U.S. Department of Transportation
Federal Aviation Administration

Northwest Mountain Region
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Oregon, Utah, Washington,
Wyoming

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September 19, 2001

Mr. Thomas F. Mueller
U.S. Army Corps of Engineers
Regulatory Branch, Seattle District Office
P.O. Box 3755
Seattle, WA 98124-3766

Dear Mr. Mueller:

Per your August 15, 2001, letter requesting a response to the question of how the operational data available today compares to the model predictions from SIMMOD, we are providing the attached paper.

If you have any further questions, please contact our office.

Sincerely,

Lowell H. Johnson
Manager, Airports Division
Northwest Mountain Region

Enclosure

9/19/2001

DELAY AT SEATTLE-TACOMA INTERNATIONAL AIRPORT (SEA)

The purpose of this paper is to address the question raised in the August 15, 2001 letter from Mr. Thomas Mueller, US Army Corps of Engineers:

> *Based on the operations data available today, how does this data compare to the model predictions from SIMMOD?*

The following sections summarize how delay was first recognized at SEA, the use of models to evaluate delay conditions, and finally, a comparison of various delay metrics used to measure actual delay.

I. Conditions Leading the Region to Show the Need for the Runway (Pre-1995)

The evolution of how the Port, FAA, and Puget Sound Region first began to identify the need for a third parallel runway at SEA goes back to the consequences of deregulation of the aviation industry. By 1984, 26 carriers served SEA, an increase from 12 carriers prior to airline deregulation in 1979. In 1985, Horizon Airlines began service to smaller cities with small aircraft service; as a result, aircraft operations at SEA grew at an unprecedented rate through 1990.

The inability of existing airfield facilities to accommodate traffic into the 21st century was first recognized in the mid-1980s when the Port completed the Comprehensive Planning Review & Airspace Update Study. The purpose of the Study was to assess the validity of previous plans developed for SEA in light of air travel growth and other changing conditions at the Airport. While previous plans had not indicated a need for a new runway, the Comprehensive Planning Review & Airspace Update Study showed that the existing two-runway system would not be capable of serving projected increases in air travel demand through the planning period.

II. Predictions of Delay Prepared for the Capacity Enhancement Plan/Master Plan Update

In 1994, the FAA initiated a Capacity Enhancement Plan to evaluate the range of options available to improve the poor weather operating capability of SEA. These data and conclusions were used in the master planning effort that was ongoing at the time of the capacity study.

The FAA's Airport and Airspace Simulation Model (SIMMOD) was utilized to evaluate both existing and future delay conditions. This model is an internationally recognized industry standard used in modeling airport and airspace operations in order to evaluate delay at busy air carrier airports. It is a fast-time simulation model that simulates operational aspects of the airport terminal airspace and airfield environment. The model traces the movements of individual aircraft throughout an airport/airspace system, while reflecting separation standards and operational procedures.

The model was calibrated for this effort against field data collected at SEA to ensure the model was site specific. The experiments were performed for a 24-hour period for each pertinent weather condition. A ten-year weather history for SEA was obtained from the National Weather Service station, located at SEA, for the period of January 1, 1982 through March 31, 1992.

As occurs in all Capacity Enhancement Planning Studies, the process begins with collecting operational data specific to the airport under study, such as SEA Airport. This includes: aircraft flight schedules and fleet mix, weather conditions, runway orientation and taxiway configuration, air traffic procedures (aircraft approach speeds, acceptance rates, separation requirements, etc.), navigational aides, and aircraft performance characteristics. As mentioned above, modelers conduct actual observations at the airport to see how the model reacts to actual conditions. During the "calibration", when deviations occur, the model parameters are refined until the model correlates with observed results. Next, the design team develops various experiments reflecting various airport layouts, and operational and activity scenarios. The simulations are run and the results are input into an annual delay model. The model calculates the annual delay for each experiment and activity level, using the percentage of time each weather condition occurs over a 10-year period. The potential delay reduction for each improvement is computed by taking the difference in annual delays between the improvement and the base case (do-nothing).

The results at SEA were determined to be valid, based on several factors:

- modelers were experienced in using the model at numerous airports across the country,
- the results compared favorably with site-specific observations at SEA, and
- the model reacted appropriately to varied inputs and produced reasonable results.

In order to capture delay savings, the simulation uses increasing demand levels and a full schedule for all-weather conditions. The total delay savings are based upon no cancellations or deviations from the scheduled flights, even during poor weather. This is done so that costs associated with flights experiencing high delay can be captured, yielding a cost associated with flights that would be cancelled in real life. A summary of the average arrival delay for the predominant weather resulting from the SIMMOD model effort is as follows:

Table 1
Summary of SIMMOD Results
(For Predominant Weather)

Existing Runway System Arrival Delay (average minutes per operation)			
Annual Operations	**Good Weather (VFR1)**	**VFR2**	**IFR1**
345,000	1.0	11.4	21.7
425,000	1.6	41.8	71.2
525,000	3.1	163.6	181.3

With Proposed Third Runway Arrival Delay (average minutes per operation)			
Annual Operations	**Good Weather (VFR1)**	**VFR2**	**IFR1**
345,000	1.0	1.7	1.9
425,000	1.6	2.6	3.1
525,000	2.1	7.3	10.1

III. Actual Delay Conditions since the Final Supplemental EIS

No additional simulations have been prepared for SEA Airport since the completion of the 1995 Capacity Enhancement Plan. However, several forms of delay data are available that have been reviewed by the FAA and the Port. Depending on the original intended use of the information, each of the sources has strengths and weaknesses in their ability to track delay at airports. Sources of such data include:

- **Operations Network (OpsNet)** – This data is collected by the FAA's Air Traffic Service for the purpose of monitoring and managing Air Traffic Control resources. OpsNet is designed to measure delay during each segment of flight, including the aircraft's arrival, departure, and passage through each Air Route Traffic Control Center (ARTCC). An aircraft is counted as delayed if it experiences a delay of 15 minutes or more in one segment. Thus, an aircraft could be delayed up to 14 minutes for several segments of the flight and not be counted as "delayed."

  The strength of OpsNet in tracking delay at airports lies in its assignment of cause to each delay. OpsNet data for 2000 indicates that 97% of the delay at SEA was attributed to weather. The next largest cause of delay events at SEA was due to closed runways or taxiways due to construction (1.4%). This weather trend can also be seen in the SIMMOD effort.

- **Benchmarking Report 2001**- In the spring of 2001, the FAA published a benchmarking report, which serves as a reference point on the state of the airport system at a specific time. The report provides a starting point for public policy discussions by providing a snap shot of the current and future state of major airport capacity using a simplified methodology that was applied consistently for the major airports in the country. The benchmark rates assume there were no site-specific airspace constraints in the terminal area; doesn't consider some cargo, non-scheduled flights, general aviation, and military operations; and is based on the best rates achievable for only two weather conditions for every airport. The report notes that these rates can be exceeded occasionally and lower rates can be expected under adverse conditions. Given these assumptions, the numbers for SEA are reasonably consistent with other information sources; however, "they are not a substitute for the more detailed analysis that should precede major investment and policy decisions".[1]

  With respect to delay, the report states that 1% of the operations at SEA are delayed more than 15 minutes. This percentage was calculated by taking OpsNet data and dividing it by the total number of current operations. The OpsNet data, as noted above, is not designed to accurately capture all delay associated with an airport. This percentage should not be confused with the results of the detailed analysis performed in the capacity study using SIMMOD.

- **Airline Service Quality Performance (ASQP)** - This data is collected by the U.S. Department of Transportation Office of Aviation Enforcement and Proceedings and published in a report titled *Air Travel Consumer Report*. This system was specifically designed to provide the traveling public with information about the on-time performance of specific airlines, airports, flights and routes that were known to consistently perform poorly.

  Unlike OpsNet, it considers an entire flight in determining delay. It defines a flight as delayed if it arrives 15 minutes or more late as compared to its published schedule. As such, it is more reflective of the actual delay events occurring in the system. However, the system does not account for airlines incorporating anticipated delay into their schedules, attribute the delay event to a cause, or track delay less than 15 minutes. In addition, only 10 of the largest U.S. airlines are required to report to the system. Therefore, it omits Horizon Airlines and United Express, which collectively represent 49% of the flights at SEA. Even with these omissions, ASQP showed SEA as the most delayed airport in the country for May of 2001. For the entire year 2000, SEA ranked 7th worst in the country behind La Guardia, San Francisco, O'Hare, Boston, Los Angeles, and Philadelphia International airports.

[1] FAA's Airport Capacity Benchmark Report 2001

Although the ranking of an airport is not particularly useful for planning of infrastructure, the data demonstrates that compared to the rest of the nation, delay at SEA is relatively severe and that it is getting worse as activity grows. This is consistent with the findings of the Capacity Enhancement Plan modeling effort.

- **Consolidated Operations and Delay Analysis System (CODAS)** - CODAS was an early attempt by the FAA's Office of System Capacity to make available consolidated sources of information in reflecting delay in the current aviation system.

  CODAS reported that average arrival delay at SEA reached 13.5 minutes during fiscal year 2000, when cancelled flights were not counted as delayed. In comparison, the SIMMOD delay curve, with all activity at SEA, and with a decade of average weather, predicted about 15-17 minutes of arrival delay in 2000. Given the differing assumptions and applications of the two information sources, these numbers are considered reasonably consistent with each other.

  Shortcomings of CODAS include its primary reliance on ASQP data and its failure to identify the cause of delay, and its use of assumptions about airline schedules that does not reflect reduced weather conditions. In addition, it makes assumptions about published airline schedules and airport operational factors such as using minimum taxi time, etc. Despite this CODAS was considered a step in the right direction.

- **Aviation System Performance Metrics (ASPM)** - ASPM is, in effect, an upgrade of CODAS and will eventually replace it. It incorporates refinements of assumptions and utilizes additional sources of information such as airline electronic flight data. This data includes actual times for departing the gate, taxi time, take offs, airborne, arrivals, etc. It also utilizes the DOT on-time performance and other statistical estimates. The system has not yet been validated and, as with CODAS, no attempt has been made to identify the causes of delays.

  ASPM data for calendar year 2000 indicates an average arrival delay of 13.10 minutes beyond the schedule for each operation at SEA. For delayed flights of greater than 15 minutes, the average delay is 45.44 minutes per operation. For IFR weather, the average delay was 15.13 minutes and in good weather the average delay was 12 minutes. More recently, ASPM showed a good weather day (August 9, 2001) with an average arrival delay of 8.73 minutes. In contrast, for a slightly reduced visibility (VFR2) day (July 23, 2001) the average arrival delay was 17.71 minutes.

  ASPMs 24-hour turnaround of information has also allowed for qualitative observation of next to real time information to corroborate delay performance. In good weather, on-time arrival performance typically runs at the 80-90% level. In reduced weather, on-time performance is consistently at the 60-70% level. For example, the on-time arrival performance reported by ASPM for the dates above were 81% for August 9th and 65% on July 23rd. Once again, with the differing assumptions between ASPM and CODAS and between CODAS and SIMMOD, the reported numbers are consistent with each other.

In conclusion, future condition results produced by a simulation model will never match completely with actual delay data as produced by various metrics described above. Reasons for these differences are many:

- modeled conditions are predicting a future outcome based on input data using averages,
- actual conditions rarely match the average condition,
- a full schedule is simulated in IFR weather to capture the associated cost to flights experiencing high delay (in reality, many flights are cancelled, diverted or held in severe weather delay conditions).

Conclusion. Despite these differences, as noted above, the delay levels determined by CODAS and ASPM are reasonably close to the level predicted by SIMMOD. It is also important to note that the current activity level is beyond the knee of the delay curve, where delays can be expected to increase significantly with relatively small increases in activity.