, to a large extent, a result of increases in demand and the wide range of aircraft sizes and weights using the airport. While weather and wind-related delays occur, they do not explain the sustained level of congestion at the airport. Instrument Flight Rules conditions exist at Vancouver International about 6.5 percent of the time.

The airport currently does not experience major landside constraints, although there is some congestion on the road system accessing the airport and some international passengers may experience delays at customs facilities.

Estimated Direct Cost of Delays. The costs of delay incurred by operators in 1988 were estimated at $800,000 per month. These estimates account for additional operating costs but do not include the estimated value of passengers' time.

Future Constraints. Demand at Vancouver International is projected to increase to 360,000 annual runway movements by the mid 1990s, while capacity, currently at 285,000 movements, is expected to decline to 265,000 movements. The estimated decline is due to an increased proportion of large carriers in the mix of operations.[11] A change in the number of major airlines serving the airport (for example, the proposed merger of Air Canada and Canada International Airlines) could reduce demand for runway capacity, and thus delays, significantly.

Response of the Air Transportation System

Airports. Vancouver International has moved most general aviation activity to another airport and instituted an Airside Capacity Enhancement Project (ACE) to address delays. Based on analysis conducted as part of ACE, an additional runway, capable of accommodating independent jet operations, is likely to be built. Operational changes at the airside of the airport have already increased capacity by eight percent. A future peak-hour landing fee is being considered.

A 1981 master-plan for Vancouver International, recommended the opening of Boundary Bay Airport to increase the region's capacity for general aviation operations. As a result, the airport was reactivated in 1983. All flight school operations were removed from Vancouver International and are now based at Boundary Bay. Boundary Bay handles over 250,00^ operations per year and is the third busiest general aviation airport in Canada.

In 1989 Vancouver International introduced a capacity improvement program which increas airside capacity by eight percent in an attempt to address the capacity problem in the short ter The program included the adoption of new procedures, taxiway improvements, and t conversion of a taxiway into a "stub" runway for departures.

In addition to these measures, the analysis suggested that a minimum landing fee be implemented in order to better distribute air traffic among the airports in the region and to build a parallel runway capable of handling large carrier operations simultaneously with the existing runway system. The airport is in the process of starting construction on the runway and on terminal facilities needed to handle the increased passenger volumes on the landside.

The Effects of Capacity Constraints on Passengers. Passenger surveys conducted at the airport do not indicate any dissatisfaction related to the delays at the airport. The increased frequencies for regional service have actually dramatically increased the level of service for these passengers despite the fact that they have caused delays at the airport. Increased service allows passengers from across British Columbia to access a larger number of domestic and international flights. For example,the number of flights between Victoria and Vancouver has increased from one to between five and six daily flights over the past year.

The Effects of Capacity Constraints on Airlines. While airlines have pointed out the cost of delays, they have continuously expanded service in recent years despite increasing delays. It is still more cost effective for the airline industry to operate from Vancouver as major regional hub and to shuttle passengers to Vancouver to allow them access to long-distance flights than to spread operations to other airports in the region. This will likely be the case as the industry accommodates future demand as well.

The Effect of Capacity Constraints on Cargo. Cargo operations at Vancouver International are not impacted significantly by the delays occurring at the airport. This is not surprising, given that between 80 and 90 percent of cargo is belly freight. Increased service which contributes to congestion actually increases air freight available from Vancouver.

Effects on Commuter Operations. The dramatic increase in regional and commuter operations (over 300 percent since 1980) has contributed significantly to the increasing delay problems at Vancouver International. This indicates that the delay costs are still smaller than the benefits generated by the increased service volumes. Delay does increase the operational costs of the airlines, but there have been no impacts on the availability of service to communities in British Columbia.

Effects on General Aviation. At Vancouver International, general aviation activities have decreased by over 60 percent to less than 30,000 operations in 1988 since 1980. This is due to increasing delays at Vancouver International and the reopening of Boundary Bay to provide an alternative. It is expected that a future peak-hour landing fee, planned at $25, will divert 20,0C general aviation operations annually from Vancouver International to other airports in the regio

WIDER ECONOMIC EFFECTS

There is no evidence indicating that delays at Vancouver International Airport have had a negative impact on the economy of British Columbia to date.

In order to determine whether major airport investment addressing future capacity problems is economically justified in the Lower Mainland region of British Columbia, a major economic impact and cost/benefit study for different scenarios was undertaken. The analysis did not attempt to identify the direct costs of not expanding airport capacity. The study defined the economic benefits likely to be gained from using alternative strategies to address the airside capacity constraint at Vancouver International. The economic analysis strongly supported construction of a parallel runway capable of serving heavy carrier traffic. The economic benefit from the runway construction, in conjunction with a peak-hour landing fee, was estimated at over $4 billion in present dollars.

It should be noted that observers believe that Vancouver International plays a key role in providing access to the international market. Cultivating the expansion of air transportation is part of Vancouver's economic development strategy. This relies on increasing capacity to meet future demands.

Economic Development Issues. The business community in British Columbia has expressed concerns about long delays at Vancouver International. Business travelers are aggravated by delays sometimes in excess of 1.5 hours, and by delays at other airports such as Prince George due to backups at Vancouver International. Economic development officials are not aware of business relocation decisions related to delays at Vancouver International. Pacific Rim businesses, looking for opportunities in British Columbia, widely recognize the problem. Uncertainties about the future quality of air service have been resolved by the decision to build the parallel runway.

Social Effects. Passengers from outlying areas have benefitted from increased frequencies on regional routes despite increasing delays. The increase in the use of smaller turbo-prop aircraft instead of larger carriers has increased the frequency of service from outlying areas and created better connections to long distance flights than were available before.

Passengers from outlying areas are taking advantage of the higher service levels. The number of passengers on regional routes has increased from less than 100,000 in 1980 to almost 1.1 million in 1987.

Environmental Impact. Future delays at Vancouver International are projected to have a negative impact on air quality if the delay problem is not addressed. There is no information on the environmental impact of existing delays at Vancouver International airport. The analysis of the feasibility of the parallel runway for Vancouver International, however, included a detailed environmental impact evaluation. The environmental analysis found that the decision

not to built the parallel runway would have a negative impact on air quality. The baseline scenario was projected to lead to higher levels of carbon monoxide, hydro carbon, and nitrogen oxide emission than the parallel runway scenario.

ENDNOTES:

1. Page 6-1 Draft Final Report, Air Transportation Demand, Aviation Industry Trends and Air Capacity In Washington Through 2020, report prepared by TRA.

2. AIRTRAC's Project IIb Report, Assessment of the Flight Plan Forecasts prepared by Dr. Richard De Neufville argues that because of its very nature there is no fixed measure of capacity.

3. Puget Sound Air Transportation Committee. Working Paper No. 7. Estimate is based on the existing airport configurations and assumes 380,000 operations and 32 million air passengers in 2020.

4. Boston Regional Airports System Study, Final Report, July 1989.

5. New England Council, Keeping New England's Economy Growing: Observations on the Emerging Crisis in Regional Air Service, Boston, October 1990.

6. New England Council, Keeping New England's Economy Growing: Observations on the Emerging Crisis in Regional Air Service, Boston, October 1990.

7. Telephone interview with Dick March, Director of Aviation Planning Massport.

8. San Francisco International Airport, Information Package, 1992.

9. Apogee Research: Regional Airport System Plan Update: Task Force - Focus Group Results, Draft Report, February 1991.

10. Phone interview with Joe Sunoma, Director of Market Research, Vancouver International Airport Authority.

11. Vancouver International Airport Airside Capacity Enhancement Project, Airside Demand/Capacity Analysis, June 1989, and James F. Mickling Management Consultants Ltd.: Vancouver International Airport Economic Analysis of Airfield Capacity Enhancement Strategies for Vancouver International Airport, March 1990.

12. Transport Canada: Vancouver International Airport Parallel Runway Project Environmental Impact, Statement, August 1990.

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APPENDIX C
COSTS AND EFFECTS OF AIR CAPACITY CONSTRAINTS CASE STUDY APPROACH

Introduction

This appendix provides a description of the approach taken for the case study analysis reported in Section VI. The case study research provides the basis for drawing conclusions for Washington about the likely costs and effects of air transportation capacity constraints in central Puget Sound. The overall objectives of the case study research were to identify, if any, the costs and effects in other regions of air capacity constraints. This approach provides the opportunity to learn how other airports and regions have been affected by air capacity constraints and to identify lessons for Washington.

The appendix is organized in the following sections:

- Case study approach.
- Case study selection criteria.
- Individuals consulted.

Case Study Approach

A case study approach was adopted in order to provide a description of the effects of capacity constraints in regions which would be analogous to a capacity constrained Puget Sound. The purpose of the descriptions is to provide insights into the types of effects, if any, we might expect to see in Washington. The case studies were designed not to focus solely on specific airport facilities but examine the hinterland (rural areas and regions) which the airport serves.

Fact-finding was conducted in each of the case study areas by conducting telephone interviews with a cross-section of observers including: airport staff, related industries, business and stakeholder interests, and knowledgeable academic observers. The interviews were used to solicit viewpoints about what has happened and the current effects of capacity constraints.

Case Study Selection Criteria

The case study locations were selected by identifying airports in states and regions that have capacity constraints and regional characteristics similar to those which would be experienced by a capacity constrained Sea-Tac and Washington.

Delay was used as an indicator of capacity constraints. As discussed in Section VI there are a number of difficulties in measuring capacity. Delay is conventionally used as an indicator of air capacity constraints. Statistics detailing the number of delays per 1,000 operations and average length of delay were used to identify airports experiencing capacity constraints.

A sampling frame of congested airports (measured by above average delays) was drawn from data listing length of delays at all airports with at least one percent of the national total of scheduled commercial enplanements. The airports in the sampling frame are shown in Exhibit C-1 below, which lists selected characteristics for these congested airports.

EXHIBIT C-1
Airports with Capacity Constraints - Selected Characteristics

		Total Operations (thousands)			Total Enplanements (thousands)		Average Delay (minutes per operation)		Level 1 Airports Hubbing Ratio	Peak Hour Capacity Index
Location Identification	City	1976	1988	Percent Change	Foreign Flag	Total	1985	1988	Connects / Enplanements 1988	1988
ABQ	Albuquerque	227	230	1.3			6.7	9.0		
ATL	Atlanta	490	779	59.0	230	23,058	8.5	9.0	63.8%	1.5
BNA	Nashville	215	271	26.0			4.8	8.1		
BOS	Boston	307	438	42.7	523	11,563	8.3	9.2	8.2%	1.25
DAY	Dayton	168	213	26.8			5.3	8.5		
DCA	Washington D.C.	326	328	0.6	0	7,710	6.6	8.3	11.0%	1.22
DEN	Denver	419	502	19.8	51	14,973	8.7	8.4	59.1%	0.99
DFW	Dallas-Fort Worth	360	675	87.5	253	22,237	8.7	9.4	50.8%	1.12
EWR	Newark	193	380	96.9	212	11,319	10.7	11.0	14.5%	1.32
JFK	New York	332	330	-0.6	3,714	15,236	9.4	11.0	6.6%	1.09
LAX	Los Angeles	483	624	29.2	2,429	21,647	7.3	7.8	13.1%	1.30
LGA	New York	345	365	5.8	379	12,085	9.8	11.0	3.3%	1.65
ORD	Chicago	718	803	11.8	880	28,374	9.0	10.8	48%	1.45
PHL	Philadelphia	311	416	33.8	170	7,780	5.5	8.2	20.8%	0.99
RDU	Raleigh-Durham	198	275	38.9			4.7	8.6		
SFO	San Francisco	343	455	32.7	1,190	14,853	8.5	8.2	16.3%	1.65
STL	St. Louis	321	433	34.9	0	10,056	6.9	7.6	59.1%	1.41
YVR	Vancouver	232	323	40.1	790	4,420	n.a.	8.4	n.a.	n.a.
SEA	Seattle	174	316	81.6	355	7,408	4.6	5.5	14.4%	1.02

Source: Winds of Change, Domestic Air Transportation Since Deregulation, TRB Special Report 230, 1991.
A Strategic Plan For the Nation's Airport System, Federal Aviation Administration, Office of Airport Planning and Programming, January 1990.
Transport Canada Aviation Forecasts "Top 9" Airports, TP9593E, August 1990.
Economic Analysis of Airfield Capacity Enhancement Strategies for Vancouver International Airport, March 1990.

The airport identification codes are listed in Exhibit C-2 below.

EXHIBIT C-2
Airport Identification Codes

ABQ: Albuquerque International Airport, Albuquerque, New Mexico
ATL: William B. Hartsfield Atlanta International Airport, Atlanta, Georgia
BNA: Nashville Metropolitan Airport, Nashville, Tennessee
BOS: Boston General Edward Lawrence Logan International Airport, East Boston, Massachusetts
DAY: Dayton (James M. Cox) International Airport, Dayton, Ohio
DCA: Washington National Airport, Washington, District of Columbia
DEN: Denver Stapleton International Airport, Denver, Colorado
DFW: Dallas/Fort Worth International Airport, Dallas/Ft. Worth, Texas
EWR: Newark International Airport, Newark, New Jersey
JFK: New York John F. Kennedy International Airport, Jamaica, New York
LAX: Los Angeles International Airport, Los Angeles, California
LGA: New York LaGuardia Airport, Flushing, New York
ORD: Chicago-O'Hare International Airport, Chicago, Illinois
PHL: Philadelphia International Airport, Philadelphia, Pennsylvania
RDU: Raleigh-Durham Airport, Morrisville, North Carolina
SEA: Seattle-Tacoma International Airport, Seattle, Washington
SFO: San Francisco International Airport, San Francisco, California
STL: St. Louis-Lambert International Airport, St. Louis, Missouri
YVR: Vancouver International Airport, Vancouver, British Columbia

In order to select the case studies, the following criteria were used to choose airports with:

- Similar hubbing ratios (connects / enplanements).
- Increasing and relatively high average delay (minutes per operation).
- Relatively high peak hour capacity index values.
- Size comparable to expected Washington growth (measured by total operations or total enplanements).

- The role of International gateway.
- Geographic isolation similar to Washington's.

When these selection criteria were applied, they resulted in the selection of the case study locations as highlighted in Exhibit C-3.

EXHIBIT C-3
Case Study Selection Criteria - Applied To Airports With Capacity Constraints

Location Identification	City	Similar Hubbing Ratio	Relatively High Average Delay	High Peak Hour Capacity Index	Comparable[1] Size	Similar Geographic Isolation	International Gateway
ABQ	Albuquerque	n.a.	✓	n.a.			
ATL	Atlanta		✓	✓			✓
BNA	Nashville	n.a.		n.a.	n.a.		
BOS	BOSTON	✓	✓	✓	✓		✓
DAY	Dayton	n.a.	✓	n.a.	n.a.		
DCA	Washington D.C.	✓		✓	✓		
DEN	Denver				✓		
DFW	Dallas-Fort Worth		✓	✓			
EWR	Newark	✓	✓		✓		
JFK	New York		✓	✓			✓
LAX	Los Angeles	✓					
LGA	New York		✓	✓	✓		
ORD	Chicago		✓	✓			
PHL	Philadelphia			✓			
RDU	Raleigh-Durham	n.a.	✓		n.a.		
SFO	SAN FRANCISCO	✓		✓	✓		✓
STL	St. Louis		✓	✓			
YVR	VANCOUVER	✓	✓	✓		✓	✓
SEA	Seattle						

n.a. — Data not available

1. No more than twice as large as Sea-Tac (enplanements) in 1988.

Individuals Consulted

Following is a listed of individuals consulted:

Boston

Dick Marchi
Director
Aviation Planning
Massport Aviation

Claire Barrett
Special Assisstant for Strategic Planning
Massport Aviation

Cynthia Nickels
Senior Business and Economics Analyst
Massport Aviation

Norman Faramelli
Transportation and Environmental Planning
Massport Aviation

Ralph Nicosia-Rusin
Planner, Airport Division
FAA, Massachussetts

Bob Ziegelaar
Director
Bangor Airport
Bangor, Maine

E.A. Tansey
Director
Theodore Francis Green State Airport
Providence, Rhode Island

Alfred Testa
Manchester Airport

Larry Sebart
Director
New England Council

Glenn Moris
Air Transportation Association

Robert Jenney
Massachusetts Aeronautics Commission

Jim Meloy
Professor
Northeastern University

Bob Simpson
Professor
Aeronautics & Astronautics Dept., MIT

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FEDERAL AVIATION ADMINISTRATION

THE EFFECT OF AIRPORT NOISE ON HOUSING VALUES: A SUMMARY REPORT

Prepared for the
Office of Environment and Energy
Federal Aviation Administration
Washington, DC 20591

By
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The Impact of Airport Noise on Housing Values: A Summary Report	September 15, 1994
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Federal Aviation Administration Office of Environment and Energy, AEE-120 800 Independence Ave., S.W. Washington, D.C. 20591.	Report summarizing past analytical studies FAA/AEE-120

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This report describes the results of a "bottom up" examination of the impact of airport noise on housing values. The primary objective of this assessment was to determine whether a valid national level determination regarding the impact of airport noise on housing values could be made based on studies at individual airports. The studies were not intended to obtain precise values of the noise impact on property values around the airports that were considered.

An analytical approach was designed that combined quantitative and qualitative techniques in a way that complements each and overcomes some of the shortcomings of previous studies that exclusively used one technique or the other. In recognition of the fact that local conditions can significantly affect real estate markets, this approach makes extensive use of local realtors and appraisers who are familiar with the area and any unique factors that must be considered when assessing the value of residential properties.

This approach was used around airports in three major metropolitan areas to determine if the approach was repeatable and verifiable, and whether it provided consistent and reliable results in terms of trends regarding the economic impact of airport noise on housing values. They were also intended to assess the reliability and accessibility of the data required for such analyses. It was concluded that this approach represents a viable method of examining the effects of airport noise on housing values at the national level. A correct application of sampling methods and the analytical technique can be used to establish the nationwide magnitude of the effect that airport noise has on property values, and may help decision makers determine national policy or guidelines regarding the impact of airport noise on housing values.

Airport noise
Aircraft noise
Housing values
Economic impact

Unclassified	Unclassified

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EXECUTIVE SUMMARY

The impact of airport noise on housing values has been the subject of numerous studies in the past. Although these studies have been useful in providing some insight into this complex issue, it is difficult to draw any clear and unambiguous conclusions from the results, since each of the studies used a variety of quantitative and qualitative techniques, different measures of noise, and dissimilar sources of information. Therefore, the results of these past studies are subject to interpretation and cannot be applied to airports in any general overall sense.

The Federal Aviation Administration's (FAA's) Office of Environment and Energy (AEE) performed a "bottom-up" examination of the nationwide impact of airport noise on housing values. The primary objective of this assessment was to determine whether a valid national level determination regarding the impact of airport noise on housing values could be made based on studies at individual airports. The studies were not intended to obtain precise values of the noise impact on property values around the airports that were considered.

An analytical approach was designed that combines quantitative and qualitative techniques in a way that complements each and overcomes some of the shortcomings of previous studies that exclusively used one technique or the other. In recognition of the fact that local conditions can significantly affect real estate markets, this approach makes extensive use of local realtors and appraisers who are familiar with the area and may be aware of unique factors that must be considered when assessing the value of residential properties.

The underlying assumption of this approach (referred to as the "neighborhood pair model") is that housing values are determined by a combination of neighborhood characteristics (e.g., the quality of local schools, local property taxes, and the crime rate) and individual housing characteristics (e.g., age of the house, number of rooms, and amenities such as swimming pools and garages). Two neighborhoods—one exposed to higher noise levels than the other—with similar characteristics are chosen. If the property values are "normalized" so that the housing traits are also comparable and airport noise is the only apparent difference, then any difference in the property value could be attributed to airport noise.

Studies were performed around airports in three major metropolitan areas. Each of the airports had well-documented noise impact information, were moderately affected by the economic changes of the past 4 years (relative to other parts of the country), and are located in communities that are not extremely sensitive to noise. These studies were intended to examine whether the analytical approach used was repeatable and verifiable and whether it

willing to be exposed to relatively higher noise levels). The neighborhood pair model would then be implemented at a representative sample of airports from each category.

Two possible methods may be used to determine the number of airports where the analyses are performed. One way of approaching this nationwide study is to implement the neighborhood pair model at airports in each category where sufficient data are available until the average noise impact measured reaches a relatively stable value. This approach, while feasible, could prove quite expensive in practice. A more cost-effective examination of this issue would use modern statistical techniques to determine the correct sample size, which would depend on the total population being considered as well as the level of error that can be tolerated.

If the sample sizes are correctly chosen, and the studies are conducted using the appropriate number of neighborhood pairs and noise levels, it is likely that anomalies due to local conditions as well as other confounding effects (e.g., changes in property value due to interest rate changes) will average out, and ultimately the resulting magnitude of airport noise impact will "regress toward the mean."

In conclusion, a viable technique exists to examine the effects of airport noise on housing levels at the national level. A correct application of sampling methods and the analytical technique can be used to establish the nationwide magnitude of the effect that airport noise has on property values and can help decision makers determine national policy or guidelines regarding the impact of airport noise on housing values.

The studies were performed at various North American airports to evaluate alternative methods for assessing the costs and benefits of airport noise mitigation. In most cases, the studies sought to determine the relationship between airport noise and the value of real estate around airports. While these studies shed some light on this complex issue, it is difficult to use them collectively to arrive at definitive conclusions.

There were some inconsistencies, even within each study, in the units used to quantify benefits and costs. Several different proxies were used to represent property values, and these proxies varied in terms of the level of detailed information captured; e.g., some studies considered actual sales data (Ref: 11), others considered average census tract property values (Ref: 4), and others used the average census block data (Ref: 9). There was also considerable variation in the noise descriptors used—ranging from the standard Day-Night Average Sound Level, or DNL (Ref: 1,2), to Noise Exposure Forecast, or NEF (Ref: 10,12), to subjective measures such as "moderate" and "substantial" (Ref: 14,15). Each study typically focused primarily on individual airports; the few that considered several airports (Ref: 4,7) yielded disappointing results by virtue of the use of highly aggregated census tract-level data, which do not include key variables such as living area or lot size.

All these factors make it difficult to arrive at any clear and unambiguous conclusions regarding airport noise and its impact on housing value, and a need was perceived to develop a standard and credible method to quantify this effect.

This report describes a series of studies that were conducted at airports in three major metropolitan areas—Baltimore, Los Angeles, and New York. The primary intent of these studies was to determine the effectiveness of an analytical procedure that was designed to estimate the effects of airport noise on housing values and to evaluate the applicability of the study results at the national level.

Chapter 2 contains a detailed description of the analytical procedure. Chapter 3 describes how this procedure was implemented around four major domestic airports, as well as the results of these studies. Chapter 4 gives some suggestions regarding how the analytical approach could be implemented at the national level. Chapter 5 presents overall comments about the studies and the conclusions drawn from them. Chapter 6 provides a bibliography of the literature that was reviewed.

- Step 2. Select sample houses from each neighborhood to normalize individual housing characteristics.
- Step 3. Compare housing values in the two neighborhoods based on real estate appraisal applications and regression modeling.

Each step is described below.

2.1 Step 1. Identification of Neighborhoods

During this phase of the process, a pool of local realtors from a number of leading real estate agencies in the city is surveyed to assess the primary neighborhood characteristics that influence home buyers in the vicinity of the airport in question. They are asked to rate these characteristics in decreasing level of importance. The neighborhood traits considered (as recommended by the National Board of Realtors) are:

- Property taxes
- Crime rate
- Quality of neighboring residential units
- Racial/ethnic/social characteristics
- Local traffic conditions/congestion
- Nearness to commercial and shopping centers
- Quality of local schools
- Quality of municipal services
- Access to public transportation
- Commuting distance
- Quality and proximity of recreational facilities.

The results of these surveys are then analyzed and tabulated for all the realtors collectively as well as for the subsample of those realtors serving the airport. These results are examined to determine which realtor's judgment most closely approximates the average survey statistics. This realtor is identified as the "norm" realtor.

As a person with a great degree of familiarity with local conditions, the norm realtor is instrumental in gaining an in-depth understanding of the real state market around the airport in question. A site survey of the residential neighborhoods impacted by airport operations is performed, and the social, ethnic, and economic conditions in the airport vicinity are evaluated. Based on the results of these surveys, the airport environs are subdivided into those that have similar neighborhood characteristics.

2.2 Step 2. Selection of Sample Houses from Each Neighborhood

In the second step, a sample of recently sold homes is selected from each of the neighborhoods identified. A number of data sources may be used to get the most accurate and complete information possible about each home. Typically, these sources include:

- Multiple Listing Service (MLS)
- Redi Data
- Comps, Inc.
- Local building department records
- Tax assessment reports.

The homes are selected based on the following criteria:

- They have been sold recently (typically, within the past 12 months).
- They have similar housing characteristics and amenities such as:
  - — Age, number of rooms and bathrooms, and square footage
  - — Items such as a swimming pool, garage, and/or spa.

The recorded sale price is obtained for each of these homes. Thus, the end result of this step of the analytical process is the identification of a set of homes in each neighborhood selected with roughly similar housing attributes and property values (see Figure 2-2). The information is then utilized as described in the next section.

2.3 Step 3. Comparison of Housing Values in Each Neighborhood Pair

In this step, two approaches are used to determine the effect of airport noise on housing values—a subjective appraisal approach and a statistical regression modeling approach (see Figure 2-3).

2.3.1 Appraisal Approach

A number of local appraisers are contacted to select the individual best suited for this study. The appraisers are evaluated on several criteria, e.g., educational background, professional qualifications and experience, understanding of the problem, recommended approach, response to a survey of factors that influence home buyers, and fees.

The selected appraiser first performs conventional appraisals of each home selected in the previous phase of the study. For a given house, three similar and proximate recently sold houses are selected. External home inspections are

in the basement, $5,000 for a two-car garage). The value of a home that has these items is accordingly increased; conversely, the price of a home that does not have these amenities is reduced appropriately.

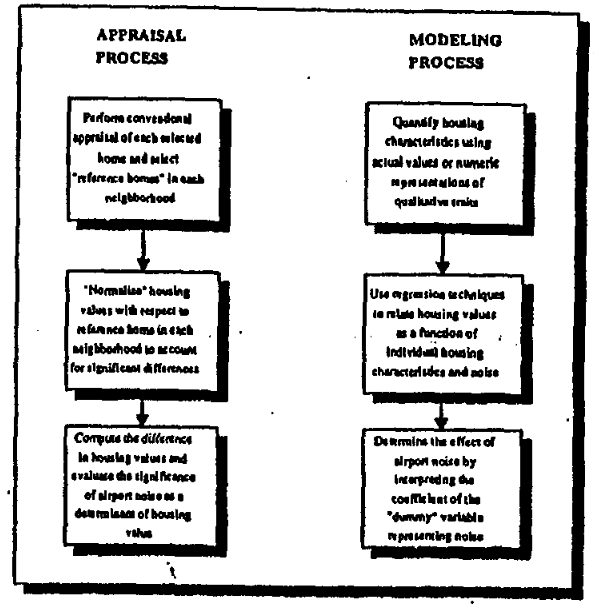

FIGURE 2-3. Determination of the Effect of Airport Noise on Housing Values

At the conclusion of the normalization procedure, the results for each neighborhood are tabulated and compared. The final results are then analyzed to determine the difference, if any, in housing values between noisy and quiet neighborhoods. This difference may be the consequence of airport noise.

2.3.2 Modeling Approach

This procedure utilizes multiple linear regression techniques to relate housing values with house characteristics and the noise levels to which they are exposed (a more complete discussion about regression techniques may be found

In addition to these characteristics, the model also considers several "binary" variables, which take on a "yes/no" (or 1/0) value in performing the multiple regression analysis:

- Existence of swimming pool
- Existence of spa
- Existence of patio
- Existence of porch/deck.

Finally, a "dummy" variable is used to represent the two different levels of noise that were considered (for example, "0" for a home in a noisy neighborhood, "1" for a home in a relatively quiet neighborhood).

This technique yields a mathematical equation of the form:

Housing value = f(Housing characteristics, Noise)

After deriving a preliminary model using this procedure, a number of statistical tests and model parameters can be used to determine its validity. These tests and parameters include but are not limited to:

- Examination of R, the multiple correlation coefficient, and R^2, the coefficient of determination, which are measures of how well the regression model describes the data

- Computation of the "t"-statistic for each independent variable, which determines the significance of individual variables; that is, whether or not the variable contributes to predicting the dependent variable

- Determination of the "power," or sensitivity, of the regression, which is the probability that the model correctly describes the relationship between the variables, provided there is one

- Computation of the Durbin-Watson statistic, which is a measure of the correlation between the residuals.

The initial model is iteratively revised based on the results of these and other tests; for example, variables that are not statistically significant are dropped, and the model is reexamined to see if the power of the study improved. Collinearities are also eliminated to the extent possible. This process continues until no further refinement is possible.

Furthermore, the sign of the coefficients of all the variables considered must be examined to compare them for consistency with the appraiser's judgment. If the coefficient associated with the variable for living area is positive, then the

3. IMPLEMENTATION OF APPROACH

The three-step procedure described in the previous chapter was implemented in three metropolitan areas around the country. First, a pilot study was conducted around Baltimore/Washington International Airport (BWI) to evaluate the soundness of the methodology that was designed to quantify the effect of airport noise on property values—that is, to determine if it was practicable and reasonably economical to implement and to assess whether the data necessary for such studies are accurate and accessible enough to make future studies of this nature feasible.

An evaluation of the pilot study revealed that while the approach was reasonable and relatively easy to implement, the area around BWI is quite limited in terms of the number of residential neighborhoods impacted by noise and the range of property values. Therefore, the next study was conducted around Los Angeles International Airport (LAX), where much larger areas are impacted, and the homes are much more diverse.

The LAX study showed a distinct difference in results depending on the relative price range of the neighborhoods. Therefore, the third study was conducted around New York's John F. Kennedy International Airport (JFK) and La Guardia Airport (LGA) to see if the same effect was observable in similarly diverse neighborhoods (such as in the metropolitan New York area).

There were other advantages to considering these airports as well: they all had well documented and up-to-date information regarding noise impact areas, the metropolitan regions that they serve were only moderately affected by the economic changes of the past 4 years (relative to other areas), and they are located in communities that were not extremely sensitive to noise at the time.

This chapter describes how each study was executed, discusses the findings, and summarizes the overall project results.

3.1 The Baltimore/Washington International Airport (BWI) Pilot Study

The pilot study around BWI (Ref: 20) was performed in the Fall of 1990 to examine the efficacy of the analytical procedure. The results of each of the three steps in the analytical process are discussed below.

3.1.1 Neighborhood Identification (Step 1)

A pool of realtors from three top real estate agencies was surveyed to assess neighborhood characteristics and their relative importance in the area around BWI. The general opinion (see Table 3-1) was that commuting distance, the

The difference between the selling price and the appraised value of each home was marginal—the appraised value was $1,538 higher than the sale price in the noisy neighborhood and only $397 higher than the sale price in the quiet neighborhood.

3.1.3 Housing Value Comparison (Step 3)

3.1.3.1 Appraisal Approach

The appraiser applied the conventional appraisal process for all the homes in the study. Based on these appraisals, one reference home was chosen in each of the selected neighborhoods.

The normalization process (as described in Section 2.3.1) was then performed for all the homes in each neighborhood. The adjustments made to the property values ranged from -$6,600 to +$14,700. The average adjusted appraised values were then compared to determine the effect of airport noise on housing values. These values were $125,879 in the quiet neighborhood and $125,262 in the noisy neighborhood.

The adjusted appraised values suggested an average $617 higher property value in the quiet neighborhood—a minimal amount that is difficult to characterize as a direct consequence of airport noise. Table 3-2 summarizes these results. The difference between the unadjusted property values and the adjusted, or normalized, values is significant, indicating considerable differences in the amenities offered across the neighborhoods.

Table 3-2. Summary of Appraisal Approach Implemented at BWI

ITEM	Neighborhood		Difference	% Difference	Difference Per dB	% Differ. Per dB
	Noisy	Quiet				
DNL, dB	72	61	11	N.A.	N.A.	N.A.
Value (unadj.)	$120,538	$126,857	-$6,319	-5.0%	-$574	-0.45%
Value (adj.)	$125,262	$125,879	-$617	-0.5%	-$56	-0.04%

3.1.3.2 Modeling Approach

The multiple regression model developed for BWI used appraised values as the dependent variable, since these were virtually identical to the sale price of each home. Table 3-3 shows the final model, which considered only those independent variables that were statistically significant.

indirectly by the airport. Hence, the market for these homes is driven more by homebuyer needs than wants; e.g., buyers are willing to trade off increased airport noise with decreased commuting distance.

Finally, the modeling process was constrained by virtue of the limited size of the population from which the sample homes were chosen. All these factors had some bearing on the overall study results.

3.2 The Los Angeles International Airport (LAX) Study

The study around LAX (Ref: 21) was performed in the Summer of 1991. This study was intended primarily to implement the analytical approach around an airport with a substantially larger number of residential areas to choose from (compared to BWI) and to see if the diversity of property values had any bearing on the overall results.

The results of each of the three steps in the analytical process are given below. It should be noted that this study used CNEL (Community Noise Exposure Level) instead of DNL to quantify noise impact, since all California airports use this metric to determine airport noise levels. It is similar to the DNL, except for an additional penalty for evening operations. Thus, CNEL contours tend to be larger than DNL contours. Since these contours were used primarily to identify areas with different noise exposure, the use of CNEL made no significant difference to this study.

3.2.1 Neighborhood Identification (Step 1)

A pool of 11 realtors from five top real estate agencies was surveyed to assess neighborhood characteristics and their relative importance in the Los Angeles area. The crime rate and the quality of local schools (see Table 3-4) were determined to be the two most important criteria considered in the homebuying process around LAX.

A norm realtor whose results approximated the average survey results was selected from the pool of realtors. The area around LAX is quite diversified, with prices ranging from $115,000 to $369,000. Thus, it was possible for the norm realtor to choose two neighborhood pairs in the vicinity of LAX—one in moderately-priced areas, the other in relatively low-priced areas. One neighborhood in each pair was exposed in a high noise level relative to the other.

The moderately-priced neighborhoods selected were to the north of the airport (see Appendix B):

the selected neighborhoods, and their values were adjusted for any differences in amenities and style.

The normalization process was performed for all the homes in each neighborhood. The adjustments made to the prices of moderately-priced homes ranged from -$20,400 to +$32,700. The adjustments made to the prices of low-priced homes ranged from -$12,520 to +$28,360.

The average adjusted appraised values were then compared within each price category to determine the effect of airport noise on housing values. In the moderately-priced areas, these values were $387,565 in the quiet neighborhood, and $326,692 in the noisy neighborhood. In the low-priced areas, these values were $158,909 in the quiet neighborhood, and $157,641 in the noisy neighborhood.

Thus, in the moderately-priced areas, the adjusted appraised values suggest an average $60,873 (18.6 percent) higher property value in the quiet neighborhood, or $4,348 (1.33 percent) per dB of "additional quiet." On the other hand, the results in the low-priced areas are much more modest—a $1,268 (0.8 percent) higher property value in the quiet neighborhood.

Tables 3-5 and 3-6 summarize these results. The difference between the unadjusted property values and the adjusted, or normalized values is significant in the low-priced neighborhoods, indicating considerable differences in the amenities offered across the neighborhood pair.

TABLE 3-5. Summary of Appraisal Approach Implemented at LAX: Low-Priced Neighborhoods

ITEM	Neighborhood		Difference	% Difference	Difference Per dB	% Differ. Per dB
	Noisy	Quiet				
CNEL, dB	72	60	12	N.A.	N.A.	N.A.
Value (unadj.)	$157,208	$171,333	-$14,125	-8.2%	-$1,177	-0.69%
Value (adj.)	$157,641	$158,909	-$1,268	-0.8%	-$106	-0.07%

TABLE 3-6. Summary of Appraisal Approach Implemented at LAX: Moderately-Priced Neighborhoods

ITEM	Neighborhood		Difference	% Difference	Difference Per dB	% Differ. Per dB
	Noisy	Quiet				
CNEL, dB	69	55	14	N.A.	N.A.	N.A.
Value (unadj.)	$321,750	$380,375	-$58,625	-15.4%	-$4,188	-1.10%
Value (adj.)	$326,692	$387,565	-$60,873	-15.7%	-$4,348	-1.12%

this effect is much more noticeable in the moderately-priced areas than in the low-priced areas, where the effect is very small.

There were several unique local factors that became apparent during the appraisal process. First, the market for low-priced homes was dominated by the desire to own a home, rather than specific neighborhood characteristics such as noise, which was, in many cases, not a serious consideration. Second, homebuyers in the Westchester area were willing to live with higher noise levels in return for homes that cost less and had more amenities than comparable ones in the quieter Kentwood area.

Third, there had been a significant downturn in the local economy in the year prior to the study, which was reflected in terms of depressed real estate values. Thus, in many cases the study compared properties that were sold up to a year apart. All these factors had some impact of the overall results.

3.3 The Study at New York Metropolitan Airports

The study in the New York metropolitan area (Ref: 22) was performed in 1993, and considered areas impacted by La Guardia (LGA) and John F. Kennedy International (JFK) airports. This study was designed to test whether the principal finding of the LAX analysis—that the impact of airport noise is more pronounced in high-priced neighborhoods—could be observed in a comparable environment.

The metropolitan New York area ideally suited this purpose, since it is similar to LAX in terms of the size and density of residential communities, and the housing values encompass a fairly broad range. The results of each of the three steps in the analytical process are given below.

3.3.1 Neighborhood Identification (Step 1)

A pool of 18 realtors from a number of top real estate agencies was surveyed to assess neighborhood characteristics and their relative importance in the area around LGA and JFK. The quality of local schools and the crime rate (see Table 3-8) were determined to be the two most important criteria considered in the home buying process in this area—exactly those weighed in the Los Angeles area.

A norm realtor whose results approximated the average survey results was selected from this pool. Given the diversified nature of the residential communities affected by these airports, the norm realtor could choose three neighborhood pairs in the New York area—the first in high-priced areas, the

3.3.2 Sample House Selection (Step 2)

A total of 90 homes (15 in each neighborhood) with roughly similar amenities were selected using the MLS, Redi Data, and other sources.

In the low-priced neighborhoods, the average sale price of homes in the quieter North Valley Stream area was $900 higher than the South Valley Stream homes. In the moderately-priced neighborhoods, the average sale price in the quieter Northwest Flushing area was $18,933 higher than the Southeast Flushing area. Finally, in the high-priced neighborhoods, the average sale price in the quieter Southern Five Towns area was $74,000 higher than the Northern Five Towns area.

3.3.3 Housing Value Comparison (Step 3)

3.3.3.1 *Appraisal Approach*

The appraiser applied the conventional appraisal process for all the homes in the study. Based on these appraisals, one reference home was chosen in each of the selected neighborhoods, and their values were adjusted for any differences in amenities and style.

The normalization process was performed for all the homes in each neighborhood. The adjustments made to the prices of low-priced homes ranged from -$31,500 to +$38,000. The adjustments made to the prices of moderately-priced homes ranged from -$4,500 to +$28,000. The adjustments made to the prices of high-priced homes ranged from -$95,500 to +$35,500.

The average adjusted appraised values were then compared within each price category to determine the effect of airport noise on housing values. In the low-priced areas, these values were $148,767 in the quiet neighborhood, and $148,033 in the noisy neighborhood. In the moderately-priced areas, these values were $231,100 in the quiet neighborhood, and $220,400 in the noisy neighborhood. In the high-priced areas, these values were $414,000 in the quiet neighborhood, and $391,633 in the noisy neighborhood.

As was observed in the LAX study, the results in the low-priced areas indicate virtually no ($733, or 0.5 percent) difference in property values between the quiet and noisy neighborhoods. In the moderately-priced areas, the adjusted appraised values suggest an average $10,700 (4.9 percent) higher property value in the quiet neighborhood, or $1,070 (0.5 percent) per dB of additional quiet. In

shows the final models. In all three models, the sign of some of the coefficients were contrary to the appraiser's judgment.

For the moderately-priced neighborhoods, the model developed did not provide a reasonable fit between the selling price and six selected housing characteristics, and some of the independent variables were not significant contributors to the model.

For the low-priced neighborhoods, the model developed provided a reasonable fit between the selling price and five selected housing characteristics. The model indicated that if the two neighborhoods were identical, then the presence of airport noise decreased housing value by an average of $724—a negligible amount. Most of the independent variables, except the dummy variable, were significant contributors to the model.

The model for the high-priced neighborhoods provided a reasonable fit between the selling price and five selected housing characteristics. The model indicated that if the two neighborhoods were identical, then the presence of airport noise decreased housing value by an average of $20,224, or 5 percent.

TABLE 3-12. Linear Regression Models Developed for LGA and JFK

High-Priced Neighborhoods	Moderately-Priced Neighborhoods	Low-Priced Neighborhoods
$Y = 275866 + 1261X_1 + 5.95X_2 + 2757X_3 + 130X_4 + 20224X_5$	$Y = 218118 + 967X_1 + 6.82X_2 + 2782X_3 + 0.62X_4 - 9413X_5 + 14918X_6$	$Y = 106342 - 393X_1 + 6399X_2 + 34X_3 + 8764X_4 + 724X_5$
Y = Sale Price X_1 = Age of House X_2 = Lot Size X_3 = Total Number of Rooms X_4 = Type of Basement (Full, Partial, None) X_5 = Dummy Variable (Quiet, Noisy)	Y = Sale Price X_1 = Age of House X_2 = Lot Size X_3 = Total Number of Rooms X_4 = Living Area X_5 = Garage (Yes, No) X_6 = Dummy Variable (Quiet, Noisy)	Y = Sale Price X_1 = Age of House X_2 = Number of Bedrooms X_3 = Living Area X_4 = Type of Basement (Full, Partial, None) X_5 = Dummy Variable (Quiet, Noisy)
$R^2 = 0.77$ F-statistic < 0.001 t-statistics for independent variables varied	$R^2 = 0.57$ F-statistic < 0.138 t-statistics for independent variables varied	$R^2 = 0.73$ F-statistic < 0.002 t-statistics for independent variables varied

- The magnitude of the impact of airport noise on housing values cannot be estimated at the national level at this time, since the impact results varied across a wide range, and only a small sample of airports was considered.

As mentioned earlier, these studies were not intended to obtain precise values of the noise impact at the individual airports, but rather used these airports as sites for assessing a methodology to measure this impact. The methodology was found to the most promising of those considered thus far, and is relatively easy to implement. There are several approaches that may be used to implement this methodology for a nationwide examination of the impact of airport noise on housing values. These alternative approaches are discussed in the next chapter.

confounding effects (such as variations in property values with interest rate fluctuations) will average out, and the resulting magnitude of airport noise impact will "regress towards the mean" for a given category.

4.1.1 Analysis Based on Airport Size

The studies described earlier focused on fairly large airports. It is unclear how airport noise would affect housing values in communities around medium and small airports. This approach would attempt to clarify this.

First, airports would be classified by size. One such classification is available in the Nationwide Noise Impact Model, or NANIM (Ref: 19), which categorizes all the U.S. airports into the following five broad classes based on the number of operations at each airport and the flying range of the aircraft:

- Large, long range
- Large, medium range
- Large, short range
- Medium, short range
- Small, short range.

After selecting a statistically significant sample of airports in each category (as described in the next section), the neighborhood pair model could be applied around each airport, ideally using larger sample sizes and a wider range of noise levels. This would provide a more accurate determination of the relationship of property values and airport noise for each airport category.

4.1.2 Analysis Based on Economic Status of Communities

The studies described above examined the issue of airport noise in largely metropolitan areas. However, its impact in more diverse settings is not known. This approach would first classify airports on the basis of the local economic conditions around the airports.

It would be necessary to first perform a survey to determine the current economic conditions of communities around airports nationwide. The survey would use property values as an indicator of local economic conditions, since these are well documented and generally easily accessible. The survey would classify all the domestic airports on the basis of the value of residential real estate in areas impacted by airport operations—for example, "low" for those with neighborhood property values below $150,000, "moderate" for those within $150,000-$300,000 range, "high" for those greater than $300,000.

property values—changes in purchasing power, interest rate fluctuations, or loss of a significant employer (the airport), and finally, express both sets of data in consistent units (for example, 1994 dollars) after making these adjustments. Any difference in the property values before and after the airport closure could possibly be attributed to being associated with airport noise.

While previous studies have generally dealt with the issue of the adverse effect of increased noise levels on property values, it is unknown whether the reverse effect is true—that is, if property values increase as noise levels decrease. This approach may also help in examining this aspect of airport noise impact.

4.2 Determination of the Number of Airports to Be Considered

Ideally, the neighborhood pair model should be used at all the airports around the country to get the most accurate estimate of the effect of airport noise on housing values. This clearly is not feasible given the amount of resources that it would necessitate. Instead, a less expensive approach would be to perform similar studies for each airport category at a number of airports that is determined using the approaches described below.

4.2.1 Steady State Approach

One approach is to systematically implement the neighborhood pair model for each member of a given category of domestic airports or affected communities (as described in the previous section). Initially, there will inevitably be some variation in the noise impact. As more airports are examined, this variation averaged over all the airports will gradually tend to become smaller (see Figure 4-1). In other words, with every additional airport that is examined, the average noise impact will vary less and less from the theoretical mean value, or will come closer to "steady state." At some point, it will be observed that adding another airport's results makes virtually no difference to the average impact, and this average value will be the noise impact for the category of airports or communities being evaluated.

4.2.2 Statistical Approach

The steady state approach, while feasible, could prove to be economically impractical to implement. A second, more cost-effective approach would use standard statistical procedures to determine how many neighborhood pairs would be required for each category of airports. This number depends on the total population of airports and the acceptable levels of confidence, or the

5. SUMMARY AND CONCLUSIONS

An analytical approach was designed to estimate the effect of airport noise on housing values. The procedure consists of three steps: 1) identification (by a local realtor) of two neighborhoods that have similar characteristics except for noise levels, 2) selection of a sample of houses from each neighborhood with reasonably similar individual housing characteristics, and 3) use of a modified appraisal process (by a local appraiser) and statistical modeling to compare the housing values in the two neighborhoods.

The local appraiser's and realtor's subjective inputs are explicitly incorporated in the neighborhood and home selection process and are useful in interpreting the modeling results. Conversely, asking the appraiser to normalize the sale prices of the selected homes to account for differences in house characteristics makes the appraisal procedure much more quantitative compared to conventional appraisals. Hence, the analytical approach was designed to minimize the effects of local conditions by using local expertise and a combination of quantitative and qualitative techniques that complement each other, and seeks to overcome the shortcomings of previous studies that exclusively used one technique or the other.

A series of studies was performed around four major airports—Baltimore-Washington International Airport (BWI), Los Angeles International Airport (LAX), New York La Guardia Airport (LGA), and New York John F. Kennedy International Airport (JFK)—to test the efficacy of this approach, to see if any distinct trends could be observed, and to determine if any inferences could be made at the national level regarding the impact of airport noise on housing values.

The results of the studies indicate that the neighborhood pair model is viable and helps establish the boundaries of the effect that airport noise has on housing values at a given airport. The observed trends are consistent, showing that the noise impact is more pronounced in higher-priced areas and is hard to detect in relatively low-priced neighborhoods. However, the magnitude of this impact cannot be estimated at the national level at this time, since the results varied across a wide range for the airports studied, and only a small sample of airports was considered.

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6. REFERENCES

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11. "An Estimate of the Effects of Airport Noise on Property Values," Mieszkowski, P. & A.M. Saper, *Journal of Urban Economics*, 1978, 5:425-440.

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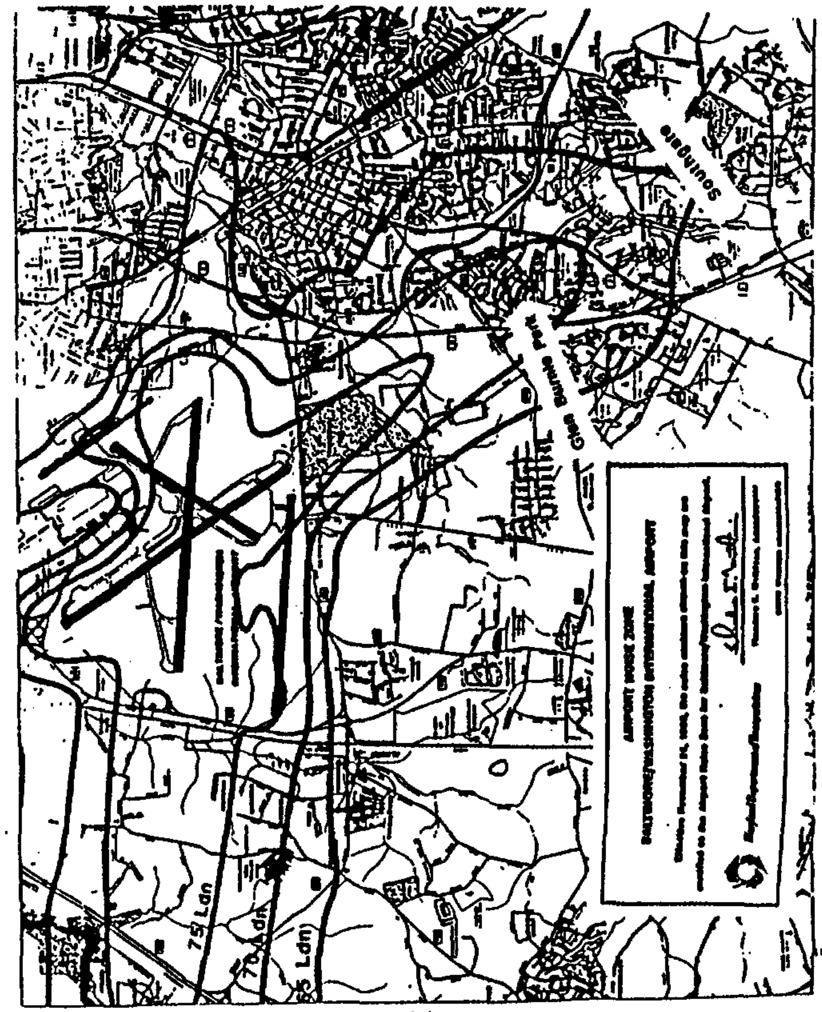
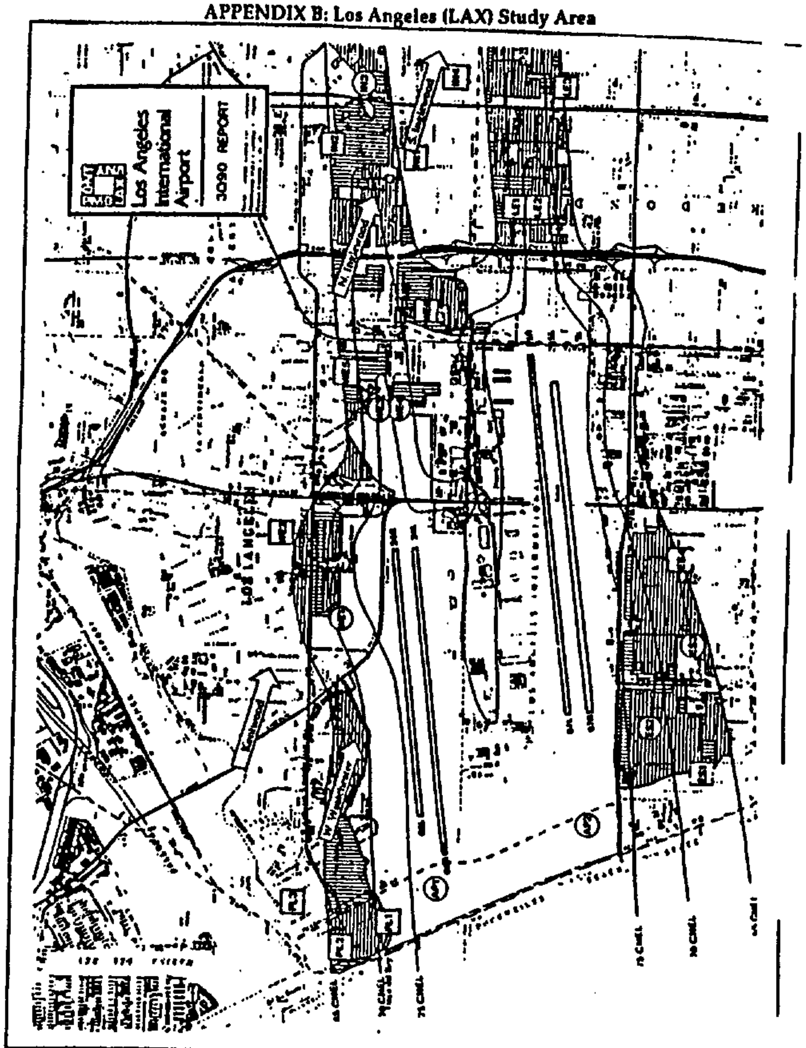
APPENDIX A: Baltimore/Washington International Airport (BWI) Study Area



APPENDIX B: Los Angeles (LAX) Study Area



B-1

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APPENDIX C: New York Study Areas

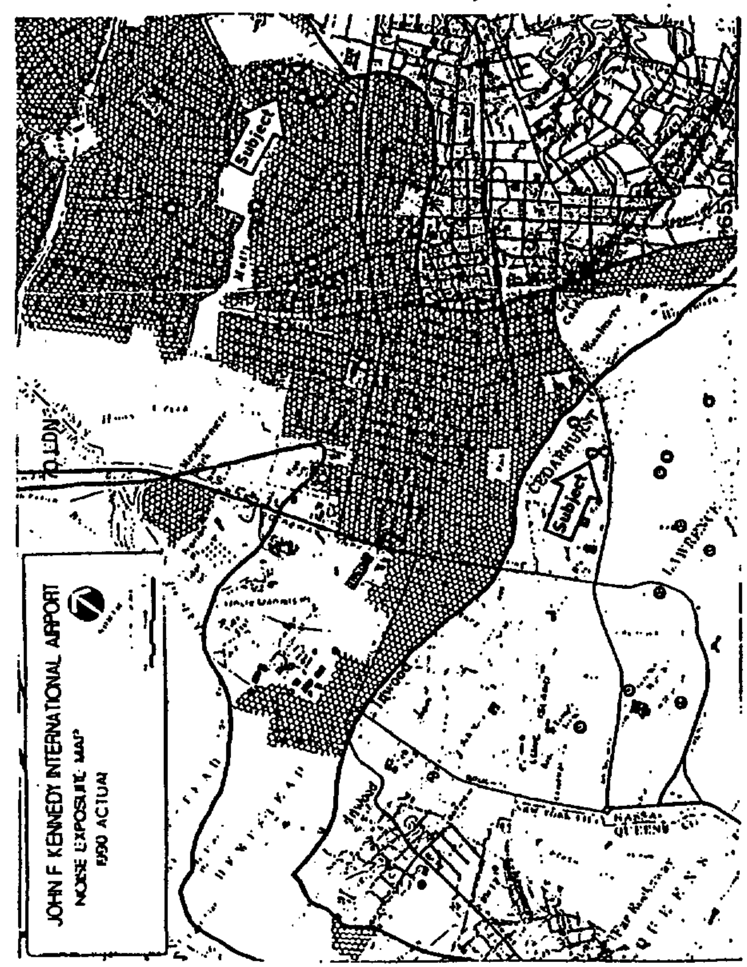

FIGURE C-1. JFK Study Area: High-Priced Neighborhoods

C-1

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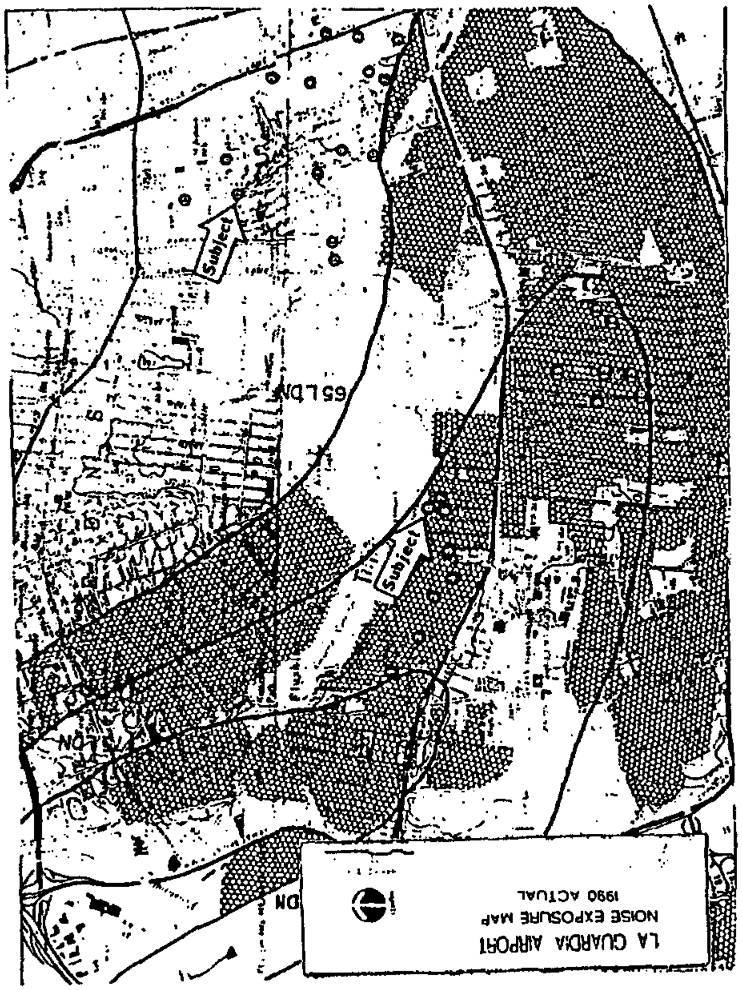

FIGURE C-3. LGA Study Area: Moderately-Priced Neighborhoods

C-3

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CHAPTER IV
ENVIRONMENTAL IMPACTS
SECTION 9 - AIR QUALITY

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Chapter 4 Section 9 Air Quality

Comment: 9-I: Introductory comment. The reader wishing to understand Chapter IV, Section 9, Air Quality in the DEIS must also read and consult Appendix D Our comments address both the discussion in the main text and relevant parts of the Appendix.

***

Comment 9-1: The discussion of the impacts on air pollution are based on two theoretical models: 1) the EDMS inventory model , and 2)a dispersion model. apparently unique to this E.I.S.

Comment 9 2: It is not possible to fully evaluate the results of the EDMS inventory modelling and provide correct comment because the assumptions and inputs used for the inventory model ere not given in the DEIS. R-10-13 R-1-6

Comment 9-3: I It is not possible to fully evaluate the results of the dispersion model and provide correct comment because the assumptions and inputs used for the dispersion model are not given in the DEIS.

Comment 9-4: While computer models are a useful supplement, they cannot subsitute for actual measurement and monitoring of pollutants in the community.

Comment 9-5: The inventory model as presented does not inventory all the pollutants emitted, particularly from aircraft (e.g., formaldehyde and 1.3 butadiene, banzene. The inventory model does not separate particulate matter from piston engines from that for turboprop/turboject engines.) Their absence is especially egregious because they are indicators for carcinogens from aircraft noise. These pollutants were included in the Midway Study which was referenced in Section 7 of the DEIS. and used to calculate health risks. R-10-30

Comment 9-6: Without validation, no computer model rises above the level of refined speculation, and we can find no evidence in the DEIS or elsewhere that either one these models have been validated with appropriate measurement & testing against model predictions, nor has there been any review of the quality of the model in the professional

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literature. Indeed, the Department of Ecology disclaimed the EDMS inventory model as being a rough estimate only. (See, "Airport's Air: How bad? Seattle Times, 1/3/92.) R-10-30

Comment 9-8: In addition, the findings reported here are proportionally out of line with previous uses of this same model at Sea-Tac by the DOE & PSAPCA (p. IV-9-10B) and with actual measurements taken in the Sea-Tac area in studies done for the Port of Seattle (Appendix p. D-92-D128.) R-10-2

Comment 9-9: The DEIS incorrectly assumes in the air quality section that, unless the pollution from pushes the region outside of legal compliance, it has no impact. Impacts well below this level have a substantial impact & should be covered.

Comment 9-10: This FEIS should point out that measurements shown in Appendix D do indeed violate the standards. For example, the 8 hour standard for carbon monoxide (CO) is 9 ppm, but measurements at the Upper Level Deltas [sic] departure gate shown on p. D99 is 10.0 ppm, well over the standard. The FEIS should identify measurements over the standards, along with modelling, and not make the faultly assumption that only illegal levels of pollution have an impact. R-10-21

omment 9-11: Although the DEIS mentions measurements taken in the Sea-Tac area in the Appendix D, pg. D92 to it fails to incorporate them into the analysis and relies solely on the unvalidated modelling. R-10-30

Comment 9-12: The EDMS Model uses departures* to calculate peak-periods at the airport , and the DEIS presents a table of assumptions used for departures at p. D3. This table explains why comment & evaluation requires that readers know the assumptions & inputs to the models. (*Departures are used because arrivals take longer than departures. If an airport can achieve 60 departures during a peak hour, it will always have <60 arrivals.) R-10-14

(a) Those running the model used only 43.9 as the assumed peak-hour departure level for 1994 ("Existing"), even though normal peak departures at Sea-Tac are greater than 60 per hour. The State's 1991 EDMS survey uses a more realistic 72 peak-hour departure level. However, peak hour departure levels of 90 are possible at Sea-Tac, as was demonstrated during the Goodwill Games. Use of the 43.9 figure does not reflect the potential peak period capacity of the existing airport and is highly questionable. The DEIS EDMS inventory greatly underestimates the levels of air pollution -- especially those from aircraft -- because of this low assumption.

(b) The model makers apparently used the same peak hour departure levels for "do-nothing" and "with project," showing peak departure levels of 46.58 for both "do-nothing" and "with project" in 2010, and 50.67 peak departure levels both "do-nothing" and "With project" for 2020. "Do Nothing" and "With Project" have precisely the same result? Then why are we wasting money on this EIS? The FEIS needs to clarify this and reconcile these numbers with those used in Chap. 2, Purpose and Need, to justify the project.

(c) Amazingly, the air pollution estimates assume that the projects would only add 6.77* flights per hour by the year 2020--even with the third runway and other projects. It is astonishing to think of spending a billion dollars or more on just 6.77 flights per hour. The FEIS needs to clarify this and reconcile these number with those used in Chap 2, "Purpose & Need" to justify the project. (*To get the 6.77/ hr. figure we subtracted 4093 peak departures given for "existing from 5067 peak departures given for "with project in 2020" on page D-3, DEIS Appendix D.) R-10-14

Comment 9.13: According to the State Department of Ecology, Air Quality Program, Sea-Tac airport is one of the largest source generators of air pollution in King County, producing 8% of the carbon monoxide and 5% of the nitrous oxides in the county. Please explain the apparently contradictory assertion on pg. IV.9-1 of the DEIS that *"Aircraft operating at Sea-Tac contribute less that 1% of the carbon monoxide emissions, nitrogen oxides, and volatile organic compound for all mobile sources within the Puget Sound Region."* R-10-2

Comment 9.14: Air emissions from Sea-Tac come from both aircraft emissions and ground transport emissions from cars & buses, for both passenger and freight. According to the DOE study referenced in question 9.2, aircraft emissions constitute approximately 88.3% of the

emissions and ground traffic the remaining 11.7%. Please explain the apparently contradictory assertion in the DEIS on pg. 9-1 that *"The majority of the pollutant emissions in the Puget Sound are generated by motor vehicles (i.e., cars, trucks, buses, taxis, motorcycles.)"* This quote prompted several other questions:

(1) Which pollutant emissions are referred to in this quotation?
(2) Doesn't the percentage depend upon which pollutants are being measured?
(3) Does it include NOx, PM2.5, and benzene and aldehyde whose contributions come more heavily from jet exhaust than others.
(4) What is the majority pollutant in the affected communities? The FEIS should give this figure.
(5) Isn't this simply a product of the assumptions fed into to the models? Could we not state the the primary pollutant was almost anything -- swiss cheeze molecules -- if we fed that assumption into the model? R-10-2

Comment 9.15: Emissions from fire tests emit significan levels of pollution, although their percent of contribution has never been measured. These are not included in the "inventory" and their contribution to the existing conditions. Although the DEIS appears to assume that this test will stop, the DEIS should explain why the Port of Seattle got an exemption from the air quality standards from the State Legislature to continue and when and under what conditions it will stop. It should also give the results if the the fire testing is not stopped, so that its contribution can be evaluated. R-10-18

Comment 9.16: Because Sea-Tac sits on one small site, unlike other comparable air pollution sources (i.e., freeways) where the source is spread, pollutants reach very high concentrations in the three mile area just around the airport. How do the models presented in the EIS account for this? R-10-17

Comment 9-17: The "brown cloud" sitting over Sea-Tac is visible the I-5 freeway and from downtown Seattle on clear days. The primary culprit in this kind of smog is ozone. Jet aircraft have contribute heavily to the ozone factor because they generate such large quantities of NO_X, which contributes to ozone formation. Newer jets create less CO but more NO_X. However, ozone was not measured R-10-20

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Comment 9.18: Full analysis of existing conditions is explicitly required under the SEPA rules. (WAC 197-11-440(6)(a). That should include all conditions for which there is a known standard and all other conditions which might have and impact--such as toxic chemicals in jet exhaust. It whould be verified by acutal measurements. The DEIS analysis of existing conditions fails to meet these tests. R-10-30 R-10-34

Comment 9-19: The E.I.S. must contain a sufficiently detailed analysis to permit a comparative evaluation of the air quality impacts that the proposal would create for each alternative, as required by the SEPA rules at Sec. 440 (5) (c) (v). The DEIS does not contain any comparative anyalysis at all. It assumes that the peak hour demand will be the same under all alternatives, doesn't reconcile its projected operations with those used elsewhere in the EIS and is grossly inadequate in the depth of its analysis--most particularly with regard to ozone. R-10-20

Comment 9-20: The E.I.S. must contain alternatives to attain the proposal's objectives at a lower environmental cost as required by SEPA, Section 440(5)(B). We can find no analysis of this in the DEIS.

Comment 9-21: The E.I.S. must investigate & fully disclose nitrogen oxide emissions at takeoff. The NOx standard is an annual standard, but given that NO is an important by-product of jet exhaust, there was certainly time to monitor these emissions for a year in the airport communities. A monitor in Beacon Hill, far from the brown cloud sitting atop Sea-Tac ,is not adequate monitoring. R-4-2

Comment 9-22: The E.I.S. must investigate and disclose air, water, and health impacts from emergency fuel dumps within 15 miles of the airport. Many citizens complain about seeing and smelling fuel dumps, but the air quality analysis neglects the subject entirely and should not. R-10-9

Comment 9-23: Sea-Tac should be treated as a "major stationary source" under the Washington State Clean Air Conformity Act defines "major stationary sources." It clearly qualifies under the definition. Aircraft emit many different chemicals, some of the highly toxic, which would be monitored &, if necessary for the public health, regulated if Sea-Tac is a "major stationary source". The DEIS fails to discuss these R-10-6

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chemicals and the standards for them even though few sources create greater amounts of these types of pollutants that modern jet airports. The DEIS must discuss all chemicals which have a sufficient impact to be regulated under the "major stationary sources" provisions of the clean air act. Port-owned facilities are not exempt from the law. R-10-6

Comment 9-24: The E.I.S. must consider no-build alternatives or mitigations that would reduce aircraft emissions.. For example, if the landside operations at Sea-Tac were administered from the standpoint of reducing idling time, this factor should be the same for all alternatives. If delays are predicted as a result of the airport reaching capacity, there is no reason why aircraft must spend this delay time idling in taxiways. Both land based and airborne air carrier traffic is highly managed. Under such a system there is no reason why aircraft must spend excessive amounts of time simply idling their engines waiting for clearance to take off. If the magnitude of aircraft emissions is a result of idling time, that impact should be addressed through alternatives and mitigations specifically responsive to that impact. R-10-47

Comment 9-25: The E.I.S. must analyze the indirect impacts caused by the proposal as required by Sec. 060(4)(d) of the SEPA rules. For example, the Flight Plan projects an expansion of office space of up to 2.3 million square feet and an additional 7,000 to 10,000 hotel rooms. All this airport-related activity is projected to occur in areas immediately surrounding the airport. This sort of secondary development would obviously produce very substantial increases in motor vehicle trips. The E.I.S. should quantify and discuss these induced transportation impacts. Assuming that the infrastructure exists to accommodate these additional trip ends, substantial air quality emissions would result. R-5-3

Comment 9-26: Because of the significant danger to the biota inherent in air pollution, Sea-Tac's contribution carbon monoxide in King County of the nitrogen oxides in King County must be addressed because of the severity of pollution in such a small area of land --less than 1/5 of 1% of King County. (May 1991 DOE Study -- Seattle Tacoma International Airport: Air Pollution Contribution). R-10-4

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Comment 9-27: The F.A.A. is responsible for implementing standards for commercial passenger jets and it does so through engine certification data provided by the manufacturers. The DEIS relies exclusive on this potentially biased data to do its modelling and it should not. The E.P.A. is currently in the process of requiring aircraft engines to conform to the standards of the Federal Clean Air Act in parts of California which severely restricts the F.A.A.'s ability to accept the manufacturer's word as the emissions certification. Actual emissions should be used to study air quality impacts.

Comment 9-28: The E.I.S. models are based on new engines, perfectly maintained. In real life, older planes fly and engines are not in perfect tune at all times. There is no air quality inspection and maintenance (I/M) program for aircraft This will tend to underestimate pollutants. The FEIS should explain how this was addressed and how it will affect the results.

Comment 9-29: It is not clear from reading the DEIS whether or not international carriers are exempt from air quality standards and thus not included in the air quality studies. We can find, for example, no Aeroflot jet equivalents in the Table , pg. D-3 calculating the peak departure levels, however. The FEIS should clarify this, as it will tend to understate jet emissions in the models compare to real emissions. There is am impact from foreign exempt carriers on air pollution and noise pollution and they need to be included in impact studies of international airports.

R-10-13

Comment 9-30: The E.I.S. must set forth how the proposed action would carry out the various commitments contained within the SIP for improving air quality in the *region.* The DEIS fails to set out the requirements clearly and utterly fails to show how they would be met.

(a) With regard to mobile sources and particularly motor vehicles, the SIP includes commitments to increase transit use and for demand management (See Appendix D to SIP.) Similar methods for aircraft use should be set out in the DEIS.

(b) Sea-Tac meets the definition of "major stationary source" and a complex source and must be so treated in this E.I.S.

R-10-47

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S.I.P, Pg. 7: (41) "Major stationary source means any stationary source (or group of stationary sources that are located on one or more contiguous or adjacent properties and are under common control of the same person or persons under common control) which:

*emits or has the potential to emit one hundred tons per year or more of any air contaminant regulated by the state or Federal Clean Air Act (Sea-Tac emits 5,125 tons per year of pollutants into the air according to the State Implementation Plan.)

*is located in a marginal or moderate ozone non attainment area (definition fits area where Sea-Tac is situated) and

*which emits or has the potential to emit one hundred tons per year or more of volatile organic compounds or oxides of nitrogen (Sea-Tac emits 1,950 metric tons/year according to the State Implementation Plan.)

*is located in a "serious" carbon monoxide non attainment area where stationary sources contribute significantly to carbon monoxide levels and which emits or has the potential to emit fifty tons per year or more of carbon monoxide or (Sea-Tac emits 3,050 metric tons/y according to the State Implementation Plan.)

*is located in a "serious" particulate matter (PM^{10}) non attainment area and which emits or has the potential to emit seventy tons per year or more of PM_{10} emissions. (Sea-Tac currently emits 68 metric tons/year according to the State Implementation Plan, and if the 3rd runway is constructed will emit much more than 70 tons of "serious" particulate matter.)

The inventory of particulate matter done for the DEIS, and reported at table IV.9-4 as .023 Tons per year particulate matter must be a typo, and

R-10-47

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CHAPTER IV
ENVIRONMENTAL IMPACTS
SECTION 10, 11, 12, 13, 14 -
WATER QUALITY & HYDROLOGY, WETLANDS,
FLOODPLAINS, COASTAL ZONE MANAGEMENT
& COASTAL BARRIERS,
WILD & SCENIC RIVERS

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Chapter IV, Section 10, Section 11 and Section 12 - Water Quality, Hydrology, Wetlands, and Floodplains

General.

Introduction to Comments on Chapter IV, Sections 10, 11 and 12. Our comments on these Chapters are in two groups. In the first group, Comments IV-10-A through IV-10-F, we include six studiesand exhibits which concern certain issues included within the scope of these Chapters; these studies present materials, data, findings, & analyses not included in the DEIS, which should be addressed in the FEIS. In the second group, Comments IV-10-1 through IV-12-2, are our comments on particular points raised in the DEIS or suggested by it.

Listing of items included as Comments IV-10-A through IV-10-F:

Comment IV-10-A: Notice of Intent to Sue Inder the Clean Water Act, from Richard A. Smith, to Mic Dinsmore, Executive Director, Port of Seattle dated June 13, 1995

Comment IV-10-B: Letter from Department of Ecology to Port of Seattle dated February 27, 1995

Comment IV-10-C: Kludt v. King County and State of Washington Highway Commisison, Port of Seattle et ux. Case No. 726259, King County Superior Court Stipulation and Settlement Agreement, October 1974.

Comment IV-10-D: Stipulated Settlement Agreement In re: Appeal of NPDES Permit, Normandy Park Community Club, City of Des Moines, and Minnie Brasher v. Port of Seattle and Department of Ecology, Case No.

Comment IV-10-E: Amended Complaint for Declaratory Judgement and Declarative Relief, City of SeaTac v. Port of Seattle, No. 95-2-03901-4

Comment IV-10-F: Flight Plan Project Phase III, Working Paper No. 11 dated October 15, 1991 and prepared by P&D Aviation

Sea-Tac airport sits on just 2400+ acres on top of a major unconfined regional acquifer located in the middle of an existing densely populated area. The central focus of this section of the DEIS must therefore be the effects of the projects alternatives on water quality end this population, both under the existing conditions, as well as the proposed alternative conditions.

Comment IV-10-1:-- Lake Reba -- Lake Reba was intended to provide flood control on Miler Creek in the event of a hundred year storm event. However, at present Lake Reba only provides storage for a storm of somewhat less than a hundred year event. If the DEIS proposes to look at Lake Reha as a regional facility providing retention/detention for the third runway expansion, it first must accommodate the hundred year event before being considered for retention/detention for an airport expansion project requiring increased capacity. These facilities need to be designed in accordance with the King County's Surface Water Management Plan, as well as the plans of the cities affected by this flood control facility.

Comment IV-10-2: -- Complaince with King County and City of SeaTac Codes -- Storm water detention facilities need to be designed and sized to include all developed areas that have been constructed without providing any retention/detention since the adoption of surface water regulations in 1977. These facilities need to be designed in accordance with the City's adopted code which references the King County Surface Water Management Design Manual.

R-13-8

Comment IV-10-3: -- Relocation of Miller and Des Moines Creeks -- This Master Plan EIS must address the proposed relocation and mitigation of said relocation of Mlier Creek above S. 160th St. or the relocation and mitigation of said relocation of Des Moines Creek above S. 200th St.

R-13-27

Comment IV-10-4: -- Fuel and De-icing Events -- The plan fails to analyze and discuss the short and long-term impacts of fuel and de-icing chemicals discharged to Miller and Des Moines Creeks. The risks and

impacts of fuel and de-icing chemicals discharged to the streams need to be studied, and a pollution control procedure must be developed in the FEIS to prohibit these chemicals from discharging into Des Moines and Miller creeks.

R-13-11

Comment IV-10-5: -- Ground Water / Springs -- The plan does not address the impacts the construction of a third runway will have on ground water/ springs in the vicinity of and west of the third runway. Springs and ground water have been a problem in the area west of the airport. Therefore, supplemental geotechnical exploration needs to be performed to define the hydrology in this area. Based upon the hydrology report, the impacts to the ground water and its movement need to be defined.

R-13-21A

Comment IV-10-6: -- Water Quality -- Miller and Des Moines Creeks -- The Master Plan EIS implies that it is looking to the basin plans for Mller and Des Moines Creeks to identify mitigations for impacts to water quality and quantity resulting from the proposed improvements. The plan should also independently address the impacts from the proposed improvements to both Des Moines and Mller Creeks independently of the basin plans.

Comment IV-10-7: -- Existing NPDES Permits -- The Master Plan EIS does not identify how the proposed improvements are consistent with the requirements of the Port's existing National Pollutant Discharge Elimination System (NPDES) Pemilt for surface water control and and industrial wastewater system discharges into Miller and Des Moines creeks. The Department of Ecology has recently infomed the Port of Seattle it is in violation of its current permit. (See Comment IV-10-B) The DEIS must also comment on a 60 dey notice of intent to sue the Port of Seattle for violations of its existing NPDES permit issued June 13, 1995. (Comment IV-10-A) The DEIS should explain how the alternatives can be legally implemented by an airport proprietor allegedly in violation of its current permit. How will future actions under the project alternatives be permitted before the current violations are corrected and litigation is resolved?

R-13-11

Comment IV-10-8: Surface Water Runoff -- The DEIS only states that the Port will provide stormwater runoff mitigation pursuant to the Department of Ecology standards. Surface water runoff requirements also need to be designed in accordance with the City of SeaTac's surface water management ordinance which references the "King County Surface Water Design Manual" standards.

Comment IV-10-9: -- Need for Supplementary EIS -- The discussion regarding streams and creeks in SeaTac is found throughout different sections of the DEIS (Water Quality, Wetlands, Floodplain). Because of this, it is difficult to ascertain the full impacts on the streams and creeks. The issue of streams and creeks should be dealt with in it's own sub-section under wetlands so that it would in easier to fully detemiine the impacts of the 3rd runway on these resources. This will result in the need for an additional review and comment period for this sub-section,

R-13-22

Comment IV-10-10: -- Existing Constraints Prohibiting Redevelopment of Millar and Des Moines Creeks -- Last but not least, the FEIS must address the issue of previous disputes and litigation concerning water quality, drainage basins, maximum flow rates, and other conditions placed on water in the Miller and Des Moines Creek basins. For example, an existing settlement agreement, between King county, the Port of Seattle, and citizens prohibit the channelization of Miller Creek contemplated in the DEIS. This would seem to obviate all of the DEIS alternatives. In a 1974 settlement agreement (Comment IV-10-C) local residents and local citizens and King County agreed:

a) *"King County agrees that it has abandoned the total channelization of Miller Creek and agrees that it will not in the future attempt the channelization of Miller creek except in limited amounts in connection with retention facilities."* (pg. 2, line 28)

b) *"King County acknowledges the long term and sincere concern of numerous citizens in the Miller Creek Basin in maintaining the quality and integrity of the creek ..."* (pg. 3, line 13)

c) *"King county will attempt to design and construct future public works, subject to technical considerations, and regulate private projects in the Miller Creek Drainage basin so that such projects will not adversely affect the present character of Miller Creek or increase the quantity of water which flows into Miller Creek."* (pg. 5, line 28)

d) *"It is understood by all signatories that breach of the terms of this settlement may result in a refiling of the lawsuit."* (pg. 1, line 28)

The FEIS must carefully consider how each of the terms above as well as all other terms of the existing settlement agreements concerning water quality in Miller and Des Moines Creeks, between parties including King County, the Port of Seattle, and others which affect the feasibility of the alternatives discussed in the DEIS.

R-13-23

<u>SECTION 11 - WETLANDS</u>

Comment IV-11-1: -- Wetland Guidelines -- The introduction of Ref. (1) states, *"Construction and monitoring wetlands is an activity that has become a key component in compensating for unavoidable impacts to wetlands. The failure of mitigation projects is often attributed to inadequate , planning, poor site selection and insufficient information on the critical environmental variables at a mitigation site. For these reasons The Washington State Department of Ecology, and Fish and Wildlife, The U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, and the U.S. Fish and.Wildlife Service, have developed this guide which outlines the information needed by these agencies to process and review permits requiring compensatory wetland mitigation. Guidelines is the assumption that less environmentally damaging alternatives which do involve fill in wetlands are available for non-water dependent activities. The burden of proof to demonstrate otherwise lies with the permit applicant"*.

Comment IV-11-2: -- Need for Two Phased Wetland Miutigation Plan -- Preparing a mitigation plan usually involves writing two separate documents: a "*Preliminary Mitigation Plan*" and a "*Final Mitigation Plan.*" This two phased approach is needed to provide regulatory agencies an opportunity to review the project before too much effort is spent on designing a mitigation plan that does not meet the legal or regulatory needs.

Comment IV-11-3: -- Missing Checklist -- In our review of Ref. (2), D.E.I.S., regarding compensatory wetlands we find a preliminary mitigation plan scattered piecemeal throughout 2,200 pages of self congratulations on finding so many ways to circumvent the impacts of their environmental actions. Even though the Ref. (1) guide is referred to by name and publication number, the recommended checklist is not in the D.E.I.S., nor is there a readily available method of checking to see if the guide is being followed for this project. The following is an abbreviated outline of Preliminary mitigation plan requirements and comment on D.E.I.S coverage: (any required guidelines item that has not been included should be furnished to all interested parties, with an appropriate additional comment time for review)

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1. Executive Summary (General discussion in Chapter IV, Section 11, and a brief (half-page) executive summary is included in Appendix P-A)

2. USGS site Quadrangle site maps, 1:25,000, including watersheds (Not included -- King County Sensitive Area Maps ware substituted instead.)

3. A l in. = 400 feet site map of the impacted area (Not included - Scale of the D.E.I.S. maps is l in. = 2,500 feet)

4. An aerial photograph, 1 in. = 100 feet, displaying site properties and wetland boundaries (Not included in the D.E.I.S.)

5. Site identified on National Wetlands Inventory Map (Not included in the D.E.I.S.)

6. Site identified on Soil Conservation Service (SCS) soil survey map (Not included in the D.E.I.S.)

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7. An analysis is needed to determine what ecological functions and social values provided by the wetland to be impacted would be lost and would need to be replaced. (Not included in the D.E.I.S.)

8. Source of water, including a map of the drainage area with flow directions (Not included in the D.E.I.S.)

9. Description of the different ecological and social functions that the wetland provides (Not included in the D.E.I.S.)

10. Describe how the wetland improves water quality in the watershed (Not included in the D.E.I.S.)

11. Describe the wetland's function in storing floodwaters and reducing peak flows (Not included in the D.E.I.S.)

12. Describe the groundwater recharge and discharge in this wetland (Not included in the D.E.I.S.)

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Comment IV-11-4: -- Non-site Compensatory Wetlands -- The function and value of wetlands to a given site are a critical/integral resource of that watershed. This D.E.I.S. proposes to fill ten (10) acres of wetland and add 40 acres of new impervious surface. Yet the compensatory wetland that is proposed is not only not on the site, it is not even in the same watershed. The FEIS should explain how water quality in the Des Moines/Miller creek basin will be improved by relocating its wetlands to another drainage basin.

Comment IV-11-5: -- Compensaatory Wetlands - Wetlands perform many different ecological functions and provide social value. This D.E.I.S. has not addressed the following: how does a "filled" wetland improve water quality in the watershed, how does a "filled" wetland function as habitat for plants and animals, how does a "filled" wetland function in storing floodwaters and reducing peak flows or for the wetland groundwater recharge and discharge. How can any of these wetland activities take place if the

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compensatory replacement of wetlands are allowed to be located in another part of the county, and in a different watershed?

Comment IV-11-6: -- Compensatory Mitigation -- This D.E.I.S. completely misses the point. The concept of "no net loss" to the wetlands inventory does not mean that an area of one watershed may be filled and destroyed, while another watershed (miles away) can be enhanced. Compensatory mitigation should not be considered until the other steps of mitigation sequencing have been carried out. The D.E.I.S. does not address the mitigation sequence, please do so. Reviewing agencies need evidence that the following steps have been carried out before they will consider compensatory mitigation: 1) Avoidance, 2) Minimization, 3) Rectification, and 4) Reduction.

Comment IV-11-7: -- Compensatory Wetlands Mitigation

The majority of the material in this D.E.I.S. is dedicated to ways of making a compensatory site (Green River Watershed) a success. What about the Miller Creek - Des Moines Creek Watershed?

Comment IV-11-8: -- Inadequately Addressed Impacts -- We consider the D.E.I.S. to be grossly deficient and totally inadequate in the area of wetlands impact, assessment of water quality impacts to the areas directly around SeaTac, assessment of changes/impacts to hydrologic regimes and the impacts of the additional impervious surface on storm water managements systems. R-13-32

Comment IV-11-9: -- Lack of Detailed Mitigation Plan --

The DEIS does not provide a detailed mitigation plan for wetlands mitigatoin. (Appendix P-A) Only a very sketchy conceptual plan has been provided. The DEIS needs to provide a detailed wetland mitigation plan R-14-13

Comment IV-11-10: -- Lack of Consideration of Potential Sites in the Same Drainage Sub-basin. -- There is no assessment of the potential sites where wetland mitigation may be implemented R-14-7

in the same drainage sub-basin (Miler Creek). These potential sites need to be identified in the DEIS.

Comment IV-11-11: -- Lack of Consideration of Potential Sites in the Same Drainage Sub-basin. -- The DEIS only mentions a general location five (5) miles S.E. in the Green River Valley for wetland mitigation. A specific site location has not been identified for the proposed wetland mitigation in the Green River basin. Since the wetland impacts are occurring in the City of SeaTac, the mitigation should also be contained within the City of SeaTac. Also, the City of SeaTac Ordinance requires that mitigation be replaced in the same watershed basin where the loss has incurred. The DEIS needs to address this issue.

Comment IV-11-12: -- Need for Supplementary EIS -- The DEIS states, "The avoidance and minimization of stream and floodplain habitat impacts will be addressed during future refinement of the fill slope design." Therefore, a supplemental DEIS will be required. Also, impacts and mitigations will need to be addressed.

Comment IV-11-13: -- City of SeaTac Mitigation -- The plan proposes to provide mitigation outside of the City of SeaTac for the impacts of constructing a third runway. Since the City receives the most significant portion of the impact, the mitigation must be incorporated within the City boundaries.

Comment IV-11-14: -- Wildlife/Wetlands -- The DEIS states that wetlands mitigation within the same drainage basin was not considered because the FAA will not certify an airport where "wildlife attractions" are within 10,000 feet of the runway. Based upon this interpretation of the FAA regulations, wetlands are regarded as wildlife attractions. The statement implies that the existing airport is not certified since ther are existing wetlands located north and south of the existing runways wwithin 10,000 feet ofthe runway. Please reconcile the statement in the DEIS that the FAA will not certify airports where wildlife attractions are within 10,00 feett of an runway with existing wetlands. R-14-7

Comment IV-11-15: -- Missing Wetlands --The DEIS does not identify a Class II wetland located approximately at 1000 S. 158th Pl. South. This wetland should be acknowledged and discussed in the FEIS. R-14-2

Comment IV-11-16: -- Need for Supplemental EIS -- The DEIS states that a detailed mitigation plan for wetland and mitigation will be conducted at a later date. A supplemental EIS will be required.

Comment IV-11-17: -- Anadronomous Fish Habitat --The DEIS does not cover the removal of fish barriers for the reestablishment of anadromous fish north of 160th street. The DEIS does not cover mitigation plans for the impacts on Miller and Des Moines creeks. These matters need to be addressed. R-13-32

Comment IV-11-18: -- Discrepency in Area of Wetlands -- the Flight Plan Project Phase III, Working Paper No. 11 dated October 15, 1991 (Comment IV-1-F) prepared by P&D Aviation (the Port of Seattle's currrent Master Plan Update consultant) estimated that 100 acres of wetlands would be required to construct a 7,000 foot runway. The current DEIS estimates only a fraction of this amount of wetlands required to construct this as well as larger runways. Explain in detail how the total area of wetlands was reduced to the present amount claimed in the DEIS. R-14-3

SECTION 12 - FLOOD PLAINS

Comment IV-12-1: A plan for Lake Reba relative to operation and flood control procedures should be developed to the satisfaction of the City. R-13-8

Comment IV-12-2: The DEIS does not provide detailed information regarding the methods in which the Port will maintain the current floodplain capacity where fill is proposed to be placed within the floodplain. Please provide this detailed information. R-13-32

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BY CERTIFIED MAIL - RETURN RECEIPT REQUESTED
Executive Director Mic Dinsmore
Port of Seattle
P.O. Box 68727
Seattle Washington 98168

June 13, 1995

Re: NOTICE OF INTENT TO SUE UNDER THE CLEAN WATER ACT

Dear Mr. Dinsmore:

I represent the Waste Action Project, P.O. Box 4832, Seattle, Washington 98104, (206)622-7803. Any response or correspondence related to this matter should be directed to me at the letterhead address.

Section 505(b) of the Clean Water Act ("CWA") requires that sixty days prior to the institution of a civil action under the authority of Section 505(a) of the CWA, a citizen must give notice of intent to sue. You are hereby given notice that, after the expiration of sixty days from the date on this NOTICE OF INTENT TO SUE or soon thereafter, the Waste Action Project will file a civil action in federal district court against the Port of Seattle ("POS").

The lawsuit will allege that POS has violated and continues to violate the CWA (see Sections 301, 308 and 402 of the CWA) and its National Pollution Discharge Elimination System ("NPDES") permit, Washington Department of Ecology ("DOE") issue number WA-002465-1 (current version issued on June 30, 1994), which authorizes discharges from the Seattle-Tacoma International Airport ("airport") to surface waters. POS's violations of its permit and the CWA are more fully described below.

I. Effluent Limitations

A. Permit condition S1.A. sets the interim effluent limitation for daily average oil and grease concentration at 8 mg/L for outfall 001. Information currently available indicates that POS has violated this limitation as follows:

	Month of Violation	Concentration Oil and Grease
1.	9/94	25.3 mg/L
2.	10/94	45 (Discharge Monitoring Report says 15)
3.	11/94	10.75
4.	12/94	9.25
5.	1/95	19.5 (Discharge Monitoring Report says 21)
6.	2/95	22.6

B. Permit condition S1.A. sets the interim effluent limitation for daily maximum oil and grease concentration at 15 mg/L for outfall 001. Information currently available indicates that POS has violated this limitation as follows:

	Month of Violation	Concentration Oil and Grease
1.	9/94	76 mg/L
2.	10/94	33
3.	10/94	76
4.	11/94	17
5.	1/95	33
6.	2/95	47
7.	2/95	39

C. Permit condition S1.A. sets the effluent limitation for daily maximum flow at 2500 gpm for outfall 001. Information currently available indicates that POS has violated this limitation as follows:

	Date of Violation	Maximum Flow
1.	10/8/94	2684 gpm
2.	10/13/94	2816.8
3.	10/19/94	2661.1
4.	10/20/94	2595.4
5.	10/26/94	3436.9
6.	10/27/94	2816.8
7.	10/31/94	2728.1
8.	11/1/94	2661.1

D. Permit condition S1.A. sets the effluent limitation for daily average TSS concentration at 21 mg/L (effective February 1, 1995). Information currently available indicates that POS has violated this limitation as follows:

	Month of Violation	TSS Concentration
1.	2/95	22.6 mg/L
2.	4/95	48

E. Permit condition S1.A. sets the effluent limitation for daily maximum TSS concentration at 33 mg/L (effective February 1, 1995). Information currently available indicates that POS has violated this limitation as follows:

	Month of Violation	TSS Concentration
1.	2/95	46 mg/L
2.	4/95	96

II. Reporting and Monitoring

A. Permit Condition S4.A. requires that Discharge Monitoring Reports ("DMRs") be submitted no later than the 15th day of the month following the completed reporting period. Permit Condition S4.I. requires that DMRs be signed by a principal executive officer, the Managing Director of the Airport Division, or a duly authorized representative. This condition sets the requirements for designation of a duly authorized representative. Available information indicates that POS has violated these requirements:

1. None of the DMRs submitted since permit issuance have been signed by an appropriate person or a duly authorized representative.

2. A complete DMR for August, 1994, was not submitted until after September 15, 1995.

3. A completed DMR for September, 1994, was not submitted until after October 15, 1994.

B. Permit Condition S3.A. sets the schedule for monitoring the effluent from the IWS (outfall 001) as follows:

Test	Sampling Frequency	Sample Type
Flow	Daily	Continuous
pH	Weekly	grab
Oil and Grease	Weekly	grab
TSS	Weekly	composite
BOD5	Monthly	composite
Total Ammonia	Monthly	composite
Total Glycols	Monthly when deicing occurs	composite
BTEX	Monthly	composite
Total Petroleum Hydrocarbon ("TPH")	Monthly	grab
Total Phenolics	Monthly	grab

Permit Condition S4. requires that monitoring be performed as specified in Condition S3. and that all monitoring results be summarized and reported on a form provided or approved by the Department of Ecology. Such forms are know as Discharge Monitoring Reports ("DMRs"). Available information indicates that POS has violated these conditions (with respect to outfall 001, discharge from the IWS):

1. POS failed to monitor total glycols in August, 1994. A deicing event did occur in this month.

2. POS failed to monitor oil and grease, TSS, BOD, total ammonia, BTEX, total phenolics, and TPH in August, 1994.

3. POS failed to monitor or report total glycols in the month of September, 1994. A deicing event did occur in this month.

4. POS failed to monitor pH, oil and grease and TSS during all weeks that discharge from the IWS occurred in September, 1994.

5. Daily maximum flow, BOD, total ammonia, total glycols, BTEX, total phenolics, and TPH are not reported on the October, 1994, DMR.

6. POS failed to monitor total glycols in the month of October, 1994. A deicing event did occur in this month.

7. Daily maximum flow, BOD, total ammonia, total glycols, BTEX, total phenolics and TPH are not reported on the November, 1994, DMR.

8. POS failed to monitor pH, oil and grease and TSS during all weeks that discharge from the IWS occurred in November, 1994.

9. POS failed to monitor total glycols in the month of November, 1994. A deicing event did occur in this month.

10. Daily maximum flow is not reported on the December, 1994, DMR.

11. POS failed to monitor pH, oil and grease and TSS during all weeks that discharge from the IWS occurred in December, 1994.

12. POS failed to monitor total glycols in the month of December, 1994. A deicing event did occur in this month.

13. POS failed to monitor pH, oil and grease and TSS during all weeks that discharge from the IWS occurred in January, 1995.

14. POS failed to monitor total glycols in the month of January, 1995. A deicing event did occur in this month.

15. Daily maximum flow is not reported on the January, 1995, DMR.

16. Daily maximum TSS and daily average TSS and oil and grease are inaccurately reported on the January, 1995, DMR.

17. The daily maximum oil and grease, BOD, TPH and TSS and the daily average oil and grease are inaccurately reported on the February, 1995, DMR.

18. POS failed to monitor total glycols in the month of February, 1995. A deicing event did occur in this month.

19. Daily maximum flow is not reported on the March, 1995, DMR.

20. POS failed to monitor pH, oil and grease and TSS during all weeks that discharge from the IWS occurred in March, 1995.

21. POS failed to monitor total glycols in the month of March, 1995. A deicing event did occur in this month.

22. POS failed to monitor pH, oil and grease and TSS during all weeks that discharge from the IWS occurred in April, 1995.

23. POS failed to monitor total glycols in the month of April, 1995. A deicing event did occur in this month.

C. Permit Condition S3.C.1 sets the requirements for monitoring storm water discharges at Outfalls 002, 003, 005, 006, 007, 008, and 009. It includes the following:

Test	Sampling Frequency
Flow	daily
pH	quarterly
Oil and Grease	quarterly
TSS	quarterly
Turbidity	quarterly
Fecal Coliform	quarterly
BOD5	quarterly
Total Ammonia	quarterly
Total Glycols	quarterly
Priority Pollutant Metals	quarterly
Surfactants	quarterly
TPH	quarterly

Permit Condition S4. requires that monitoring be performed as specified in Condition S3. and that all monitoring results be summarized and reported on a form supplied or approved by the Department of Ecology no later than the 15th day of the month following the reporting period. Available information indicates that POS has violated these conditions:

1. On the DMRs for August, 1994, POS failed to report daily maximum flows for outfalls 003, 005, 006, 007, 008, and 009.

2. POS took its quarterly stormwater samples in September, 1994 pursuant to Condition S3.C.1. However, monitoring results for pH, oil and grease TSS, turbidity, fecal coliform BOD5, total ammonia, total glycols, priority pollutant metals, surfactants, and TPH for Outfalls 002 and 003 and priority pollutant metals for Outfalls 005, 006, 007, 008 and 009 were not provided in accordance with Condition S3. because they were not submitted by October 15, 1994 and, when they were later submitted, they were not on a form supplied or approved by the Department of Ecology.

D Permit Condition S3.C.2 sets the requirements for monitoring storm water discharges at Outfalls 004 and 010. It includes the following:

Test	Sampling Frequency
Flow	daily
pH	annually
Oil and Grease	annually
TSS	annually
Turbidity	annually
Fecal Coliform	annually
BOD5	annually

Permit Condition S4. requires that monitoring be performed as specified in Condition S3. and that all monitoring results be summarized and reported on a form supplied or approved by the Department of Ecology no later than the 15th day of the month following the reporting period. Available information indicates that POS has violated these conditions:

On the DMRs for August, 1994, POS failed to report daily maximum flows for outfalls 004 and 010.

E. Permit Condition S3.A. footnote d requires POS to submit for DOE review and approval the laboratory method that will be used to analyze glycol concentrations for samples taken from outfall 001. Similarly, Permit Condition S3.C.1. footnote f requires the same for samples taken from outfalls 003, 005, 006, 007, 008, and 009. POS has violated these conditions by failing to submit all of the required information.

F. Permit Condition S4.H. requires that, if POS monitors any pollutant more frequently than required by the Permit, the monitoring should be done using acceptable test procedures and the results of the monitoring must be included in POS self-monitoring reports. POS has violated this condition by failing to submit to DOE stormwater monitoring results for outfalls 002, 003, 004, 005, 006, 007, 008, 009, and 010 taken since February, 1995, pursuant to the terms of the Stipulated Settlement Agreement And Agreed Order Of Dismissal for PCHB No. 94-157 and 94-160.

G. Permit Condition S4.J. requires that unauthorized discharges such as collection system overflows or plant bypasses be reported immediately to the Department of Ecology and the Department of Health, Shellfish Program. POS has violated this condition by failing to immediately report overflows and bypasses, including those referred to in section III. of this letter.

III. <u>Bypass</u>

Permit Condition S16. states that; "[t]he intentional bypass of storm water from all or any portion of a storm water treatment system whenever the design capacity of the treatment system is not exceeded, is prohibited" unless certain conditions are met.

Permit Condition G1. states that, "[a]ll discharges and activities authorized by this permit shall be consistent with the terms and conditions of this permit."

Permit Condition G2. states that, "[t]he Permittee shall at all times properly operate and maintain all facilities and systems of collection, treatment and control (and related appurtenances) which are installed or used by the Permittee for pollution control."

Permit Condition G5. states that, "[t]he intentional bypass of wastes from all or any portion of a treatment works is prohibited" unless certain conditions are met.

A. Available information indicates that on November 29, 1990, an overflow event from industrial wastewater system ("IWS") lagoons 2 and 3 occurred resulting in a bypass of wastes to Des Moines Creek and violation of Permit Conditions S15., G1., G2., and/or G5.

B. Available information indicates that a 40,000 gallon overflow event from IWS lagoons 1 and 2 occurred on October 31, 1994 resulting in a bypass of wastes to Des Moines Creek and violation of Permit Conditions S15., G1., G2., and/or G5.

C. Available information indicates that overflows and/or bypasses to Des Moines Creek via the drainage ditch on the north side of S. 188th Street from IWS lagoons 1 and 2 occur on a regular and frequent basis. This occurred on dates including, but not limited to, December 20, 1994, December 22, 1994, January 8, 1995, January 9, 1995, and February 21, 1995. These overflows and/or bypasses violate Permit Conditions S15., G1., G2., and/or G5.

D. Available information indicates that overflows and/or bypasses to Des Moines Creek from IWS lagoon 3 via an overflow weir or pipe located near the southeast corner of the lagoon occur on a regular and frequent basis. These overflows and/or bypasses violate Permit Conditions S15., G1., G2., and/or G5.

E. Available information indicates that cross-connections between the collection and conveyance systems for the IWS and the stormwater system lead to the bypass of wastewater from the IWS to the stormwater system. Wastewater which should be treated by the IWS is instead discharged directly to Des Moines and/or Miller Creeks via the stormwater system under certain conditions. These cross-connections and/or bypasses violate Permit Conditions S15., G1., G2., and/or G5.

F. Available information indicates that, during periods of heavy precipitation, the IWS collection lines back up with waste and overflow to surrounding areas due to limited IWS collection system capacity. This occurred on June 22, 1993, at the Continental - United Airlines fuel farm site IWS sump (see letter dated July 15, 1993, from Reynold Tomes, Burns & MacDonald Waste Consultants Inc. to Dan Tisoncik, United Airlines). This category of overflows is not limited to this incident (see also memo from W. E. Broughor to Jack Block regarding Update on Miller Creek and Des Moines Creek, July 12, 1994).

G. Permit Condition S1.A. authorizes the discharge of industrial wastewater to Puget Sound after treatment by the IWS. The permit authorizes the discharge of stormwater from outfalls 002 - 010. The permit defines "Industrial Wastewater" as

> "water or liquid-carried waste from industrial or commercial processes, as distinct from domestic wastewater. These wastes may result from any process or activity of industry, manufacture, trade or business, from the development of any natural resource, or from animal operations such as feed lots, poultry houses, or dairies. The term includes contaminated storm water and, also, leachate from solid waste facilities."

The permit defines "Storm Water" as

> "that portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, pipes, and other features of a storm water drainage system into a defined surface water body, or a constructed infiltration facility."

1. Discharges from the hazardous material storage area located in the southwest corner of the airport are routed via an unpermitted outfall to a ditch along S. 188th St. These discharges constitute discharges of "industrial wastewater" as defined by the permit and not "storm water". Discharge of this waste without treatment by the IWS constitutes a bypass and violation of Permit Conditions S15., G1., G2., and/or G5. This bypass has occurred during and following every significant precipitation event since issuance of the permit.

2. Discharges from the following areas include discharges of "industrial wastewater" as aircraft servicing occurs in these areas:

	Area #	Description
a.	undesignated	Gate B5 area
b.	undesignated	Area north of S. Satellite
c.	100	Port maintenance shop yard
d.	111	A portion of the large area that drains areas between A and B Concourses and S. Satellite
e.	115	A portion of the large area located between A and B Concourses and S. Satellite
f.	303	Area immediately surrounding SDS1-110
g.	undesignated	Gate C8 area
h.	104	Northeast of North Satellite
i.	106 - 107	Flush gutters near North Satellite
j.	109	Catch basin SDS1-48, located at NW edge of main building between B and C Concourses
k.	110	Two catch basins next to B Concourse building
l.	309	Closed manholes located along west edge of main building

Discharges from these areas are not treated by the IWS and are instead discharged to Des Moines and/or Miller Creeks via the stormwater system. These are bypasses and violations of Permit Conditions S16., G1., G2., and/or G5. These bypasses occur during and after significant precipitation events.

IV. Unpermitted Discharges

Section 301(a) of the CWA prohibits the discharge of any pollutant except in compliance with specified sections of the CWA, including Section 402.

POS discharges pollutants from outfalls not authorized by the permit. These include 1 - 5) five outfalls on the east side of 12th Avenue South between South 160th Street and South 166th Place, 6) an outfall on the north side of South 188th Street approximately 80 feet west of 28th Avenue South, 7) an outfall on the north side of South 188th Street approximately 180 feet east of 16th Avenue South, 8) an outfall on the north side of South 188th Street just below the IWS plant (in a large cement box-like structure), 9) an outfall on the north side of South 188th Street approximately 50 feet east of Gate W-9 (a large metal pipe), 10) an outfall on the north side of South 188th Street approximately 160 feet east of the Des Moines Memorial Drive intersection (in a large cement box-like structure), and 11) an outfall on the south side of South 156th Street just east of Gate W-1A (drains basin SDN-4). All of these outfalls are to ditches which are tributaries to waters of the United States. None of these outfalls were identified by POS in its application for the permit.

V. Sludge

Permit Condition G2. requires POS to, "at all times properly operate and maintain all facilities and systems of collection, treatment, and control (and related appurtenances) which are installed or used by the Permittee for pollution control." POS has not removed sludge from IWS lagoons 1 and 2 since 1986. The resultant build up of sludge contributes to problems with the operation of the IWS and very strong petroleum odors in the vicinity of the lagoons. POS's failure to remove the sludge from IWS lagoons 1 and 2 constitutes a violation of Condition G2. since proper operation and maintenance practices include the removal of IWS lagoon sludge on a routine basis and preclude the build up of sludge as POS has allowed.

VI. Non-compliance Notification

Permit Condition G4. requires POS to provide the Department of Ecology with specific information if, for any reason, POS does not comply with, or will be unable to comply with, any of the discharge limitations or other conditions specified in the permit. POS has violated this condition by failing to provide notice containing the requisite information for any of the permit violations described in this letter.

The discharge of pollutants from these outfalls is in violation of the CWA because they are not permitted pursuant to Sections 301 and 402 of the CWA.

VII. Reporting Violations - Prior Permit

Until June 30, 1994 (issuance of the current permit), discharges from the airport were covered by NPDES permit No. 002465-1, issued on November 30, 1988 (the "prior permit"). Condition S1. of the prior permit set the following effluent limitations and monitoring schedule:

Parameter	Outfall	Daily Ave.	Daily Max.	Sample Frequency	Sample Type
Total Oil and Grease	001	10 mg/L No visible	15 mg/L oils or grease	weekly	grab
pH	001	Not outside	of range 6.5-8.5	weekly	grab
flow	001		5,985,000 gpd	daily	estimate
flow	002		28,800 gpd	monthly	estimate
Temp.	002		70° F	monthly	grab

Condition S2. of the prior permit required POS to monitor parameters as specified in Condition S1. Condition S2.A. required monitoring results obtained during the previous six months to be summarized and reported on a form provided or approved by the Department of Ecology and submitted no later than the fifteenth day of the month following the completed reporting period.

POS violated these conditions:

1. For the monitoring period of January to June, 1994, POS failed to conduct any of the required monitoring and/or to submit the required DMR form.

2. For the monitoring period of July to December, 1993, POS failed to report daily maximum flow, maximum and minimum pH, and daily maximum oil and grease on the DMR form. In addition, POS failed to monitor any parameters and/or to submit any sample results for outfall 002.

3. For the monitoring period of January to June, 1993, POS failed to report daily maximum flow, maximum and minimum pH, and daily maximum oil and grease on the DMR form. In addition, POS failed to monitor any parameters and/or to submit any sample results for outfall 002. The data was not submitted until January 3, 1994.

4. For the monitoring period of July to December, 1992, POS failed to report daily maximum flow, maximum and minimum pH, and daily maximum oil and grease on the DMR form. In addition, POS failed to monitor any parameters and/or to submit any sample results for outfall 002. The data was not submitted until May 10, 1993.

5. For the monitoring period of January to June, 1992, POS failed to report daily maximum flow, maximum and minimum pH, and daily maximum oil and grease on the DMR form. In addition, POS failed to monitor

any parameters and/or to submit any sample results for outfall 002. The data was not submitted until August 17, 1992.

6. For the monitoring period of July to December, 1991, POS failed to report daily maximum flow, maximum and minimum pH, and daily maximum and daily average oil and grease on the DMR form. In addition, POS failed to monitor any parameters and/or to submit any sample results for outfall 002. The data was not submitted until August 17, 1992.

7. For the monitoring period of January to June, 1991, POS failed to report daily maximum flow, maximum and minimum pH, and daily maximum and daily average oil and grease on the DMR form. In addition, POS failed to monitor any parameters and/or to submit any sample results for outfall 002. The data was not submitted until August 17, 1992.

8. For the monitoring period of July to December, 1990, POS failed to report daily maximum flow, maximum and minimum pH, and daily maximum and daily average oil and grease on the DMR form. In addition, POS failed to monitor any parameters and/or to submit any sample results for outfall 002. The data was not submitted until August 17, 1992.

These violations are ongoing violations because they are of the same nature and continuing monitoring and reporting violations of the conditions of the current permit.

The violations described above only reflect what the information currently available indicates. We allege that POS's violations of its NPDES permit and the CWA are ongoing. We intend to sue for all permit violations, including those yet to be discovered and those committed subsequent to the date of this notice of intent to sue.

Pursuant to Section 309(d) of the CWA, POS is subject to a penalty of up to $25,000 per day for each of the violations described above. In addition to civil penalties, we will seek injunctive relief to prevent further violations pursuant to Section 505(a) and (d) of the CWA and such other relief as is permitted by law. Also, we will seek recovery of costs, including attorney's and expert witness' fees, as provided in Section 505(d) of the CWA.

We believe that this NOTICE OF INTENT TO SUE sufficiently states grounds for filing suit. We intend, at the close of the 60-day period, or shortly thereafter, to file a citizen suit against POS under Section 505(a) of the Clean Water Act.

Very truly yours,

Richard A. Smith

c:
Director Mary Riveland, Washington Department of Ecology
Administrator Carol Browner, U.S. Environmental Protection Agency
Administrator Charles Clarke, U.S. Environmental Protection Agency, Region X

U.S. Department of Transportation
Federal Aviation Administration

800 Independence Ave. S.W.
Washington

MAR

Mr. Peter Townsend
Peter Townsend and Associates, P.S.
1648 South 310th
Suite 12
Federal Way, WA 98003

Dear Mr. Townsend:

As requested in your letter of January 29, I am enclosing a table of the top 30 airports (ranked by passenger enplanements) that lists the number of people living within the DNL 65dB noise contours. The table includes the data source and the year the population data represents.

As you can see, not all of the airports listed have filed Part 150 studies with the Federal Aviation Administration. The population numbers listed in the table are based on Part 150 studies, Environmental Impact Statements, or information directly obtained from the airports.

If there are any additional questions, please contact Jim Littleton on my staff at 202-267-3579.

Sincerely,

Thomas L. Connor

Thomas L. Connor
Manager, Technology Division
Office of Environment and Energy

Enclosure

Population Exposed to 65 LDN

Rank (1)	Airport	Population	Base Year	Data Source
1	O'Hare	209,890	1988	Part 150
2	Atlanta-Hartsfield	80,000	1984	Part 150
3	Dallas-Ft.Worth	16,834	1989	DEIS(2)
4	Los Angeles	92,291	1983	other(3)
5	Denver	14,666	1989	EIS(4)
6	San Francisco	44,440	1982	other
7	St. Louis	79,600	1986	Part 150
8	Newark	65,078	1986	other
9	La Guardia	461,749	1986	other
10	Phoenix	30,993	1987	Part 150
11	Greater Pittsburg	6,634	1984	Part 150
12	Miami	130,000	1985	other
13	Detroit-Wayne Co	37,510	1986	Part 150
14	Boston-Logan	99,000	1980	other
15	Kennedy	212,210	1980	other
16	Minneapolis-St. Paul	18,554	1987	Part 150
17	Charlotte	13,243	1988	Part 150
18	Memphis	72,780	1985	other
19	Houston Int'l	4,022	1984	EIS
20	Philadelphia	n/a		
21	Washington-National	24,500	1989	other
22	Orlando	3,480	1985	Part 150
23	Honolulu	6,468	1987	other
24	Las Vegas-McCarran	17,090	1987	other
25	Seattle-Tacoma	78,146	1984	Part 150
26	Balt-Washington	14,194	1987	other
27	Salt Lake City	3,915	1984	Part 150
28	Cincinnati	2,019	1985	EIS
29	Kansas City	282	1980	81 EIS,p.34
30	Cleveland	28,730	1981	84 part 150,p.82,p93

Footnotes:
1.Source 'Terminal Area Forecasts' FAA-APO-90-6 July 1990 (Air carrier operations)
2.Draft Environmental Impact Statement
3.Information obtained directly from airports or other studies.
4.Environmentat Impact Statement

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03/09/93 15:10 202267332 FAA HDQTRS-APO 002/002

930309

AIRPORTS RANKED BY AIR TAXI OPERATIONS IN 1990

SEARCH: LOCID [ ] STATE [ ] REGION [ ] SEARCHLIST [T123568]

LOC	CITY NAME	AI-ITIN 1990
ATL	ATLANTA	182
DFW	DALLAS-FORT WORTH	174
LAX	LOS ANGELES	161
BOS	BOSTON	158
SEA	SEATTLE	151
ORD	CHICAGO	147
GCN	GRAND CANYON	141
DEN	DENVER	130
PHL	PHILADELPHIA	128
CVG	COVINGTON/CINCINNATI,	127
CLT	CHARLOTTE	123
STL	ST LOUIS	108
JFK	NEW YORK	102
SJU	SAN JUAN	101
MDW	CHICAGO	100
MIA	MIAMI	100
PIT	PITTSBURGH	98
PDX	PORTLAND	97
EWR	NEWARK	88
BWI	BALTIMORE	88
ALB	ALBANY	86
MSP	MINNEAPOLIS	81
JNU	JUNEAU	80
LAS	LAS VEGAS	80
SFO	SAN FRANCISCO	78
PHX	PHOENIX	77
OGG	KAHULUI	72
CLE	CLEVELAND	72
STT	CHARLOTTE AMALIE	71
MEM	MEMPHIS	70
LGA	NEW YORK	68
FAT	FRESNO	67
LIH	LIHUE	65
BNA	NASHVILLE	65
RDU	RALEIGH-DURHAM	64

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Preliminary Population and Land Cover Impact Analysis

Introduction

This preliminary analysis studies several impacts of various supplemental airport sites. The analysis takes into account the effects of a new supplemental airport and projected noise levels on 1990 population. Effects on population forecast for 2020 are included to show the airport sites in relation to the adopted regional growth and development strategy. The analysis also includes current land cover and patterns of development. All sites that meet the basic requirements for air space and constructability are included.

The purpose of the analysis is to provide a means of comparing the approximate level of impacts to people and their activities that could result from developing an airport. The next step in this analysis will evaluate impacts to environmental features (i.e. wetlands) on the airport sites as well as refine the estimates of population impacts.

Methodology

These impacts are based on the layout prototype and its projected noise level contours applied to each site. The supplementary airport facility layout includes two independent parallel runways and space for parking, aircraft storage, and other ancillary activities. The noise contours (for 65 L_{dn} and 55 L_{dn}) are derived from the FAA's Integrated Noise Model (INM) based on forecast ...els of activity. The airport perimeter is the smallest areas, about 2,140 acres. The 65 L_{dn} noise contour extends 14,356 feet beyond the north end of the runways, and 11,110 feet beyond the south end. The 55 L_{dn} noise contour extends 26,027 feet to the north and 45,968 feet to the south of the runways. Both the airport layout prototype and the noise contour modeling are described in Working Paper No. 2.

The three impact areas (airport facility perimeter, 65 L_{dn} and 55 L_{dn} noise contours) were overlaid onto land cover and population maps using a Geographic Information System (GIS). The GIS is a computer tool that allows comparison of different types of mapped information. For this analysis, the GIS was used to overlay the airport facility perimeter and noise contours ...t each potential airport site to calculate noise exposure estimates for population and land cover. ...he overlay calculates the area in common, or the intersection, of the different map coverages.

...e impacts for each of these areas were calculated separately, not cumulatively. This means ... area within the 65 L_{dn} noise contour does not include the area within the airport facility ...imeter, likewise the 55 L_{dn} noise contour area does not include either the area within the 65 ... noise contour or the airport facility perimeter. Separate calculations best describe the ...erent types of impacts (also, because of the shape of the noise contours, the facility ...meter includes some area outside of each noise contour).

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Table 1. 1990 Population Site Impacts and Noise Exposure

AIRPORT SITE NAME	Non-Cumulative Estimates by Impact Area					
	Airport Perimeter Area		65 Ldn Noise Contour Area		55 Ldn Noise Contour Area	
	Population	Households	Population	Households	Population	Households
Arlington	1,832	342	680	220	24,373	8,847
Bothell/Mill Creek	3,446	1,109	2,834	982	43,736	15,458
Duvall	864	278	376	118	5,431	1,739
Enumclaw	874	324	282	105	5,020	332
Frederickson	2,285	747	564	186	9,199	3,079
Lake Sawyer	1,837	601	821	258	6,749	2,219
Marysville East	654	212	301	98	10,695	3,677
Marysville West	769	269	834	274	20,760	7,998
McChord	5,615	1,945	4,552	1,677	40,321	15,587
Redmond	987	312	455	140	15,166	4,887
* Stanwood	486*	172*	103*	37*	2,565*	932*
* Tanwax Lake	260	85	51	17	2,934*	335*

* *The impact areas for these sites extend beyond the PSRC boundaries.*

NOTE: (total estimates calculated on a proportional allocation of population by TAZ (traffic analysis zones) to the area within the airport site perimeter and noise contours.

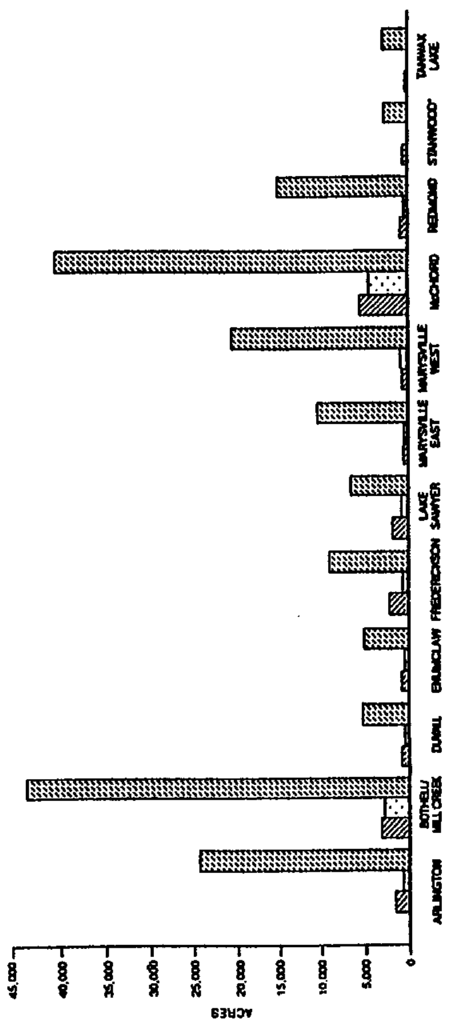

Figure 1.
1990 Population Site Impacts and Noise Exposure

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Table 2. 1990 and 2020 Population Site Impacts

AIRPORT SITE NAME	Non-Cumulative Estimates by Impact Area: Airport Perimeter Area			65 Ldn Noise Contour Area		
	1990	2020	Difference	1990	2020	Difference
Arlington	1,832	2,765	933	680	965	285
Bothell/Mill Creek	3,446	6,411	2,965	2,834	5,472	2,639
Duvall	864	1,735	870	376	603	227
Enumclaw	874	968	93	282	317	35
Frederickson	2,285	4,334	2,050	564	1,242	678
Lake Sawyer	1,837	2,441	605	821	1,151	330
Marysville East	654	1,351	697	301	639	338
Marysville West	769	1,278	508	834	1,408	574
McChord	5,615	6,168	552	4,552	5,263	710
Redmond	987	2,259	1,271	455	997	542
* Stanwood	486	811	325	103	116	13
* Tanwax Lake	260	370	110	51	73	22

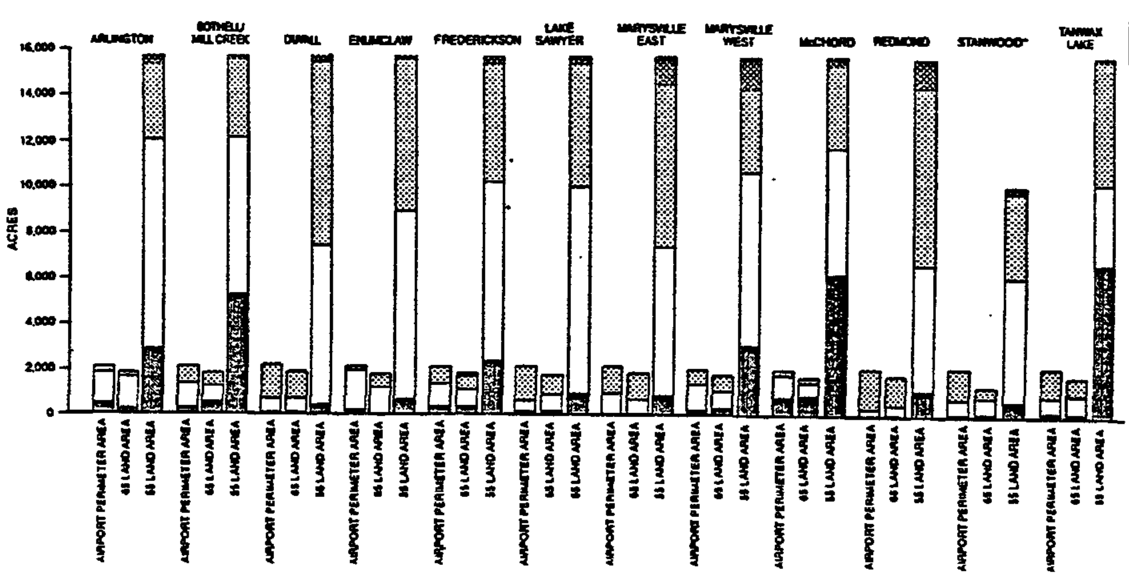
** Data incomplete; the impact areas for these sites extend beyond the PSRC boundaries.*

NOTE: Initial estimates calculated on a proportional allocation of population by TAZ (traffic analysis zones) to the area within the airport site perimeter and noise contours.

Table 3. Land Cover Impacts
Acreages Based on 1992 Classified Landsat Images

AIRPORT SITE NAME	AIRPORT PERIMETER AREA Developed Land	Open Land	Forest Land	Other Areas	65 Ldn NOISE CONTOUR AREA Developed Land	Open Land	Forest Land	Other Areas	55 Ldn NOISE CONTOUR AREA Developed Land	Open Land	Forest Land	Other Areas
Arlington	483	1,414	210	32	184	1,287	196	27	2,886	9,162	3,155	427
Bothell/Mill Creek	286	1,138	713	3	440	738	514	2	5,233	6,865	3,375	157
Duvall	35	603	1,495	7	38	578	1,047	29	372	6,968	7,989	301
Enumclaw	71	1,919	142	6	28	1,180	467	19	672	8,237	6,601	120
Frederickson	358	1,093	652	4	319	919	419	69	2,393	7,837	5,014	385
Lake Sawyer	146	499	1,486	8	135	701	786	72	944	8,948	5,439	299
Marysville East	44	1,037	1,058	0	24	613	1,050	7	926	6,535	7,004	1,164
Marysville West	277	1,241	608	13	247	770	657	20	3,207	7,573	3,428	1,422
McChord	944	1,015	177	3	907	605	167	15	6,383	5,398	3,527	322
Redmond	30	392	1,713	3	46	429	1,217	2	1,212	5,383	8,842	194
• Stanwood	50	799	1,286	3	186	710	410	9	626	5,523	3,860	145
(no data area)								380*				5,476*
Tanwax Lake	130	771	1,237	0	97	842	740	16	660	6,051	8,800	120

* *The noise contours for this site extends beyond the PSRC boundaries where comparable land cover are available.*



* Impact area extends beyond available data coverage

Developed Land
Open Land
Forest Land
Other Areas

Figure 2.
Land Cover Impacts

FAA Bulletin Board
(202) 267-9647

ENGINE RUN-UP IN THE INM

AIRCRAFT:
TYPES
AC A300RU CURVE=2CF650 PARAM=AP31 STAGE 1=RUNUP
CATEGORY=JCOM

PROFILES TAKEOFF
PF RUNUP SEGMENTS=3 WEIGHT=262000 ENGINES=2

DISTANCES	0	10	20
ALTITUDES	0	0	99999
SPEEDS	160	160	160
THRUSTS	43404	1	

INT. NM.

TAKEOFFS BY FREQUENCY:

TRACK TR1 RWY 09 STRAIGHT 50
OPER A300RU STAGE 1 D=60

EXPLAINATION:
To introduce the effects of engine run-up into the INM the above information should be ADDED to the input file for each aircraft type of concern. While the above example is for the INM aircraft A300, it serves as an example for any aircraft -- simply substitute the appropriate aircraft parameters.

AC A300RU -- describes the INM aircraft type with RU to identify run-up. This a user specifed designator.

CURVE=2CF650 -- is the INM noise curve name for the A300

PARAM=AP31 -- is the INM approach parameter name for the A300

STAGE 1=RUNUP -- user specified takeoff profile name

PF RUNUP .... -- this line specifies 3 segments will be used for run-up, the aircraft weight and the number of engines

DISTANCES -- this line gives the 3 segments for ground distance

ALTITUDES -- this line gives the 3 segments for altitude. The first two segments are set to zero, the final segment altitude takes the aircraft straight up

SPEEDS -- the INM reference speed is specified here, so no further adjustments are made by the INM

THRUSTS -- the first segment specifies the actual takeoff thrust for that aircraft (from INM data base). In the following segment, thrust is dropped to the lowest value acceptable to the INM

TRACK -- this line specifies the user definable track

OPER A300RU -- matches the aircraft type defined by the user under TYPES

STAGE 1 D=60 -- says that the aircraft does a 60 second run-up. For DNL or Leq the user specifies the appropriate number of seconds. For SEL, this value should be set to 1 (one operation).

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STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

Northwest Regional Office, 3190 - 160th Ave S.E. • Bellevue, Washington 98008-5452 • (206) 649-7000

February 27, 1995

Mr. William E. Brougher
Director, Facilities and Maintenance
Port of Seattle
Sea-Tac International Airport
PO Box 68727
Seattle, WA 98168

Dear Ms. Brougher:

The Department of Ecology finds the Treatability Study and Performance Test for the Industrial Waste Treatment Plant at Sea-Tac International Airport dated January 13, 1994 fails to satisfy Condition S5.B. of your NPDES permit. The study did not address Condition S5.B. which requires a determination of the relationship between effluent total suspended solids and hydraulic loading rate and other operating parameters of the dissolved air flotation units.

The study determined how the dissolved air flotation unit's operating parameters affected the removal efficiency of oil and grease. It concluded the effluent limit of 10 milligrams per liter (mg/L) should be achieved. The study did not address total suspended solids.

Of immediate and special concern to Ecology were those portions of the study which found poor maintenance of the waste water treatment system and recommends improvements. These findings of concern include the following.

1. The interim effluent limit for oil and grease is a daily average of 8 mg/L.

2. Only three of the four dissolved air flotation units were operating. The study must include all four dissolved air flotation units.

3. The study demonstrated oil and grease discharges of less than 3 mg/L are achievable at a flow rate of 3.5 gallons per minute per square foot and a chemical dosage of 20 milligrams per liter.

4. Normally, facilities are thoroughly prepared for studies of this importance. However, when the test crew arrived on December 27, 1994 Dissolved Air Flotation (DAF) Unit No. 1 was found to have a broken chemical feed pump.

Mr. William B. Brougher
Page 2
February 27, 1995

Before the test could start, Dissolved Air Flotation Unit No. 3 needed emergency repairs to replace an undersized pipe in the main air injection line which supplies air to the flotation tank. Dissolved Air Flotation Unit No. 4 had a leaky threaded joint coupling causing the pump to lose prime. Dissolved Air Flotation Unit No. 6 had insufficient air because of an undersized and badly corroded air line installed in 1965.

Conclusions

1. The Port of Seattle violated Condition G2 on December 27, 1994. Condition G2 requires Sea-Tac to properly operate and maintain all treatment systems at all times. Some of the improper operations and maintenance have been occurring since 1965.

   Although the study does not meet the intent of permit Condition S5.B., Ecology agrees with the study's recommendations on how to improve operations.

2. The Port of Seattle must develop and follow an operating plan including an inspection schedule for the dissolved air flotation system by April 1, 1995. This is recommended on page A-1, paragraph 1.D. The operating plan must be periodically reviewed and updated. Discharges that result from a failure to follow the requirements of the plan may be considered proof that the equipment was not properly operated and maintained and may be considered a violation of Condition G2.

3. The Port must submit a test plan to determine the relationship between TSS and operating parameters which satisfies Condition S5.B. within 14 days of the receipt of this letter. Ecology will respond in writing within seven days approving the plan or with additional needed measurements. Study results must be submitted to Ecology no later than May 1, 1995.

4. The Port should immediately install backup pumps and install more reliable pumps as recommended in the study. Feed back control systems using pH meters is recommended on page B-1 and should be installed.

5. Backup dissolved air flotation units are necessary. On page A-9 the study suggests adding two, 250 square foot units that would serve as backup units and add to the marginal flotation detention times.

   Flotation detention times should be 20 to 60 minutes. Flotation detention times currently at Sea-Tac are less than 10.7 and 14.3 minutes when the DAF units are operated at the recommended maximum flow rate of 3.6 gallons per minute per square foot. Ecology agrees with the conclusion on page A-8 that this is not enough time for oil separation.

Mr. William B. Brougher
Page 3
February 27, 1995

6. Lagoon #1 needed immediate cleaning as noted on page A-10 paragraph 9.H. A monitoring and cleaning schedule is needed for all three lagoons.

7. The most significant data on effluent is in Appendix D on the last page of the report. It should be in the body of the report. Recommendations of critical improvements to the reliability of the treatment plant are described only in Appendixes A and B. They should also be in the body of the report.

Feel free to contact me at (206) 649-7293 if you have any questions.

Sincerely,

John Drabek, PE
Water Quality Program

JD:jd:tm

cc: Deborah North, WQ-NWRO
Kevin Fitzpatrick, WQ-NWRO

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IN THE SUPERIOR COURT OF THE STATE OF WASHINGTON
IN AND FOR THE COUNTY OF KING

CITY OF SEATAC, a municipal corporation of the State of Washington, Plaintiff, vs. PORT OF SEATTLE, a municipal corporation of the State of Washington, Defendant.	No. 95-2-03901-4 AMENDED COMPLAINT FOR DECLARATORY JUDGEMENT AND DECLARATIVE RELIEF

I. PARTIES

1.1 The Plaintiff, City of SeaTac, is a Washington municipal corporation and general purpose government, operating as a code city pursuant to the provisions of Title 35A of the Revised Code of Washington (RCW).

1.2 The Defendant, Port of Seattle, is a Washington municipal corporation and limited purpose government, operating as a port district pursuant to the provisions of Title 53 RCW.

II. JURISDICTION AND VENUE

This court has jurisdiction over this matter pursuant to RCW 2.08.010 and RCW 7.24.010. Venue is proper pursuant to RCW 4.12.025.

III. FACTS

3.1 The Port is the owner and operator of Seattle-Tacoma International Airport ("Airport"). The Airport has been operated by the Port for approximately fifty years, and is currently approximately 2500 acres in size. The Airport is located within the corporate limits of the Plaintiff.

3.2 In 1990, the Plaintiff was incorporated as a city from an area that was unincorporated King County prior thereto. Prior to the incorporation of the Plaintiff, the Defendant performed many

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(206) 241-9100

development functions that are the subject of this declaratory judgement action. Additionally, the Defendant operates its own police and fire departments, its own water utility, and has installed systems for collecting and conveying Airport sanitary sewage to area treatment and disposal facilities, and for collecting and draining storm water from Airport property into surrounding storm water disposal systems.

3.5 Since the incorporation of the Plaintiff, the Plaintiff has established and developed a number of municipal functions, services and facilities, including police services, fire and emergency response services, storm water collection, drainage and disposal facilities, road maintenance services, building and code enforcement services and land use and planning services. Currently, water from the Airport storm water collection facilities drains into storm water facilities of the Plaintiff.

3.6 The Defendant owns a significant amount of property located within the corporate limits of the Plaintiff. In addition to the property that the Defendant uses for airport and airport related purposes. Some of the property owned by the Defendant is leased to other private and public parties, including the Plaintiff, and is used by the tenants thereof for various purposes such as commercial, industrial and park purposes.

IV. AUTHORITY OF THE PLAINTIFF

4.1 On February 28, 1990, the Plaintiff, City of SeaTac, was incorporated from an area that was unincorporated King County prior thereto. As such, pursuant to Article XI § 11 of the Constitution of the State of Washington, the Plaintiff, City of SeaTac became authorized to "make and enforce within its limits all such local police, sanitary and other regulations as are not in conflict with general laws."

4.2 In accordance with the Plaintiff's incorporation as a code city pursuant to Title 35A, the Optional Municipal Code, and as more particularly provided in RCW 35A. 01.010, the Plaintiff is conferred with "the broadest powers of local self-government consistent with the Constitution of this state." That section of the RCW further provides as follows:

> [illegible]

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(206) 241-9100

> under the provisions of this title, whether the grant is in specific terms or in general terms, shall be liberally construed in favor of the municipality.

4.3 Pursuant to the provisions of RCW 35A.70.040, and Chapter 19.27 RCW, the Plaintiff is authorized to adopt and enforce the State Building Code. Section 19.27.031 RCW specifically identifies which codes are included (Uniform Building Code and Uniform Building Code Standards, Uniform Mechanical Code, Uniform Fire Code and Uniform Fire Code Standards, and Uniform Plumbing Code and Uniform Plumbing Code Standards), and provides that the state building code shall be in effect in all counties and cities in the state. RCW 19.27.050 further indicates that if the Plaintiff did not have a building department to enforce the State Building Code, it would have to contract for services to enforce the State Building Code within its jurisdictional boundaries. The Plaintiff does have a building department and it does enforce the building codes within its jurisdictional boundaries. On February 22, 1990, the Plaintiff initially adopted its Building and Construction Code as a part of Ordinance No. 90-1021, codified as Title 13 of the SeaTac Municipal Code (SMC). The parties have agreed that the Plaintiff is to handle permitting and enforcement of the State Building Code, including building, mechanical, plumbing and electrical permits. In that regard, the Plaintiff's permitting and enforcement of the state building code on Defendant's Airport property is not part of the controversy in this complaint.

4.4 Among the various municipal activities, authorities and functions with which the Plaintiff is involved, a number of them have become subject of disagreement or dispute between the Plaintiff and the Defendant. Those municipal activities, authorities and functions include the following:

A. Zoning. The Plaintiff's authority for zoning stems from Chapter 35A.63 RCW. More specifically, RCW 35A.63.060 requires the Plaintiff to provide for the preparation of a "comprehensive plan for anticipating and influencing the orderly and coordinated development of land and building uses of the code city and its environs." The elements that the Plaintiff is authorized to include in its comprehensive plan, pursuant to RCW 35A.63.062, include, among others, as follows: a conservation element for the conservation, development, and utilization of natural resources; an open spaces, park and recreation element; a transportation element showing a comprehensive system of surface, air, and water

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transportation routes and facilities; a public-use element showing general locations, designs, and arrangements of public buildings and uses; and other elements dealing with subjects that, in the opinion of the City Council of the Plaintiff, relate to the development of the municipality, or are essential or desirable to coordinate public services and programs with such development. Additionally, RCW 35A.63.100 provides the authority for the Plaintiff to adopt and implement (1) official maps and regulations relating to designating locations and requirements for streets, parks, public buildings, and other facilities, and protecting such sites such sites against encroachment by buildings and other physical structures; (2) zoning designations and districts regulating use of public and private lands, buildings and structures, and the locations, height, bulk, number of stories, and size of buildings, size of yards, population density, ratio of land area and structure area, setbacks, area required for off-street parking, protection of access to direct sunlight for solar energy systems, and other related standards, requirements and regulations; (3) design standards, requirements, regulations, and procedures for the subdivision of land into two or more parcels; (4) priorities for the development and scheduling of public improvements; and (5) such other matters as may be otherwise authorized by law or as the City Council of the Plaintiff deems necessary or appropriate to effectuate the goals and objectives if the comprehensive plan or parts thereof and the purposes of Chapter 35A.63 RCW. Although the Plaintiff initially adopted the provisions of the King County Zoning Code (Title 21) by reference in its Ordinance No. 90-1019, in February of 1990, the Plaintiff's zoning ordinance was updated in 1992 by the adoption of the City of SeaTac Zoning Code (Title 15) in City of SeaTac Ordinance No.92-1041. The initial zoning code of the Plaintiff included zoning and land use designations for property of the Defendant used in its airport operations. The Plaintiff's initial zoning code kept the same zoning and land use designations that King County had at that time for the Defendant's airport operations property, including Airport Open Space (AOU), and Light Manufacturing with P suffix (LM-P) - [Airport Facility uses only].

B. Sensitive areas ordinance. In addition to the Plaintiff's authority to include a conservation element and an open spaces, park and recreation element in its comprehensive plan, as described above, the Plaintiff is authorized to designate environmentally sensitive

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areas within its jurisdictional boundaries pursuant to RCW 90.76.040, consistent with the interest of the Plaintiff as a local government agency in environmentally sensitive area protection, as identified in RCW 90.56.060. In those regards, the Plaintiff adopted its Environmentally Sensitive Areas ordinance as a part of Ordinance No. 92-1041, codified as Chapter 15.30 of the SeaTac Municipal Code (SMC).

C. Storm water control. In addition to the responsibilities for planning of and reviewing drainage, flooding and storm water run-off in the area and nearby its jurisdictional boundaries, as set forth in RCW 35.63.090, pursuant to the provisions of RCW 35.58.200, the Plaintiff is authorized and granted the power to prepare a comprehensive water pollution abatement plan including provisions for storm water drainage and to acquire, construct, improve, replace, repair, maintain, operate and regulate facilities for storm water drainage within and without the metropolitan area. RCW 35.67.025 provides for rates and charges for storm water control facilities. Pursuant to RCW 35.92.021 and 90.03.500, the rates and charges that the Plaintiff imposes shall apply to any publicly-owned, including state-owned, real property that causes or contributes to storm water damage. Additionally, RCW 35A.80.010 authorizes the Plaintiff to establish a utility for these purposes. The Plaintiff adopted its initial Surface and Storm Water Management ordinance on August 14, 1990, with the Surface and Storm Water Management provisions being codified as Chapter 12.10 SMC. In these regards, the Defendant has not challenged or contested the Plaintiff's rates and charges. Furthermore, the Defendant has communicated to the Plaintiff that it has no intention of challenging or contesting the Plaintiff's rates and charges for storm water control. Accordingly, the Plaintiff's storm water rates and charges, and their application to projects on the Defendant's Airport property are not part of the controversy in this complaint.

D. SEPA. Pursuant to the provisions of RCW 43.21C, et seq., including RCW 43.21C.030, the Plaintiff is authorized and responsible for compliance with the State Environmental Policy Act, and with the State Environmental Policy Act Rules as set forth in Chapter 197-11 of the Washington Administrative Code (WAC). The Plaintiff adopted its initial Environmental Rules and Procedures ordinance on October 23, 1990, with the Environmental Rules and Procedures being codified as Chapter 13.30 SMC.

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E. Impact fees and concurrency. Pursuant to the provisions of RCW 36.70A.070, the Plaintiff is required to develop, as a part of its comprehensive plan "a transportation element" that implements, and is consistent with, the land use element." RCW 36.70A.070 further specifies, in pertinent part, that the transportation element shall include the following sub-elements:

(a) land use assumption used in estimated travel;
(b) facilities and services needed, including:
(i) an inventory of air, water and land use transportation facilities and services, including transit alignments, to define existing capital facilities and travel levels as a basis for future planning;
(ii) level of service standards for all arterials and transit routes to serve as a gage to judge performance of the system. These standards shall be regionally coordinated;
(iii) specific actions and requirements for bringing into compliance any facilities or services that are below an established level of service standard;
(iv) forecasts of traffic for at least 10 years based on the adopted land use plan to provide information on the location, timing, and capacity needs of future growth;
(v) identification of system expansion needs and transportation system management needs to meet current and future demands; ...
(d) intergovernmental coordination efforts, including an assessment of the impacts of the transportation plan and land use assumptions on the transportation systems of adjacent jurisdictions; ...

RCW 36.70A.070 prohibits approval of a development "if the development causes the level of service on a transportation facility to decline below the standards adopted in the transportation element of the comprehensive plan, unless transportation improvements or strategies to accommodate the impacts of development are made concurrent with the development." [It is from this reference that the word "concurrency" stems.] RCW 39.92.020 (6) defines "transportation impact fee" as "a monetary charge imposed on new development for the purpose of mitigating off-site transportation impacts that are a direct result of the proposed development." Pursuant to RCW 39.92.030, 39.92.040, and 82.02.050 (2) the Plaintiff is authorized to impose transportation impact fees on development activity as a part of the financing for public facilities for transportation system improvements. The Plaintiff adopted its Transportation Impact Fees ordinance on January 11, 1994, with the Transportation Impact Fees provisions being codified as Chapter 11.15 SMC.

F. Police Jurisdiction. Pursuant to the above cited authorities, including Article XI § 11 of the Constitution of the State of Washington, the Plaintiff has police and law enforcement

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jurisdiction within its corporate boundaries.

V. AUTHORITY OF THE DEFENDANT

5.1 As provided in RCW 53.04.010, port districts are authorized to acquire, construct, develop and regulate air transfer and terminal facilities and "other commercial transportation, transfer, handling, storage and terminal facilities and industrial improvements." Additionally, pursuant to chapter 53.08 RCW, port districts are granted powers to construct, acquire, conduct, and operate air terminal facilities, including the authority to improve their lands by developing them for sale or lease for industrial and commercial purposes; operate sewer and water utilities; operate facilities for control of air, water or other pollution; appoint police officers with full police powers for an airport police department; and construct, improve, and repair any streets or highways that serve port facilities. In accordance therewith, the Defendant owns and operates the Seattle-Tacoma International Airport ("Airport"), a facility that it has operated and expanded since commencing operations in 1944. The authority of the Defendant to operate its airport is further found in Chapter 14.08 RCW.

5.2 The Airport is located within the corporate boundaries of the Plaintiff, although the Defendant owns other properties located within and outside of the Plaintiff's corporate boundaries.

5.3 Prior to the incorporation of the Plaintiff, City of SeaTac, in 1990, the general purpose government in which the Airport was located was King County. Although King County did have zoning and land use regulations for the Defendant's airport operations property, and had done so since the initial development of the Highline Communities Plan in the 1950's, King County did not assert its many development regulatory authorities, including permitting and enforcing the state building codes, and the Defendant carried out those functions until the incorporation of the Plaintiff and the execution of the cooperative agreement regarding building, mechanical, electrical and plumbing permits referred to hereinabove.

5.4 The Defendant has and continues to provide its Airport property with a variety governmental services, including operation of its own police and fire departments, its own water utility, a sanitary sewage transfer system, and a storm water collection system that discharges water into storm water lines of the Plaintiff.

5.5 The Defendant has, pursuant to RCW 14.08.120 and 14.08.330, police jurisdiction,

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some exclusive (for airport and air navigation property operated and controlled by it), and some concurrent (for other airport related property).

VI. STATEMENT OF CONTROVERSY REGARDING AUTHORITY OVER AIRPORT DEVELOPMENT ACTIVITIES

6.1 The Plaintiff, relying on the authorities cited in Section 3.4 of this complaint, asserts that it has the jurisdiction and responsibility to regulate development activities occurring within its corporate boundaries, even where the property is property of the Defendant and property used for airport purposes. The Defendant asserts that the Plaintiff lacks authority to regulate such activity except as authorized by the September 1992 agreement.

6.2 The parties have agreed to seek the declaratory judgement requested in this action to determine whether, and to what extent, Airport development activities may be exempt from the Plaintiff's regulatory authority, and to determine what is included within the meaning of "airport and air navigation facility" and "operated and controlled by" a municipality, whether jointly or separately.

VII. STATUTES AND ASSERTIONS PIVOTAL TO MATTERS IN CONTROVERSY

7.1 RCW 14.08.330, in describing jurisdictional authority over airport operations, provides as follows:

> [illegible]

The parties disagree on the interpretation and application of the above statute, and particularly the terms and phrases as follows: airport, air navigation facility, and police jurisdiction. The parties

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further disagree on the intent, extent and scope of "exclusive" and "concurrent" jurisdiction as provided therein. The Plaintiff asserts the statute warrants a restrictive reading, limiting the exclusiveness of jurisdiction to only those facilities that are actually involved in airport operations and air navigation functions, whereas the Defendant asserts an expanded reading of the statute and the "exclusiveness", applying it to any property owned by the Defendant, and so as to devest the Plaintiff from authority over those functions and responsibilities set forth in Section 3.4 hereof as to any property owned by the Defendant that is or could be used for airport or airport related purposes.. The Plaintiff further asserts that the term "police jurisdiction", as used in the statute, is limited and not inclusive or the equivalent of "police power" as that term is used in the law.

7.2 RCW 14.08.120(2), referenced in RCW 14.08.330 in terms of the concurrent jurisdiction over adjacent territory, provides, among the powers conferred on municipalities operating airports, the following:

> [illegible]

The parties disagree on the interpretation and application of the above statute, and, as with RCW 14.08.330, the parties disagree on the meaning of the term: airport, and also, on the meaning of the term restricted landing area. The Plaintiff asserts the statute warrants a restrictive reading, likewise being restricted to only those facilities that are actually involved in airport operations and air

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navigation functions, whereas the Defendant asserts an expanded reading of the statute, applying it broadly to properties unconnected to airport operations and air navigation facilities.

7.3 The parties hereto further disagree on the division and sharing of jurisdiction and responsibility for zoning in and around the airport, and particularly the interpretation and intent of Chapter 14.12 RCW. RCW 14.12 .030 provides as follows:

> [illegible]
>
> [illegible]

The Plaintiff construes that statute as clearly authorizing and recognizing its role in adoption and enforcement of zoning regulations. This is particularly so in light of the definition of RCW 14.12.010, including "Airport hazard area", as follows:

> (3) "Airport hazard area" means any area of land or water upon which an airport hazard might be established if not prevented as provided in this chapter.

The Plaintiff further asserts that it has authority to provide for zoning in and around the Airport based on RCW 14.12.050, as follows:

> [illegible]
>
> [illegible]

> political subdivision, the more stringent limitation or requirement shall govern and prevail. (Emphasis added.)

The Plaintiff asserts that these statutes establish its zoning authority, even, in this case, over property actually involved in airport operations, with the "joint board" and "in the event of conflict" provisions, whereas the Defendant asserts that the joint zoning authority between the parties applies only to property not owned or used by the Defendant for airport or airport related purposes.

7.4 The parties further disagree on what is included within the meaning of "airport and air navigation facility", and what is meant by "operated and controlled by" a municipality, whether jointly or separately, relative to the language of RCW 14.08.330. Resolution of these questions is needed since there is a conflict in interpretations between the parties regarding the application of police jurisdictional responsibilities pursuant to Article XI sec. 11 of the Constitution of the State of Washington (for the Plaintiff), and RCW 14.08.120 and 14.08.330 (for the Defendant). This conflict is especially troublesome since the Plaintiff leases property from the Defendant that it uses for park purposes, over which both parties claim police jurisdiction. However, the issue also needs to be resolved as it applies to other property owned by the Defendant, but leased to other parties for commercial and industrial (or other) purposes. It is appropriate that these issues be resolved so that the police jurisdiction responsibilities can be consistently identified and appropriately divided.

VIII. PRAYER FOR RELIEF

Wherefore, the Plaintiff and the Defendant request that this Court enter a declaratory judgment which determines whether and to what extent the Defendant is exempt from regulatory authority of the Plaintiff, considering separately the application of such authority to (a) activities of the Defendant involving "Airport Operations", (b) activities of the Defendant not involving "Airport Operations" and (c) activities of entities other than the Defendant, in each of the following regulatory areas:

1. Zoning
2. Sensitive areas ordinance
3. Storm water control
4. SEPA
5. Impact fees and concurrency, and

6. Police jurisdiction.

The Court's ruling should clarify the respective authorities of the Plaintiff and the Defendant in each of these regulatory areas both inside and outside of property of the Defendant, and involving "Airport Operations", and not involving "Airport Operations", and what is meant by "airport and air navigation facility", and what is meant by "operated and controlled by", as those terms are used in RCW 14.08.330.

DATED this 19 day of May, 1995.

Daniel B. Held WSBA # 8217
Attorney for Plaintiff, City of SeaTac

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60 day notice is of violation of this.

BEFORE THE POLLUTION CONTROL HEARINGS BOARD
STATE OF WASHINGTON

MINNIE O. BRASHER, NORMANDY PARK COMMUNITY CLUB, and THE CITY OF DES MOINES, Appellants, v. STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY, AND PORT OF SEATTLE, Respondents.	No. 94-157 & 94-160 STIPULATED SETTLEMENT AGREEMENT AND AGREED ORDER OF DISMISSAL

IT IS HEREBY STIPULATED by and between Appellants, Minnie O. Brasher, Normandy Park Community Club, and The City of Des Moines, and by their attorney, Richard A. Smith, and the respondents, State of Washington, Department of Ecology, by its attorney, Ronald L. Lavigne, and the Port of Seattle and its attorneys, Ross A. Macfarlane and Lori A. Terry, that the above-entitled matters shall be dismissed with prejudice, based upon the following Stipulated Settlement Agreement.

STIPULATED SETTLEMENT AGREEMENT

1. The AKART determination required under Condition S5.A of the Port's NPDES Permit No. WA-002465-1 ("the permit"), shall be subject to public comment as provided below. Any final effluent limits, selection of technology and schedule for implementation will be accomplished through a permit modification and shall be subject to public comment. Additionally, the plant-level economic achievability test identified in the last paragraph of Condition S5.A shall be conducted and considered in a manner consistent with Washington State law governing AKART determinations.

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2. If the Department of Ecology determines the need for effluent limitations for any stormwater outfalls subject to this permit, the effluent limitations shall be established through permit modification procedures, which shall be subject to public comment.

3. The Port and appellants shall develop a public participation master plan. One of the components of this public participation master plan shall include setting up a Monitoring Team, including representatives designated by appellants. The Monitoring Team shall be established within twenty (20) days from the date of this Agreement. This Monitoring Team shall work with the Port in the following areas:

A. Representatives of the Monitoring Team designated by Appellants shall be allowed to observe and obtain split samples of monitoring required under the permit or the terms of this agreement. The Port shall discuss sampling protocols and procedures with the Monitoring Team and shall describe such protocols and procedures in writing to the Monitoring Team and shall provide written updates if necessary. The Port shall provide the Monitoring Team with such reasonable advance notification of a sampling event as is available under the circumstances. Appellants shall provide the Port with a roster of designated representatives and reasonable advance notice of monitoring participants (no more than three in number for each monitoring event) to assist the Port with necessary security arrangements. Appellants recognize that waiver of liability is required for entry onto non-public areas of Port property.

B. The Port will provide the Monitoring Team with a telephone number that will be available 24 hours a day to report any noted spills or other water quality problems during observations. Additionally, the Monitoring Team will provide the Port with the telephone number of a designated representative that can be called by the Port in the event of a spill or other event that would benefit from prompt response or other event having the potential to affect water quality in Miller or Des Moines Creeks for the purposes of identifying the event and any planned response measures.

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C. In a timely manner, the Port will provide to the appellants' representative copies of all public information, including all information submitted to regulatory agencies related to its NPDES permit, including but not limited to, all discharge monitoring reports, all sampling and monitoring data on the operation of the IWS, and all information regarding the management of the stormwater system.

D. The Monitoring Team shall work with the Port to identify improvements in stormwater sampling and monitoring, including increased sampling frequency where technically appropriate. The Port commits, at a minimum, to conduct two additional sampling events of permitted stormwater outfalls during 1995, pursuant to a sampling plan developed with the Monitoring Team.

4. The Port agrees that it will work with Ecology and the Monitoring Team to determine whether additional outfalls on 188th Street should be added to the permit. The Port agrees that if Ecology determines that these outfalls drain industrial areas on the Sea-Tac Airport, these outfalls will be added to the permit. Decision under this paragraph shall be made within 60 days from the date of this agreement.

5. The Port agrees to submit the Stormwater Pollution Prevention Plan by April 30, 1995, except planning for proposed capital improvements, which shall be completed by June 30, 1995. Additionally, the Port shall complete all non-capital BMP's required under Condition S10.A.2. by January 1, 1996.

6. The Port shall complete all measures required to implement the AKART determination required under Condition S5.A. no later than five (5) years from the date that Ecology modifies the permit pursuant to Section 1 to incorporate the AKART determination. This shall not preclude Ecology or the Port from establishing a shorter schedule for AKART implementation.

7. On or before January 31, 1995, the Port agrees to provide appellants' counsel with a copy of a final report from Kennedy-Jenks Consultants that analyzes and suggests interim measures

that can be implemented to improve the operation of the IWS. The appellants may provide comments on the report to the Port and the Port will implement all recommendations that will help the plant to operate at maximum efficiency and meet permit effluent limits. The Port shall respond in writing to all timely comments and, if it chooses not to implement all recommendations made by Kennedy-Jenks, shall state in writing to Ecology and the Monitoring Team why recommendations are not implemented.

8. The Port agrees to provide documentation to appellants' counsel confirming that cross-connections have already been eliminated. The Port agrees that remaining cross-connections will be eliminated and that the Port will provide documentation regarding the scheduling of future cross-connection elimination and documentation of the elimination of cross-connections as it occurs. The Port shall address elimination of cross-connections and conveyance of stormwater to stormwater outfalls that may be routed to the IWS in the Stormwater Pollution Prevention Plan required by Condition S10.

9. The Port agrees to provide to appellants' counsel documentation confirming that the "livestock quarantine area" is no longer used for livestock and that it will not be used for livestock. The Port also agrees to document whether there are any livestock or other animal quarantine areas at the airport, and, if so, where the wastewater is discharged to.

10. The Port commits to remain involved in the Basin Plans for Miller and Des Moines Creeks. In this regard, the Port has agreed to pay for 25% of the cost of stream gauge monitoring of Miller Creek. Concerning Des Moines Creek, the Port has estimated a budget of up to $150,000 for the Des Moines Creek Basin Plan and the "visioning process" that will examine the future of Des Moines Creek. This commitment is contingent upon an inter-local agreement, which is yet to be signed. This agreement does not, however, establish a precedent for any set percentage of contribution to future planning or mitigation activities.

11. Concerning Miller Creek, the Port agrees that it will work with the Monitoring Team to establish a short term monitoring plan and a menu of potential response options. After a monitoring plan has been developed, the Port will conduct weekly monitoring of the outfalls into the Miller Creek basin and the outfall from Lake Reba into Miller Creek for a period of four (4) months for the following parameters: glycol, BOD, TSS, flow, ammonia, and turbidity. The monitoring shall include a minimum of sixteen sampling events, and shall extend beyond 4 months if necessary to obtain stormwater samples. If after a total of four (4) months of monitoring, no water quality impacts are shown from the Port's permitted outfalls or the discharge from Lake Reba to Miller Creek, no additional monitoring or other action shall be required except as required under the permit. The Monitoring Team will review the monitoring data after the first two (2) months of monitoring and again after four (4) months of monitoring, and will discuss in good faith options to solve any identified water quality problems resulting from airport runoff. If the monitoring data shows no impacts from the Port's permitted outfalls or the discharge from Lake Reba to Miller Creek above applicable water quality standards, no further monitoring or actions will be required except as required under the permit. If the monitoring data shows adverse impacts above applicable water quality standards resulting from airport runoff, the Monitoring Team will evaluate short and long-term response options. The menu of options available to solve water quality problems shall be a non-exclusive list of potential solutions determined by the Monitoring Team during the first two month period of monitoring based on a technical discussion. The Port shall consult with Ecology to select options deemed appropriate and necessary to address identified water quality problems resulting from airport runoff based on cooperative discussions with the response team. Any short-term solutions must be consistent with appropriate long-term measures. Nothing in this paragraph shall be construed to prevent Ecology from taking action to address water quality problems in Miller Creek.

12. By June 15, 1995, the Port agrees that it will undertake one round of sediment sampling in Lake Reba similar to the sediment sampling that occurs in the IWS lagoons. The

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sampling shall be conducted based on a sampling program developed in consultation with the Monitoring Team and Ecology.

13. The Port agrees to send to appellants' counsel a copy of the Vehicle Washwater Study required under Condition S5.F of the permit.

14. The appellants, Minnie O. Brasher, Normandy Park Community Club, and the City of Des Moines each agree that they will not bring a citizen-suit action against the Port for any alleged violations of the Clean Water Act, occurring prior to this Agreement, which relates to or arises from NPDES permit WA-002465-1.

15. The Port shall comply with all requirements of this Stipulated Settlement Agreement within the time periods specified herein. However, if any circumstance arises that has caused or that will cause non-compliance with the requirements of this Agreement, the Port shall submit written notification to the plaintiffs no later than ten (10) days after the date the Port first concludes that such circumstance has caused or will cause non-compliance, describing in detail the length or anticipated length of the non-compliance, the precise circumstances causing non-compliance, and the measures taken or to be taken to prevent or minimize the non-compliance and the schedule for implementation of the measures to be taken.

Providing the Port has complied with this notice provision, then, in the event the Port fails to comply, or anticipates failing to comply with the requirements of this Agreement and the Port's non-compliance was caused by circumstances beyond the Port's control, which could not be overcome by due diligence, then the Port's failure to comply shall not constitute a violation of this Agreement. To the extent that non-compliance is caused by circumstances beyond the Port's control, which could not be overcome by due diligence, milestone dates set forth in this Agreement shall be adjusted to account for delay.

16. All parties to this agreement acknowledge that they have had the benefit of counsel in reviewing the terms of this Stipulated Settlement Agreement.

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17. This Stipulated Settlement Agreement contains the entire agreement between the parties. The parties are not relying upon any representation, warranty, or oral agreement that is not contained within the written terms of this Stipulated Settlement Agreement.

18. In consideration of this Stipulated Settlement Agreement, the appellants agree to dismiss with prejudice the above-entitled actions (PCHB Nos. 94-157 and 94-160). The permit shall be affirmed in all respects except as modified by this stipulation.

19. The parties stipulate that the Board shall retain jurisdiction for the purpose of enforcing the terms of this Stipulated Settlement Agreement.

DATED this ___ day of ___________, 1995.

Minnie O. Brasher

NORMANDY PARK COMMUNITY CLUB

By: Tom H. Mitchell
Its Authorized Director

CITY OF DES MOINES

By: ____________________
James Gorham
City Attorney for the City of Des Moines

____
Richard A. Smith
Attorney for Appellants
Minnie O. Brasher, Normandy Park Community Club and City of Des Moines

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WASHINGTON STATE ATTORNEY GENERAL

By: ____________________
Ronald L. Lavigne, WSBA # 18550
Assistant Attorney General
Attorney for Respondent
Department of Ecology

PORT OF SEATTLE

By: ____________________
Thomas A. Newlon
Senior Port Counsel

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By: ____________________
Ross A. Macfarlane, WSBA # 04863
Lori A. Terry, WSBA # 22006
Attorneys for Respondent
Port of Seattle

PRESTON GATES & ELLIS

TOTAL P.01

ORDER OF DISMISSAL

Having reviewed the foregoing Stipulated Settlement Agreement and the files and pleadings herein, and it appearing that the parties have reached agreement;

IT IS HEREBY ORDERED that the foregoing Stipulated Settlement Agreement is entered as an Order of this Board and that these cases (PCHB Nos. 94-157 and 94-160) are dismissed with prejudice.

DATED this ___ day of __________, 1995.

____
James A. Tupper, Jr.
Administrative Law Judge
Pollution Control Hearings Board

____
Robert V. Jensen, Chairman

____
Richard C. Kelley, Member

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STIPULATION AGREED TO AND PRESENTED BY:

PRESTON GATES & ELLIS

By______________________
Ross A. Macfarlane, WSBA # 14863
Lori A. Terry, WSBA # 22006
5000 Columbia Center
701 Fifth Avenue
Seattle, WA 98104
(206) 623-7580

Attorneys for Respondent
Port of Seattle

WASHINGTON STATE ATTORNEY GENERAL

By______________________
Ronald L. Lavigne, WSBA # 18550
Assistant Attorney General

Attorney for Respondent
Department of Ecology

STIPULATION AGREED TO AND NOTICE OF PRESENTMENT WAIVED:

____
Richard A. Smith

Attorney for Appellants
Minnie O. Brasher, Normandy Park
Community Club, and the City
of Des Moines

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IN THE SUPERIOR COURT OF THE STATE OF WASHINGTON FOR KING COUNTY

WILLIS W. KLUDT, et ux., et al., Plaintiffs

v.

KING COUNTY and STATE OF WASHINGTON HIGHWAY COMMISSION, Defendants.

NO. 726259

STIPULATION AND AGREEMENT FOR SETTLEMENT

WHEREAS, the parties hereto, Willis W. Kludt and Helen D. Kludt; William C. Hall and Beverly H. Hall, his wife Roy L. McCullough and Janis P. McCullough, his wife; Franklin H. Trunkey and Barbara L. Trunkey, his wife; Alva E. Wiseman and Evelyn H. Wiseman, his wife; and Harry E. Dennis and Jean H. Dennis, his wife; King County; and Washington State Highway Commission, desirous of settling the King County Superior Court action known as Kludt, et ux., et al. v. King County, et al., Cause No. 726259;

WHEREAS, the parties have reached agreement on the general direction and nature of future King County hydraulic planning and construction activity in the Miller Creek drainage basin;

WHEREAS, it is understood by all signatories that breach of the terms of this settlement may result in a refiling of the lawsuit;

WHEREAS, prior to and throughout the pendency of this proceeding, Miller Creek has been the subject of numerous

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studies, including the RIBCO Urban Run-off and Basin Drainage Study (1974) and the Sea-Tac Community's Plan (1974);

WHEREAS, King County currently is without sufficient capital construction funds to proceed with a hydraulic project in Miller Creek and therefore is unable to assign a commencement date to any proposed public works activities;

WHEREAS, the parties agree that this agreement is in settlement of the existing litigation and does not constitute an admission of liability by either defendant Washington State Highway Commission or defendant King County;

THEREFORE, in consideration of the promises exchanged herein, the parties agree as follows:

1. King County and the Washington State Highway Commission recognize that serious flooding and drainage problems have existed in Miller Creek drainage basin for a number of years, that such problems will increase in the future as development increases, and King County agrees that corrective programs and drainage facilities are required and should be implemented as promptly as possible.

2. King County Department of Public Works, Division of Hydraulics, pledges the use of $65,000.00 in remaining revenue sharing funds for further planning and design study in the Miller Creek basin. Said funds will be expended upon completion of the RIBCO Urban Run-off and Basin Drainage Study and the Sea-Tac Community's plan. The Division of Hydraulics anticipates that such further planning and design studies will take place during 1975.

3. King County agrees that it has abandoned the total channelization of Miller Creek and agrees that it will not in the future attempt the channelization of Miller Creek except in limited amounts in connection with retention facilities.

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4. Plaintiffs acknowledge and recognize there are numerous possible methods of maintaining the character and quality of Miller Creek and further recognize that there are other residents and property owners in the Miller Creek basin whose views as to project design and implementation will also be considered equally by King County. Plaintiffs also recognize that the King County Council will have final approval as to the design, location, scope and nature of any project in Miller Creek drainage basin. The Division of Hydraulics will, however, recommend to the King County Council and will use its best efforts to achieve the programs, concepts and agreements contained herein.

5. King County acknowledges the long term and sincere concern of numerous citizens in the Miller Creek basin in maintaining the quality and integrity of the creek and guarantees continued solicitation of citizen input in the final selection of a design solution.

6. King County's Surface Water Utility Board, created by Council Motion 1478, will present to the Council during October 1974 its report calling for the creation of a county-wide surface water utility pursuant to the terms of the County Services Act, RCW 36.94, and requesting initial funding of $1 million. The creation of such an utility requires comprehensive sub-basin planning of detailed surface water management solutions and would permit the levying and collecting of service charges within each sub-basin in which a solution is planned and initiated.

7. Upon completion of the planning and design studies for the Miller Creek basin as provided herein, the surface water utility will prepare a sewerage general plan for the Miller Creek basin. The surface water utility will use its best efforts to

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obtain approval of said plan by the King County Council, the requisite review committee and any other governmental agencies having authority or jurisdiction over the plan area.

8. Upon completion of the Miller Creek sewerage general plan, the surface water utility will proceed as soon as practicable with implementing the necessary financing so that work pursuant to the plan may be initiated. Without limitation of any appropriate method of financing, King County will impose the necessary charges on all property owners within the Miller Creek basin and will consider the levying of rates and charges based on impervious surface areas.

9. The Washington State Highway Department will recommend to the Washington State Highway Commission that the Washington State Highway Department pay any assessment levied by King County based upon the assessments levied upon other property owners in the Miller Creek basin in accordance with the impervious surface area of state highways (SR 509 and SR 518) owned by the Washington State Highway Department in the Miller Creek drainage basin as such drainage projects implemented by King County benefit those highway systems.

10. Upon approval of the sewerage general plan and obtaining the necessary financing, King County will proceed with the construction of appropriate facilities, as set forth in said plan which will:

a. improve the water quality of Miller Creek;

b. prevent surface water from being collected and discharged into Miller Creek in excess of its natural capacity;

c. maintain or improve the present character and appearance of Miller Creek.

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11. King County Division of Hydraulics will support the concept of regional holding ponds as a method of Miller Creek preservation and protection, and, further the Division of Hydraulics will analyze the proposed location of holding pond sites as presented in Fig. 7 of Sea-Tac Community's Plan, water quality analysis, for effectiveness and potential storage capacity.

12. King County Department of Public Works will maintain and operate any holding ponds which form part of a county operated regional drainage management system.

13. King County supports the concept of run-off rate control as the common approach to drainage planning and management, including the use of holding facilities and roof-top retention. The Division of Hydraulics will recommend to the Council passage of an appropriate ordinance to implement run-off rate controls of future development and construction.

14. King County will continue to require developers to provide temporary sedimentation collection facilities during construction to insure that sediment-laden water does not enter the natural drainage system.

15. King County and the state of Washington will explore and attempt to design, subject to technical considerations and as far as practical, future road construction projects in the Miller Creek drainage basin which will retard peak flow run-off from county and state roads and highways and properties, including the use of grass ditches, weirs, smaller pipes and culverts (where ditch retention is feasible) and other diversion and diffusion facilities.

16. King County will attempt to design and construct future public works, subject to technical considerations, and regulate private projects in the Miller Creek drainage basin so that such projects will not adversely affect the present character of Miller Creek or increase the quantity of water which flows into Miller Creek.

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17. In the event this agreement is not implemented, plaintiffs may refile said action, and defendants agree not to raise any defenses based on the statute of limitations.

18. Plaintiffs agree to dismiss the action above-captioned as to defendants King County and Washington State Highway Commission with each party to pay its own costs and attorneys' fees.

19. A schedule of planned implementation of this agreement shall be provided to plaintiffs within five days of the date of the agreement by King County and King County shall use its best efforts to follow said schedule and shall advise the plaintiffs concerning any possible changes in said schedule and reasons therefore.

DATED this ____ day of October, 1974.

CHRISTOPHER T. BAYLEY
Prosecuting Attorney

By ______________________
DIANE E. GRAY, Deputy

By ______________________
J. RICHARD QUIRK, Deputy
Attorneys for King County

____
WILLIAM E. BOLAND, Attorney for
Washington State Highway Commission

____
NORMAN WINN, Attorney for
Plaintiffs

On behalf of all plaintiffs

____
WILLIS W. KLUDT

____
HELEN D. KLUDT

CHRISTOPHER T. BAYLEY
Prosecuting Attorney
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THE FLIGHT PLAN PROJECT PHASE III

PUGET SOUND AIR TRANSPORTATION COMMITTEE

First Work Paper #11

Seattle-Tacoma International Airport With New Dependent Runway

In this alternative, a new 7,000-foot runway would be constructed 2,500 feet from Runway 16L-34R. This separation distance would allow dependent instrument approaches. For this alternative, additional property must be acquired between 9th and 12th Avenues South and between South 176th Street and State Route 518, to provide for construction of the new runway.

Land Acquisition is estimated to be 400 acres with 372 homes, 200 acres undeveloped and 100 acres of wetlands.

Airport access improvements include: Widen SR 518/Airport Freeway for four and one half miles and widen I-5 for two miles. Revise SR 518 interchanges at I-5 and the SR 509 and Airport Freeway interchange with SR 518. Pacific Highway South would be widened for three miles.

Arlington Municipal Airport With New Runway Extension

Under this alternative, the north-south runway at Arlington Municipal Airport would be lengthened 1,670 feet at the north end to a total of 7,000 feet. The general aviation area on the east side of the airport would remain. A new passenger terminal would be constructed between the two runways. Long-term parking could be provided at the west side of the airport and air cargo, maintenance, and support activities can be accommodated south of Runway 11-29. New parallel taxiways would be constructed for each runway to serve future aviation needs.

Land Acquisition is estimated to be 100 acres with 20 homes on 60 acres and 35 acres with industrial potential.

Airport access improvements include the widening of I-5 for three miles, a new access road from I-5 (1.5 miles) and a new interchange at I-5.

Arlington Municipal Airport With New Runway

A new 7,000 foot long parallel north-south runway would be constructed west of the existing north-south runway. Additionally, the present north-south runway would be extended 1,670 feet to 7,000 feet. Additional property would be acquired on the north, east, and south sides of the airport to accommodate the required expansion. The passenger terminal would be located at midfield between the parallel runways on the east side of the airport. Air cargo and maintenance activities could be located at the northeast corner of the airport. Support functions could be accommodated at the south end of the airport.