**AIR QUALITY CRITERIA POLLUTANT EMISSIONS INVENTORY**

**TASK 2.8**

**WORKING PAPER – DOCUMENTATION OF ASSUMPTIONS**

The emissions inventory was developed for Seattle-Tacoma International Airport (the Airport) sources using the FAA’s EDMS Version 5.1.4.1. The purpose of the inventory was to identify existing conditions emissions of criteria pollutants as part of the Sustainable Airport Master Plan (SAMP) and to serve as a baseline for considering various strategies to achieve the Port of Seattle’s air quality goals and objective. EDMS was used, as at the time the study began, it was the FAA’s state-of-the-art emissions model and is required when assessing aviation emission sources at Airports.[[1]](#footnote-1) It recognized by the U.S. Environmental Protection Agency (USEPA) as the preferred tool for modeling aircraft emissions.

EDMS was used to estimate emissions from non‐road mobile sources, such as, aircraft engines, auxiliary power units, ground support equipment, ground access vehicles, training fires, and stationary sources, such as generators, commercial kitchens, cooling towers, boilers, and bulk liquid storage tanks. For this evaluation, detailed airport activity characteristics were collected to model each of these sources. Relative to what is typically the dominant airport source (aircraft), data was collected and incorporated into EDMS details on types of aircraft, engine combinations, number of landing and takeoffs (LTOs), and the operating time in each of the LTOs modes (takeoff, climbout, taxi-idle, startup, and approach).

The purpose of this paper is to supplement the Protocol document that was prepared before the analysis was initiated, but documenting the assumptions that produced the results to be used as the existing conditions in the SAMP.

# Methodology

LeighFisher (LFA) collected data concerning each of the airport sources for inclusion in the EDMS model. This data reflects the sources of emissions and the general activity associated with those sources (such as number of sources, engines, fuel types, and run times). EDMS has an internal database of emission factors for Airport pollutant sources for most criteria air pollutants. These emission factors are typically in units of mass per unit of time or distance (e.g., grams/ second, or grams/mile). The EDMS database of emission factors reflects differences in emissions based on fuel type, fuel burn, engine power load, manufacture year, and manufacturer, among many other characteristics.

These emission factors are used by EDMS to calculate a total estimated emission inventory for a specified time period by multiplying the emission factor for the particular source, by the operating time, distance traveled, or number of events input by the user. The result is the estimated total emissions for each source group and ultimately total estimated emissions for the study period.

Airport‐specific information, such as latitude and longitude coordinates of the official Airport Reference Point (ARP) and elevation of the ARP above sea level are provided within the EDMS structure for each of the National Plan of Integrated Airport (NPIAS) airports. All other Airport‐specific information must be collected and manually entered into the program. EDMS, however, includes default information for some conditions. Where default data was used in this analysis, it is noted.

To estimate emissions from aircraft sources, a series of data inputs is needed, which include number of aircraft operations, aircraft operations by fleet mix, aircraft engine type equipage, and aircraft operating times.

Standard weather data includes mixing height and temperature as discussed below.

***Mixing Height***

The mixing height is the height of vertical mixing of the atmosphere and particles above the ground. Warm air at the surface of the Earth rises at a given rate. As long as the air is warmer than the ambient temperature, it will continue to rise. However, once the air cools, it slows down and eventually stops rising. It is at this junction that determines the mixing height.  The default mixing height value in EDMS of 3,000 feet was used.

***Temperature***

Daily averages of the maximum, minimum, and mean temperatures for the annual and ozone season are the standard weather inputs for EDMS. Temperature data provided by the National Climate Data Center (NCDC), a division of National Oceanic and Atmospheric Administration were used as the EDMS temperature inputs for the emissions inventory. NCDC Climate “Normals” data were collected in 30-year increments. The period of 1981 to 2010 was used in EDMS model. The annual daily temperature was determined to be 52 degrees Fahrenheit (°F) with an average daily high temperature of 63.25 °F and an average daily low temperature of 41.65 °F.

# Emission Sources

Emissions at the Airport were modeled for the following sources:

1. Aircraft Engines
2. Auxiliary Power Units (APUs)
3. Ground Support Equipment (GSE) including the Port’s fleet vehicles
4. Stationary Sources
5. Parking Traffic
6. Roadway Traffic

It is important to note that fire training is not conducted at Sea-Tac Airport, and thus, no fire training emissions are reported.

## Aircraft Engines

Emissions from aircraft engines are related to the combustion of aircraft fuel. The emissions from the aircraft engines vary depending on the number of aircraft operations, aircraft type, engine type, and operating time in each of the modes of operation.

LFA used the following sources to obtain data on aircraft operations:

* **FAA Traffic Control Tower records** (providing total aircraft operations by FAA categories of activity).
* **Port of Seattle Airport Statistics** (<https://www.portseattle.org/About/Publications/Statistics/Airport-Statistics/Pages/default.aspx> providing total annual aircraft operations).
* **The Official Airline Guide (OAG)** – providing scheduled air carrier activity by company, time of day, and general aircraft type (LFA has a subscription to electronic form)
* **The Port of Seattle’s Aircraft Noise & Monitoring System records** (ANOMS): provided by the Port’s noise office, this data was for the period January 1, 2014 to December 31, 2014. The data contained information about each flight, time of day, airline, and aircraft.
* **FAA Aviation System Performance Metrics (ASPM)**: providing total aircraft operations by month and taxi-idle-delay time. (electronic form: <https://aspm.faa.gov/apm/sys>/ )
* **JP Airline Fleets International** (JP Fleets), 2013-14 Edition: LFA maintains a subscription to this publication which identifies the fleet of each airline and the engines used by that company.
* For aircraft types that are not documented in JP Airline Fleet, LFA used the following sources to identify the type of aircraft and engines associated with that aircraft:
	+ ***Jane’s All the World’s Aircraft*** annual publication: LFA maintains a subscription to Jane’s.
	+ ***Jane’s Encyclopedia of Aviation***, 2011-2012 Edition
	+ **FAA Registry** (<http://registry.faa.gov/aircraftinquiry/>): From the ANOMS, if aircraft were identified by the N number, and a specific engine not known, the FAA database was consulted to determine if it provided additional insight about the aircraft.

Total annual aircraft operations were obtained from the Port of Seattle Airport Statistics for 2014, which were verified by FAA’s ASPM data. The records provide a breakdown of operations into the following categories:

* **Air Carrier**: An aircraft with seating capacity of more than 60 seats or a maximum payload capacity of more than 18,000 pounds carry passengers or cargo for hire or compensation
* **Air Taxi**: An aircraft designed to have a maximum seating capacity of 60 seats or less or a maximum payload capacity of 18,000 pounds or less carrying passengers or cargo for hire or compensation
* **General Aviation (GA)**: Takeoffs and landings of all civil aircraft, except those classified as air carriers or air taxis.
* Military

**Table 2‑1** lists the annual aircraft operations data reported by the Port of Seattle by category of operation.

Table 2‑1

**NUMBER OF OPERATIONS BY TYPE**

|  |  |  |
| --- | --- | --- |
| **OPERATION TYPE** | **2014 OPERATIONS** | **% of Annual** |
| Air Carrier |  325,425  | 95.6% |
| Air Taxi |  10,813  | 3.2% |
| General Aviation |  4,113  | 1.2% |
| Military |  127  | <0.1% |
| **Total 2014 Operations** |  **340,478** | **100%** |
| *Source: Port of Seattle, Sea-Tac International Airport Passenger, Cargo and Operations Summary for December 2014 Note: percentages may not add due to rounding.*[*https://www.portseattle.org/About/Publications/Statistics/Airport-Statistics/Pages/default.aspx*](https://www.portseattle.org/About/Publications/Statistics/Airport-Statistics/Pages/default.aspx) *(see December 2014 report for year to date 2014)* |

### Aircraft Operation Types

Once the total number of aircraft operations were identified, LFA assigned the operations according to the aircraft fleet mix, an understanding of the various categories of activity can improve the assignment of fleet mix. From the data in **Table 2‑1**, it was not possible to identify All-Cargo operations. Therefore, other sources of that data were to separately capture that activity and associated fleet mix. Therefore, the activity was then categorized by the following: (1) Commercial, (2) Cargo, (3) GA, and (4) Military.

To determine the number of Commercial and Cargo aircraft operations, the Port of Seattle statistics reports of annual aircraft landings for 2014 were used to determine the percent of Commercial landings versus All-Cargo landings for 2014. Using Port data, it was determined that 98.5% of aircraft landings were commercial aircraft operations, and 1.5% were all-cargo aircraft operations. Commercial and All-cargo aircraft operations include both Air Carrier and Air Taxi operations. The sum of Air Carrier and Air Taxi operations (336,238 operations, from **Table 2‑2)** were multiplied by the respective percent of aircraft landings to determine annual Commercial and Aircraft operations.

Table 2‑2

**Number of Landings by Operator Type**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Type** | **number of Operators** | **number of Landings** | **percent of Landings** | **Total Operations** |
| Commercial |  39  |  164,003  | 98.5% |  331,301  |
| All-Cargo |  17  |  2,444  | 1.5% |  4,937  |
| **Total** |  **166,447**  |  |  **336,238**  |
| *Source: Port of Seattle, Sea-Tac International Airport Passenger, Cargo, and Operations Summary for December 2014, and LeighFisher, 2016. (total landing by airline) May not add due to rounding* |

Commercial LTOs were calculated by multiplying “Total Operations” numbers by the fleet mix data provided by ANOMS. The calculated fleet mix for each operation type is provided in **Table A1-2**. Commercial aircraft LTOs and Remain-Over-Night operations (RONs) that were used as EDMS inputs are shown in **Table A2-1**.

Cargo aircraft LTOs were organized by aircraft type and by count of cargo operations, as provided by ANOMS data to generate a fleet mix. The aircraft LTOs were calculated by multiplying the count of operations by the calculated fleet mix for each aircraft type. The calculated cargo aircraft fleet mix is provided in **Table A1-3.** Cargo aircraft LTOs that were used as EDMS inputs are shown in **Table A2-2.**

The annual LTOs for GA operations were organized by aircraft type and by count of GA operations, as provided by ANOMS to generate a fleet mix. The aircraft LTOs were calculated by multiplying the count of operations by the calculated fleet mix for each aircraft type. The calculated cargo aircraft fleet mix is provided in **Table A1-4.** GA aircraft LTOs that were used as EDMS inputs are shown in **Table A2-2**.

The annual LTOs for Military Aircraft operations were generated in the same fashion as General Aviation and Cargo aircraft LTOs were generated. There was only one operation type for Military aircraft operations. Thus, a fleet mix was not calculated. The EDMS inputs are shown in **Table A2-3.**

### Fleet Mix

Once the annual number of aircraft operations by operation types was identified, the next step was to identify the aircraft type or fleet mix associated with those aircraft operations. The Port’s ANOMS data was used as it identifies the aircraft type using a three letter code (i.e., 739 for Boeing 737-900). The ANOMS system obtains its data from the FAA’s Air Traffic Control System which obtains such information from the aircraft transponder, which is used to control activity arriving to and from the Airport, and thus, is viewed as having the greatest accuracy.

LFA conducted a spot check of the ANOMS data using the OAG to verify the ANOMS data was an accurate representation by comparing the air carrier and air taxi operations. As shown in **Table A1-1**, the similar fleet mixes from the OAG and ANOMs databases provide confidence in the ANOMS data. The LFA Team decided to use the ANOMS data for the fleet mix as it contains GA and Military operations, whereas OAG does not is OAG data is limited to scheduled operations.

**Table A1-3** shows the full commercial aircraft fleet mix. The GA and Military aircraft fleet mix was determined by matching ANOMS data with *Jane’s Encyclopedia of Aviation (2011-2012 Edition)* to determine aircraft types that operate at the Airport. This is necessary, as for the smaller and slower performing aircraft, the transponder data/FAA Radar data captured by the ANOMS system uses broader categories of aircraft, rather than specific aircraft.

Aircraft operations were also categorized by airline, and then by aircraft types using ANOMS data to provide a more detailed and tailored fleet mix to the commercial airlines.

Summary of steps: the following steps were taken to identify aircraft operations by aircraft fleet mix:

1. Obtain number of operations by operation category: Air Carrier, Air Taxi, General Aviation, and Military (Table 2-1) (Data from Port’s activity statistics page for year end 2014)
2. Downloaded each month activity statistics from the Port “Landings by Airline by Aircraft” and summarized those landings by all-cargo operators (FedEx, BX, CargoLux, etc) in order to identify the cargo operations. From this annual summary, LFA identifying a number of landings as a percentage of total landings for cargo so that these aircraft types could be identified. See spreadsheet SEA\_2014\_Total\_Operations.xls which was used to produce Table 2-2.
3. The commercial aircraft fleet mix was determined by multiplying the Commercial “Total Operations” number in Table 2-2 with the % fleet mix from Table A1-2 (ANOMS fleet mix “% of fleet”).
4. Because APU use differs for aircraft assigned to a gate versus a remain overnight (RON) position, commercial aircraft that would use a RON were identified. RON use was estimated per carrier based on spreadsheet (SEA\_2014\_PCAirData.xls). This distribution of operations is shown in Table A2-1.
5. The Cargo aircraft fleet mix was calculated by multiplying the Cargo “Total Operations” number in Table 2-2 with the ANOMS fleet mix.
6. The General Aviation Fleet and Military mix was calculated by multiplying the number of GA operations by the ANOMS fleet mix for GA operations.

### Aircraft Engine Types

To assign engine types to each operation, LFA used the 2013‐2014 edition of JP Fleets, which contains engine type information for each airline, air taxi, large non‐commercial government, and corporate operator. If an aircraft category/airline/aircraft type operating at the Airport is found to have more than one engine type match in JP Fleets, the LFA Team assigned an engine type based on the proportional distribution of known engine types for that aircraft category/airline/aircraft type operating at the Airport.

For example, as shown in **Table A1-3** for an American Airlines (AA) flight with a Boeing 737-900, the data from JP Fleets indicate that there are two engine types used approximately 50% of the time: CFM CFM56-7B24 and CFM CFM56-7B27. The ANOMS data indicates that this flight represents 12% of the fleet. Thus, it is considered that there is one AA operation type with a Boeing 737-900 and a CFM CFM56-7B24 engine representing 6% of the fleet (half of the 12%), and another AA operation type with a Boeing 737-900 and a CFM CFM56-7B27 representing 6% of the fleet.

### Aircraft Operating Times

**Figure 1** below illustrates the modes of the LTO Cycle. There are six phases of the aircraft landing‐takeoff (LTO) cycle that can be classified as either ground mode or the airborne mode. The ground mode includes taxi‐in, taxi‐out, and startup. The airborne mode includes takeoff, climb out, and approach.



**Figure 1 - Illustration of the LTO Cycle**

#### EDMS default times were used for: takeoff, climbout, approach, and startup. For Taxi-Idle-delay, data from the ASPM was used for 2014. Whereas the default data in EDMS is 26 minutes (taxi-in/out combined), the ASPM data for Sea-Tac showed: 21.51 minutes as taxi-in and out.[[2]](#footnote-2)

## Auxiliary Power Units

Emissions generated by auxiliary power units (APUs) occur when an aircraft is taxiing from the runway and/or parked: (1) at the gate, (2) at a cargo ramp, and (3) at a maintenance ramp or hangar. To acquire the most accurate information for use in estimating aircraft APU emissions, LFA collected data from the Port on the availability of electric ground power units (GPUs) and pre‐conditioned air (PCA) units at each of the Passenger gates. All Passenger gates at the Airport have available ground power and PCA, and thus are not required to use APUs during the substantial portion of their time at the gate.

Because of this variability, APU usage times were determined by airline-specific factors, using data collected by Port staff. The Port data resulted in the following APU use times:

1. *Alaska Airlines, Horizon Air, Southwest Airlines, United Airlines:* APUs are used 7 minutes per operation, or 3.5 minutes per arrival or departure.
2. *Delta Airlines, U.S. Airways, Virgin America, JetBlue Airways, EVA Air:* APUs are used for 50% of OAG-scheduled gate occupancy time.
3. *All other airlines not indicated above:* APUs are used for 100% of the OAG-schedule gate occupancy time (i.e., APUs are never turned off as aircraft are not connected to ground power and PCA units).

To determine actual gate occupancy times, LFA used proprietary software for flight linking based on OAG schedules, which provides substantially more accurate gate use time values than EDMS default values. These APU usage times were assumed to apply to RON operations.

The default EDMS APU type for each Commercial and Cargo aircraft type were used and *Jane’s All the World’s Aircraft* will be used as a cross reference to verify if there are any aircraft with no APU features.

GA and Military aircrafts typically do not occupy passenger gates, but the aircrafts may be equipped with APUs. Because default EDMS APU assignments are not available for the GA and Military aircraft types, the APU with the lowest horsepower rating was selected. For GA and Military aircrafts, the GTCP 36-100 and the GTCP 85 (200 HP) APUs were selected, respectively. EDMS default APU operating times of 90 minutes per operation were used.

The list of APU usage times for Commercial, Cargo, General Aviation and Military operations are given in **Tables A2-4 through A2-7** respectively.

## Ground Support Equipment

Ground support equipment (GSE) encompasses all equipment that is needed to service aircraft and the airport on the ground during a normal turn‐ around and generally includes the following primary types of equipment:

* **Baggage Tractors** transfer passenger baggage and some cargo to/from gates. The baggage tractor is the most recognizable type of GSE at an airport. These vehicles are used totransport luggage, mail, and cargo between an aircraft and the airport terminal and/or processing/sortingfacilities.
* **Belt Loaders** load and unload baggage and cargo into/from an aircraft.
* **Provision Trucks**, or catering trucks, are used todeliver food, drinks, and other supplies to aircraft while onthe ground. These trucks tend to be powered by largediesel engines and have lifts in the back to move thestorage compartment to the height of the aircraft. Thesetrucks are also usually owned by airlines and/or flight kitchens.
* **Pushback Tractors** maneuver aircraftaway from (i.e., out of) gates. Although an aircraft’s engines arecapable of moving an aircraft in reverse, this is not typicallydone for aircraft with jet engines due to the resulting “jetblast” that would occur on the ramp.
* **Deicer Trucks** spray hot liquid onto aircraft in inclement weather to remove ice buildup andprevent future accumulation of ice. These trucks typicallyhave: (1) an engine on the front that is used to move thetruck and run pumps and lifts, and (2) a rear engine thatheats the deicing liquid. Deicing trucks typically carry a2,000-gallon tank of deicing liquid, and a 100- to 110-gallondiesel fuel tank to run for an eight to 10 hour shift.
* **Lavatory Trucks** and motorized carts are used by airlines to remove restroom waste from aircraft.

It is important to note that this emissions inventory does not list GSE that operate on electric power, as electric GSE are considered to have no criteria pollutant emissions.

**Table A2-8** lists the GSE assumptions used in EDMS including GSE type, fuel type, year (age) and population units. The EDMS default values for GSE annual operating times, load factors, and engine horsepower ratings were used.

### Modeling Approach

EDMS offers two methods for estimation of GSE emissions, (1) an activity-based method, or (2) a population-based method. With the activity-based method, the model assigns levels of GSE activity per aircraft operation for each aircraft specified in the model. This approach quantifies emissions based on the number of aircraft operations and the GSE typical for each aircraft. In the population-based method, an inventory of equipment is developed and linked with annual hours of usage to calculate an emissions inventory from hourly emissions factors. A population-based method, which provides for a more rigorous and accurate approach to estimating GSE emissions, was used for estimating all GSE at the Airport.

For Port owned GSE which service the airport (also called fleet vehicles), the inventory was provided by Port staff. For non-Port owned GSE, the inventory was provided using data from the Airport Cooperative Research Program (ACRP) field survey in 2012.[[3]](#footnote-3) If any parameter data such as age or fuel type was unavailable, the average or most common parameter was used. If operating data was not available, either EDMS defaults or professional assumptions based on airline industry standards were used.

### Modeling Parameters

The following are parameters used as inputs to model GSE-related emissions:

* **Age** refers to the number of years the GSE has been in use since the year it was manufactured. Documenting the age of the GSE is important because, as the equipment gets older, the engine can degrade and emit more pollutants. Stricter emission standards over the years have greatly reduced emissions and older equipment was typically manufactured under less stringent emission standards. Additionally, older vehicles are not equipped with up-to-date emission control technologies. If the age of the equipment was unknown, the default EDMS value was used which employs a distribution of ages based on national usage patterns.
* **Horsepower** refers to the power rating of the engine. Generally, as the horsepower increases, the amount of emissions increases. The EDMS default value was used.
* **Average Vehicle Speed** for GSE modeled as on-road vehicles were assigned the default average speed of 10 mph. No off-road GSE were modeled in this inventory.
* **Load Factor**, given as a percentage, refers to the time-weighted average of engine use relative to full power. The EDMS default value was used.
* **Operating Time** refers to the annual utilization time or mileage of the equipment. The EDMS default values were used or the values were derived from known operational data.
* **Fuel Type**: refers to the type of fuel used to operate the equipment. Virtually all GSE are powered by gasoline, diesel, or electric. As noted, emissions from electric-powered GSE were not included in this emissions inventory.

## Stationary Sources

On‐Airport stationary sources of emissions included in this emissions inventory are:

* Generators
* Boilers

These stationary sources are a small percentage of the overall Airport emissions inventory and are unlikely to change significantly from year‐to‐year. The Port provided run-time hours, horsepower ratings of the generators, and estimated energy used by boilers.

The following are parameters used for modeling boiler-related stationary source emissions:

* **Fuel Type**: refers to the type of fuel used. Boilers are assumed to use natural gas.
* **Type of boiler** refers to the construction of boiler for its intended use (i.e., residential furnace, wall-fired boiler, or tangential boiler), capacity of the boiler (in British Thermal Units (BTU) per hour), and controls for emissions. It is assumed that all boilers are wall-fired with a capacity of less than 100 million BTU per hour and no emissions controls (uncontrolled).
* **10003 of cubic meters used**, or million cubic meters used, refers to the energy used by the boiler. The Port provided annual energy usage for boilers in 2014 in therms, which was converted to million cubic meters of natural gas.

The following are parameters used for modeling generator-related stationary source emissions:

* **Fuel Type**: Diesel was chosen for all generator stationary sources.
* **Hours Operated**: The annual run-hours for generators were provided by the Port.
* **Horsepower** is the power rating of the generator’s engine. Horsepower ratings for each generator were provided by the Port, and were used to override EDMS default horsepower ratings. It is important to note that EDMS does not allow horsepower rating inputs larger than 1000 HP. Thus, for many generator sources, the horsepower rating was divided in half or in thirds, and were entered into EDMS two or three times, respectively, in order to simulate the emissions of a generator with a horsepower rating greater than 1000 HP. A generator inventory list is provided in **Table A1‑5**.

The EDMS inputs for boilers and generators are provided in **Tables A2-9 and A2-10**, respectively.

## Parking Traffic

Vehicular traffic at the only on‐Airport multi‐story parking garage, “Main Garage”, was modeled. The emissions were modeled in EDMS assuming vehicular traffic consisted of gasoline‐powered light duty vehicles, which include automobiles, sport utility vehicles, and pickup trucks. LFA also used Vissim,[[4]](#footnote-4) a traffic modeling tool, to model traffic flows and obtain assumptions for average vehicle speed, distance travelled, idle time, and traffic volumes. The Vissim data ensured that the data used in the emissions inventory was consistent with that used in other parts of the traffic analysis for the SAMP.

The following inputs were used in EDMS to model emissions from Main Garage traffic:

* **Vehicle type**: Light-duty passenger vehicles, gasoline-powered. This vehicle conservatively represents the average vehicle accessing the garage, capturing SUVs, pickups, and sedans that are fueled by unleaded gasoline, diesel, or electric.
* **Average vehicle age**: 7 years. (Source: Port of Seattle)
* **Average vehicle speed**: 5 miles per hour (mph). (Source: Vissim model)
* **Vehicle idle time**: 1.5 minutes (Source: Vissim model)
* **Distance traveled** by each vehicle: 1,548.08 meters, or the equivalent of a passenger vehicle driving up four helices (curved ramps that feed each floor of the garage) in the parking structure. (Source: Vissim model)
* **Traffic volumes**: 2,085,676 vehicles annually (Source: Vissim model)

## roadway Traffic

LFA modeled emissions from all roadway-related activity that occurs within the Airport boundary (i.e., on-Airport roadways). On-Airport roadway traffic includes emissions from all motor vehicle activities, including that of private vehicles, commercial vehicles, and Airport-operated ground transportation vehicles and access vehicles that service roadways.

The emissions inventory includes emissions from the following roadway vehicular traffic:

* Passenger cars (including rental cars)
* Taxicabs
* Limousines
* Rental shuttle/buses
* Hotel shuttles
* Parking shuttles
* Airline/Airport employee shuttles
* Charter/Public Buses
* Shared‐ride Vans
* Airporters
* Service/Delivery Vehicles

Emissions from roadway traffic are a product of traffic volumes (number of vehicles accessing the Airport), emissions factors (default EDMS emission factors were used), vehicle miles travelled (VMT), and speed. LFA used results from the Airport’s Vissim model to estimate annual VMT and average speed at Airport roadways.

The Vissim model, which simulates on‐Airport roadways for a 24‐hour period during the Airport’s peak month (July), was developed through consultation with (1) PSRC (the metropolitan planning organization for the Puget Sound Region, (2) Washington State Department of Transportation, (3) Port staff for relevant roadway traffic studies and counts and (4) daily traffic counts collected for the SAMP inventory. To convert the 24‐hour VISSIM results to an estimate of annual VMT, LFA calculated total traffic volumes (as counted by traffic cameras) entering the Upper Drive, Lower Drive, and Main Garage. The volume was divided by 31 to establish an average day in July. The annual volume total was then divided by the average day in July to calculate the annual ratio. The annual ratio was multiplied by the VISSIM 24‐hour results to estimate the annual VMT. Additionally, average vehicle speed was calculated from the average of two years’ of simulated roadway traffic. Assumptions about the vehicle average age and fuel type were provided by Port staff.

Most of the roadway traffic was assumed to be powered by diesel or gasoline fuel. The Port specified some roadway types as powered by compressed natural gas (CNG) and propane. For CNG-powered vehicles, custom emission factors were used in place of default EDMS emission factors whereas all other fuel type emission factors assumed EDMS default. For CNG, emission factors were calculated based on the FAA’s Voluntary Airport Low Emission (VALE) Technical Report,[[5]](#footnote-5) which provides CNG emission factors for carbon monoxide (CO), particulate matter (PM), nitrous oxides (NOx), and nonmethane hydrocarbons (NMHC). Conversion factors to EDMS emission factor units (grams per mile) were by the USEPA, Energy Information Agency (EIA), and Department of Energy (DOE) conversion factors. Specifically, brake specific fuel consumption (BSFC) and fuel densities of gasoline,[[6]](#footnote-6) fuel density of CNG,[[7]](#footnote-7) and fuel economies[[8]](#footnote-8) were used to calculate conversions.

Propane, or liquefied propane gas (LPG) vehicles were modeled as gasoline-powered vehicles, due to their similar emissions and limited availability of emissions comparisons between gasoline- and LPG-powered vehicles.

The results of the Vissim model and EDMS inputs are provided in **Table A2-11**. It is important to note that vehicular traffic was modeled on a *per vehicle* basis. The annualized VMT was divided by 1,000 vehicles to model emissions on a per 1,000 vehicle basis.

# Emissions Inventory for 2014

**Table 3-1** summarizes the criteria pollutant emissions for all sources in the year 2014 at the Airport. Criteria pollutants are NOx, volatile organic compounds (VOCs), CO, particulate matter with aerodynamic diameters equal to or less than 2.5 micrometers (PM2.5) or 10 micrometers (PM10), sulfur oxides (SOx) and lead. Because very little AvGas, the only fuel that contains lead, is dispensed at Sea-Tac, the evaluation did not include consideration of lead emissions.

Table 3‑1

**Criteria Pollutant Emission Inventory, 2014**

|  |  |
| --- | --- |
| **emission source** | **short tons of pollutants (2014)** |
| **nox** | **VOC** | **CO** | **SOx** | **pm-10** | **PM-2.5** | **total** |
| Aircraft Engines |  1,623  |  242  |  1,329  |  158  |  8  |  8  |  3,395  |
| APUs |  72  |  5  |  48  |  9  | 22  |  22  |  149  |
| GSE | 307 | 78 | 2,292 | 21 | 20 | 19 | 2,738 |
| Stationary Sources |  17  |  1  |  12  |  0  |  22  |  23  |  34  |
| Parking |  1  |  2  |  36  |  0  |  1  |  1  |  39  |
| Ground Transport |  32  |  19  |  462  |  2  |  1  |  0  |  516  |
| ***Total*** |  **2,052**  |  **347**  |  **4,178**  |  **54**  |  **53**  |  **187**  |  **6,871**  |
| *Source: LeighFisher, 2016* |

# Appendix A: SUPPORTING DATA

Table A1-1

**AIRCRAFT FLEEX MIX AND DATA SOURCE COMPARISON - 2013**

|  |  |  |  |
| --- | --- | --- | --- |
| **OAG Aircraft Type** | **2013 ANOMS Aircraft Type** | **OAG %** | **2013ANOMS %** |
| DE HAVILLAND DHC-8-400 | DH8D | 24.86% | 25.37% |
| BOEING 737-800 | B738 | 19.66% | 19.57% |
| BOEING B-737-700LR | B737 | 11.32% | 11.62% |
| BOEING B-737-900 | B739 | 8.56% | 8.43% |
| AIRBUS A320-100/200 | A320 | 7.05% | 7.14% |
| BOEING B-737-400 | B734 | 5.99% | 6.03% |
| BOEING B-757-200 | B752 | 4.80% | 4.95% |
| BOEING B-767-300 | B763 | 1.96% | 2.09% |
| BOEING B-737-300 | B733 | 1.77% | 1.90% |
| CANADAIR CRJ-700 | CRJ7 | 1.66% | 1.63% |
| EMBRAER 120 BRASILIA | E120 | 1.55% | 1.55% |
| AIRBUS A319 | A319 | 1.40% | 1.44% |
| DE HAVILLAND DHC-8-300 | DH8C | 1.17% | 1.15% |
| CESSNA 208 | C208 | 1.09% | 0.54% |
| CANADAIR CRJ-200ER | CRJ2 | 0.91% | 0.70% |
| AIRBUS INDUSTRIE A321 | A321 | 0.87% | 0.80% |
| BOEING B-777-200/200LR/233LR | B772 | 0.77% | 0.46% |
| AIRBUS INDUSTRIE A330-200 | A333 | 0.75% | 0.85% |
| BOEING B-757-300 | B753 | 0.73% | 0.76% |
| BOEING B-747-400 | B744 | 0.64% | 0.83% |
| DOUGLAS MD-11 | MD11 | 0.51% | 0.01% |
| BOEING B-747F | B77W | 0.41% | 0.15% |
| CANADAIR CRJ-900 | CRJ9 | 0.36% | 0.44% |
| AIRBUS A300-600 | A306 | 0.32% | 0.01% |
| ERJ-190 -EMBRAER 190 | E190 | 0.32% | 0.31% |
| DOUGLAS DC-10-30 | DC10 | 0.21% | 0.01% |
| BOEING B-767-200 | B762 | 0.01% | 0.00% |
| AIRBUS INDUSTRIE A340-300 | A343 | 0.01% | 0.01% |
| BOEING B-767-400 | B764 | 0.01% | 0.02% |
| BOEING B-737-500 | B735 | 0.01% | 0.01% |
| Other | Other | 0.33% | 1.23% |
| *Source: Federal Aviation Administration, Airport Noise and Operations Monitoring System (ANOMS) and Official Airline Guide (OAG)* |

| Table A1‑2**Commercial Aircraft FLEET MIX GENERATED FROM ANOMS DATA (2014)** |
| --- |
| Airline | Aircraft Type | Total |
| ASA | B738 | 11.91% |
| ASA | B739 | 8.56% |
| ASA | B734 | 5.97% |
| ASA | B737 | 4.28% |
| ASA | A320 | 0.01% |
| ASA | DH8D | 0.01% |
| QXE | DH8D | 23.82% |
| QXE | B739 | 0.01% |
| DAL | B752 | 2.67% |
| DAL | B738 | 1.72% |
| DAL | B763 | 1.36% |
| DAL | B739 | 0.83% |
| DAL | B753 | 0.61% |
| DAL | A332 | 0.51% |
| DAL | A333 | 0.42% |
| DAL | A320 | 0.42% |
| DAL | A319 | 0.08% |
| DAL | B772 | 0.06% |
| DAL | MD90 | 0.02% |
| DAL | B744 | 0.01% |
| SWA | B737 | 4.82% |
| SWA | B733 | 1.72% |
| SWA | B738 | 0.87% |
| SWA | B735 | 0.01% |
| UAL | A320 | 1.79% |
| UAL | B739 | 1.73% |
| UAL | B738 | 1.14% |
| UAL | A319 | 0.83% |
| UAL | B752 | 0.78% |
| UAL | B737 | 0.11% |
| UAL | B753 | 0.02% |
| UAL | B772 | 0.01% |
| UAL | B763 | 0.01% |
| SKW | CRJ7 | 3.13% |
| SKW | CRJ9 | 1.71% |
| SKW | E120 | 0.81% |
| SKW | CL60 | 0.22% |
| SKW | CRJ2 | 0.07% |
| AAL | B738 | 2.90% |
| AAL | B752 | 0.30% |
| CPZ | E170 | 2.21% |
| AWE | A320 | 1.24% |
| AWE | A321 | 0.81% |
| AWE | A319 | 0.08% |
| AWE | B752 | 0.01% |
| VRD | A320 | 0.99% |
| VRD | A319 | 0.51% |
| JBU | A320 | 1.37% |
| JZA | DH8C | 1.12% |
| JZA | CRJ2 | 0.07% |
| JZA | CRJ9 | 0.07% |
| JZA | DH8D | 0.01% |
| FFT | A320 | 0.53% |
| FFT | A319 | 0.28% |
| CFS | C208 | 0.63% |
| HAL | A332 | 0.42% |
| SCX | B738 | 0.18% |
| SCX | B737 | 0.16% |
| BAW | B772 | 0.14% |
| BAW | B744 | 0.13% |
| BAW | B77W | 0.05% |
| ACA | E190 | 0.30% |
| KAL | B772 | 0.15% |
| KAL | B744 | 0.09% |
| KAL | B77L | 0.05% |
| KAL | B77W | 0.01% |
| AAR | A333 | 0.17% |
| AAR | B744 | 0.11% |
| UAE | B77W | 0.17% |
| UAE | B77L | 0.04% |
| ANA | B788 | 0.21% |
| EVA | B744 | 0.17% |
| EVA | B77W | 0.03% |
| ICE | B752 | 0.20% |
| DLH | A333 | 0.11% |
| DLH | A343 | 0.08% |
| CHH | B788 | 0.10% |
| CHH | A332 | 0.05% |
| CAL | B744 | 0.15% |
| EJA | C750 | 0.03% |
| EJA | C56X | 0.02% |
| EJA | C680 | 0.02% |
| EJA | GALX | 0.01% |
| EJA | F2TH | 0.01% |
| EJA | H25B | 0.01% |
| EJA | C560 | 0.01% |
| OAE | B763 | 0.09% |
| NWA | A332 | 0.04% |
| NWA | A333 | 0.01% |
| CFG | B763 | 0.05% |
| AAY | MD83 | 0.01% |
| RPA | E190 | 0.01% |
| AMX | B738 | 0.004% |
| KFS | B722 | 0.001% |
| BSK | B738 | 0.001% |
| NRL | B732 | 0.001% |
| BOE | B763 | 0.0003% |
| TSC | B737 | 0.001% |
| SIA | A321 | 0.001% |
| *Source: Federal Aviation Administration, Airport Noise and Operations Monitoring System (ANOMS).* *Note: ASA = Alaska Airlines, QXE = Horizon Air, DAL = Delta Airlines, SWA = Southwest Airlines, UAL = United Airlines, SKW = SkyWest Airlines, AAL = American Airlines, CPZ = Compass Airlines, AWE = US Airways, VRD = Virgin America, JBU = JetBlue Airways, JZA = Jazz Aviation LP, FFT = Frontier Airlines, CFS = Empire Airlines, HAL = Hawaii Airlines, SCX = Sun Country Airlines, KAL = Korean Air, BAW = British Airways, ACA = Air Canada, AAR = Asiana Airlines, UAE = Emirates Airlines, ANA = All Nippon Airways, EVA = EVA Air, ICE = Iceland Air, DLH = Lufthansa, CHH = Hainan Airlines, CAL= China Airlines, OAE=Omni Air, CFG = Condor, AAY = Allegiant Air, RPA = Republic Airlines, AMX = Aeromexico, KFS = Kalitta Charters, BSK = Miami Air Internatioinal/Quest Cargo International, NRL = Nolinor Aviation, BOE = Boeing, TSC = Energjet, SIA = Singapore Airlines**Note: Data on Singapore Airlines was not provided by ANOMS. Data was provided by the Port of Seattle.* |

| Table A1‑2**Commercial Aircraft Fleet Mix by Airline and Aircraft Type (2014)** |
| --- |
| **aIRLINE** | **aIRCRAFT type** | **ENGINE TYPE** | **ANOMS FLEET MIX (%)** | **ENGINE SPLIT** | **% of fleet** |
| ASA | Boeing 737-890 (w) | CFM CFM56-7B24 | 11.9% | 50% | 6.0% |
| ASA | Boeing 737-890 (w) | CFM CFM56-7B27 | 11.9% | 50% | 6.0% |
| ASA | Boeing 737-990ER | CFM CFM56-7B26 | 8.6% | 50% | 4.3% |
| ASA | Boeing 737-990 (w) | CFM CFM56-7B24 | 8.6% | 50% | 4.3% |
| ASA | Boeing 737-490 | CFM CFM56-3C1 | 6.0% | 100% | 6.0% |
| ASA | Boeing 737-790 (w) | CFM CFM56-7B22 | 4.3% | 50% | 2.2% |
| ASA | Boeing 737-790 (w) | CFM CFM56-7B24 | 4.3% | 50% | 2.2% |
| QXE | Bombardier Dash 8-402Q | PWC PW150A | 23.8% | 100% | 23.9% |
| DAL | Boeing 757-232 | PW PW2037 | 2.7% | 100% | 2.7% |
| DAL | Boeing 737-832 (w) | CFM CFM56-7B26 | 1.7% | 100% | 1.7% |
| DAL | Boeing 767-332 | GE CF6-80A2 | 1.4% | 40% | 0.5% |
| DAL | Boeing 767-332ER (w) | GE CF6-80C2B6 | 1.4% | 40% | 0.5% |
| DAL | Boeing 767-332ER (w) | PW PW4060 | 1.4% | 20% | 0.3% |
| DAL | Boeing 737-990ER | CFM CFM56-7B26 | 0.8% | 100% | 0.8% |
| DAL | Boeing 757-351 | PW PW2043 | 0.6% | 100% | 0.6% |
| DAL | Airbus A330-223 | PW PW4168 | 0.5% | 100% | 0.5% |
| DAL | Airbus A330-323 | PW PW4168 | 0.4% | 100% | 0.4% |
| DAL | Airbus A320-212 | CFM CFM56-5A3 | 0.4% | 100% | 0.4% |
| DAL | Airbus A319-114 | CFM CFM56-5A5 | 0.1% | 100% | 0.1% |
| DAL | Boeing 777-232ER | RR Trent 895 | 0.1% | 100% | 0.1% |
| DAL | McDonnell Douglas MD-90-30 | IAE V2525-D5 | 0.0% | 100% | 0.0% |
| SWA | Boeing 737-7H4 (w) | CFM CFM56-7B22 | 4.8% | 100% | 4.8% |
| SWA | Boeing 737-3H4 (w) | CFM CFM56-3B1 | 1.7% | 50% | 0.9% |
| SWA | Boeing 737-3L9 | CFM CFM56-3B2 | 1.7% | 50% | 0.9% |
| SWA | Boeing 737-8H4 (w) | CFM CFM56-7B26 | 0.9% | 100% | 0.9% |
| SWA | Boeing 737-5H4 | CFM CFM56-3C1 | 0.0% | 50% | 0.0% |
| SWA | Boeing 737-5H4 | CFM CFM56-3B1 | 0.0% | 50% | 0.0% |
| UAL | Airbus A320-232 | IAE V2527-A5 | 1.8% | 100% | 1.8% |
| UAL | Boeing 737-924ER | CFM CFM56-7B26 | 1.7% | 100% | 1.7% |
| UAL | Boeing 737-824 (w) | CFM CFM56-7B26 | 1.1% | 100% | 1.1% |
| UAL | Airbus A319-131 | IAE V2522-A5 | 0.8% | 100% | 0.8% |
| UAL | Boeing 757-222 | PW PW2037 | 0.8% | 100% | 0.8% |
| UAL | Boeing 737-724 (w) | CFM CFM56-7B24 | 0.1% | 100% | 0.1% |
| UAL | Boeing 757-324 (w) | RR RB211-535E4 | 0.0% | 100% | 0.0% |
| UAL | Boeing 777-222ER | PW PW4090 | 0.0% | 100% | 0.0% |
| SKW | Bombardier CRJ-701ER | GE CF34-8C5 | 3.1% | 100% | 3.1% |
| SKW | Bombardier CRJ-900ER NG | GE CF34-8C5 | 1.7% | 100% | 1.7% |
| SKW | Embraer EMB-120 Brasilia ER | PWC PW118 | 0.8% | 100% | 0.8% |
| SKW | Bombardier CRJ-200LR | GE CF34-3B1 | 0.3% | 100% | 0.3% |
| AAL | Boeing 737-823 (w) | CFM CFM56-7B26 | 2.9% | 100% | 2.9% |
| AAL | Boeing 757-223 (w) | RR RB211-535E4 | 0.3% | 100% | 0.3% |
| CPZ | Embraer 175-LR | GE CF34-8E5 | 2.2% | 100% | 2.2% |
| AWE | Airbus A320-231 0317 | IAE V2500-A1 | 1.2% | 100% | 1.3% |
| AWE | Airbus A321-231 | IAE V2527-A5 | 0.8% | 100% | 0.8% |
| AWE | Airbus A319-112 | CFM CFM56-5B6 | 0.1% | 100% | 0.1% |
| VRD | Airbus A320-214 | CFM CFM56-5B4 | 1.0% | 100% | 1.0% |
| VRD | Airbus A319-112 | CFM CFM56-5B6 | 0.5% | 100% | 0.5% |
| JBU | Airbus A320-232 | IAE V2527-A5 | 1.4% | 100% | 1.4% |
| JZA | Bombardier Dash 8-301 | PWC PW123 | 1.1% | 100% | 1.1% |
| JZA | Bombardier CRJ-200ER 7330 | GE CF34-3B1 | 0.1% | 100% | 0.1% |
| JZA | Bombardier CRJ-705LR | GE CF34-8C5 | 0.1% | 100% | 0.1% |
| JZA | Bombardier Dash 8-402 NextGen | PWC PW150A | 0.0% | 100% | 0.0% |
| FFT | Airbus A320-214 | CFM CFM56-5B4 | 0.5% | 100% | 0.5% |
| FFT | Airbus A319-111 | CFM CFM56-5B5 | 0.3% | 100% | 0.3% |
| CFS | Cessna 208B Grand Super Cargomaster | PWC PT6A-114A | 0.6% | 100% | 0.6% |
| HAL | Airbus A330-243 | RR Trent 772B-60 | 0.4% | 100% | 0.4% |
| HAL | Boeing 767-33AER (w) | PW PW4060 | 0.0% | 100% | 0.0% |
| SCX | Boeing 737-8BK (w) | CFM CFM56-7B27 | 0.2% | 100% | 0.2% |
| SCX | Boeing 737-73V | CFM CFM56-7B22 | 0.2% | 100% | 0.2% |
| KAL | Boeing 777-2B5ER | PW PW4090 | 0.2% | 100% | 0.2% |
| KAL | Boeing 747-4B5F | PW PW4056 | 0.1% | 50% | 0.0% |
| KAL | Boeing 747-4B5ERF | PW PW4062 | 0.1% | 50% | 0.0% |
| KAL | Boeing 777-FB5 | GE GE90-110B1 | 0.0% | 100% | 0.0% |
| KAL | Boeing 777-3B5ER | GE GE90-115B | 0.0% | 100% | 0.0% |
| BAW | Boeing 777-236ER | GE GE90-85B | 0.1% | 100% | 0.1% |
| BAW | Boeing 747-436 | RR RB211-524H2 | 0.1% | 100% | 0.1% |
| BAW | Boeing 777-336ER | GE GE90-115B | 0.1% | 100% | 0.1% |
| ACA | Embraer 190-AR | GE CF34-10E5 | 0.3% | 100% | 0.3% |
| AAR | Airbus A330-323 | PW PW4168 | 0.2% | 100% | 0.2% |
| AAR | Boeing 747-446SF | GE CF6-80C2B1 | 0.1% | 100% | 0.1% |
| UAE | Boeing 777-31HER | GE GE90-115B | 0.2% | 100% | 0.2% |
| UAE | Boeing 777-21HLR | GE GE90-110B1 | 0.0% | 100% | 0.0% |
| ANA | Boeing 787-8 | RR Trent 1000 | 0.2% | 100% | 0.2% |
| EVA | Boeing 747-45E | GE CF6-80C2B1 | 0.2% | 100% | 0.2% |
| EVA | Boeing 777-35EER | GE GE90-115B | 0.0% | 100% | 0.0% |
| ICE | Boeing 757-208 (w) | RR RB211-535E4 | 0.2% | 100% | 0.2% |
| DLH | Airbus A330-343 | RR Trent 772B-60 | 0.1% | 100% | 0.1% |
| CHH | Boeing 787-8 | GE GEnx-1B64 | 0.1% | 100% | 0.1% |
| CHH | Airbus A330-243 | RR Trent 772B-60 | 0.1% | 100% | 0.1% |
| CAL | Boeing 747-409F | GE CF6-80C2B1 | 0.1% | 100% | 0.1% |
| OAE | Boeing 767-319ER | GE CF6-80C2B6 | 0.1% | 100% | 0.1% |
| CFG | Boeing 767-330ER (w) | PW PW4062 | 0.05% | 100% | 0.05% |
| AAY | McDonnell Douglas MD-83 | PW JT8D-219 | 0.01% | 100% | 0.01% |
| RPA | Embraer 190-AR | GE CF34-10E6 | 0.01% | 100% | 0.01% |
| AMX | Boeing 737-8Z9 (w) | CFM CFM56-7B27 | 0.004% | 100% | 0.004% |
| KFS | Boeing 727-2M7F Adv | PW JT8D-17 | 0.001% | 100% | 0.001% |
| BSK | Boeing 737-81Q (w) | CFM CFM56-7B26 | 0.001% | 100% | 0.001% |
| NRL | Boeing 737-229QC Adv | PW JT8D-15(NOR3) | 0.001% | 100% | 0.001% |
| BOE | Boeing 767-33AER | GE CF6-80C2B6 | 0.0003% | 100% | 0.0003% |
| TSC | Boeing 737-73V (w) | CFM CFM56-7B24 | 0.001% | 100% | 0.001% |
| SIA | Airbus A320-214 | CFM CFM56-5B4 | 0.001% | 100% | 0.001% |
| *Source: LeighFisher; Federal Aviation Administration, Airport Noise and Operations Monitoring System (ANOMS), 2015.**Note: “% of Fleet” refers to methodology described in Section 4.3 Engine Types.**Note: ASA = Alaska Airlines, QXE = Horizon Air, DAL = Delta Airlines, SWA = Southwest Airlines, UAL = United Airlines, SKW = SkyWest Airlines, AAL = American Airlines, CPZ = Compass Airlines, AWE = US Airways, VRD = Virgin America, JBU = JetBlue Airways, JZA = Jazz Aviation LP, FFT = Frontier Airlines, CFS = Empire Airlines, HAL = Hawaii Airlines, SCX = Sun Country Airlines, KAL = Korean Air, BAW = British Airways, ACA = Air Canada, AAR = Asiana Airlines, UAE = Emirates Airlines, ANA = All Nippon Airways, EVA = EVA Air, ICE = Iceland Air, DLH = Lufthansa, CHH = Hainan Airlines, CAL= China Airlines, OAE=Omni Air, CFG = Condor, AAY = Allegiant Air, RPA = Republic Airlines, AMX = Aeromexico, KFS = Kalitta Charters, BSK = Miami Air Internatioinal/Quest Cargo International, NRL = Nolinor Aviation, BOE = Boeing, TSC = Energjet, SIA = Singapore Airlines* |

Table A1-3

**cargo Aircraft Fleet Mix by Airline and Aircraft Type (2014)**

| **aIRCRAFT type** | **operations** | **% of fleet** |
| --- | --- | --- |
| McDonnell Douglas MD-11BCF |  1,487  | 36.9% |
| McDonnell Douglas MD-10-30AF |  946  | 23.4% |
| Airbus A300-605R F |  472  | 11.7% |
| Boeing 757-2B7SF |  248  | 6.1% |
| McDonnell Douglas MD-10-30F |  245  | 6.1% |
| Boeing 747-4R7F |  176  | 4.4% |
| Boeing 767-3Y0ER |  174  | 4.3% |
| Airbus A300-622R F |  149  | 3.7% |
| Boeing 777-FS2 |  84  | 2.1% |
| Airbus A310-203F |  22  | 0.5% |
| Boeing 767-223SF |  18  | 0.4% |
| Boeing 747-222SF |  14  | 0.3% |
| **Total** | **4,035** |  |
| *Source: LeighFisher; Federal Aviation Administration, Airport Noise and Operations Monitoring System (ANOMS), 2015.* |

Table A1‑4

**General Aviation aircraft Fleet Mix by Aircraft Type (2014)**

| **aIRCRAFT type** | **operations** | **% of fleet** |
| --- | --- | --- |
| Dassault Falcon 50 |  271  | 17.9% |
| Piper PA-31 Navajo |  177  | 11.7% |
| Cirrus SR22 |  118  | 7.8% |
| Gulfstream IV-SP |  79  | 5.2% |
| Cessna 172 Skyhawk |  64  | 4.2% |
| Cessma 560 Citation XLS |  61  | 4.0% |
| Raytheon Hawker 800 |  60  | 4.0% |
| Raytheon Super King Air 300 |  58  | 3.8% |
| Bombardier Challenger 600 |  45  | 3.0% |
| Cessna 550 Citation II |  41  | 2.7% |
| Bombardier Challenger 300 |  41  | 2.7% |
| Gulfstream V-SP |  39  | 2.6% |
| Pilatus PC-12 |  34  | 2.2% |
| Cessna 560 Citation V |  33  | 2.2% |
| Cessma 680 Citation Sovereign |  28  | 1.8% |
| Cessna 208 Caravan |  28  | 1.8% |
| Bombardier Learjet 45 |  26  | 1.7% |
| Bombardier Learjet 31 |  26  | 1.7% |
| Dassault Falcon 2000-EX |  25  | 1.7% |
| Bombardier Learjet 35A/36A |  22  | 1.5% |
| Dassault Falcon 900-B |  22  | 1.5% |
| Raytheon Beechjet 400 |  22  | 1.5% |
| Cessna 525 Citationjet |  21  | 1.4% |
| Bombardier Learjet 60 |  18  | 1.2% |
| Piper PA-47 500TP |  16  | 1.1% |
| Israel IAI-1125 Astra |  16  | 1.1% |
| Cessna 650 Citation III |  15  | 1.0% |
| Embrarer EMB120 Brasilia |  14  | 0.9% |
| Cessna 525 Citationjet |  14  | 0.9% |
| Cessna 414 |  13  | 0.9% |
| Cessna 750 Citation X |  13  | 0.9% |
| Convair CV-580 |  13  | 0.9% |
| Gulfstream G200 |  13  | 0.9% |
| Raytheon King Air 90 |  12  | 0.8% |
| Cessna 310 |  9  | 0.6% |
| Raytheon Beech Bonanza 36 |  7  | 0.5% |
| **Total Operations** | **1,514** |  |
| *Source: LeighFisher; Federal Aviation Administration, Airport Noise and Operations Monitoring System (ANOMS), 2015.* |

Table A1‑5

**generator inventory (2014)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **generator/pump** | **stationary source** | **type** | **annual operating hours** | **horsepower rating (HP)** |
| Airfield Light 1 | Generator | Diesel Fuel | 122.7 | 2400 |
| Airfield Light 2 | Generator | Diesel Fuel | 87.7 | 2400 |
| Building Lights 1 | Generator | Diesel Fuel | 4 | 67 |
| Building Lights 2 | Generator | Diesel Fuel | 5.2 | 80 |
| Boiler 3 Generator | Generator | Diesel Fuel | 1 | 380 |
| Concourse A C4 | Generator | Diesel Fuel | 33 | 1341 |
| Concourse A Fire | Generator | Diesel Fuel | 3.5 | 240 |
| Concourse A STEP | Generator | Diesel Fuel | 2 | 2012 |
| Parking Garage | Generator | Diesel Fuel | 4.4 | 235 |
| Pump 01 | Generator | Diesel Fuel | 6.8 | 412 |
| Pump 02 | Generator | Diesel Fuel | 6.6 | 412 |
| Pump 03 | Generator | Diesel Fuel | 2.6 | 412 |
| Pump 04 | Generator | Diesel Fuel | 7.4 | 412 |
| Pump 05 | Generator | Diesel Fuel | 4.5 | 380 |
| Pump 07 | Generator | Diesel Fuel | 5.6 | 380 |
| Pump 8 | Generator | Diesel Fuel | 4.4 | 380 |
| Toll Plaza | Generator | Diesel Fuel | 4.1 | 503 |
| WWTP | Generator | Diesel Fuel | 16.6 | 165 |
| *Source: Port of Seattle, 2015* |

# Appendix EDMS Inputs

| Table A2‑1**COMMERCIAL AIRCRAFT OPERATIONS INPUTS IN EDMS (2014)** |
| --- |
| **EDMS ID** |  **aIRCRAFT** | **ENGINE TYPES** | **Annual Operations** | **Annual RONS (2014)** |
| COM - 01 | Boeing 737-890 (w) | CFM CFM56-7B24 |  19,841  |  2,281  |
| COM - 02 | Boeing 737-890 (w) | CFM CFM56-7B27 |  19,841  |  2,281  |
| COM - 03 | Boeing 737-990ER | CFM CFM56-7B26 |  14,255  |  2,373  |
| COM - 04 | Boeing 737-990 (w) | CFM CFM56-7B24 |  14,255  |  2,190  |
| COM - 05 | Boeing 737-490 | CFM CFM56-3C1 |  19,880  |  2,008  |
| COM - 06 | Boeing 737-790 (w) | CFM CFM56-7B22 |  7,125  |  365  |
| COM - 07 | Boeing 737-790 (w) | CFM CFM56-7B24 |  7,125  |  -  |
| COM - 08 | Bombardier Dash 8-402Q | PWC PW150A |  79,338  |  -  |
| COM - 09 | Boeing 757-232 | PW PW2037 |  8,884  |  730  |
| COM - 10 | Boeing 737-832 (w) | CFM CFM56-7B26 |  5,729  |  730  |
| COM - 11 | Boeing 767-332 | GE CF6-80A2 |  1,815  |  146  |
| COM - 12 | Boeing 767-332ER (w) | GE CF6-80C2B6 |  1,815  |  146  |
| COM - 13 | Boeing 767-332ER (w) | PW PW4060 |  908  |  73  |
| COM - 14 | Boeing 737-990ER | CFM CFM56-7B26 |  2,773  |  1,643  |
| COM - 15 | Boeing 757-351 | PW PW2043 |  2,032  |  183  |
| COM - 16 | Airbus A330-223 | PW PW4168 |  1,715  |  548  |
| COM - 17 | Airbus A330-323 | PW PW4168 |  1,397  |  730  |
| COM - 18 | Airbus A320-212 | CFM CFM56-5A3 |  1,389  |  -  |
| COM - 19 | Airbus A319-114 | CFM CFM56-5A5 |  252  |  -  |
| COM - 20 | Boeing 777-232ER | RR Trent 895 |  189  |  -  |
| COM - 21 | McDonnell Douglas MD-90-30 | IAE V2525-D5 |  56  |  -  |
| COM - 22 | Boeing 737-7H4 (w) | CFM CFM56-7B22 |  16,040  |  3,285  |
| COM - 23 | Boeing 737-3H4 (w) | CFM CFM56-3B1 |  2,864  |  -  |
| COM - 24 | Boeing 737-3L9 | CFM CFM56-3B2 |  2,864  |  -  |
| COM - 25 | Boeing 737-8H4 (w) | CFM CFM56-7B26 |  2,905  |  -  |
| COM - 26 | Boeing 737-5H4 | CFM CFM56-3C1 |  13  |  -  |
| COM - 27 | Boeing 737-5H4 | CFM CFM56-3B1 |  13  |  -  |
| COM - 28 | Airbus A320-232 | IAE V2527-A5 |  5,975  |  1,825  |
| COM - 29 | Boeing 737-924ER | CFM CFM56-7B26 |  5,753  |  -  |
| COM - 30 | Boeing 737-824 (w) | CFM CFM56-7B26 |  3,799  |  183  |
| COM - 31 | Airbus A319-131 | IAE V2522-A5 |  2,765  |  -  |
| COM - 32 | Boeing 757-222 | PW PW2037 |  2,610  |  183  |
| COM - 33 | Boeing 737-724 (w) | CFM CFM56-7B24 |  357  |  -  |
| COM - 34 | Boeing 757-324 (w) | RR RB211-535E4 |  51  |  -  |
| COM - 35 | Boeing 777-222ER | PW PW4090 |  42  |  -  |
| COM - 36 | Bombardier CRJ-701ER | GE CF34-8C5 |  10,411  |  -  |
| COM - 37 | Bombardier CRJ-900ER NG | GE CF34-8C5 |  5,682  |  -  |
| COM - 38 | Embraer EMB-120 Brasilia ER | PWC PW118 |  2,685  |  -  |
| COM - 39 | Bombardier CRJ-200LR | GE CF34-3B1 |  956  |  -  |
| COM - 40 | Boeing 737-823 (w) | CFM CFM56-7B26 |  9,645  |  2,190  |
| COM - 41 | Boeing 757-223 (w) | RR RB211-535E4 |  989  |  365  |
| COM - 42 | Embraer 175-LR | GE CF34-8E5 |  7,372  |  -  |
| COM - 43 | Airbus A320-231 0317 | IAE V2500-A1 |  4,143  |  183  |
| COM - 44 | Airbus A321-231 | IAE V2527-A5 |  2,707  |  1,095  |
| COM - 45 | Airbus A319-112 | CFM CFM56-5B6 |  257  |  -  |
| COM - 46 | Airbus A320-214 | CFM CFM56-5B4 |  3,282  |  730  |
| COM - 47 | Airbus A319-112 | CFM CFM56-5B6 |  1,684  |  -  |
| COM - 48 | Airbus A320-232 | IAE V2527-A5 |  4,566  |  365  |
| COM - 49 | Bombardier Dash 8-301 | PWC PW123 |  3,747  |  365  |
| COM - 50 | Bombardier CRJ-200ER 7330 | GE CF34-3B1 |  248  |  -  |
| COM - 51 | Bombardier CRJ-705LR | GE CF34-8C5 |  244  |  -  |
| COM - 52 | Bombardier Dash 8-402 NextGen | PWC PW150A |  30  |  -  |
| COM - 53 | Airbus A320-214 | CFM CFM56-5B4 |  1,753  |  -  |
| COM - 54 | Airbus A319-111 | CFM CFM56-5B5 |  933  |  -  |
| COM - 55 | Cessna 208B Grand Super Cargo master | PWC PT6A-114A |  2,096  |  -  |
| COM - 56 | Airbus A330-243 | RR Trent 772B-60 |  1,410  |  730  |
| COM - 57 | Boeing 767-33AER (w) | PW PW4060 |  14  |  -  |
| COM - 58 | Boeing 737-8BK (w) | CFM CFM56-7B27 |  595  |  -  |
| COM - 59 | Boeing 737-73V | CFM CFM56-7B22 |  546  |  -  |
| COM - 60 | Boeing 777-2B5ER | PW PW4090 |  505  |  -  |
| COM - 61 | Boeing 747-4B5F | PW PW4056 |  148  |  -  |
| COM - 62 | Boeing 747-4B5ERF | PW PW4062 |  148  |  -  |
| COM - 63 | Boeing 777-FB5 | GE GE90-110B1 |  151  |  -  |
| COM - 64 | Boeing 777-3B5ER | GE GE90-115B |  37  |  -  |
| COM - 65 | Boeing 777-236ER | GE GE90-85B |  465  |  -  |
| COM - 66 | Boeing 747-436 | RR RB211-524H2 |  420  |  -  |
| COM - 67 | Boeing 777-336ER | GE GE90-115B |  168  |  -  |
| COM - 68 | Embraer 190-AR | GE CF34-10E5 |  1,001  |  -  |
| COM - 69 | Airbus A330-323 | PW PW4168 |  572  |  183  |
| COM - 70 | Boeing 747-446SF | GE CF6-80C2B1 |  366  |  -  |
| COM - 71 | Boeing 777-31HER | GE GE90-115B |  576  |  -  |
| COM - 72 | Boeing 777-21HLR | GE GE90-110B1 |  120  |  -  |
| COM - 73 | Boeing 787-8 | RR Trent 1000 |  687  |  -  |
| COM - 74 | Boeing 747-45E | GE CF6-80C2B1 |  566  |  183  |
| COM - 75 | Boeing 777-35EER | GE GE90-115B |  106  |  106  |
| COM - 76 | Boeing 757-208 (w) | RR RB211-535E4 |  661  |  -  |
| COM - 77 | Airbus A330-343 | RR Trent 772B-60 |  378  |  -  |
| COM - 78 | Boeing 787-8 | GE GEnx-1B64 |  334  |  -  |
| COM - 79 | Airbus A330-243 | RR Trent 772B-60 |  171  |  -  |
| COM - 80 | Boeing 747-409F | GE CF6-80C2B1 |  483  |  -  |
| COM - 81 | Boeing 767-319ER | GE CF6-80C2B6 |  312  |  -  |
| COM - 82 | Boeing 767-330ER (w) | PW PW4062 |  155  |  -  |
| COM - 83 | McDonnell Douglas MD-83 | PW JT8D-219 |  40  |  -  |
| COM - 84 | Embraer 190-AR | GE CF34-10E6 |  38  |  -  |
| COM - 85 | Boeing 737-8Z9 (w) | CFM CFM56-7B27 |  15  |  -  |
| COM - 86 | Boeing 727-2M7F Adv | PW JT8D-17 |  3  |  -  |
| COM - 87 | Boeing 737-81Q (w) | CFM CFM56-7B26 |  4  |  -  |
| COM - 88 | Boeing 737-229QC Adv | PW JT8D-15(NOR3) |  4  |  -  |
| COM - 89 | Boeing 767-33AER | GE CF6-80C2B6 |  1  |  -  |
| COM - 90 | Boeing 737-73V (w) | CFM CFM56-7B24 |  2  |  -  |
| COM - 91 | Airbus A320-214 | CFM CFM56-5B4 |  4  |  -  |
| **TOTAL Commercial OPERATIONS** |  | **331,301** | **289** |
| *Source: LeighFisher, 2015.* *Note: Remain Overnight hardstands (RONs) are a subset of total operations. To obtain the number of annual operations without RONs, “Annual RONs” were subtracted from “Annual Operations”. In EDMS, an additional RON identifier was added to the “EDMS ID”, e.g., “COM-01-RON” was used to indicate RON operations.* |

Table A2‑2

**Cargo Aircraft Operations Inputs in EDMS (2014)**

| **edms id** | **aIRCRAFT type** | **ENGINE TYPE** | **ANNUAL Operations (2014)** |
| --- | --- | --- | --- |
| CARGO - 01 | McDonnell Douglas MD-11BCF | PW PW4460 |  1,820  |
| CARGO - 02 | McDonnell Douglas MD-10-30AF | GE CF6-50C2 |  1,157  |
| CARGO - 03 | Airbus A300-605R F | GE CF6-80C2A5 |  578  |
| CARGO - 04 | Boeing 757-2B7SF | RR RB211-535E4 |  303  |
| CARGO - 05 | McDonnell Douglas MD-10-30F | GE CF6-50C2 |  300  |
| CARGO - 06 | Boeing 747-4R7F | RR RB211-524H2 |  215  |
| CARGO - 07 | Boeing 767-3Y0ER | GE CF6-80C2B6 |  213  |
| CARGO - 08 | Airbus A300-622R F | PW PW4158 |  182  |
| CARGO - 09 | Boeing 777-FS2 | GE GE90-110B1 |  103  |
| CARGO - 10 | Airbus A310-203F | GE CF6-80A3 |  27  |
| CARGO - 11 | Boeing 767-223SF | GE CF6-80A2 |  22  |
| CARGO - 12 | Boeing 747-222SF | PW JT9D-7R4G2 |  17  |
|  | **TOTAL CARGO OPERATIONS** |  | **4,937** |
| *Source: LeighFisher, 2015.*  |

Table A2‑2

**General Aviation and military Aircraft Operations Inputs in EDMS (2014)**

| **edms id** | **aIRCRAFT type** | **ENGINE TYPE** | **ANNUAL Operations (2014)** |
| --- | --- | --- | --- |
| MIL - 01 | Bombardier Global Express | BR700-710A2-20 |  **127**  |
| **TOTAL Military Operations** |
| GA - 01 | Dassault Falcon 50 | TFE731-3 |  736  |
| GA - 02 | Piper PA-31 Navajo | TIO-540-J2B2 |  481  |
| GA - 03 | Cirrus SR22 | TIO-540-J2B2 |  321  |
| GA - 04 | Gulfstream IV-SP | TAY 611-8C |  215  |
| GA - 05 | Cessna 172 Skyhawk | IO-320-D1AD |  174  |
| GA - 06 | Cessma 560 Citation XLS | JT15D-5, -5A, -5B |  166  |
| GA - 07 | Raytheon Hawker 800 | TFE731-3 |  163  |
| GA - 08 | Raytheon Super King Air 300 | PT6A-60A |  158  |
| GA - 09 | Bombardier Challenger 600 | CF34-3B |  122  |
| GA - 10 | Cessna 550 Citation II | PW530 |  111  |
| GA - 11 | Bombardier Challenger 300 | AS907-1-1A |  111  |
| GA - 12 | Gulfstream V-SP | BR700-710C4-11 |  106  |
| GA - 13 | Pilatus PC-12 | PT6A-67B |  92  |
| GA - 14 | Cessna 560 Citation V | PW530 |  90  |
| GA - 15 | Cessma 680 Citation Sovereign | PW306B |  76  |
| GA - 16 | Cessna 208 Caravan | PT6A0-114A |  76  |
| GA - 17 | Bombardier Learjet 45 | TFE731-2-2B |  71  |
| GA - 18 | Bombardier Learjet 31 | TFE731-2-2B |  71  |
| GA - 19 | Dassault Falcon 2000-EX | PW308C |  68  |
| GA - 20 | Bombardier Learjet 35A/36A | TFE731-2/2A |  60  |
| GA - 21 | Dassault Falcon 900-B | TFE731-3 |  60  |
| GA - 22 | Raytheon Beechjet 400 | JT15D-5, -5A, -5B |  60  |
| GA - 23 | Cessna 525 Citationjet | JT15D-1 SERIES |  57  |
| GA - 24 | Bombardier Learjet 60 | PW306A |  49  |
| GA - 25 | Piper PA-47 500TP | PT6A-42 |  43  |
| GA - 26 | Israel IAI-1125 Astra | TFE731-2/2A |  43  |
| GA - 27 | Cessna 650 Citation III | TFE731-3 |  41  |
| GA - 28 | Embrarer EMB120 Brasilia | PW 118 |  38  |
| GA - 29 | Cessna 525 Citationjet | JT15D-1 SERIES |  38  |
| GA - 30 | Cessna 414 | TIO-540-J2B2 |  35  |
| GA - 31 | Cessna 750 Citation X | AE3007C TYPE 2 |  35  |
| GA - 32 | Convair CV-580 | 501D22A |  35  |
| GA - 33 | Gulfstream G200 | PW306A |  35  |
| GA - 34 | Raytheon King Air 90 | PT6A-135A |  33  |
| GA - 35 | Cessna 310 | TIO-540-J2B2 |  24  |
| GA - 36 | Raytheon Beech Bonanza 36 | TIO-540-J2B2 |  19  |
| **TOTAL General Aviation Operations** | **4,113** |
| Source: Leigh Fisher, July 2016 |

| Table A2‑3**Commercial Aircraft APU Usage Inputs in EDMS (2014)** |
| --- |
| **edms id** | **Airline** | **OAG gate occupancy time (minutes)** | **adjusted APU usage per operation (minutes)** |
| COM - 01 | Alaska Airlines = AS / ASA | 45 | 7 |
| COM - 02 | Alaska Airlines = AS / ASA | 45 | 7 |
| COM - 03 | Alaska Airlines = AS / ASA | 50 | 7 |
| COM - 04 | Alaska Airlines = AS / ASA | 45 | 7 |
| COM - 05 | Alaska Airlines = AS / ASA | 40 | 7 |
| COM - 06 | Alaska Airlines = AS / ASA | 40 | 7 |
| COM - 07 | Alaska Airlines = AS / ASA | 40 | 7 |
| COM - 08 | Horizon Air = QX / QXE | 30 | 7 |
| COM - 09 | Delta Air Lines = DL / DAL | 50 | 25 |
| COM - 10 | Delta Air Lines = DL / DAL | 40 | 20 |
| COM - 11 | Delta Air Lines = DL / DAL | 61 | 30.5 |
| COM - 12 | Delta Air Lines = DL / DAL | 105 | 52.5 |
| COM - 13 | Delta Air Lines = DL / DAL | 105 | 52.5 |
| COM - 14 | Delta Air Lines = DL / DAL | 51 | 25.5 |
| COM - 15 | Delta Air Lines = DL / DAL | 71 | 35.5 |
| COM - 16 | Delta Air Lines = DL / DAL | 165 | 82.5 |
| COM - 17 | Delta Air Lines = DL / DAL | 120 | 60 |
| COM - 18 | Delta Air Lines = DL / DAL | 40 | 20 |
| COM - 19 | Delta Air Lines = DL / DAL | 40 | 20 |
| COM - 20 | Delta Air Lines = DL / DAL | 240 | 120 |
| COM - 21 | Delta Air Lines = DL / DAL | 30 | 15 |
| COM - 22 | Southwest Airlines = SWA | 25 | 7 |
| COM - 23 | Southwest Airlines = SWA | 30 | 7 |
| COM - 24 | Southwest Airlines = SWA | 30 | 7 |
| COM - 25 | Southwest Airlines = SWA | 45 | 7 |
| COM - 26 | Southwest Airlines = SWA | 30 | 7 |
| COM - 27 | Southwest Airlines = SWA | 30 | 7 |
| COM - 28 | United Airlines = UA / UAL | 45 | 7 |
| COM - 29 | United Airlines = UA / UAL | 50 | 7 |
| COM - 30 | United Airlines = UA / UAL | 45 | 7 |
| COM - 31 | United Airlines = UA / UAL | 40 | 7 |
| COM - 32 | United Airlines = UA / UAL | 50 | 7 |
| COM - 33 | United Airlines = UA / UAL | 41 | 7 |
| COM - 34 | United Airlines = UA / UAL | 50 | 7 |
| COM - 35 | United Airlines = UA / UAL | 100 | 7 |
| COM - 36 | SkyWest Airlines = OO / SKW | 0 | 0 |
| COM - 37 | SkyWest Airlines = OO / SKW | 0 | 0 |
| COM - 38 | SkyWest Airlines = OO / SKW | 25 | 25 |
| COM - 39 | SkyWest Airlines = OO / SKW | 0 | 0 |
| COM - 40 | American Airlines = AA / AAL | 50 | 50 |
| COM - 41 | American Airlines = AA / AAL | 60 | 60 |
| COM - 42 | Compass Airlines = CP / CPZ | 0 | 0 |
| COM - 43 | US Airways = US / AWE | 50 | 25 |
| COM - 44 | US Airways = US / AWE | 61 | 30.5 |
| COM - 45 | US Airways = US / AWE | 50 | 25 |
| COM - 46 | Virgin America = VX / VRD | 45 | 22.5 |
| COM - 47 | Virgin America = VX / VRD | 40 | 20 |
| COM - 48 | JetBlue Airways = B6 / JBU | 45 | 22.5 |
| COM - 49 | Jazz Aviation LP= QK / JZA | 28 | 28 |
| COM - 50 | Jazz Aviation LP= QK / JZA | 0 | 0 |
| COM - 51 | Jazz Aviation LP= QK / JZA | 0 | 0 |
| COM - 52 | Jazz Aviation LP= QK / JZA | 28 | 28 |
| COM - 53 | Frontier Airlines = F9 / FFT | 45 | 45 |
| COM - 54 | Frontier Airlines = F9 / FFT | 45 | 45 |
| COM - 55 | Empire Airlines = EM / CFS | 0 | 0 |
| COM - 56 | Hawaiian Airlines = HA / HAL | 120 | 120 |
| COM - 57 | Hawaiian Airlines = HA / HAL | 560 | 560 |
| COM - 58 | Sun Country Airlines = SY / SCX  | 52 | 52 |
| COM - 59 | Sun Country Airlines = SY / SCX  | 47 | 47 |
| COM - 60 | Korean Air = KE / KAL | 100 | 100 |
| COM - 61 | Korean Air = KE / KAL | 100 | 100 |
| COM - 62 | Korean Air = KE / KAL | 100 | 100 |
| COM - 63 | Korean Air = KE / KAL | 100 | 100 |
| COM - 64 | Korean Air = KE / KAL | 100 | 100 |
| COM - 65 | British Airways = BA / BAW | 125 | 125 |
| COM - 66 | British Airways = BA / BAW | 140 | 140 |
| COM - 67 | British Airways = BA / BAW | 125 | 125 |
| COM - 68 | Air Canada = AC / ACA | 0 | 0 |
| COM - 69 | Asiana Airlines = OZ / AAR | 120 | 120 |
| COM - 70 | Asiana Airlines = OZ / AAR | 120 | 120 |
| COM - 71 | Emirates Airline = EK / UAE | 290 | 290 |
| COM - 72 | Emirates Airline = EK / UAE | 290 | 290 |
| COM - 73 | All Nippon Airways = NH / ANA | 120 | 120 |
| COM - 74 | EVA Air = BR / EVA (aka EVA Airways Corp) | 120 | 60 |
| COM - 75 | EVA Air = BR / EVA (aka EVA Airways Corp) | 120 | 60 |
| COM - 76 | Icelandair = FI / ICE | 600 | 600 |
| COM - 77 | Lufthansa = LH / DLH | 115 | 115 |
| COM - 78 | Hainan Airlines = HU / CHH | 145 | 145 |
| COM - 79 | Hainan Airlines = HU / CHH | 145 | 145 |
| COM - 80 | China Airlines = CI / CAL | 100 | 100 |
| COM - 81 | Omni Air International = OY / OAE | 125 | 125 |
| COM - 82 | Condor = DE / CFG | 125 | 125 |
| COM - 83 | Allegiant Air = G4 / AAY | 40 | 40 |
| COM - 84 | Republic Airlines = RW / RPA | 0 | 0 |
| COM - 85 | Aeromexico = AM / AMX | 40 | 40 |
| COM - 86 | Kalitta Charters = KFS | 30 | 30 |
| COM - 87 | Miami Air International = BSK | 40 | 40 |
| COM - 88 | Nolinor Aviation = NRL | 40 | 40 |
| COM - 89 | Boeing | 100 | 100 |
| COM - 90 | Enerjet = ENJ | 40 | 40 |
| COM - 91 | Singapore | 40 | 40 |
| *Source: LeighFisher, 2015 Note EDMS default time is 26 minutes.*  |

Table A2‑4

**cargo Aircraft APU Usage Inputs in EDMS (2014)**

|  |  |  |
| --- | --- | --- |
| **edms id** | **Airline** | **APU usage per operation (minutes)** |
| CARGO - 01 | FedEx | 180 |
| CARGO - 02 | FedEx | 180 |
| CARGO - 03 | FedEx | 180 |
| CARGO - 04 | FedEx | 180 |
| CARGO - 05 | FedEx | 180 |
| CARGO - 06 | FedEx | 180 |
| CARGO - 07 | FedEx | 180 |
| CARGO - 08 | FedEx | 180 |
| CARGO - 09 | FedEx | 180 |
| CARGO - 10 | FedEx | 180 |
| CARGO - 11 | FedEx | 180 |
| CARGO - 12 | FedEx | 180 |
| *Source: LeighFisher, 2015* |

Table A2‑5

**general aviation Aircraft APU Usage Inputs in EDMS (2014)**

|  |  |  |
| --- | --- | --- |
| **edms id** | **apu type** | **APU usage per operation (minutes)** |
| GA - 01 | GTCP 36-100 | 90 |
| GA - 02 | - | 0 |
| GA - 03 | - | 0 |
| GA - 04 | GTCP 36-100 | 90 |
| GA - 05 | - | 0 |
| GA - 06 | - | 0 |
| GA - 07 | GTCP 36-100 | 90 |
| GA - 08 | - | 0 |
| GA - 09 | GTCP 36-100 | 90 |
| GA - 10 | - | 0 |
| GA - 11 | - | 0 |
| GA - 12 | - | 0 |
| GA - 13 | - | 0 |
| GA - 14 | - | 0 |
| GA - 15 | - | 0 |
| GA - 16 | - | 0 |
| GA - 17 | - | 0 |
| GA - 18 | - | 0 |
| GA - 19 | GTCP 36-100 | 90 |
| GA - 20 | - | 0 |
| GA - 21 | GTCP 36-100 | 90 |
| GA - 22 | - | 0 |
| GA - 23 | - | 0 |
| GA - 24 | - | 0 |
| GA - 25 | - | 0 |
| GA - 26 | - | 0 |
| GA - 27 | - | 0 |
| GA - 28 | GTCP 36-100 | 90 |
| GA - 29 | - | 0 |
| GA - 30 | - | 0 |
| GA - 31 | - | 0 |
| GA - 32 | - | 0 |
| GA - 33 | GTCP 36-100 | 90 |
| GA - 34 | - | 0 |
| GA - 35 | - | 0 |
| GA - 36 | - | 0 |
| *Source: LeighFisher, 2015* |

Table A2‑6

**military Aircraft APU Usage Inputs in EDMS (2014)**

|  |  |  |
| --- | --- | --- |
| **edms id** | **apu type** | **APU usage per operation (minutes)** |
| MIL - 01 | GTCP 85 (200 HP) | 90 |
| *Source: LeighFisher, 2015* |

| Table A2‑7**gse MODELING Inputs in EDMS** |
| --- |
| **edms id** | **GSE Type** | **edms GSE Type** | **fuel type** | **manufacturing year** | **population (units)** |
| AC-1 | Air Heater | Air Conditioner | Diesel | 1998 | 3 |
| AC-2 | Air Heater | Air Conditioner | Diesel | 1999 | 1 |
| AC-3 | Air Heater | Air Conditioner | Diesel | 2000 | 1 |
| AC-4 | Air Heater | Air Conditioner | Diesel | 2004 | 1 |
| AC-5 | Air Heater | Air Conditioner | Gasoline (Modeled as Diesel) | 2007 | 1 |
| AC-6 | Air Heater | Air Conditioner | Diesel | 2008 | 4 |
| AC-7 | Air Heater | Air Conditioner | Diesel | 2003 | 28 |
| AS-1 | Air Start | Air Start | Gasoline | 1997 | 1 |
| AS-2 | Air Start | Air Start | Diesel | 1997 | 13 |
| AS-3 | Air Start | Air Start | Diesel | 1992 | 1 |
| AS-4 | Air Start | Air Start | Diesel | 1995 | 1 |
| AS-5 | Air Start | Air Start | Diesel | 1997 | 1 |
| AS-6 | Air Start | Air Start | Diesel | 1998 | 1 |
| AS-7 | Air Start | Air Start | Diesel | 2001 | 1 |
| AS-8 | Air Start | Air Start | Diesel | 2002 | 1 |
| AS-9 | Air Start | Air Start | Diesel | 2003 | 1 |
| AS-10 | Air Start | Air Start | Diesel | 2006 | 1 |
| AS-11 | Air Start | Air Start | Diesel | 1986 | 1 |
| AS-12 | Air Start | Air Start | Diesel | 1990 | 1 |
| AT-1 | Aircraft Tractor | Aircraft Tractor | Gasoline | 1995 | 1 |
| AT-2 | Aircraft Tractor | Aircraft Tractor | Diesel | 1985 | 1 |
| AT-3 | Aircraft Tractor | Aircraft Tractor | Diesel | 1987 | 1 |
| AT-4 | Aircraft Tractor | Aircraft Tractor | Diesel | 1988 | 1 |
| AT-5 | Aircraft Tractor | Aircraft Tractor | Diesel | 1989 | 1 |
| AT-6 | Aircraft Tractor | Aircraft Tractor | Diesel | 1990 | 1 |
| AT-7 | Aircraft Tractor | Aircraft Tractor | Diesel | 1991 | 1 |
| AT-8 | Aircraft Tractor | Aircraft Tractor | Diesel | 1993 | 1 |
| AT-9 | Aircraft Tractor | Aircraft Tractor | Diesel | 1994 | 1 |
| AT-10 | Aircraft Tractor | Aircraft Tractor | Diesel | 1998 | 1 |
| AT-11 | Aircraft Tractor | Aircraft Tractor | Diesel | 2000 | 1 |
| AT-12 | Aircraft Tractor | Aircraft Tractor | Diesel | 2001 | 2 |
| AT-13 | Aircraft Tractor | Aircraft Tractor | Diesel | 2005 | 1 |
| AT-14 | Aircraft Tractor | Aircraft Tractor | Diesel | 2008 | 1 |
| AT-15 | Aircraft Tractor | Aircraft Tractor | Diesel | 1995 | 46 |
| BT-1 | Baggage Tractors | Baggage Tractors | Gasoline | 1998 | 37 |
| BT-2 | Baggage Tractors | Baggage Tractors | Gasoline | 1986 | 2 |
| BT-3 | Baggage Tractors | Baggage Tractors | Gasoline | 2001 | 1 |
| BT-4 | Baggage Tractors | Baggage Tractors | Gasoline | 2002 | 1 |
| BT-5 | Baggage Tractors | Baggage Tractors | Gasoline | 2003 | 1 |
| BT-6 | Baggage Tractors | Baggage Tractors | Gasoline | 2007 | 1 |
| BT-7 | Baggage Tractors | Baggage Tractors | Gasoline | 2009 | 6 |
| BT-8 | Baggage Tractors | Baggage Tractors | Diesel | 1998 | 33 |
| BT-9 | Baggage Tractors | Baggage Tractors | Diesel | 1985 | 3 |
| BT-10 | Baggage Tractors | Baggage Tractors | Diesel | 1993 | 3 |
| BT-11 | Baggage Tractors | Baggage Tractors | Diesel | 1998 | 2 |
| BT-12 | Baggage Tractors | Baggage Tractors | Diesel | 1999 | 4 |
| BT-13 | Baggage Tractors | Baggage Tractors | Diesel | 2000 | 1 |
| BT-14 | Baggage Tractors | Baggage Tractors | Diesel | 2001 | 1 |
| BT-15 | Baggage Tractors | Baggage Tractors | Diesel | 2002 | 1 |
| BT-16 | Baggage Tractors | Baggage Tractors | Diesel | 2004 | 1 |
| BT-17 | Baggage Tractors | Baggage Tractors | Diesel | 2005 | 2 |
| BT-18 | Baggage Tractors | Baggage Tractors | Diesel | 2006 | 3 |
| BT-19 | Baggage Tractors | Baggage Tractors | Diesel | 1999 | 18 |
| BL-1 | Belt Loader | Belt Loader | Gasoline | 2001 | 22 |
| BL-2 | Belt Loader | Belt Loader | Gasoline | 1990 | 1 |
| BL-3 | Belt Loader | Belt Loader | Gasoline | 1991 | 1 |
| BL-4 | Belt Loader | Belt Loader | Gasoline | 1998 | 1 |
| BL-5 | Belt Loader | Belt Loader | Gasoline | 2000 | 6 |
| BL-6 | Belt Loader | Belt Loader | Gasoline | 2002 | 2 |
| BL-7 | Belt Loader | Belt Loader | Gasoline | 2003 | 2 |
| BL-8 | Belt Loader | Belt Loader | Gasoline | 2005 | 1 |
| BL-9 | Belt Loader | Belt Loader | Gasoline | 2006 | 1 |
| BL-10 | Belt Loader | Belt Loader | Diesel | 2001 | 29 |
| BL-11 | Belt Loader | Belt Loader | Diesel | 2007 | 6 |
| BL-12 | Belt Loader | Belt Loader | Diesel | 2009 | 1 |
| BL-13 | Belt Loader | Belt Loader | Propane | 2001 | 1 |
| BL-14 | Belt Loader | Belt Loader | Propane | 1999 | 3 |
| CST-1 | Cabin Service/Catering Truck | Cabin Service Truck | Gasoline | 2000 | 3 |
| CST-2 | Cabin Service/Catering Truck | Cabin Service Truck | Gasoline | 1994 | 1 |
| CST-3 | Cabin Service/Catering Truck | Cabin Service Truck | Diesel | 2000 | 11 |
| CST-4 | Cabin Service/Catering Truck | Cabin Service Truck | Diesel | 2006 | 1 |
| CL-1 | Cargo Loader | Cargo Loader | Diesel | 1998 | 21 |
| CL-2 | Cargo Loader | Cargo Loader | Diesel | 1987 | 1 |
| CL-3 | Cargo Loader | Cargo Loader | Diesel | 1991 | 1 |
| CL-4 | Cargo Loader | Cargo Loader | Diesel | 1992 | 1 |
| CL-5 | Cargo Loader | Cargo Loader | Diesel | 1993 | 1 |
| CL-6 | Cargo Loader | Cargo Loader | Diesel | 1994 | 2 |
| CL-7 | Cargo Loader | Cargo Loader | Diesel | 1995 | 1 |
| CL-8 | Cargo Loader | Cargo Loader | Diesel | 1997 | 1 |
| CL-9 | Cargo Loader | Cargo Loader | Diesel | 1999 | 1 |
| CL-10 | Cargo Loader | Cargo Loader | Diesel | 2000 | 8 |
| CL-11 | Cargo Loader | Cargo Loader | Diesel | 2001 | 1 |
| CL-12 | Cargo Loader | Cargo Loader | Diesel | 2002 | 2 |
| CL-13 | Cargo Loader | Cargo Loader | Diesel | 2004 | 1 |
| CL-14 | Cargo Loader | Cargo Loader | Diesel | 2006 | 3 |
| CL-15 | Cargo Loader | Cargo Loader | Diesel | 2007 | 2 |
| CL-16 | Cargo Loader | Cargo Loader | Gasoline | 1998 | 7 |
| CL-17 | Cargo Loader | Cargo Loader | Propane | 1998 | 1 |
| DT-1 | Deicing Truck | Deicing Truck | Diesel (Modeled as Gasoline) | 1991 | 32 |
| DT-2 | Deicing Truck | Deicing Truck | Diesel (Modeled as Gasoline) | 1982 | 1 |
| DT-3 | Deicing Truck | Deicing Truck | Diesel (Modeled as Gasoline) | 1989 | 1 |
| DT-4 | Deicing Truck | Deicing Truck | Diesel (Modeled as Gasoline) | 1993 | 1 |
| DT-5 | Deicing Truck | Deicing Truck | Gasoline | 1991 | 4 |
| DT-6 | Deicing Truck | Deicing Truck | Gasoline | 1997 | 1 |
| DT-7 | Deicing Truck | Deicing Truck | Gasoline | 1986 | 1 |
| DT-8 | Deicing Truck | Deicing Truck | Gasoline | 1996 | 1 |
| DT-9 | Deicing Truck | Deicing Truck | Gasoline | 1997 | 1 |
| FL-1 | Forklift | Forklift | Diesel | 1998 | 5 |
| FL-2 | Forklift | Forklift | Propane | 1998 | 13 |
| FT-1 | Fuel Truck | Fuel Truck | Diesel | 1995 | 1 |
| FT-2 | Fuel Truck | Fuel Truck | Diesel | 1997 | 21 |
| FT-3 | Fuel Truck | Fuel Truck | Diesel | 1998 | 1 |
| LT-1 | Lavatory Truck | Lavatory Truck | Diesel | 1994 | 7 |
| LT-2 | Lavatory Truck | Lavatory Truck | Gasoline | 1994 | 13 |
| L-1 | Lift | Lift | Diesel | 2001 | 20 |
| L-2 | Lift | Lift | Gasoline | 1996 | 1 |
| L-3 | Lift | Lift | Gasoline | 2000 | 1 |
| L-4 | Lift | Lift | Gasoline | 2001 | 2 |
| L-5 | Lift | Lift | Gasoline | 2006 | 1 |
| L-6 | Lift | Lift | Propane | 2001 | 2 |
| LC-1 | Light Cart/Light Stand | Other | Diesel | 2014 | 11 |
| LC-2 | Light Cart/Light Stand | Other | Gasoline | 2014 | 1 |
| PS-1 | Passenger Stairs | Passenger Stand | Diesel | 2001 | 1 |
| PS-2 | Passenger Stairs | Passenger Stand | Diesel | 2007 | 1 |
| PS-3 | Passenger Stairs | Passenger Stand | Diesel | 2011 | 1 |
| PS-4 | Passenger Stairs | Passenger Stand | Diesel | 1998 | 4 |
| PS-5 | Passenger Stairs | Passenger Stand | Diesel | 1971 | 1 |
| PS-6 | Passenger Stairs | Passenger Stand | Gasoline | 1998 | 4 |
| PS-7 | Passenger Stairs | Passenger Stand | Propane | 1998 | 1 |
| UC-1 | Utility Cart | Cart | Diesel (Modeled as Gasoline) | 2014 | 12 |
| UC-2 | Utility Cart | Cart | Propane (Modeled as Gasoline) | 2014 | 3 |
| GPU-1 | Ground Power Unit | Ground Power Unit | Diesel | 2001 | 36 |
| GPU-2 | Ground Power Unit | Ground Power Unit | Diesel | 1987 | 1 |
| GPU-3 | Ground Power Unit | Ground Power Unit | Diesel | 1988 | 2 |
| GPU-4 | Ground Power Unit | Ground Power Unit | Diesel | 1996 | 1 |
| GPU-5 | Ground Power Unit | Ground Power Unit | Diesel | 1999 | 2 |
| GPU-6 | Ground Power Unit | Ground Power Unit | Diesel | 2000 | 2 |
| GPU-7 | Ground Power Unit | Ground Power Unit | Diesel | 2001 | 1 |
| GPU-8 | Ground Power Unit | Ground Power Unit | Diesel | 2004 | 2 |
| GPU-9 | Ground Power Unit | Ground Power Unit | Diesel | 2008 | 6 |
| GPU-10 | Ground Power Unit | Ground Power Unit | Diesel | 2011 | 1 |
| GPU-11 | Ground Power Unit | Ground Power Unit | Gasoline | 2001 | 1 |
| MT-1 | Other Airfield Support/Box Truck/Water Truck | Service Truck | Diesel | 2002 | 1 |
| MT-2 | Maintenance Truck; Other Airfield Support/Box Truck/Water Truck | Service Truck | Diesel | 2005 | 26 |
| MT-3 | Other Airfield Support/Box Truck/Water Truck | Service Truck | Diesel | 2008 | 1 |
| MT-4 | Other Airfield Support/Box Truck/Water Truck | Service Truck | Gasoline | 2005 | 5 |
| MT-5 | Other Airfield Support/Box Truck/Water Truck | Service Truck | Natural Gas | 2005 | 1 |
| MT-6 | Other Airfield Support/Box Truck/Water Truck | Service Truck | Propane | 2005 | 2 |
| * Age: EDMS default values were used.
* Horsepower: EDMS default values were used.
* Average Vehicle Speed for GSE modeled were assigned the default average speed of 10 mph.
* Load Factor: the EDMS default values were used.
* Operating Time: EDMS default values were used.

*Source: LeighFisher, 2015* |

Table A2‑8

**Boilers - Stationary Sources EDMS Inputs**

| **edms id** | **stationary source** | **type** | **10003 cubic meters per year** |
| --- | --- | --- | --- |
| Boil - Bus Maint. | Boiler | Natural Gas: Wall Fired Boiler, <100 Million BTU/hr, Uncontrolled |  59.22  |
| Boil - Central Plant | Boiler | Natural Gas: Wall Fired Boiler, <100 Million BTU/hr, Uncontrolled |  8,015.16  |
| Boil - Dist. Center | Boiler | Natural Gas: Residential Furnace |  16.14  |
| Boil - Fire Dept. | Boiler | Natural Gas: Wall Fired Boiler, <100 Million BTU/hr, Uncontrolled |  76.60  |
| Boil - Fleet Maint. | Boiler | Natural Gas: Wall Fired Boiler, <100 Million BTU/hr, Uncontrolled |  144.86  |
| Boil - Learn Center | Boiler | Natural Gas: Residential Furnace |  23.78  |
| Boil - Pumphouse | Boiler | Natural Gas: Residential Furnace |  3.50  |
| *Source: LeighFisher, 2015* |

Table A2‑9

**generators - Stationary Sources EDMS Inputs (2014)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **GENERATOR/PUMP** | **edms id** | **stationary source** | **type** | **annual operating hours** | **horsepower rating (HP)** |
| Airfield Light 1 | Gen - Airfld Light 1 | Generator | Diesel Fuel | 122.7 | 2,400 |
| Airfield Light 2 | Gen - Airfld Light 1 (2) | Generator | Diesel Fuel | 122.7 | 2,400 |
| Building Lights 1 | Gen - Airfld Light 1 (3) | Generator | Diesel Fuel | 122.7 | 2,400 |
| Building Lights 2 | Gen - Airfld Light 2 | Generator | Diesel Fuel | 87.7 | 2,400 |
| Boiler 3 Generator | Gen - Airfld Light 2 (2) | Generator | Diesel Fuel | 87.7 | 2,400 |
| Concourse A C4 | Gen - Airfld Light 2 (3) | Generator | Diesel Fuel | 87.7 | 2,400 |
| Concourse A Fire | Gen - Bldg Lights 1 | Generator | Diesel Fuel | 4 | 67 |
| Concourse A STEP | Gen - Bldg Lights 2 | Generator | Diesel Fuel | 5.2 | 80 |
| Parking Garage | Gen - Boiler 3 | Generator | Diesel Fuel | 1 | 380 |
| Pump 01 | Gen - Conc A C4 | Generator | Diesel Fuel | 33 | 1,341 |
| Pump 02 | Gen - Conc A C4 (2) | Generator | Diesel Fuel | 33 | 1,341 |
| Pump 03 | Gen - Conc A Fire | Generator | Diesel Fuel | 3.5 | 240 |
| Pump 04 | Gen - Conc A STEP | Generator | Diesel Fuel | 2 | 2012 |
| Pump 05 | Gen - Conc A STEP (2) | Generator | Diesel Fuel | 2 | 2012 |
| Pump 07 | Gen - Parking Garage | Generator | Diesel Fuel | 4.4 | 235 |
| Pump 8 | Gen - Pump 01 | Generator | Diesel Fuel | 6.8 | 412 |
| Toll Plaza | Gen - Pump 02 | Generator | Diesel Fuel | 6.6 | 412 |
| WWTP | Gen - Pump 03 | Generator | Diesel Fuel | 2.6 | 412 |
| GENERATOR/PUMP | Gen - Pump 04 | Generator | Diesel Fuel | 7.4 | 412 |
| Airfield Light 1 | Gen - Pump 05 | Generator | Diesel Fuel | 4.5 | 380 |
| Airfield Light 2 | Gen - Pump 07 | Generator | Diesel Fuel | 5.6 | 380 |
| Building Lights 1 | Gen - Pump 8 | Generator | Diesel Fuel | 4.4 | 380 |
| Building Lights 2 | Gen - Toll Plaza | Generator | Diesel Fuel | 4.1 | 503 |
| Boiler 3 Generator | Gen - WWTP | Generator | Diesel Fuel | 16.6 | 165 |
| *Source: LeighFisher, 2015* |

Table A2‑10

**Roadway Traffic EDMS Inputs (2014)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **edms id** | **edms vehicle class** | **manufactured year** | **fuel type** | **average speed (mph)** | **vmt per 1,000 vehicles** |
| 01 Passenger Cars | Light Duty Vehicles (Passenger Cars) | 2007 | Gasoline |  30  |  54,065  |
| 02 Taxicabs | Light Duty Vehicles (Passenger Cars) | 2010 | Gasoline |  30  |  6,773  |
| 03 Limousines | Light Duty Trucks 1 | 2008 | Gasoline |  30  |  4,027  |
| 04 Rental Shuttles (CNG) | Class 3 Heavy Duty Vehicles | 2004 | CNG |  15  |  1,199  |
| 05 Hotel Shuttles | Class 3 Heavy Duty Vehicles | 2004 | Gasoline |  15  |  3,486  |
| 06 Parking Shuttles | Class 3 Heavy Duty Vehicles | 2004 | Gasoline |  15  |  5,179  |
| 07 Charter/Cruises | Class 3 Heavy Duty Vehicles | 1999 | Diesel |  30  |  87.42  |
| 08 Shared Van (Diesel) | Light Duty trucks 3 | 2009 | Diesel |  25  | 57 |
| 09 Shared Van (LPG) | Light Duty trucks 3 | 2004 | Propane |  25  |  517  |
| 10 Airporters | Class 3 Heavy Duty Vehicles | 1999 | Diesel |  30  |  146  |
| 11 Airline Shuttles (CNG) | Class 3 Heavy Duty Vehicles | 1999 | CNG |  20  |  563  |
| 12 Serv Delivery | Class 3 Heavy Duty Vehicles | 2004 | CNG |  20  |  235  |
| *Note: VMT is vehicle miles travelled.* *Source: LeighFisher, 2015* |

# Appendix: Emissions by source

This section provides detailed emissions for each source type:

* Auxiliary Power Units
* Ground Support Equipment
* Stationary Sources
* Parking Traffic
* Roadway Traffic

Table A3‑1

**aircraft engine Emissions by Arrivals/Departures and Remain-Over-Nights**

|  |  |
| --- | --- |
| **emission source** | **short tons of pollutants (2014)** |
| **nox** | **VOC** | **CO** | **SOx** | **pm-10** | **PM-2.5** | **total** |
| **Aircraft Engines** |  **1,623**  |  **242**  |  **1,329**  | **158**  | **22**  |  **22**  |  **3,395**  |
|  Arrivals/Departures |  1,435  |  224  |  1,208  | 141 | 20 | 20 |  3,047  |
|  RONs |  188  |  18  |  121  | 17 | 2 | 2 |  348  |
| *Note: APUs = Auxiliary Power Units; RON = Remain-Over-Night**Numbers may not add up to due rounding.**Source: LeighFisher, 2016* |

Table A3‑2

**Auxiliary Power Units Emissions by Arrivals/Departures and Remain-Over-Nights**

|  |  |
| --- | --- |
| **emission source** | **short tons of pollutants (2014)** |
| **nox** | **VOC** | **CO** | **SOx** | **pm-10** | **PM-2.5** | **total** |
| **APUs (Total)** |  **72**  |  **5**  |  **48**  |  **9**  | **8**  |  **8**  |  **149**  |
|  Arrivals/Departures |  65  | 4 | 44 | 8 | 8 | 8 |  136  |
|  RONs |  7  | 0 | 3 | 1 | 1 | 1 |  13  |
| *Note: APUs = Auxiliary Power Units; RON = Remain-Over-Night**Numbers may not add up due to rounding.**Source: LeighFisher, 2016* |

Table A3‑3

**Auxiliary Power Unit Emissions by Airline**

|  |  |
| --- | --- |
| **Airline** | **short tons of pollutants (2014)** |
| **nox** | **VOC** | **CO** | **SOx** | **pm-10** | **PM-2.5** | **total** |
| Alaska Airlines | 261 | 28 | 174 | 25 | 3 | 3 | **494** |
| Horizon Air | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| Delta Airlines | 349 | 36 | 287 | 33 | 4 | 4 | **713** |
| Southwest Airlines | 182 | 21 | 126 | 17 | 2 | 2 | **351** |
| United Airlines | 136 | 15 | 86 | 12 | 2 | 2 | **254** |
| SkyWest Airlines | 0 | 0 | 2 | 0 | 0 | 0 | **3** |
| American Airlines | 23 | 2 | 14 | 2 | 0 | 0 | **42** |
| Compass Airlines | 0 | 0 | 1 | 0 | 0 | 0 | **1** |
| US Airways | 57 | 3 | 25 | 5 | 1 | 1 | **92** |
| Virgin America | 24 | 2 | 24 | 2 | 0 | 0 | **53** |
| JetBlue Airways | 11 | 0 | 4 | 1 | 0 | 0 | **17** |
| Jazz Aviation | 29 | 68 | 146 | 9 | 2 | 2 | **256** |
| Frontier Airlines | 12 | 3 | 14 | 1 | 0 | 0 | **31** |
| Empire Airlines | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| Hawaiian Airlines | 10 | 1 | 6 | 1 | 0 | 0 | **18** |
| Sun Country Airlines | 5 | 1 | 4 | 0 | 0 | 0 | **10** |
| Korean Airlines | 40 | 3 | 33 | 5 | 1 | 1 | **81** |
| British Airways | 58 | 9 | 45 | 5 | 1 | 1 | **118** |
| Air Canada | 15 | 2 | 14 | 2 | 0 | 0 | **34** |
| Asiana Airlines | 42 | 4 | 48 | 4 | 0 | 0 | **100** |
| Emirates Airlines | 13 | 1 | 16 | 2 | 0 | 0 | **33** |
| Nippon Airways | 0 | 0 | 1 | 0 | 0 | 0 | **1** |
| EVA Air | 3 | 0 | 2 | 0 | 0 | 0 | **5** |
| Iceland Air | 2 | 1 | 2 | 0 | 0 | 0 | **5** |
| Lufthansa | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| Hainan Airlines | 0 | 0 | 1 | 0 | 0 | 0 | **1** |
| China Airlines | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| Omni Air International | 13 | 0 | 3 | 1 | 0 | 0 | **18** |
| Condor | 11 | 2 | 14 | 1 | 0 | 0 | **29** |
| Allegiant Air | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| Republic Airlines | 9 | 0 | 5 | 1 | 0 | 0 | **16** |
| Aeromexico | 4 | 1 | 4 | 0 | 0 | 0 | **10** |
| Kalitta Charters | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| Miami Air International | 4 | 0 | 1 | 0 | 0 | 0 | **6** |
| Nolinor Aviation | 32 | 5 | 29 | 3 | 0 | 0 | **69** |
| Boeing | 4 | 0 | 2 | 0 | 0 | 0 | **6** |
| Enerjet | 112 | 10 | 61 | 10 | 1 | 1 | **195** |
| Singapore |  0 |  0 |  0 |  0 |  0 |  0 |  **0** |
| **Total** | **1,463** | **222** | **1,195** | **143** | **20** | **20** | **3,063** |
| *Note: Numbers may not add up due to rounding.**Source: LeighFisher, 2016* |

Table A3‑4

**ground support equipment emissions by equipment type**

|  |  |
| --- | --- |
| **gse type** | **short tons of pollutants (2014)** |
| **nox** | **VOC** | **CO** | **SOx** | **pm-10** | **PM-2.5** | **total** |
| Air Conditioner | 33 | 1 | 12 | 0 | 2 | 2 | **494** |
| Air Start | 21 | 2 | 38 | 0 | 1 | 1 | **0** |
| Aircraft Tractor | 0 | 0 | 0 | 0 | 0 | 0 | **713** |
| Baggage Tractor | 51 | 19 | 594 | 5 | 4 | 4 | **351** |
| Belt Loader | 28 | 12 | 399 | 3 | 2 | 1 | **254** |
| Cabin Service Truck | 19 | 5 | 168 | 1 | 1 | 1 | **3** |
| Cargo Loader | 19 | 4 | 83 | 1 | 2 | 2 | **42** |
| Cart | 0 | 0 | 2 | 0 | 0 | 0 | **1** |
| Deicer | 32 | 22 | 780 | 7 | 0 | 0 | **92** |
| Fork Lift | 3 | 1 | 13 | 0 | 0 | 0 | **53** |
| Fuel Truck | 3 | 0 | 1 | 0 | 0 | 0 | **17** |
| Ground Power Unit | 76 | 7 | 77 | 1 | 6 | 6 | **256** |
| Lavatory Truck | 8 | 2 | 66 | 1 | 1 | 0 | **31** |
| Lift | 4 | 1 | 23 | 0 | 0 | 0 | **0** |
| Other | 4 | 1 | 8 | 0 | 0 | 0 | **18** |
| Passenger Stand | 1 | 0 | 7 | 0 | 0 | 0 | **10** |
| Service Truck |  6 |  1 |  22 |  0 |  0 |  0 |  **81** |
| **Total** | **307** | **78** | **2,292** | **19** | **21** | **20** | **3,063** |
| *Note: GSE = Ground Support Equipment**Numbers may not add up due to rounding.**Source: LeighFisher, 2016* |

Table A3‑5

**stationary source emissions by source type**

|  |  |
| --- | --- |
| **stationary source** | **short tons of pollutants (2014)** |
| **nox** | **VOC** | **CO** | **SOx** | **pm-10** | **PM-2.5** | **total** |
| Boiler | 14 | 1 | 12 | 0 | 1 | 1 | **29** |
| Generator |  3 |  0 |  1 |  0  |  0 |  0 |  **5** |
| **Total** | 17 | 1 | 12 | 1 | 1 | 0 | **34** |
| *Numbers may not add up due to rounding.**Source: LeighFisher, 2016* |

Table A3‑6

**roadway traffic emissions by source type**

|  |  |
| --- | --- |
| **roadway type** | **short tons of pollutants (2014)** |
| **nox** | **VOC** | **CO** | **SOx** | **pm-10** | **PM-2.5** | **total** |
| Airline Shuttles | 0 | 0 | 1 | 0 | 0 | 0 | **1** |
| Airporters | 0 | 0 | 0 | 0 | 0 | 0 | **1** |
| Charter/Cruises | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| Hotel shuttles | 8 | 3 | 31 | 0 | 0 | 0 | **46** |
| Limousines | 1 | 1 | 23 | 0 | 0 | 0 | **27** |
| Parking Shuttles | 11 | 4 | 45 | 0 | 0 | 0 | **68** |
| Passenger cars | 8 | 9 | 290 | 0 | 1 | 0 | **340** |
| Rental shuttles | 0 | 0 | 2 | 0 | 0 | 0 | **2** |
| Serv Delivery | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| Shared Van Diesel | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| Shared Van Propane | 0 | 0 | 1 | 0 | 0 | 0 | **1** |
| Taxicabs |  0 |  1 |  26 |  0 |  0 |  0 |  **30** |
| **Total** | **32** | **19** | **462** | **1** | **2** | **0** | **516** |
| *Note: GSE = Ground Support Equipment**Numbers may not add up due to rounding.**Source: LeighFisher, 2016* |

1. After initiation of the SAMP, the FAA released the Aviation Environmental Design Tool (AEDT) Version 2b for use in preparing airport air quality analyses. Because the study was scoped for EDMS, and initiated before the release of AEDT, EDMS was used. It is anticipated that the two models would produce similar results. [↑](#footnote-ref-1)
2. FAA ASPM data for the year 2014. <https://aspm.faa.gov/apm/sys/> (see spreadsheet – (2014 ASPM Data.xls) [↑](#footnote-ref-2)
3. ACRP 02-16: *Airport Ground Support Equipment (GSE) Emission Reduction Strategies, Inventory and Tutorial* (2012) as documented in ACRP Report 78 <http://www.trb.org/Main/Blurbs/168172.aspx> [↑](#footnote-ref-3)
4. Vissim is a multi-modal traffic flow simulation software system used to simulate traffic conditions on roadways. [↑](#footnote-ref-4)
5. Federal Aviation Administration, Voluntary Airport Low Emission Program Technical Report Version 7 (Revised December 2, 2010), Table 5-2 [↑](#footnote-ref-5)
6. United States Environmental Protection Agency, EPA420-R-02-005, January 2002, Update Heavy-Duty Engine Emission Conversion Factors for MOBILE6 [↑](#footnote-ref-6)
7. According to the EIA, CNG has a fuel density about 38% less than gasoline. <https://www.eia.gov/todayinenergy/detail.cfm?id=14451> [↑](#footnote-ref-7)
8. The US Department of Energy estimates that CNG-powered vehicles achieve approximately the same fuel economy as a conventional gasoline vehicle, <http://www.afdc.energy.gov/fuels/natural_gas_basics.html> [↑](#footnote-ref-8)