# Hartsfield-Jackson Atlanta International Airport

Documentation for the CY 2014 Criteria Air Pollutant Emission Inventory

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# 1. Introduction

Presented herein is an emissions inventory of calendar year (CY) 2014 air emissions from non-permitted sources operating at Hartsfield-Jackson Atlanta International Airport (H-JAIA). The inventory was prepared for inclusion in the State Implementation Plan (SIP) for the year 2015 ozone (O3) National Ambient Air Quality Standard (NAAQS) that is being prepared by the Georgia Department of Natural Resources Environmental Protection Division (EPD). Accordingly, emissions of nitrogen oxides ($NO_x$) and volatile organic compounds (VOC), which are precursors to $O_3$ formation, are presented.

Although the SIP is being prepared for the purposes of $O_3$ compliance, the provided inventory also includes estimates of the U.S. Environmental Protection Agency's (EPA's) other criteria pollutants which are: carbon monoxide (CO), particulate matter measuring ten micrometers or less in diameter ($PM_{10}$), particulate matter measuring 2.5 micrometers or less in diameter ($PM_{2.5}$), and sulfur dioxide ($SO_2$).[1]

The H-JAIA sources for which emissions are provided in this report are: aircraft, auxiliary power units (APUs), and ground service equipment (GSE). The detailed methodologies, input data and assumptions that were used to develop the CY 2014 emissions inventory are also provided.

# 2. Emissions Inventory Results

CY 2014 emissions from aircraft, APUs and GSE are summarized on **Table 1**. As shown, in CY 2014 these sources are estimated to have emitted 7,975 tons of CO, 5,013 tons of $NO_x$, 103 tons of $PM_{10}$, 102 tons of $PM_{2.5}$, 581 tons of $SO_2$, and 708 tons of VOC.

[1] Of note, emissions of lead (Pb) are discounted from this inventory because there is only a nominal amount of activity at H-JAIA that is performed by piston engine powered aircraft fueled by leaded aviation gasoline.

**TABLE 1 – CY 2014 ANNUAL EMISSIONS INVENTORY (TONS)**

| Source | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | VOC |
|---|---|---|---|---|---|---|
| **Aircraft** | **5,561** | **4,630** | **71** | **71** | **554** | **617** |
| Startup[a] | -- | -- | -- | -- | -- | 145 |
| Taxi-Out | 3,420 | 690 | 25 | 25 | 201 | 294 |
| Takeoff | 39 | 1,961 | 15 | 15 | 104 | 5 |
| Climb Out | 26 | 1,070 | 9 | 9 | 65 | 3 |
| Approach | 287 | 482 | 9 | 9 | 73 | 18 |
| Taxi-in | 1,789 | 428 | 14 | 14 | 112 | 153 |
| **APUs** | **204** | **132** | **22** | **22** | **20** | **15** |
| **GSE** | **2,210** | **251** | **9** | **9** | **7** | **76** |
| **Total** | **7,975** | **5,013** | **103** | **102** | **581** | **708** |

[a] EDMS only provides estimates of VOCs from starting an engine(s) on an aircraft.
Values may reflect rounding.
Source: Emissions and Dispersion Modeling System (EDMS) version 5.1.4.1
Prepared by KB Environmental Sciences, Inc., 2020.

# 3. Emissions Inventory Methodology

The calculation methodologies, input data, and assumptions that were used to develop the CY 2014 emissions estimate are described in the following sections of this report.

## 3.1. Aircraft

The number of aircraft operations and the type of aircraft that operate at an airport (the aircraft fleet mix) are important factors in estimating the level of air pollutant/precursor emissions. In the year 2014, there were 868,359 annual operations. The Federal Aviation Administration's (FAA's) Emissions and Dispersion Modeling System EDMS v.5.1.4.1 was used to estimate emissions from aircraft operating within Landing/Take-Off cycles (LTOs). One LTO includes one aircraft arrival and one aircraft departure where are comprised of the following aircraft operational modes: approach, taxi-in, startup, taxi-out, take-off, and climb-out. The EDMS definitions of each of these operational modes is provided below:

- Approach" begins when an aircraft descends below the atmospheric mixing height and ends when an aircraft touches down on a runway
- "Taxi-in" includes the time an aircraft taxis between the runway and a terminal and all ground-based delay incurred through the aircraft route.

- "Startup" begins with fuel flowing into an aircraft engine's annular combustor. At this point, any emissions are unburned, raw fuel vapor (i.e., VOC).[2]
- "Taxi/out" includes the time aircraft taxi between a terminal and a runway and all ground-based delay incurred through the aircraft route.
- "Takeoff" begins when full power is applied to an aircraft and ends when an aircraft reaches approximately 500 to 1,000 feet. At this altitude, pilots typically power back for a gradual ascent.
- "Climb Out" begins when an aircraft powers back from the takeoff mode and ascends to the height of the atmospheric mixing zone.

Area-specific atmospheric mixing height data was used in the EDMS. Notably, the mixing height affects only the time and aircraft is in the operational modes of approach for arrivals and climb out for departures. For the purpose of preparing the year 2014 emissions inventory, the EDMS default mixing height of 3,000 feet was assumed.

The CY 2014 aircraft fleet mix was developed using H-JAIA-specific data that was extracted from the City of Atlanta Department of Aviation's (DOA's) Noise and Operations Monitoring System (NOMS). Because aircraft destination data (i.e., trip or stage length data) were not available for the year 2014, EDMS default trip lengths were assumed.

**Table 2** provides the number of LTOs by each EDMS aircraft airframe and engine combination as well as aircraft category (i.e., passenger air carrier aircraft, passenger commuter aircraft, etc.). For the purpose of estimating emissions associated with the aircraft taxi mode, average airport-wide taxi times were obtained from the FAA's Aviation Performance System Metrics (ASPM) database. For CY 2014, the average ASPM taxi in time for arrivals was 11.43 minutes and the average taxi out time for departures was 22.02 minutes.

[2] *Engine Startup Emissions*, International Civil Aviation Organization (ICAO)/Committee on Aviation Environmental Protection (CAEP) Working Group 3, May 2006.

**TABLE 2 –AIRCRAFT FLEET MIX AND NUMBER OF LTOS**

| Aircraft Category | EDMS Aircraft | EDMS Engine | Number of LTOs |
|---|---|---|---|
| Passenger – Air Carrier | Airbus A319-100 Series | CFM56-5A5 | 13,952 |
| | Airbus A320-100 Series | CFM56-5-A1 | 5,144 |
| | Airbus A320-100 Series | CFM56-5B4 | 5,144 |
| | Airbus A320-100 Series | CFM56-5B4 | 1,193 |
| | Airbus A320-100 Series | V2527-A5 | 1,193 |
| | AirbusA321-200Series | CFM56-5B3/P | 1,985 |
| | AirbusA330-300Series | CF6-80E1A3 | 109 |
| | AirbusA330-300Series | PW4168TalonII | 1,364 |
| | AirbusA330-300Series | Trent772 | 109 |
| | AirbusA380-800Series | GP7270 | 226 |
| | Boeing717-200Series | BR700-715A1-30 | 53,229 |
| | Boeing737-700Series | CFM56-7B20 | 5,655 |
| | Boeing737-700Series | CFM56-7B22 | 17,323 |
| | Boeing737-700Series | CFM56-7B26(8CM051) | 5,859 |
| | Boeing737-800Series | CFM56-7B26E | 28,049 |
| | Boeing747-400Series | RB211-524H | 680 |
| | Boeing747-8 | GEnx-2B67TAPS(11GE139) | 237 |
| | Boeing757-200Series | PW2037(4PW072) | 47,662 |
| | Boeing757-300Series | PW2043 | 3,190 |
| | Boeing767-200ER | CF6-80A2 | 3,329 |
| | Boeing767-300ER | CF6-80C2B6 | 3,329 |
| | Boeing767-300ER | PW4060PhaseIII | 3,329 |
| | Boeing767-400 | CF6-80C2B8F | 2,371 |
| | Boeing777-200-ER | GE90-115B | 364 |
| | Boeing777-200-ER | GE90-85BDACII(3GE064) | 1,213 |
| | Boeing777-200-ER | GE90-90BDACII(6GE090) | 1,213 |
| | BoeingDC-9-50Series | JT8D-17Reducedemissions | 158 |
| | BoeingMD-82 | JT8D-217 | 937 |
| | BoeingMD-83 | JT8D-217 | 39,541 |
| | BoeingMD-83 | JT8D-219EnvironmentalKit(E_Kit) | 39,541 |
| | BoeingMD-90 | V2525-D5 | 35,694 |
| | BombardierCRJ-700 | CF34-8C1 | 12,527 |
| | BombardierCRJ-900 | CF34-8C5LEC(8GE110) | 21,142 |
| | EmbraerERJ170 | CF34-8E5LEC(8GE108) | 4,754 |
| | EmbraerERJ190 | CF34-10E6SAC | 796 |
| Passenger - Commuter | BombardierCRJ-200-LR | CF34-3B | 55,950 |
| | EmbraerERJ135-LR | AE3007A1E | 1,094 |
| | EmbraerERJ145-LR | AE3007A1Type3(reducedemissions) | 3,411 |
| | Saab340-B-Plus | CT7-9B | 2,395 |
| Cargo – Air Carrier | AirbusA300B4-600Series | CF6-80C2A5(1GE020) | 293 |
| | AirbusA300B4-600Series | PW4158 | 293 |
| | AirbusA340-300Series | CFM56-5C4 | 285 |
| | Boeing747-300Series | CF6-80C2B1 | 242 |
| | Boeing747-400Freighter | PW4056 | 242 |
| | Boeing747-400Series | PW4062 | 242 |
| | Boeing747-400Series | RB211-524H | 242 |
| | Boeing747-8Freighter | GEnx-2B67TAPS(11GE139) | 331 |

| Aircraft Category | EDMS Aircraft | EDMS Engine | Number of LTOs |
|---|---|---|---|
| | Boeing757-200SeriesFreighter | PW2040(4PW073) | 444 |
| | Boeing757-200SeriesFreighter | RB211-535E4(3RR028) | 268 |
| | Boeing767-200Series | PW4060PhaseIII | 57 |
| | Boeing767-200SeriesFreighter | CF6-80A | 57 |
| | Boeing767-300Series | CF6-80C2B6 | 472 |
| | Boeing777-200-LRFreighter | GE90-110B1 | 151 |
| | Boeing777-200-LRFreighter | GE90-115B | 151 |
| | BoeingDC-10-30ER | CF6-50C2 | 626 |
| | BoeingMD-11Freighter | CF6-80C2D1F | 382 |
| Cargo – General Aviation | BombardierChallenger600 | ALF502L-2 | 97 |
| | BombardierLearjet31 | TFE731-2-2B | 263 |
| | Cessna208Caravan | PT6A-114A | 529 |
| | Cessna560CitationV | PW530 | 126 |
| | Cessna560CitationXLS | JT15D-5,-5A,-5B | 263 |
| | Cessna750CitationX | AE3007CType2 | 112 |
| | deHavillandDHC-6-200TwinOtter | PT6A-20 | 122 |
| | deHavillandDHC-8-100 | PW121 | 151 |
| | RaytheonBeech1900-D | PT6A-67D | 261 |
| | RaytheonBeechjet400 | JT15D-5,-5A,-5B | 125 |
| General Aviation | BombardierGlobalExpress5000 | BR700-710A2-20 | 105 |
| | BombardierLearjet45 | TFE731-2-2B | 154 |
| | Cessna172Skyhawk | IO-320-D1AD | 215 |
| | Cessna441ConquestII | TPE331-10 | 182 |
| | Cessna500CitationI | JT15D-1series | 99 |
| | Cessna525CitationJet | JT15D-1series | 99 |
| | Cessna560CitationXLS | JT15D-5,-5A,-5B | 129 |
| | DassaultFalcon2000 | PW308C | 178 |
| | deHavillandDHC-6-200TwinOtter | PT6A-20 | 153 |
| | GulfstreamIV-SP | TAY611-8C | 123 |
| | MitsubishiMU-300Diamond | JT15D-4series(1PW036) | 126 |
| | PiaggioP.180Avanti | PT6A-66 | 102 |
| | RaytheonBeechBaron58 | TIO-540-J2B2 | 143 |
| | RaytheonHawker800 | TFE731-3 | 154 |
| Total | | | 434,180 |

## 3.2. Auxiliary Power Units

An APU is a small turbine engine that is used on some aircraft to generate electricity and compressed air. APUs operate the aircraft's instruments, lights, ventilation and other equipment when the aircraft's main engines are shut down. An APU also provides power to restart the aircraft's main engines after shutdown. APU's may be activated when an aircraft is on approach and may also be used during taxiing. However typically pilots use APUs shortly before departing a gate and prior to the time when pre-flight instrument checks are performed.

For the purpose of estimating emissions from APUs, and because recent airport-specific data was unavailable, the EDMS default APU usage (i.e., run time) of 26 minutes per LTO was assumed.

## 3.3. Ground Service Equipment

EDMS calculates emissions from GSE as a function of the fuel type, operating hours per LTO, and the estimated horsepower of the equipment. As with APUs and because recent airport-specific data was unavailable, the EDMS default GSE assignments by aircraft type as well as GSE usage (i.e., run times) by aircraft type were assumed. The EDMS default GSE and default run times are listed in **Table 3**.

# 4. Operational Profiles

For the purpose of generally distributing the annual emissions presented in Table 1 to any month, day, or hour of CY 2014, operational profiles that describe the level of activity at the airport were derived using data from the NOMS. The profiles are provided in **Table 4**. At the request of the Georgia Environmental Protection Division (GA EPD), daily operational profiles specific to the month of July were also derived. Using the profiles, the level of aircraft, APU, and GSE air pollutant and pollutant precursor emissions that occurred on an average workday (i.e., Monday through Friday) in July of CY 2014 was also estimated. These data are provided in **Table 5**.

### TABLE 3 –EDMS DEFAULT GSE

| GSE | Fuel Type | Horsepower | Load Factor | Operating Time (minutes) | |
|---|---|---|---|---|---|
| | | | | Departure | Arrival |
| F250 / F350 | Diesel | 235 | 0.20 | 8 | 7 |
| FMC Commander 15 | Diesel | 80 | 0.50 | 40 | 40 |
| Hi-Way / TUG 660 Chassis | Diesel | 71 | 0.53 | 5 | 5 |
| Hi-Way F650 | Diesel | 210 | 0.53 | 8 | 7 |
| Hi-Way F650 | Diesel | 210 | 0.53 | 10 | 10 |
| Hi-Way F650 | Diesel | 210 | 0.53 | 18 | 17 |
| Stewart & Stevenson TUG 660 | Gasoline | 107 | 0.50 | 15 | 15 |
| Stewart & Stevenson TUG 660 | Gasoline | 107 | 0.50 | 18 | 17 |
| Stewart & Stevenson TUG 660 | Gasoline | 107 | 0.50 | 24 | 24 |
| Stewart & Stevenson TUG MA 50 | Gasoline | 107 | 0.55 | 18 | 17 |
| Stewart & Stevenson TUG MA 50 | Gasoline | 107 | 0.55 | 38 | 37 |
| Stewart & Stevenson TUG MA 50 | Gasoline | 107 | 0.55 | 60 | 60 |
| TLD 1410 | Diesel | 56 | 0.25 | 0 | 15 |
| Wollard TLS-770 / F350 | Diesel | 235 | 0.25 | 0 | 25 |

### TABLE 4 – OPERATIONAL PROFILES

| Monthly Profile | | Daily Profile | | Hourly Profile | |
|---|---|---|---|---|---|
| January | 0.863 | Monday | 1.000 | 0 | 0.051 |
| February | 0.801 | Tuesday | 0.978 | 1 | 0.023 |
| March | 1.000 | Wednesday | 0.968 | 2 | 0.014 |
| April | 0.950 | Thursday | 0.990 | 3 | 0.012 |
| May | 0.981 | Friday | 0.997 | 4 | 0.026 |
| June | 0.967 | Saturday | 0.847 | 5 | 0.095 |
| July | 0.992 | Sunday | 0.957 | 6 | 0.206 |
| August | 0.980 | | | 7 | 0.485 |
| September | 0.928 | | | 8 | 0.907 |
| October | 0.967 | | | 9 | 0.914 |
| November | 0.901 | | | 10 | 0.916 |
| December | 0.930 | | | 11 | 0.808 |
| | | | | 12 | 0.847 |
| | | | | 13 | 0.776 |
| | | | | 14 | 0.889 |
| | | | | 15 | 1.000 |
| | | | | 16 | 0.874 |
| | | | | 17 | 0.854 |
| | | | | 18 | 0.859 |
| | | | | 19 | 0.998 |
| | | | | 20 | 0.799 |
| | | | | 21 | 0.654 |
| | | | | 22 | 0.478 |
| | | | | 23 | 0.180 |

### TABLE 5 – CY 2014 EMISSIONS INVENTORY FOR A WEEKDAY IN JULY (TONS)

| Source | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | VOC |
|---|---|---|---|---|---|---|
| Aircraft | 14.5 | 12.0 | 0.2 | 0.2 | 1.4 | 1.6 |
| APUs | 0.5 | 0.3 | 0.1 | 0.1 | 0.1 | <0.1 |
| GSE | 5.7 | 0.7 | <0.1 | <0.1 | <0.1 | 0.2 |
| Total | 20.7 | 13.0 | 0.3 | 0.3 | 1.5 | 1.8 |

[a] EDMS only provides estimates of VOCs from starting an engine(s) on an aircraft.
[b] The level of emissions that occurred on an average weekday in July in CY 2014 is estimated to be approximately 0.26 percent of the total annual emissions in Table 1.
Values may reflect rounding.
Source: Emissions and Dispersion Modeling System (EDMS) version 5.1.4.1
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