J. Air Quality, Greenhouse Gases and Emissions Reductions

This appendix provides the following detailed information and data tables in support of Chapter 8, *Air Quality and Greenhouse Gas Emissions*:

J.1 Fundamentals of Air Quality

This section contains a summary of air quality and air emissions with a particular emphasis on airport-related emissions where appropriate. This material is intended to supplement and provide background information for the materials contained in Chapter 8, *Air Quality and Greenhouse Gas Emissions*.

J.1.1 Pollutant Types and Standards

The U.S. Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) for a select group of "criteria air pollutants" designed to protect public health, the environment, and the quality of life from the detrimental effects of air pollution. Listed alphabetically, these pollutants are briefly described below. The NAAQS are listed in Section II, *Regulatory Framework* of this appendix.

- **Carbon monoxide (CO)** is a colorless, odorless, tasteless gas. It may temporarily accumulate, especially in cool, calm weather conditions, when fuel use reaches a peak and CO is chemically most stable due to the low temperatures. CO from natural sources usually dissipates quickly, posing no threat to human health. Transportation sources (e.g., motor vehicles), energy generation, and open burning are among the predominant anthropogenic (i.e., man-made) sources of CO.
- **Lead (Pb)** in the atmosphere is generated from industrial sources including waste oil and solid waste incineration, iron and steel production, lead smelting, and battery and lead manufacturing. The lead content of motor vehicle emissions, which was the major source of lead in the past, has significantly declined with the widespread use of unleaded fuel. Low-lead fuel used in some general aviation (GA) aircraft is still a source of airport-related lead.
- **Nitrogen dioxide (NO_2)**, nitric oxide (NO), and the nitrate radical (NO_3) are collectively called oxides of nitrogen (NO_X). These three compounds are interrelated, often changing from one form to another in chemical reactions, and NO_2 is the compound commonly measured for comparison to the NAAQS. NO_X is generally emitted as NO, which is oxidized to NO_2. The principal man-made source of NO_X is fuel combustion in motor vehicles and power plants – aircraft engines are also a source. Reactions of NO_X with other atmospheric chemicals can lead to formation of ozone (O_3) and acidic precipitation.
- **Ozone (O_3)** is a secondary pollutant, formed from daytime reactions of NO_X and volatile organic compounds (VOCs) in the presence of sunlight. VOCs, which are a subset of hydrocarbons (HC) and have no NAAQS, are released in industrial processes and from evaporation of gasoline and solvents. Sources of NO_X are discussed above.
- **Particulate matter ($PM_{10}/PM_{2.5}$)** comprises very small particles of dirt, dust, soot, or liquid droplets called aerosols. The NAAQS for $PM_{10}/PM_{2.5}$ is segregated by sizes (i.e., equal to or less than 10 and equal to or less than 2.5 microns as PM_{10} and $PM_{2.5}$, respectively). $PM_{10}/PM_{2.5}$ is formed as an exhaust product in the internal combustion engine or can be generated from the breakdown and dispersion of other solid materials (e.g., fugitive dust).

- **Sulfur oxides (SO_X)** are primarily composed of sulfur dioxide (SO_2) which is emitted in natural processes and by man-made sources such as combustion of sulfur-containing fuels and sulfuric acid manufacturing.
- Additionally, there are gases that trap heat in the atmosphere that are called greenhouse gases (GHGs). GHGs are also associated with airport activities. The primary GHGS that are associated with Logan Airport operations are listed and described below.
- **Carbon dioxide (CO_2)** enters the atmosphere through burning fossil fuels (i.e., coal, natural gas, and oil), solid waste, trees, and other biological materials, and also as a result of certain chemical reactions (e.g., cement production). Carbon dioxide is removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle.
- **Methane (CH_4)** is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices, land use, and the decay of organic waste in municipal solid waste landfills.
- **Nitrous oxide (N_2O)** is emitted during agricultural, land use, and industrial activities; combustion of fossil fuels and solid waste; as well as during treatment of wastewater.
- Currently there are no specific U.S. laws or regulations that call for the regulation of GHGs for airports directly.

J.1.2 Sources of Airport Air Emissions

Large metropolitan airports generate air emissions from the following general source categories: aircraft, auxiliary power unit (APUs), ground service equipment (GSE), motor vehicles traveling to, from, and moving about the airport; fuel storage and transfer facilities; a variety of stationary sources (e.g., steam boilers, back-up generators); an assortment of aircraft maintenance activities (e.g., painting, cleaning, repair); routine airfield, roadway, and building maintenance activities (e.g., painting, cleaning, repair); and periodic construction activities for new projects or improvements to existing facilities.

Table J-1 provides a summary listing of airport-related sources of air emissions, the associated pollutants, and their characteristics.

Table J-1 Airport-related Sources of Air Emissions

Sources	Emissions	Characteristics
Aircraft	CO, NO_2, PM_{10}/$PM_{2.5}$, SO_2, VOCs and GHGs	Exhaust products of fuel combustion vary depending on aircraft engine type, number of engines, power setting, and period of operation. Emissions are also emitted by an aircraft's auxiliary power unit (APU).
Motor vehicles	CO, NO_2, PM_{10}/$PM_{2.5}$, SO_2, VOCs and GHGs	Exhaust products of fuel combustion from patron and employee traffic approaching, departing, and moving about the airport site. Emissions vary depending on vehicle type, distance traveled, operating speed, and ambient conditions.
Ground service equipment (GSE)	CO, NO_2, PM_{10}/$PM_{2.5}$, SO_2, VOCs and GHGs	Exhaust products of fuel combustion from service trucks, tow tugs, belt loaders, and other portable equipment.
Fuel storage and handling	VOCs	Formed from the evaporation and vapor displacement of fuel from storage tanks and fuel handling facilities. Emissions vary with fuel usage, type of storage tank, refueling method, fuel type, vapor recovery, climate, and ambient temperature.
Stationary sources	CO, NO_2, PM_{10}/$PM_{2.5}$, SO_2, VOCs and GHGs	Exhaust products of fossil fuel combustion from boilers dedicated to indoor heating requirements and emissions from incinerators used for waste reduction. Emissions are generally well controlled with operational techniques and post-burn collection methods. Sources include boilers and hot water generators, emergency generators, incinerators, surface coating operations, welding operations, and firefighting facilities.
Construction Activities[1]	CO, NO_2, PM_{10}/$PM_{2.5}$, SO_2, VOCs and GHGs	Construction projects may have associated emissions from dust generated during excavation and land clearing, exhaust emissions from construction equipment and motor vehicles, and evaporative emissions from asphalt paving and painting. The amount of particulate emissions varies with the material type, the amount of area exposed, and meteorology. The construction of airport and airfield improvement projects at airports represents temporary sources of emissions.

Source: CMT, 2024.

Notes: CO - carbon monoxide; GHGs – greenhouse gases; NO_2 - nitrogen dioxide; PM_{10}/$PM_{2.5}$ - particulate matter equal to or less than 10 microns in diameter (PM_{10}) and equal to or less than 2.5 microns in diameter ($PM_{2.5}$); $SO_{2.5}$ - sulfur dioxide; and VOC - volatile organic compounds.

Air emissions associated with construction activities at Logan Airport were not computed for the 2022 analysis.

J.2 Regulatory Framework

The federal Clean Air Act (CAA), National Ambient Air Quality Standards (NAAQS), and similar state laws govern air quality issues in Massachusetts. The NAAQS and the Massachusetts State Implementation Plan (SIP), a document that describes measures to attain and maintain compliance with the NAAQS, regulate air quality in the Boston Metropolitan Area and other areas of the state. These regulations as well as those associated with GHGs are discussed in the following sections.

J.2.1 National Ambient Air Quality Standards (NAAQS)

The NAAQS for these criteria air pollutants are subdivided into the Primary Standards (designed to protect human health) and the Secondary Standards (designed to protect the environment and human welfare) and are listed below in **Table J-2**. Exceedances of these values constitute violations of the NAAQS.

Table J-2 NAAQS

Pollutant	Primary/ Secondary	Averaging Time	Standard		Form
			ppm	µg/m3	
Carbon Monoxide (CO)	Primary	8 hours	9	10,000	Not to be exceeded more than once a year.
		1 hour	35	40,000	Not to be exceeded more than once a year.
Lead (Pb)	Primary and Secondary	Rolling 3-Month Average	—	0.15	Not to exceed this level.
Nitrogen Dioxide (NO_2)	Primary	1 hour	0.100	188	The 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 0.100 ppm.
	Primary and Secondary	Annual	0.053	100	Not to exceed this level.
Ozone (O_3)	Primary and Secondary	8 hours[1]	0.070	—	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years.
Particulate Matter with a diameter ≤10µm (PM_{10})	Primary and Secondary	24 hours	—	150	Not to be exceeded more than once a year on average over 3 years.
Particulate Matter with a	Primary and Secondary	24 hours	—	35	The 3-year average of the 98th percentile for each population-oriented monitor within an area is not to exceed this level.

Table J-2 NAAQS

Pollutant	Primary/ Secondary	Averaging Time	Standard		Form
			ppm	µg/m3	
diameter ≤2.5µm ($PM_{2.5}$)	Primary	Annual	—	12	The 3-year average of the weighted annual mean from single or multiple monitors within an area is not to exceed this level.
	Secondary	Annual	—	15	The 3-year average of the weighted annual mean from single or multiple monitors within an area is not to exceed this level.
Sulfur Dioxide (SO_2)	Primary	1 hour	0.075	196	The 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed this level.
	Secondary	3 hours	0.5	1,300	Not to be exceeded more than once a year.

Source: U.S. Environmental Protection Agency (EPA), "NAAQS Table." August 21, 2023, (https://www.epa.gov/criteria-air-pollutants/naaqs-table).

Note: There are no NAAQS standards for NO_X. µg/m^3 - micrograms per cubic meter; ppm - parts per million.

1 Final rule signed October 1, 2015, and effective December 28, 2015. A 2008 O_3 standard remains in effect in some areas.

J.2.2 Air Quality Designation Status

EPA, state, and local air quality agencies maintain outdoor air monitoring networks to measure air quality conditions and gauge compliance with the NAAQS. Based upon the data collected by these agencies, all areas throughout the country are designated by U.S.EPA with respect to their compliance with the NAAQS. **Table J-3** provides the definitions of each of these designations.

Table J-3 EPA Air Quality Designations

Attainment	Maintenance	Nonattainment Area	Unclassifiable
Any area that meets the NAAQS established for each criteria air pollutant.	Any area that is in transition from formerly being a Nonattainment area to an Attainment area (referred to as a Maintenance area).	Any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) one or more of the NAAQS.	Any area that cannot be classified based on available information as meeting or not meeting the NAAQS.

Source: CMT, 2024.

For O_3, CO, PM_{10}, and $PM_{2.5}$, the nonattainment designations are further classified by the severity, or degree, of the violation of the NAAQS. For example, in the case of O_3, these classifications range from highest to lowest as extreme, severe, serious, marginal, and moderate.

The nonattainment designation of an area has a bearing on the emission control measures required and the time periods allotted by which a State Implementation Plan (SIP) must demonstrate attainment of the NAAQS. It is also important to note that the degree of nonattainment determines the thresholds that are "*de minimis,*" or levels below which a formal SIP General Conformity Determination is not required.

Finally, the boundaries of nonattainment areas are generally determined based on Core Based Statistical Areas (CBSA) as defined by U.S. census data (air monitoring station locations and contributing emission sources also play a role). Regional pollutants such as O_3 can encompass multiple CBSAs and can extend across state lines. Nonattainment areas for localized pollutants, such as lead and CO, typically only comprise a partial CBSA or a local "hot-spot."

Logan Airport is in the Boston Metropolitan Area. In accordance with the CAA, all areas within Massachusetts are designated as either attainment, nonattainment, or maintenance with respect to the NAAQS.[1,2] The regulatory air quality designation statuses for the Boston Metropolitan Area, as of the publication of this *2022 ESPR*, are listed in **Table J-4**. As shown, the area is designated to be in attainment of all pollutants, except for CO, which is designated to be in maintenance. Notably, there has not been a measured exceedance of the CO standards since 1995 (28 years) and, in 2018, the Massachusetts Department of Environmental Protection (MassDEP) published a Second 10-Year Limited Maintenance Plan for CO that details the agency's plans to maintain levels of CO below the standards.[3]

Table J-4 Air Quality Designation Status for the Boston Metropolitan Area

Pollutant		Designation
Ozone (O_3)	2008 Standard	Attainment
	2015 Standard	Attainment
Carbon Monoxide (CO)		Maintenance[1]
Nitrogen Dioxides (NO_2)		Attainment
Particulate Matter (PM_{10})		Attainment
Particulate Matter ($PM_{2.5}$)		Attainment

1 U.S.EPA, Nonattainment Areas for Criteria Pollutants (Green Book). https://www.epa.gov/green-book.

2 An area with air quality levels that meet or are below the NAAQS is designated as attainment; an area with air quality levels that are above the NAAQS is designated as nonattainment; and an area that has attained the NAAQS but remains subject to certain requirements of the CAA is designated as maintenance. An area may also be designated as unclassifiable when there is lack of data to form a basis for determining attainment status. Nonattainment areas can be further classified as extreme, severe, serious, moderate, and marginal by the degree of non-compliance with the NAAQS.

3 Commonwealth of Massachusetts, Massachusetts Department of Environmental Planning, Revision to the Massachusetts State Implementation Plan for Carbon Monoxide, Second 10-Year Limited Maintenance Plan for the Boston Metropolitan Area, Lowell, Springfield, Waltham, and Worcester. February 9, 2018.

Table J-4 Air Quality Designation Status for the Boston Metropolitan Area

Pollutant	Designation
Sulfur Dioxide (SO_2)	Attainment
Lead (Pb)	Attainment

Source: U.S.EPA, "Nonattainment Areas for Criteria Pollutants (Green Book)," August 30, 2023, https://www.epa.gov/green-book.

1 The Boston Metropolitan Area was redesignated to a maintenance area for CO on April 1, 1996. Although the 20-year maintenance period has lapsed, the details/requirements of the maintenance plan that are in the SIP continue to be in the SIP until the State/Area makes a SIP revision requesting removal of such a maintenance plan.

Historically, the Boston Metropolitan Area, as well as other areas of Massachusetts, was designated nonattainment for O_3 standards that were promulgated in 1979 and 1997 and were subsequently revoked.[4] Due to the requirements of the CAA, MassDEP remains obligated to enforce SIP elements that address O_3. The current O_3 standard for which the area is designated attainment was promulgated in 2015. The 2015 O_3 NAAQS is a revision to the 2008 O_3 NAAQS. The 2015 revision strengthened (i.e., lowered) the standard by which areas would be designated attainment or nonattainment. From the time that the 2008 NAAQS was promulgated, there have been no exceedances of either NAAQS.[5]

While the Boston Metropolitan Area is designated attainment for O_3, the entire state of Massachusetts, along with 10 other states and a Consolidated Metropolitan Statistical Area that includes the District of Columbia and northern Virginia, comprise an Ozone Transport Region (OTR).[6] Because Massachusetts is in the OTR, the state is required to submit a SIP to the U.S.EPA and provide a certain level of controls on the sources that emit the pollutants that form O_3, even though the area is designated attainment for the pollutant. Within the Boston Metropolitan Area, major new or modified sources must comply with Reasonably Available Control Technology (RACT) requirements of the SIP to lower emissions of the O_3-forming pollutants (i.e., NO_X and VOC).

J.2.3 State Implementation Plans (SIPs)

For the purposes of this summary explanation of SIPs, it is sufficient to characterize SIPs as the principal instrument by which a state formulates and implements its strategies for bringing Nonattainment or Maintenance areas into compliance with the NAAQS. In equally broad terms, the SIP contains the necessary emission limitations, control measures and timetables for achieving this objective. Therefore,

4 The 1979 standard was revoked on June 15, 2005 (https://www.epa.gov/green-book/designation-and-naaqs-information-related-1-hour-ozone-1979-standard-naaqs-revoked), and the 1997 standard was revoked on April 6, 2015 (https://www.epa.gov/green-book/designation-and-naaqs-information-related-8-hour-ozone-1997-standard-naaqs-revoked).

5 The 2008 O_3 NAAQS was promulgated by the U.S.EPA on May 12, 2012 (Federal Register, Vol 77, No. 98, Page 30160).

6 Ozone can travel with the wind over long distances, creating air quality problems far downwind of pollution sources and can be transported across state borders. Therefore, the Ozone Transport Commission (OTC), which is a multi-state organization, was created under the CAA. The OTC is responsible for advising U.S.EPA on transport issues and for developing and implementing regional solutions to the ground-level ozone problem in the Northeast and Mid-Atlantic regions known as the OTR. The OTR encompasses 11 states, including Massachusetts. The CAA sets out specific requirements for the OTR states. These requirements entail submitting a SIP and installing a certain level of controls for the pollutants that form ozone (VOC and NO_X), even if they meet the ozone standards.

the SIP development process is delegated to state air quality agencies that may in turn rely on regional, county, and local agencies to help prepare emission inventories that include airport-related emissions.

The SIPs prepared for Massachusetts detail the State's regulatory plans for maintaining levels of CO and O_3 below the NAAQS. The SIPs that are applicable to the Boston Metropolitan Area are listed in **Table J-5**. Included in the SIPs is a measure to control the growth of parking spaces which was meant to decrease the number of VMT in the South Boston neighborhood of Boston. The number of commercial and employee parking spaces allowed at Logan Airport is regulated by the Logan Airport Parking Freeze (310 Code of Massachusetts Regulations 7.30), which is an element of the Massachusetts SIP under the CAA (42 U.S.C. §7401 et seq. [1970]).

The intent of the Logan Airport Parking Freeze is to reduce air emissions by shifting air passengers to travel modes that require fewer vehicle trips. However, survey data since the 1970s has consistently shown that constrained parking has the unintended consequence of shifting air passengers to travel modes with higher numbers of vehicle trips, despite Massport's extensive efforts to provide and encourage the use of HOV travel modes. An amendment to increase the Logan Airport Parking Freeze by 5,000 on-Airport commercial parking spaces was finalized on March 6, 2018, and effective on April 5, 2018. For additional information, see Chapter 6, *Ground Access*.

Table J-5 SIPs for the Boston Metropolitan Area

Standard	Title	Status	Comments
Carbon Monoxide (CO)	Maintenance Plan	Published February 2018	This second 10-year Maintenance Plan is required for any area that was formerly designated as nonattainment to show that it will not regress to a nonattainment status. The current maintenance plan meets the requirements of Section 175A of the CAA and conforms to U.S.EPA guidance for CO maintenance plans.[1]
Ozone (O_3)	2008 SIP	Certified February 2018	In February 2018, MassDEP's transport SIP was certified. This Certification fulfilled the interstate transport requirements in Section 110(a)(2)(D)(i) of the CAA and completed MassDEP's Infrastructure SIP Certification in accordance with Sections 110(a) (1) and (2) of the CAA for the 2008 O_3 NAAQS.[2]
	2015 SIP	Certified September 2018	In October 2015, U.S.EPA lowered (i.e., made stricter) the NAAQS for O_3. In September 2018, MassDEP's infrastructure SIP was certified. This certification fulfilled the infrastructure requirements of CAA Sections 110(a)(1) and (2), as well as interstate transport requirements in Section 110(a)(2)(D)(i).[3]

Table J-5 SIPs for the Boston Metropolitan Area

Standard	Title	Status	Comments
	2008 and 2015 SIP	Published October 2018	MassDEP prepared this revision to the Massachusetts SIP to address RACT requirements for the 2008 and 2015 8-hour O_3 NAAQS. For certain source categories, MassDEP is submitting regulations that establish new or more stringent RACT controls. For other source categories, MassDEP is certifying that previously adopted RACT regulations and controls represent RACT for implementing the 2008 and 2015 O_3 NAAQS.[4]

Source: Commonwealth of Massachusetts, Massachusetts Department of Environmental Protection, "Massachusetts State Implementation Plans (SIPs)." August 30, 2023, https://www.mass.gov/lists/massachusetts-state-implementation-plans-sips#ozone-sip-.

Notes: The number of commercial and employee parking spaces allowed at Logan Airport is regulated by the Logan Airport Parking Freeze (310 Code of Massachusetts Regulations 7.30 and 40 Code of Federal Regulations 52.1120), which is an element of the State Implementation Plan (SIP) under the federal Clean Air Act (CAA).

CAA – Clean Air Act, U.S.EPA – Environmental Protection Agency, MassDEP – Massachusetts Department of Environmental Protection, CO – Carbon Monoxide, O_3 – Ozone, SIP – State Implementation Plan, NAAQS – National Ambient Air Quality Standards, and RACT – Reasonably Available Control Technology.

1 Commonwealth of Massachusetts, Massachusetts Department of Environmental Protection, Second 10-Year Limited Maintenance Plan for the Boston Metropolitan Area, Lowell, Springfield, Waltham, and Worcester, February 9, 2018.

2 Commonwealth of Massachusetts, Massachusetts Department of Environmental Protection, Certification of Adequacy of the Massachusetts State Implementation Plan with Clean Air Act Section 110(a)(2)(D)(i) Interstate Air Pollution Transport Requirements for the 2008 Ozone National Ambient Air Quality Standards, February 9, 2018.

3 Commonwealth of Massachusetts, Massachusetts Department of Environmental Protection, Certification of Adequacy of the Massachusetts State Implementation Plan Regarding Clean Air Act Sections 110(a)(1) and (2) for the 2015 Ozone National Ambient Air Quality Standards, September 27, 2018.

4 Commonwealth of Massachusetts, Massachusetts Department of Environmental Protection, Massachusetts Reasonably Available Control Technology State Implementation Plan Revision For the 2008 and 2015 Ozone National Ambient Air Quality Standards, October 18, 2018.

J.2.4 Logan Airport Air Quality Permits for Stationary Sources of Emissions

Massport received a Title V Air Quality Operating Permit for Logan Airport in September 2004, and the most recent renewal was issued in July 2015. At the time of this filing, Massport is in the process of renewing its Title V Operating permit.[7] This permit covers Massport-operated stationary sources including the Central Heating and Cooling Plant, snow melters, fuel dispensers, boilers, emergency generators, and fuel storage tanks.

J.2.5 Greenhouse Gas Policy and Guidelines

GHGs are known to contribute to climate change. In 2009, the U.S.EPA issued a proposed finding that GHGs also contribute to air pollution that may endanger public health or welfare. This action laid the initial legal groundwork for the regulation of GHG emissions nationwide under the CAA, although currently there are no specific U.S. laws or regulations that call for the regulation of GHGs for airports

7 Minor Modification (Application) No. MBR-95-OPP-094RM.

directly.[8] According to the U.S.EPA's most recent *Inventory of U.S. GHG Emissions and Sinks*, published in 2023, aircraft emissions represent 6.6 percent of the U.S. transportation sector GHG emissions. In turn, the transportation sector's GHG emissions are estimated to be 29 percent of total U.S. emissions compared with other sectors, including commercial and residential (30 percent), industry (30 percent), and agriculture (11 percent).[9]

In May 2010, the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) revised the *Massachusetts Environmental Policy Act (MEPA) Greenhouse Gas Emissions Policy and Protocol*.[10] Under the revised policy, certain projects subject to review under MEPA (though not annual EDR/ESPR filings) are required to:

- Quantify GHG emissions generated by a proposed project; and
- Identify measures to avoid, minimize, or mitigate such emissions.[11]

With respect to the *2022 ESPR* GHG emissions inventories,[12] the following information is noteworthy:

- Although the *2022 ESPR* is not subject to the MEPA GHG policy (because it does not propose any discrete projects), since the *2007 EDR,* Massport has voluntarily prepared an inventory of GHG emissions both directly and indirectly associated with the Airport.
- The emission source categories in the *2022 ESPR* comply with MEPA's requirement to analyze the environmental impacts of direct and indirect mobile and stationary source emissions.
- The 2022 GHG emissions inventories were prepared following methodological guidance by the Transportation Research Board's (TRB) Airport Cooperative Research Program (ACRP) Report 11: *Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories*[13] as well as the guidance of the Airports Council International (ACI) Airport Carbon Accreditation (ACA) Program.[14] The inventory assigns GHG emissions based on Scopes 1, 2, and 3, which are based on ownership or control (whether they are controlled by Massport, the airlines or other airport tenants, or the public).

---

8 GHG emission reduction measures have been adopted by the U.S.EPA for new aircraft engines, but these regulations do not apply directly to airports.

9 EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021*, (published 2023), https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2021.

10 Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs, Revised MEPA Greenhouse Gas Emissions Policy and Protocol, effective May 5, 2010, https://www.mass.gov/files/documents/2016/08/rp/ghg-policy-final-summary.pdf.

11 GHGs are comprised primarily of carbon dioxide CO_2, methane CH_4, nitrous oxides N_2O, and three groups of fluorinated gases (i.e., sulfur hexafluoride [SF6], hydrofluorocarbons [HFCs], and perfluorocarbons [PFCs]). GHG emission sources associated with airports are generally limited to CO_2, CH_4, and N_2O.

12 This ESPR GHG inventory is one of three that Massport prepares annually; however, the other two comprise only stationary sources of GHGs and are filed with MassDEP and the U.S.EPA, respectively. These reports are for Massport-owned-and-operated equipment only, and do not cover any tenant-owned/operated-equipment or facilities.

13 National Academies of Sciences, Engineering, and Medicine 2009, Transportation Research Board, Airport Cooperative Research Program, Report 11: *Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories*, 2009, Washington, D.C.: The National Academies Press, https://nap.nationalacademies.org/catalog/14225/guidebook-on-preparing-airport-greenhouse-gas-emissions-inventories.

14 ACA, https://aci-lac.aero/airport-carbon-accreditation/.

- Massport has direct ownership or control over a small percentage of the GHG emission sources (which include Massport fleet vehicles, stationary sources, and electrical consumption within Massport buildings). As with most commercial service airports, the majority of the GHG emission sources are owned or controlled by the airlines, other airport tenants (such as rental car companies), and the public (such as passenger motor vehicles).
- Massport also prepares two other GHG emissions inventories for stationary sources at Logan Airport:
- A GHG emissions inventory for the MassDEP GHG Emissions Reporting Program for those sources meeting the criteria for Category 1 and Scope 1 (only those sources under the direct ownership and control of Massport);[15,16] and
- A U.S.EPA Greenhouse Gas Summary Report. [17]

Consistent with ACRP and ACA guidelines, the GHG emissions in the *2022 ESPR* are based on ownership and control and are delineated as follows:

- **Scope 1/Direct** – GHG emissions from sources that are owned and controlled by the reporting entity (in this case, Massport), such as stationary sources and Airport-owned fleet motor vehicles.
- **Scope 2/Indirect** – GHG emissions associated with the generation of electricity consumed but generated off-site at public utilities.
- **Scope 3/Indirect and Optional** – GHG emissions that are associated with the activities of the reporting entity (in this case, Massport), but are associated with sources that are owned and controlled by others. These include aircraft-related emissions, emissions from Airport tenant activities, as well as ground transportation to and from the Airport.

J.3 Modeling Tools

The modeling tools and emission factor databases used to estimate emissions for calendar year 2022 and the Future Planning Horizon are described in the sections below.

J.3.1 FAA Aviation Environmental Design Tool (AEDT)

Massport uses the Federal Aviation Administration's (FAA's) Aviation Environmental Design Tool (AEDT, Version 3e)[18] for air quality modeling of aircraft-related emissions. AEDT replaced the FAA's legacy Emissions and Dispersion Modeling System (EDMS) tool in 2015. The AEDT model was used for the first time for the emission estimates reported in the *2016 EDR*.

15 Boston Logan International Airport. 2022. Massachusetts Department of Environmental Protection (MassDEP) GHG Emissions Reporting Program.

16 Starting with the 2016 reporting year MassDEP combined GHG Reporting with its Source Registration reporting program.

17 EPA, Greenhouse Gas Summary Report for Boston Logan International Airport for calendar year 2022.

18 U.S. Department of Transportation (DOT), Federal Aviation Administration, "Aviation Environmental Design Tool (AEDT)," https://aedt.faa.gov/. At the time of the preparation of the *2022 ESPR*, AEDT Version 3e (released on May 9, 2022) was the latest version of AEDT.

The AEDT noise and air quality model was released in 2015 and is FAA's approved computer model for calculating emissions from aircraft-related sources. As discussed in Chapter 7, *Noise*, AEDT is also designed to assess airport noise. The AEDT model was developed to incorporate the most up-to-date and best-available science. The latest version of AEDT at the time of the *2022 ESPR* emission estimates was AEDT3e, which was released in May of 2022.

AEDT3e introduced new features, improvements, and updates from the previous model version 3d used in the *2020/2021 EDR,* primarily aimed at the processes and inputs used to compute dispersion modeling. However, the model changes that may affect the results of the 2022 air quality emissions inventories are minor and consist of the following:[19]

- Updates to emissions calculations for boiler/heater, fuel tank, sand salt pile, and solvent degreaser based on the latest U.S.EPA approved methodologies, and
- Updates to the "Airport," "Fleet" and "Study" database within AEDT.

Furthermore, the earliest model applied was in the 1990 inventory which was prepared using the Logan Dispersion Modeling System (LDMS). The 1998 through 2015 inventories were prepared using EDMS (the version of which varied by year), and the 2016 through 2022 inventories used AEDT (multiple versions). As stated in the *2016 EDR*, there are significant differences in EDMS and AEDT that resulted in differences when comparing the results between the two models. The primary differences are described in the *2016 EDR* as being differences in the input data, variances in the aircraft operational characteristics, and differences in the aircraft times-in-mode (in particular those for aircraft climb out during which emissions of NO_X are greatest), emission factors, and a more robust airframe/engine database in AEDT. Additionally, there continue to be updates and variances between versions of AEDT.

J.3.2 EPA Motor Vehicle Emission Simulator (MOVES)

At the time that emission estimates were prepared for the *2022 ESPR*, MOVES Version 3.1 was the U.S.EPA's latest approved computer model for estimating emissions from mobile sources (i.e., on-road motor vehicles and most nonroad equipment).[20] MOVES estimates emissions at the national, county, and project level for criteria air pollutants/precursor pollutants, GHGs, and air toxics. Compared to the previous version (i.e., MOVES3.0.3), MOVES3.1 incorporates minor revisions. MOVES3.1 adds an inspection/maintenance (I/M) program benefit for Class 2b and 3 gasoline trucks with a gross vehicle weight rating of between 8,500 and 14,000 pounds (Regulatory Class 41). With this minor revision, these trucks will now receive the same proportional I/M benefit for exhaust emissions as lower-classification gasoline trucks. This benefit was missing in previous versions of MOVES.

19 U.S. DOT, Federal Aviation Administration, Aviation Environmental Design Tool, Version 3e, https://aedt.faa.gov/3e_information.aspx.

20 EPA, "MOVES3 Update Log", webpage accessed on August 21, 2023, https://www.epa.gov/moves/moves3-update-log.

According to the U.S.EPA release notes, this minor revision may decrease VOC, NO_X, and CO emissions in some areas, but it will not substantially change on-road criteria air pollutant emission rates in MOVES3 at the County Scale.[16]

J.3.3 GHG Emission Factors Hub

The GHG emissions inventory was prepared using U.S.EPA's GHG Emission Factors Hub (modified on April 1, 2022).[21] U.S.EPA's GHG Emission Factors Hub was designed to provide organizations with a regularly updated and easy-to-use set of default emission factors for organizational GHG reporting. Key sources for these emission factors include:

- EPA's Greenhouse Gas Reporting Program.
- EPA's Emissions & Generation Resource Integrated Database (eGRID).
- Inventory of U.S. Greenhouse Gas Emissions and Sinks.
- Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4).

J.4 Emissions Inventory Data Inputs and Assumptions

The following sections provide the data inputs and assumptions associated with Logan Airport operations used to prepare the 2022 and Future Planning Horizon analyses. Air emissions associated with Logan Airport operations result from aircraft, GSE (including APUs), motor vehicles, and a source category called "other." Each of these sources of emissions for both years is presented in **Table J-6** along with the input data, assumptions, and brief descriptions of the assessment methodology.

J.4.1 Overall Data Inputs and Assumptions

Logan Airport operations result from aircraft, GSE (including APUs), motor vehicles, and a source category called "other." Each of these sources of emissions for the 2022 and Future Planning Horizon years are presented in **Table J-6** along with the input data, assumptions, and brief descriptions of the assessment methodology.

Notably, there are several limitations on the predictive ability of air quality models relating to years as distant as 10 to 15 years out. For example, the FAA's AEDT model used to conduct the aircraft and GSE analyses is often updated by FAA, but these updates do not account for future-year technological changes. The EDRs and ESPRs update assumptions and technological advances as they are available.

21 EPA, GHG Emission Factors Hub, accessed on November 20, 2023, https://www.epa.gov/climateleadership/ghg-emission-factors-hub.

Table J-6 Overall Data Inputs and Assumptions by Source

Source	Inputs	2022	Future Planning Horizon

Aircraft	*Operations and Fleet Mix*	• The Logan Airport aircraft fleet was grouped into four categories: commercial air carriers, commuter aircraft, GA, and cargo aircraft.
		• The 2022 aircraft fleet mix at Logan Airport was used as input to FAA's AEDT.
		• Where aircraft/engine type combinations operating at Logan Airport were not available in the AEDT database, substitutions were made based on the closest match of aircraft frame and engine types using professional judgment.
		• Total LTOs increased by 42.3 percent, from 2021 to 2022, with
		  o Air carrier LTOs increasing by 55.4 percent,
		  o Commuter LTOs increasing by 29.3 percent,
		  o Air cargo LTOs increasing by 14.6 percent, and
		  o GA LTOs increasing by 15.5 percent.
		• The increase in total LTOs is attributable to the recovery in demand for air travel in 2022 from pre-pandemic (2019) levels. However, 2022 LTOs are still below 2019 levels (11.4 percent less).
			• As with the 2022 emissions inventory, the most recent version, AEDT3e, was used to compute the future Logan Airport emissions inventory. While current aircraft and motor vehicle engine technologies are likely to change, become more efficient, and use alternative fuels not used currently, these changes cannot feasibly be accounted for, and thus are not included in the model. Similarly, the modeled aircraft reflect current technologies and cannot adequately characterize the low-emissions profiles of certain developing engine technologies. Thus, the predicted emissions represent a conservative estimate (likely over-estimate) of future conditions.
			• LTOs are forecasted to increase from 189,307 in 2022 (213,588 in 2019) to 247,501, with
			  o Air carrier LTOs increasing from 119,167 in 2022 (147,122 in 2019) to 171,709,
			  o Commuter LTOs increasing from 48,292 in 2022 (46,888 in 2019) to 49,028,
			  o Air cargo LTOs decreasing from 7,344 in 2022 (3,855 in 2019) to 6,725, and
			  o GA LTOs increasing from 14,504 in 2022 (15,731 in 2019) to 20,039.
			• Section J.4 of this appendix contains the input data that were used in AEDT, including aircraft category, aircraft types, aircraft engines, and LTOs.

	Taxi Times	• Updated aircraft taxi/delay times are based on data obtained from the FAA Aviation System Performance Metrics (ASPM) database for the year 2022. • According to ASPM, the average aircraft taxi/delay times at Logan Airport from 2021 to 2022 increased 5.5 percent from 22.3 minutes to 27.8 minutes. • The increase in aircraft taxi/delay times is due to the increase in aircraft operations at Logan Airport from 2021 to 2022.	• Aircraft taxi times for the Future Planning Horizon were developed from the Boston Logan Runway Incursion Mitigation (RIM) study and FAA's ASPM database, which provides the use of the Airport for each of the main runway configurations. • The average taxi time forecasted for the Future Planning Horizon is approximately two minutes less than the times reported for 2022 (i.e., 25.6 minutes).

Table J-6 Overall Data Inputs and Assumptions by Source

Source	Inputs	2022	Future Planning Horizon
Ground Service Equipment (GSE)	*Types and Time-in-mode (TIM)*	• GSE (including APUs) were modeled using FAA's AEDT. • Reductions attributable to Massport's AFV Program and the conversion of Massport and/or tenant GSE and fleet vehicles to CNG or electric were included in the analysis. • GSE types and TIM data was based on: o Logan Airport-specific GSE TIM survey conducted in 2017, o The GSE fuel use (i.e., gasoline, diesel, liquid petroleum gas, electric) data from Massport's 2022 Vehicle Aerodrome Permit Application Program for Logan Airport, and o AEDT's aircraft specific GSE default data. • Recent data from a subset of airlines has suggested that Aerodrome data is not completely representative of the GSE at Logan Airport. This data is currently being evaluated and the findings will be presented in the next EDR.	• The estimation of APU emissions was based on data from the 2017 on-site GSE TIM survey, as well as forecasted future aircraft fleet operations and assuming 100% of gates having ground power and pre-conditioned air. • 98 percent of the GSE fleet were assumed to be converted to eGSE by the Future Planning Horizon.
Motor Vehicles	*Emission Factors, Vehicle-Miles-Travelled (VMT), and Mode Share*	• Motor vehicle emission factors for cruise and idling modes were obtained from U.S.EPA's MOVES model (i.e., MOVES) combined with MassDEP-recommended motor vehicle fleet mix data, operating conditions, and other Massachusetts-specific input parameters. • In general, the emission factors obtained from MOVES decrease as years progress due to improved manufacturers' engine efficiencies. However, variances in model versions and vehicle mixes can affect emission factor outputs. In 2022 emission factors for VOCs and CO decreased and NO_X and $PM_{10}/PM_{2.5}$ increased from 2021 levels. • Example MOVES input/output files are included in Table J-9 and Table J-10, respectively, of this appendix.	• As with 2022, motor vehicle emission factors for the Future Planning Horizon were obtained from the most recent version of U.S.EPA's MOVES model (MOVES3.1). • County-specific data (fuel characteristics, I/M program, age distribution, etc.) were provided by MassDEP. • The MOVES model reflects the continuous reduction in motor vehicle emissions over time. • Example MOVES input/output files are included in Table J-9 and Table J-10, respectively, of this appendix. • Chapter 6 of the 2022 ESPR provides a discussion of the on-Airport VMT data and curbside/parking volumes used for the Future Planning Horizon analysis. • Curbside Idling times were assumed to be the same as 2022 analysis year.

Table J-6 Overall Data Inputs and Assumptions by Source

Source	Inputs	2022	Future Planning Horizon
		• Chapter 6, *Ground Access*, of the *2022 ESPR* provides a discussion of the on-Airport VMT data and curbside/parking volumes used for the 2022 analysis. • A curb idling survey to support the development of the *2022 ESPR* motor vehicle emissions inventories was conducted in July/August of 2023. • Vehicles mode share was based on the *2022 Logan Air Passenger Ground Access Survey* prepared in March 2023.	• Vehicles mode share were assumed to be the same as 2022 analysis year.
Other	*Emission Factors and Throughputs*	• Other sources include stationary sources at Boston-Logan such as fuel storage and handling facilities, boilers, snow melters, emergency generators, space heaters, and fire training activities. • Emissions at Logan Airport were based on annual fuel throughput records for 2022. • Emission factors were based on appropriate U.S.EPA emission factors such as: o Compilation of Air Pollution Emission Factors (AP42), o manufacturer provided emission factors, or o emission factors obtained from NO_X RACT compliance testing. Notably, emission factors used to estimate boiler emissions were based on the stack test data performed in March 2022. • In 2022, the Central Heating and Cooling Plant's natural gas usage has decreased by 40 percent and ultra-low sulfur diesel (ULSD) has increased by 76 percent.	• Emissions associated with fuel storage and handling, the Central Heating and Cooling Plant, snow melters, emergency generators, space heaters, and fire training at Logan Airport are based largely on fuel throughput, and are expected to become more fuel-efficient, less fuel-dependent, and emit fewer emissions in the Future Planning Horizon. • Boilers were assumed to be all electric in the Future Planning Horizon. • Emergency generators and space heaters were estimated using the average fuel throughput for the past five years, combined with the anticipated increase in terminal building square footage. • Snow melters were assumed to be 100 percent green hydrogen. • Fire training were based on the past five-year average usage. • The same emission factors used in 2022 were also assumed for the future condition.

Table J-6 Overall Data Inputs and Assumptions by Source

Source	Inputs	2022	Future Planning Horizon
		• Massport is planning to upgrade the Central Heating and Cooling Plant at Logan Airport to accommodate the anticipated increase in heating load for the Terminal E expansion project. This project will include replacing the existing dual-fuel Boiler 3 with a new natural gas-fired boiler of approximately the same capacity. • Massport is also planning to continue to further reduce the Central Heating and Cooling Plant emissions as part of a Net Zero Roadmap by 2031 strategy.	

Notes: APU – Auxiliary Power Unit, FAA – Federal Aviation Administration, AEDT – Aviation Environmental Design Tool, AFV – Alternative Fuel Vehicles, CNG – Compressed Natural Gas, EDR/ESPR – Environmental Data Report/ Environmental Data Report/Environmental Status and Planning Report, GA – General Aviation, MOVES – Motor Vehicle Emission Simulator (MOVES), NO_X RACT– Nitrous Oxide Reasonably Available Control Technology, and VMT – Vehicle-Mile-Travelled.

Massport undertakes a variety of programs to reduce Airport-related emissions that it does not directly own or control through its support of HOV initiatives, including subsidizing free outbound Silver Line Service from Logan Airport; supporting use of AFVs by airport taxis; providing eGSE charging stations and other initiatives to facilitate the replacement of gas- and diesel-powered GSE with eGSE; and providing 400-Hz power and PCA at all aircraft contact gates. Massport is also collaborating with the Massachusetts Clean Energy Center (MassCEC) to study opportunities to enable conversion of the ride-for-hire fleet (RideApp, Rental Car Taxi and limousine vehicles) that serves Logan Airport to transition to electric vehicles. In early 2022, MassCEC provided a grant to initiate this work and provided funding to enhance Logan's EV charging infrastructure.

J.4.2 Aircraft Fleet and Annual Landing and Takeoff (LTO) Data

FAA's AEDT Version 3e was used to prepare the 2022 and Future Planning Horizon Year air quality analyses as it was the most current version at the time of the preparation of the *2022 ESPR*. In December 2023, FAA released Version 3f of AEDT.

Table J-7 contains the data that were used in AEDT 3e to represent actual conditions at Logan Airport in 2022 and the Future Planning Horizon Year, respectively. These data include aircraft type, engine type, and the number of annual LTOs.[22] The aircraft are divided into four categories: air carrier (AC), cargo (CA), commuter (CO), and general aviation (GA).

22 One LTO is equal to two operations (i.e., arrival + departure).

Table J-7 Aircraft Fleet Mix and Annual LTOs by Aircraft Type

AEDT Aircraft Type	AEDT Engine Type	2022	Future	Category
Air Carrier				
Embraer ERJ190-LR	CF34-10E6	19,490	13,520	AC
Airbus A321-100 Series	V2533-A5	17,967	20,050	AC
Airbus A320-200 Series	V2527-A5	8,050	7,788	AC
Airbus A321-100 Series	CFM56-5B3/P	6,369	--	AC
Airbus A220-300	PW1524G	5,857	12,570	AC
Boeing 737-900-ER	CFM56-7B27E/B1	5,537	5,010	AC
Airbus A220-100	PW1519G	5,192	9,760	AC
Boeing 737-800 Series	CFM56-7B27	5,066	5,780	AC
Boeing 737-800 Series	CFM56-7B26	3,771	--	AC
Boeing 737-9	LEAP-1B28/28B1/28B2/28B3	3,519	20,050	AC
Airbus A319-100 Series	V2522-A5	3,070	13,325	AC
Airbus A321-NEO	LEAP-1A35A/33/33B2/32/30	3,068	19,775	AC
Airbus A320-200 Series	V2527-A5 SelectOne™ Upgrade Package	2,890	--	AC
Airbus A319-100 Series	CFM56-5B6/P	2,727	--	AC
Boeing 737-700 Series	CFM56-7B24	1,874	2,105	AC
Airbus A321-NEO	PW1133G-JM	1,855	--	AC
Boeing 737-700 Series	CFM56-7B22	1,617	--	AC
Boeing 737-800 Series	CFM56-7B24/3	1,236	--	AC
Airbus A319-100 Series	CFM56-5A5	1,196	--	AC
Airbus A330-300 Series	CF6-80E1A4	1,095	--	AC
Boeing 737-8	LEAP-1B28/28B1/28B2/28B3	1,013	15,875	AC
Airbus A330-300 Series	Trent 772	969	--	AC
Airbus A320-NEO	PW1127G-JM	847	9,525	AC
Boeing 777-300 ER	GE90-115B	842	3,805	AC
Airbus A321-200 Series	CFM56-5B3/P	781	--	AC
Airbus A350-900 series	Trent XWB-84	721	1,990	AC
Airbus A330-300 Series	PW4168A	714	--	AC

Table J-7 Aircraft Fleet Mix and Annual LTOs by Aircraft Type

AEDT Aircraft Type	AEDT Engine Type	2022	Future	Category
Boeing 787-9 Dreamliner	GEnx-1B76A/P2	643	2,045	AC
Airbus A319-100 X/LR	V2524-A5 SelectOne™ Upgrade Package	609	--	AC
Airbus A320-200 Series	CFM56-5B4/P	602	--	AC
Airbus A320-NEO	LEAP-1A26/26E1	588	--	AC
Boeing 767-300 ER	CF6-80C2B6F	569	--	AC
Boeing 767-300 ER	PW4060	525	--	AC
Airbus A321-NEO	PW1133GA-JM	472	--	AC
Embraer ERJ190	CF34-8E5	446	--	AC
Boeing 737-900-ER	CFM56-7B26/3	406	--	AC
Boeing 737-8	LEAP-1B25	400	--	AC
Boeing 777-200 Series	Trent 892	387	1,563	AC
Boeing 737-800 Series	CFM56-7B26/3	383	--	AC
Airbus A330-200 Series	CF6-80E1A4	353	1,745	AC
Airbus A320-200 Series	CFM56-5B3/3	349	--	AC
Airbus A330-900N Series (Neo)	Trent7000-72	321	2,955	AC
Boeing 767-400	CF6-80C2B8F	267	--	AC
Airbus A340-600 Series	Trent 556-61	256	--	AC
Boeing 737-700 Series	CFM56-7B24/3	250	--	AC
Airbus A320-200 Series	CFM56-5A3	222	--	AC
Airbus A321-NEO	CFM56-5B2/3	212	--	AC
Airbus A330-200 Series	Trent 772	211	--	AC
Boeing 747-400 Series	CF6-80C2B1F	205	--	AC
Boeing 737-900-ER	CFM56-7B26	177	--	AC
Airbus A380-800 Series	Trent 970-84	172	443	AC
Boeing 787-9 Dreamliner	Trent 1000-J3	170	--	AC
Airbus A340-300 Series	CFM56-5C4	157	--	AC
Airbus A320-200 Series	V2527E-A5	150	--	AC
Boeing 767-300 ER	CF6-80C2B7F	149	--	AC

Table J-7 Aircraft Fleet Mix and Annual LTOs by Aircraft Type

AEDT Aircraft Type	AEDT Engine Type	2022	Future	Category
Airbus A320-200 Series	CFM56-5B4	139	--	AC
Airbus A330-300 Series	CF6-80E1A3	138	--	AC
Boeing 737-8	LEAP-1B27	135	--	AC
Airbus A220-300	PW1521G	133	--	AC
Boeing 737-900 Series	CFM56-7B26	122	--	AC
Boeing 777-200 Series	GE90-90B	113	--	AC
Airbus A319-100 Series	CFM56-5B6/3	110	--	AC
Boeing 737-800 Series	CFM56-7B27E/B1	110	--	AC
Airbus A330-900N Series (Neo)	Trent7000-72C	99	--	AC
Airbus A319-100 X/LR	V2527-A5M SelectOne™ Upgrade Package	93	--	AC
Airbus A330-200 Series	PW4168A	90	--	AC
Boeing 787-8 Dreamliner	GEnx-1B70/75/P2	81	--	AC
Boeing 767-300 ER	PW4056	80	--	AC
Airbus A320-200 Series	CFM56-5-A1	77	--	AC
Boeing 737-800 Series	CFM56-7B24	74	--	AC
Boeing 737-700 Series	CFM56-7B26	72	--	AC
Boeing 787-10 Dreamliner	Trent 1000-K2	68	1,555	AC
Airbus A321-200 Series	CFM56-5B3/3	60	--	AC
Boeing 757-300 Series	RB211-535E4B	49	--	AC
Airbus A350-1000 Series	Trent XWB-97	43	--	AC
Airbus A330-200 Series	CF6-80E1A2	42	--	AC
Boeing 737-400 Series	CFM56-3C-1	29	--	AC
Boeing 787-9 Dreamliner	Trent 1000-J2	27	--	AC
Airbus A330-200 Series	CF6-80E1A3	25	--	AC
Boeing 777-200-ER	GE90-94B	17	--	AC
Boeing 787-8 Dreamliner	Trent 1000-CE3	15	--	AC
Airbus A320-200 Series	V2522-D5	14	--	AC
Boeing 777-200-ER	GE90-90B	11	--	AC

Table J-7 Aircraft Fleet Mix and Annual LTOs by Aircraft Type

AEDT Aircraft Type	AEDT Engine Type	2022	Future	Category
Airbus A340-300 Series	CFM56-5C4/P	10	--	AC
Boeing 737-700 Series	CFM56-7B24E	10	--	AC
Boeing 737-700 Series	CFM56-7B20	9	--	AC
Airbus A319-100 Series	V2527-A5	9	--	AC
Airbus A319-100 X/LR	CFM56-5B7/3	7	--	AC
Boeing 737-9	LEAP-1B28BBJ1	7	--	AC
Boeing 717-200 Series	BR700-715A1-30	6	--	AC
Boeing 757-300 Series	RB211-535E4B	6	--	AC
Boeing 747-8	GEnx-2B67	6	480	AC
Airbus A319-100 Series	CFM56-5B3/3	6	--	AC
Boeing 737-800 Series	CFM56-7B27/3	5	--	AC
Boeing 757-300 Series	PW2040	4	--	AC
Airbus A321-100 Series	CFM56-5B1/3	4	--	AC
Embraer ERJ190	CF34-10E6A1	3	--	AC
Airbus A320-200 Series	CFM56-5B4/2	3	--	AC
Boeing 777-200 Series	PW4084	3	--	AC
Boeing 777-200 Series	GE90-90B	3	--	AC
Boeing 787-8 Dreamliner	GENX-1B64	3	--	AC
Boeing 787-8 Dreamliner	GEnx-1B70	2	--	AC
Airbus A380-800 Series	GP7270	2	--	AC
Boeing 737-800 Series	CFM56-7B27E/F	2	--	AC
Boeing 787-10 Dreamliner	GEnx-1B76A/P2	1	--	AC
Airbus A320-NEO	PW1127GA-JM	1	--	AC
Airbus A318-100 Series	CFM56-5B9/3	1	--	AC
Airbus A320-200 Series	V2527-A5E SelectOne™ Upgrade Package	1	--	AC
Airbus A319-100 Series	CFM56-5B7/P	1	--	AC
Embraer ERJ190	CF34-10E7-B	1	--	AC
Airbus A319-100 Series	CFM56-5B4/2P	1	--	AC

Table J-7 Aircraft Fleet Mix and Annual LTOs by Aircraft Type

AEDT Aircraft Type	AEDT Engine Type	2022	Future	Category
Total Air Carrier Aircraft LTOs		119,167	171,709	
Cargo				
Boeing 767-300 ER Freighter	CF6-80C2B6F	2,961	4,332	CA
Boeing 757-200 Series	PW2037	2,850	371	CA
Boeing 757-300 Series	RB211-535E4B	--	400	
Boeing 757-200 Series	RB211-535E4B	372	--	CA
Cessna 208 Caravan	PT6A-114	193	1,374	CA
Airbus A300F4-600 Series	CF6-80C2A5F	178	--	CA
Airbus A300B4-600 Series	PW4158	128	--	CA
Boeing 767-300BCF	CF6-80C2B6F	125	--	CA
Boeing 757-200 Series	RB211-535E4	81	--	CA
Boeing MD-11 Freighter	CF6-80C2D1F	65	--	CA
Cessna 208 Caravan	TPE331-12B	64	248	CA
Boeing 757-200 Series Freighter	RB211-535E4	64	--	CA
Boeing 767-300 Series	CF6-80C2B6F	55	--	CA
Boeing 767-200 Series Freighter	JT9D-7R4D, -7R4D1	29	--	CA
Boeing 767-200 Series Freighter	CF6-80A	28	--	CA
Boeing MD-11 Freighter	PW4060	22	--	CA
Boeing 757-200 Series Freighter	PW2040	20	--	CA
Boeing 757-200 Series	PW2040	20	--	CA
Boeing MD-11 Freighter	PW4062	19	--	CA
Boeing 767-300 Series	PW4060	16	--	CA
Airbus A300F4-600 Series	CF6-80C2A5	14	--	CA
Boeing 767-300 Series	PW4x52	12	--	CA
Boeing 767-300 ER Freighter	CF6-80C2B7F	7	--	CA
Boeing 767-300 Series	CF6-80C2B6	6	--	CA
Boeing 767-200 Series	CF6-80C2B7F	6	--	CA
Boeing 767-200 Series Freighter	CF6-80A2	3	--	CA

Table J-7 Aircraft Fleet Mix and Annual LTOs by Aircraft Type

AEDT Aircraft Type	AEDT Engine Type	2022	Future	Category
Boeing 777-200-LR	GE90-115B	3	--	CA
Boeing 767-200 Series	PW4060	2	--	CA
Boeing MD-10-30	CF6-50C2	1	--	CA
Total Cargo Aircraft LTOs		**7,344**	**6,725**	
Commuter				
Embraer ERJ175	CF34-8E5	21,696	27,845	CO
Cessna 402	TIO-540-J2B2	13,922	--	CO
Embraer ERJ175-LR	CF34-8E5	3,559	939	CO
Bombardier CRJ-900	CF34-8C5	2,304	5,012	CO
Bombardier de Havilland Dash 8 Q400	PW150A	1,926	3,170	CO
Embraer Phenom 300 (EMB-505)	PW530	1,115	--	CO
Embraer ERJ170	CF34-8E5	790	175	CO
Embraer ERJ145-LR	AE3007A1	784	--	CO
Tecnam P2012 Traveller	TIO-540-J2B2	727	--	CO
Embraer ERJ145-LR	AE3007A	657	--	CO
Embraer ERJ170-LR	CF34-8E5	321	--	CO
Bombardier CRJ-705-LR	CF34-8C5	161	--	CO
Embraer ERJ170	CF34-8E5A1	115	--	CO
Bombardier Global 6000	BR700-710A2-20	112	--	CO
Embraer ERJ145-LR	AE3007A1P	36	--	CO
Bombardier CRJ-200	CF34-3B/-3B1	27	--	CO
Bombardier (Canadair) CRJ200 ExecLiner	CF34-3A1	23	--	CO
Bombardier CRJ-700	CF34-8C1	8	--	CO
Bombardier Challenger 850	CF34-3B/-3B1	4	--	CO
Bombardier Learjet 36	TFE731-2-2B	3	--	CO
Bombardier CRJ-700	CF34-8C5B1	2	--	CO

Table J-7 Aircraft Fleet Mix and Annual LTOs by Aircraft Type

AEDT Aircraft Type	AEDT Engine Type	2022	Future	Category
Total Commuter Aircraft LTOs		**48,292**	**49,028**	
General Aviation				
Cessna 680-A Citation Latitude	PW306B	1,289	--	GA
Pilatus PC-12	PT6A-67	1,075	1,020	GA
Bombardier Challenger 350	AS907-2-1A (HTF7350)	1,062	--	GA
Pilatus PC-12	PT6A-67B	779	--	GA
Cessna 560 Citation Excel	PW530	449	2,775	GA
Dassault Falcon 2000	PW308C BS 1289	426	--	GA
Cessna 560 Citation XLS	PW530	402	--	GA
Bombardier Global Express	BR700-710A2-20	366	--	GA
Raytheon Super King Air 300	PT6A-67A	350	--	GA
Bombardier Challenger 300	AS907-2-1A (HTF7350)	338	--	GA
Raytheon Hawker 800	TFE731-2/2A	336	--	GA
Gulfstream G650ER	BR700-725A1-12	331	--	GA
Cessna 700 Citation Longitude	AS907-2-1S (HTF7700L)	321	--	GA
Gulfstream G-5 Gulfstream 5 / G-5SP Gulfstream G500	BR700-710C4-11	310	--	GA
Cessna CitationJet CJ/CJ1 (Cessna 525)	JT15D-1 series	307	--	GA
Bombardier Challenger 600	CF34-3A1	275	--	GA
Gulfstream G400	TAY 611-8C	256	--	GA
Embraer Praetor 500	AS907-3-1E-A1 (HTF7500E)	239	--	GA
Raytheon Beechjet 400	JT15D-5, -5A, -5B	225	--	GA
Cessna 680 Citation Sovereign	PW306B	223	--	GA
Cessna 750 Citation X	AE3007C1	218	3,820	GA
Bombardier Challenger 605	CF34-3B/-3B1	201	--	GA
Cirrus SR22 Turbo (FAS)	TIO-540-J2B2	200	--	GA
Kaman SH-2 Seasprite	T700-GE-401 -401C	197	221	GA
Bombardier Learjet 60	PW306A	193	--	GA
Bombardier Global 5000	BR700-710A2-20	186	--	GA

Table J-7 Aircraft Fleet Mix and Annual LTOs by Aircraft Type

AEDT Aircraft Type	AEDT Engine Type	2022	Future	Category
Gulfstream G280	AS907-2-1G (HTF7250G)	179	--	GA
Pilatus PC-24	JT15D-5C	175	--	GA
Sikorsky S-76 Spirit	T700-GE-700	153	192	GA
Raytheon C-12 Huron	PT6A-41	137	--	GA
Cessna CitationJet CJ4 (Cessna 525C)	JT15D-5C	131	--	GA
Dassault Falcon 900-LX	TFE731-3	128	--	GA
Bombardier Learjet 45	TFE731-2/2A	123	--	GA
Cessna 750 Citation X	PW308A	116	--	GA
Raytheon Beech Baron 58	TIO-540-J2B2	116	--	GA
Cessna 680 Citation Sovereign	PW308C BS 1289	114	--	GA
Honda HA-420 Hondajet	PW610F	109	--	GA
Cessna 560 Citation V	JT15D-5, -5A, -5B	105	--	GA
Falcon 7X	PW307A	99	--	GA
Dassault Falcon 50-EX	TFE731-2/2A	89	--	GA
Gulfstream IV-SP	TAY Mk611-8	88	--	GA
Piper PA-31 Navajo	TIO-540-J2B2	80	--	GA
Bell 429	TPE331-1	78	--	GA
Gulfstream Aerospace Gulfstream G500 (G-7)	PW814GA	76	--	GA
CIRRUS SF-50 Vision	JT15D-1 series	74	--	GA
Bombardier Challenger 604	CF34-3B/-3B1	68	--	GA
Bombardier Learjet 35	TFE731-3	60	--	GA
Bombardier Learjet 31	TFE731-3	58	--	GA
Raytheon Beech Bonanza 36	TIO-540-J2B2	57	370	GA
Piper PA-34 Seneca	TSIO-360C	57	--	GA
Gulfstream G150	TFE731-3	54	--	GA
Gulfstream G600	PW815GA	54	--	GA
Cessna S550 Citation S/II	PW610F	53	--	GA
Raytheon Hawker 800	TFE731-3	52	--	GA

Table J-7 Aircraft Fleet Mix and Annual LTOs by Aircraft Type

AEDT Aircraft Type	AEDT Engine Type	2022	Future	Category
Bombardier Learjet 75	TFE731-3	52	--	GA
Raytheon Beech 99	TPE331-6	43	--	GA
Embraer Praetor 600	AS907-3-1E-A3 (HTF7500E)	41	--	GA
Bombardier Global 7500	Passport20-19BB1A	41	--	GA
Piper PA-32 Cherokee Six	TIO-540-J2B2	40	--	GA
Gulfstream G550	BR700-710A1-10	37	--	GA
Gulfstream G200	TFE731-2/2A	37	--	GA
Raytheon Premier I	JT15D-4 series	33	--	GA
Gulfstream G450	TAY Mk611-8	30	--	GA
Bombardier Learjet 35	TFE731-2-2B	30	--	GA
Embraer ERJ135 Legacy Business	AE3007A1P	29	--	GA
Gulfstream G-5 Gulfstream 5 / G-5SP Gulfstream G500	BR700-710A1-10	29	--	GA
Raytheon Hawker 1000	PW306A	29	--	GA
Bombardier Challenger 601	CF34-3A	27	1,784	GA
Cessna 560 Citation Ultra	JT15D-5C	26	--	GA
SOCATA TBM 850	PT6A-66	26	--	GA
Bombardier Challenger 300	HTF7000 (AS907-1-1A)	25	--	GA
Aerospatiale SA-350D Astar (AS-350)	TPE331-3	25	--	GA
Gulfstream G100	TFE731-2/2A	24	--	GA
Cessna 414	TIO-540-J2B2	24	--	GA
Cirrus SR20	IO-360-B	23	463	GA
Bombardier Learjet 45	TFE731-2-2B	23	--	GA
Bombardier Learjet 55	TFE731-3	22	--	GA
Robinson R44 Raven / Lycoming O-540-F1B5	TIO-540-J2B2	22	--	GA
Embraer ERJ135 Legacy Business	AE3007A1E	21	--	GA
Bell 206 JetRanger	250B17B	21	--	GA
Piper PA46 Malibu (FAS)	TIO-540-J2B2	20	--	GA

Table J-7 Aircraft Fleet Mix and Annual LTOs by Aircraft Type

AEDT Aircraft Type	AEDT Engine Type	2022	Future	Category
Cessna 421 Piston	IO-360-B	19	--	GA
Cessna 650 Citation III	TFE731-2/2A	19	--	GA
Dassault Falcon 8X	PW307D	19	--	GA
Cessna 182	IO-360-B	18	--	GA
Raytheon Hawker 4000 Horizon	PW308A	18	--	GA
Piper PA-24 Comanche	TIO-540-J2B2	17	--	GA
Cessna 210 Centurion	TIO-540-J2B2	16	--	GA
DAHER TBM 900/930	PT6A-66	16	--	GA
Cessna 400 (FAS)	TSIO-360C	16	--	GA
Embraer Phenom 100 (EMB-500)	PW530	15	--	GA
Eurocopter EC-T2 (CPDS)	TPE331-3	14	--	GA
Bombardier Learjet 40	TFE731-2/2A	14	--	GA
Piper PA-31T Cheyenne	PT6A-135A	13	--	GA
Dassault Falcon 900-EX	TFE731-3	12	--	GA
Eurocopter AS 355NP	250B17B	12	--	GA
Eurocopter EC-130	TPE331-3	11	--	GA
Piper PA-28 Cherokee Series	O-320	11	--	GA
Bell 407 / Rolls-Royce 250-C47B	250B17B	11	--	GA
Cessna 310	TIO-540-J2B2	11	--	GA
Cessna 182 R (FAS)	IO-360-B	10	--	GA
Gulfstream G200	PW306A	10	--	GA
Cessna 172 Skyhawk	O-320	10	--	GA
Raytheon Beech 99	PT6A-28	9	--	GA
Bombardier Learjet 70	TFE731-3	9	--	GA
Piper PA46-TP Meridian	PT6A-42	9	--	GA
Agusta A-109	250B17B	8	--	GA
Raytheon Super King Air 300	PT6A-60A	7	--	GA
Dornier 328 Jet	PW306B	7	--	GA

Table J-7 Aircraft Fleet Mix and Annual LTOs by Aircraft Type

AEDT Aircraft Type	AEDT Engine Type	2022	Future	Category
Dassault Falcon 100	TFE731-3	6	--	GA
Eclipse 500 / PW610F	PW610F	6	--	GA
Dassault Falcon 50-EX	TFE731-3	6	--	GA
Bombardier Learjet 45-XR	TFE731-2-2B	6	--	GA
Raytheon Super King Air 200	PT6A-41	5	--	GA
Piaggio P.180 Avanti	PT6A-60	5	--	GA
Raytheon Beech 99	PT6A-36	5	--	GA
Cessna 206	TIO-540-J2B2	4	--	GA
Cessna 501 Citation ISP	PW610F	4	--	GA
Dassault Falcon 20-F	CF700-2D	4	--	GA
Dassault Falcon 200	TFE731-3	3	--	GA
Beech E-55 (FAS)	TIO-540-J2B2	3	--	GA
Cessna 340	TIO-540-J2B2	3	--	GA
Mooney M20-K	TSIO-360C	3	--	GA
Bombardier Challenger 601	CF34-3A1	2	--	GA
Cessna 441 Conquest II	TPE331-10UK	2	4,305	GA
Airbus A340-200 Series	CFM56-5C4	2	--	GA
Aerostar PA-60	TIO-540-J2B2	2	--	GA
Gulfstream G100	TFE731-3	2	--	GA
Bell 427	TPE331-1	2	--	GA
Cessna 500 Citation I	PW530	2	--	GA
CESSNA CITATION 510	PW530	2	--	GA
Diamond DA62	IO-360-B	2	--	GA
Gulfstream III (FAS)	SPEY Mk511	1	--	GA
Dassault Falcon 20-D	CF700-2D	1	--	GA
Raytheon Beech 1900-C	PT6A-67D	1	--	GA
Piper PA-30 Twin Comanche	IO-320-D1AD	1	--	GA
Cessna 560 Citation Encore	PW530	1	--	GA

Table J-7 Aircraft Fleet Mix and Annual LTOs by Aircraft Type

AEDT Aircraft Type	AEDT Engine Type	2022	Future	Category
Embraer ERJ140	AE3007A1P	1	--	GA
Airbus A340-500 Series	Trent 556-61	1	--	GA
Bell 206L-4T Long Ranger	250B17B	1	--	GA
Beech 23 Musketeer Sundowner (FAS)	O-320	1	--	GA
Raytheon King Air 90	PT6A-28	1	--	GA
Cessna 150 Series	O-200	1	--	GA
Cessna 425 Conquest I	PT6A-135A	1	--	GA
Cessna 441 Conquest II	TPE331-10GT	1	--	GA
Cessna 550 Citation Bravo	PW530	1	4,492	GA
Diamond DA40	IO-360-B	1	--	GA
Diamond DA42 Twin Star	IO-360-B	1	--	GA
Gulfstream II	SPEY Mk511	1	--	GA
Quest Kodiak 100	PT6A-34	1	--	GA
Mitsubishi MU-2	TPE331-5A	1	--	GA
Piper PA-27 Aztec	TIO-540-J2B2	1	--	GA
Piper PA-42 Cheyenne Series	TPE331-14	1	--	GA
Saab 2000	PW127-A	1	--	GA
EADS Socata TB-20 Trinidad	TIO-540-J2B2	1	--	GA
Velocity (FAS)	IO-360-B	1	--	GA
DeHavilland DHC-6-100 Twin Otter	PT6A-27	--	597	
Israel IAI-1124-A Westwind II	TFE731-3	1	--	GA
Total General Aviation Aircraft LTOs		**14,504**	**20,039**	
Total Fleet LTOs		**189,307**	**247,501**	

Source: CMT and HMMH, 2024.

Notes: LTOs – landing and takeoff cycles; AC – Air carrier; CA – Cargo; CO – commuter; and GA – general aviation.

J.4.3 Ground Service Equipment (GSE)/Auxiliary Power Unit (APU) Time-in-Mode (TIM) Survey

The most recent GSE/APU time-in-mode (TIM) survey conducted at Logan Airport was performed on June 27-28, 2017. Data from the survey as well as information developed from ACRP Report 149[23] and AEDT's default TIM data was used in support of the *2022 ESPR*. The purpose of a GSE/APU TIM survey is to provide up-to-date operating times, which directly affect GSE/APU emissions.

TIM is the average time that GSE and APUs operate during a single aircraft LTO cycle. The surveyed TIM data are used in place of the default TIM values in AEDT, thus yielding emissions that better reflect actual conditions at Logan Airport. The 2017 TIM survey focused on the most prevalent airlines (e.g., Southwest, JetBlue, American, Delta, and United) and the most common aircraft types, such as narrow-body air carriers (e.g., A320, A321, B737, B757) and large commuter aircraft (e.g., ERJ170, ERJ190, CRJ700, CRJ900). The GSE and APU TIM data for the surveyed aircraft are provided in **Table J-8**. GSE TIM data for the remaining aircraft within Logan's fleet are based on AEDT defaults.

APU operating times for wide-body/large commuter air carriers, and small commuter aircraft, were assumed to have a TIM of 7 minutes per LTO. GA aircraft in the fleet were not equipped with APUs. Cargo aircraft APU TIM data was based on AEDT defaults (i.e., 26 minutes per LTO).

Table J-8 GSE/APU TIM Data (minutes) By Aircraft Category

Source	Narrow-Body Air Carriers	Large Commuter Aircraft
Aircraft Tractor	6.37	7.13
Baggage Tractor	27.23	17.43
Belt Loader	26.85	14.88
Cabin Service Truck	2.07	0.53
Catering Truck	11.30	13.28
Hydrant Truck	3.73	2.53
Lavatory Truck	4.82	2.45
Service Truck	0.12	0.57
Water Service Truck	1.65	0.75
APUs	16.63	14.70

Source: GSE TIM survey conducted by CMT with assistance from Massport (security escorts) on June 27-28, 2017.
Note: APUs – Auxiliary power units.

23 National Academies of Sciences, Engineering, and Medicine 2009, Transportation Research Board, Airport Cooperative Research Program, Report 149: *Improving Ground Support Equipment Operational Data for Airport Emissions Modeling*, 2015, Washington, DC: The National Academies Press, https://crp.trb.org/acrpwebresource4/acrp-report-149-improving-ground-support-equipment-operational-data-for-airport-emissions-modeling/.

J.4.4 MOVES Example Input/Output Files

The version of U.S.EPA's MOVES that was the latest version at the time the analysis of motor vehicle emissions for 2022 and the Future Planning Horizon Year was performed (MOVES 3.1) was used.[24]

MOVES emission factors were multiplied by average daily vehicle miles traveled (VMT) to calculate daily emissions. The on-Airport traffic data are summarized in the VMT analyses of Appendix H, *Ground Access.*[25] In addition to estimating emissions from vehicles on roadways, MOVES was used to obtain vehicle emissions at idle to estimate parking and curbside motor vehicle emissions. Idling emissions were estimated by multiplying emission factors by an estimate of the total motor vehicle idling time in parking lots and at the arrival and departure curbsides at the Airport. Examples of MOVES, Version 3.1 input/output files are provided in **Table J-9** and **Table J-10**, respectively**.**

Table J-9 MOVES3.1 Example Input File


```
<runspec version="MOVES3.1.0">
    <description><![CDATA[Boston Logan ESPR 2022 Summer Avg PCPT]]></description>
    <models>
        <model value="ONROAD"/>
    </models>
    <modelscale value="Inv"/>
    <modeldomain value="PROJECT"/>
    <geographicselections>
        <geographicselection type="COUNTY" key="25025" description="Suffolk County, MA (25025)"/>
    </geographicselections>
    <timespan>
        <year key="2022"/>
        <month id="6"/>
        <day id="5"/>
        <beginhour id="24"/>
        <endhour id="24"/>
        <aggregateBy key="Hour"/>
    </timespan>
    <onroadvehicleselections>
        <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="21" sourcetypename="Passenger Car"/>
        <onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="21" sourcetypename="Passenger Car"/>
        <onroadvehicleselection fueltypeid="5" fueltypedesc="Ethanol (E-85)" sourcetypeid="21" sourcetypename="Passenger Car"/>
        <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="21" sourcetypename="Passenger Car"/>
        <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="31" sourcetypename="Passenger Truck"/>
        <onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="31" sourcetypename="Passenger Truck"/>
        <onroadvehicleselection fueltypeid="5" fueltypedesc="Ethanol (E-85)" sourcetypeid="31" sourcetypename="Passenger Truck"/>
        <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="31" sourcetypename="Passenger Truck"/>
```


24 U.S. Environmental Protection Agency, "MOVES3: Latest Version of MOtor Vehicle Emission Simulator (MOVES)," updated August 5, 2022, https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves.

25 Due to the modified roadway configuration of the Ted Williams Tunnel, through-traffic no longer traverses Airport property. Therefore, as of 2003, emissions from these vehicles are no longer included as part of the Logan Airport emissions inventory.

Table J-9 MOVES3.1 Example Input File


```
</onroadvehicleselections>
<offroadvehicleselections>
</offroadvehicleselections>
<offroadvehiclesccs>
</offroadvehiclesccs>
<roadtypes>
    <roadtype roadtypeid="1" roadtypename="Off-Network" modelCombination="M1"/>
    <roadtype roadtypeid="2" roadtypename="Rural Restricted Access" modelCombination="M1"/>
    <roadtype roadtypeid="3" roadtypename="Rural Unrestricted Access" modelCombination="M1"/>
    <roadtype roadtypeid="4" roadtypename="Urban Restricted Access" modelCombination="M1"/>
    <roadtype roadtypeid="5" roadtypename="Urban Unrestricted Access" modelCombination="M1"/>
</roadtypes>
<pollutantprocessassociations>
    <pollutantprocessassociation pollutantkey="90" pollutantname="Atmospheric CO2" processkey="1" processname="Running Exhaust"/>
    <pollutantprocessassociation pollutantkey="90" pollutantname="Atmospheric CO2" processkey="2" processname="Start Exhaust"/>
    <pollutantprocessassociation pollutantkey="90" pollutantname="Atmospheric CO2" processkey="90" processname="Extended Idle Exhaust"/>
    <pollutantprocessassociation pollutantkey="90" pollutantname="Atmospheric CO2" processkey="91" processname="Auxiliary Power Exhaust"/>
    <pollutantprocessassociation pollutantkey="98" pollutantname="CO2 Equivalent" processkey="1" processname="Running Exhaust"/>
    <pollutantprocessassociation pollutantkey="98" pollutantname="CO2 Equivalent" processkey="2" processname="Start Exhaust"/>
    <pollutantprocessassociation pollutantkey="98" pollutantname="CO2 Equivalent" processkey="90" processname="Extended Idle Exhaust"/>
    <pollutantprocessassociation pollutantkey="98" pollutantname="CO2 Equivalent" processkey="91" processname="Auxiliary Power Exhaust"/>
    <pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="1" processname="Running Exhaust"/>
    <pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="15" processname="Crankcase Running Exhaust"/>
    <pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="2" processname="Start Exhaust"/>
    <pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="16" processname="Crankcase Start Exhaust"/>
    <pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="90" processname="Extended Idle Exhaust"/>
    <pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
    <pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="91" processname="Auxiliary Power Exhaust"/>
    <pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="1" processname="Running Exhaust"/>
    <pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="2" processname="Start Exhaust"/>
    <pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="90" processname="Extended Idle Exhaust"/>
    <pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="91" processname="Auxiliary Power Exhaust"/>
    <pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="1" processname="Running Exhaust"/>
    <pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="2" processname="Start Exhaust"/>
    <pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="90" processname="Extended Idle Exhaust"/>
    <pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="91" processname="Auxiliary Power Exhaust"/>
    <pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="1" processname="Running Exhaust"/>
    <pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="2" processname="Start Exhaust"/>
    <pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="90" processname="Extended Idle Exhaust"/>
    <pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="91" processname="Auxiliary Power Exhaust"/>
    <pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="1" processname="Running Exhaust"/>
    <pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="15" processname="Crankcase Running Exhaust"/>
    <pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="2" processname="Start Exhaust"/>
    <pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="16" processname="Crankcase Start Exhaust"/>
    <pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="90" processname="Extended Idle Exhaust"/>
```

Table J-9 MOVES3.1 Example Input File


```
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="6" pollutantname="Nitrous Oxide (N2O)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="6" pollutantname="Nitrous Oxide (N2O)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="6" pollutantname="Nitrous Oxide (N2O)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="6" pollutantname="Nitrous Oxide (N2O)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="17" processname="Crankcase Extended Idle
Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="11" processname="Evap Permeation"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="13" processname="Evap Fuel Leaks"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="18" processname="Refueling Displacement Vapor
Loss"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="19" processname="Refueling Spillage Loss"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="17" processname="Crankcase Extended Idle
Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="17" processname="Crankcase Extended Idle
Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="106" pollutantname="Primary PM10 - Brakewear Particulate" processkey="9" processname="Brakewear"/>
<pollutantprocessassociation pollutantkey="107" pollutantname="Primary PM10 - Tirewear Particulate" processkey="10" processname="Tirewear"/>
<pollutantprocessassociation pollutantkey="116" pollutantname="Primary PM2.5 - Brakewear Particulate" processkey="9" processname="Brakewear"/>
```

Table J-9 MOVES3.1 Example Input File


```
		<pollutantprocessassociation pollutantkey="117" pollutantname="Primary PM2.5 - Tirewear Particulate" processkey="10" processname="Tirewear"/>
		<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="1" processname="Running Exhaust"/>
		<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="2" processname="Start Exhaust"/>
		<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="90" processname="Extended Idle Exhaust"/>
		<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="91" processname="Auxiliary Power Exhaust"/>
		<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="1" processname="Running Exhaust"/>
		<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="15" processname="Crankcase Running Exhaust"/>
		<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="2" processname="Start Exhaust"/>
		<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="16" processname="Crankcase Start Exhaust"/>
		<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="90" processname="Extended Idle Exhaust"/>
		<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
		<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="91" processname="Auxiliary Power Exhaust"/>
		<pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy Consumption" processkey="1" processname="Running Exhaust"/>
		<pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy Consumption" processkey="2" processname="Start Exhaust"/>
		<pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy Consumption" processkey="90" processname="Extended Idle Exhaust"/>
		<pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy Consumption" processkey="91" processname="Auxiliary Power Exhaust"/>
		<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="1" processname="Running Exhaust"/>
		<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="15" processname="Crankcase Running Exhaust"/>
		<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="2" processname="Start Exhaust"/>
		<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="16" processname="Crankcase Start Exhaust"/>
		<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="90" processname="Extended Idle Exhaust"/>
		<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
		<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="91" processname="Auxiliary Power Exhaust"/>
		<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="11" processname="Evap Permeation"/>
		<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="13" processname="Evap Fuel Leaks"/>
		<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="18" processname="Refueling Displacement Vapor Loss"/>
		<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="19" processname="Refueling Spillage Loss"/>
		<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="1" processname="Running Exhaust"/>
		<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="15" processname="Crankcase Running Exhaust"/>
		<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="2" processname="Start Exhaust"/>
		<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="16" processname="Crankcase Start Exhaust"/>
		<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="90" processname="Extended Idle Exhaust"/>
		<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
		<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="91" processname="Auxiliary Power Exhaust"/>
		<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="11" processname="Evap Permeation"/>
		<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="13" processname="Evap Fuel Leaks"/>
		<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="18" processname="Refueling Displacement Vapor Loss"/>
		<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="19" processname="Refueling Spillage Loss"/>
	</pollutantprocessassociations>
	<databaseselections>
	</databaseselections>
	<internalcontrolstrategies>
```

Table J-9 MOVES3.1 Example Input File


```
</internalcontrolstrategies>
<inputdatabase servername="" databasename="" description=""/>
<uncertaintyparameters uncertaintymodeenabled="false" numberofrunspersimulation="0" numberofsimulations="0"/>
<geographicoutputdetail description="LINK"/>
<outputemissionsbreakdownselection>
    <modelyear selected="false"/>
    <fueltype selected="true"/>
    <fuelsubtype selected="false"/>
    <emissionprocess selected="false"/>
    <onroadoffroad selected="false"/>
    <roadtype selected="true"/>
    <sourceusetype selected="true"/>
    <movesvehicletype selected="false"/>
    <onroadscc selected="false"/>
    <estimateuncertainty selected="false" numberOfIterations="2" keepSampledData="false" keepIterations="false"/>
    <sector selected="false"/>
    <engtechid selected="false"/>
    <hpclass selected="false"/>
    <regclassid selected="false"/>
</outputemissionsbreakdownselection>
<outputdatabase servername="" databasename="suffolk_2022_avg_summer_PCPT_out_7228" description=""/>
<outputtimestep value="Hour"/>
<outputvmtdata value="true"/>
<outputsho value="true"/>
<outputsh value="true"/>
<outputshp value="true"/>
<outputshidling value="true"/>
<outputstarts value="true"/>
<outputpopulation value="true"/>
<scaleinputdatabase servername="localhost" databasename="suffolk_county_avg_summer_2022_pcpt_in" description=""/>
<pmsize value="0"/>
<outputfactors>
    <timefactors selected="true" units="Hours"/>
    <distancefactors selected="true" units="Miles"/>
    <massfactors selected="true" units="Grams" energyunits="Joules"/>
</outputfactors>
<savedata>

</savedata>

<donotexecute>

</donotexecute>

<generatordatabase shouldsave="false" servername="" databasename="" description=""/>
```

Table J-9 MOVES3.1 Example Input File

```
		<donotperformfinalaggregation selected="false"/>
	<lookuptableflags scenarioid="" truncateoutput="true" truncateactivity="true" truncatebaserates="true"/>
</runspec>
```

Source: CMT and Massport, 2024.

Table J-10 MOVES3.1 Example Output File

```
MasterKey;MOVESRunID;iterationID;yearID;monthID;dayID;hourID;stateID;countyID;zoneID;linkID;pollutantID;processID;sourceTypeID;regClassId;fuelTypeID;modelYearID;roa
dTypeID;SCC;emissionQuant;activityTypeID;activity;emissionRate;massUnits;distanceUnits
1,1,2022,2,5,15,25,25025,250250,29,21,0,5,0,5,00;1;1;2022;2;5;15;25;25025;250250;29;119;\N;21;0;5;0;5;00;0;1;0;\N;g;mi
1,1,2022,2,5,15,25,25025,250250,29,21,0,2,0,5,00;1;1;2022;2;5;15;25;25025;250250;29;119;\N;21;0;2;0;5;00;0;1;0;\N;g;mi
1,1,2022,2,5,15,25,25025,250250,29,21,0,1,0,5,00;1;1;2022;2;5;15;25;25025;250250;29;119;\N;21;0;1;0;5;00;0;1;0;\N;g;mi
1,1,2022,2,5,15,25,25025,250250,28,21,0,5,0,4,00;1;1;2022;2;5;15;25;25025;250250;28;119;\N;21;0;5;0;4;00;0;1;0.0006571990088559687;0;g;mi
1,1,2022,2,5,15,25,25025,250250,28,21,0,2,0,4,00;1;1;2022;2;5;15;25;25025;250250;28;119;\N;21;0;2;0;4;00;0;1;0.007095689885318279;0;g;mi
1,1,2022,2,5,15,25,25025,250250,28,21,0,1,0,4,00;1;1;2022;2;5;15;25;25025;250250;28;119;\N;21;0;1;0;4;00;0;1;0.992247998714447;0;g;mi
1,1,2022,2,5,15,25,25025,250250,27,21,0,5,0,3,00;1;1;2022;2;5;15;25;25025;250250;27;119;\N;21;0;5;0;3;00;0;1;0.0006571990088559687;0;g;mi
1,1,2022,2,5,15,25,25025,250250,27,21,0,2,0,3,00;1;1;2022;2;5;15;25;25025;250250;27;119;\N;21;0;2;0;3;00;0;1;0.007095689885318279;0;g;mi
1,1,2022,2,5,15,25,25025,250250,27,21,0,1,0,3,00;1;1;2022;2;5;15;25;25025;250250;27;119;\N;21;0;1;0;3;00;0;1;0.992247998714447;0;g;mi
1,1,2022,2,5,15,25,25025,250250,26,21,0,5,0,2,00;1;1;2022;2;5;15;25;25025;250250;26;119;\N;21;0;5;0;2;00;0;1;0.0006571990088559687;0;g;mi
1,1,2022,2,5,15,25,25025,250250,26,21,0,2,0,2,00;1;1;2022;2;5;15;25;25025;250250;26;119;\N;21;0;2;0;2;00;0;1;0.007095689885318279;0;g;mi
1,1,2022,2,5,15,25,25025,250250,26,21,0,1,0,2,00;1;1;2022;2;5;15;25;25025;250250;26;119;\N;21;0;1;0;2;00;0;1;0.992247998714447;0;g;mi
1,1,2022,2,5,15,25,25025,250250,24,31,0,5,0,5,00;1;1;2022;2;5;15;25;25025;250250;24;119;\N;31;0;5;0;5;00;0;1;0;\N;g;mi
1,1,2022,2,5,15,25,25025,250250,24,31,0,2,0,5,00;1;1;2022;2;5;15;25;25025;250250;24;119;\N;31;0;2;0;5;00;0;1;0;\N;g;mi
1,1,2022,2,5,15,25,25025,250250,24,31,0,1,0,5,00;1;1;2022;2;5;15;25;25025;250250;24;119;\N;31;0;1;0;5;00;0;1;0;\N;g;mi
1,1,2022,2,5,15,25,25025,250250,23,21,0,5,0,5,00;1;1;2022;2;5;15;25;25025;250250;23;119;\N;21;0;5;0;5;00;0;1;0;\N;g;mi
1,1,2022,2,5,15,25,25025,250250,23,21,0,2,0,5,00;1;1;2022;2;5;15;25;25025;250250;23;119;\N;21;0;2;0;5;00;0;1;0;\N;g;mi
1,1,2022,2,5,15,25,25025,250250,23,21,0,1,0,5,00;1;1;2022;2;5;15;25;25025;250250;23;119;\N;21;0;1;0;5;00;0;1;0;\N;g;mi
1,1,2022,2,5,15,25,25025,250250,22,31,0,5,0,5,00;1;1;2022;2;5;15;25;25025;250250;22;119;\N;31;0;5;0;5;00;0;1;0.0024370900355279446;0;g;mi
1,1,2022,2,5,15,25,25025,250250,22,31,0,2,0,5,00;1;1;2022;2;5;15;25;25025;250250;22;119;\N;31;0;2;0;5;00;0;1;0.0479217991232872;0;g;mi
1,1,2022,2,5,15,25,25025,250250,22,31,0,1,0,5,00;1;1;2022;2;5;15;25;25025;250250;22;119;\N;31;0;1;0;5;00;0;1;0.9496409893035889;0;g;mi
1,1,2022,2,5,15,25,25025,250250,21,21,0,5,0,5,00;1;1;2022;2;5;15;25;25025;250250;21;119;\N;21;0;5;0;5;00;0;1;0.0006571990088559687;0;g;mi
1,1,2022,2,5,15,25,25025,250250,21,21,0,2,0,5,00;1;1;2022;2;5;15;25;25025;250250;21;119;\N;21;0;2;0;5;00;0;1;0.007095689885318279;0;g;mi
1,1,2022,2,5,15,25,25025,250250,21,21,0,1,0,5,00;1;1;2022;2;5;15;25;25025;250250;21;119;\N;21;0;1;0;5;00;0;1;0.992247998714447;0;g;mi
1,1,2022,2,5,15,25,25025,250250,20,31,0,5,0,5,00;1;1;2022;2;5;15;25;25025;250250;20;119;\N;31;0;5;0;5;00;0;1;0.0024370900355279446;0;g;mi
1,1,2022,2,5,15,25,25025,250250,20,31,0,2,0,5,00;1;1;2022;2;5;15;25;25025;250250;20;119;\N;31;0;2;0;5;00;0;1;0.0479217991232872;0;g;mi
1,1,2022,2,5,15,25,25025,250250,20,31,0,1,0,5,00;1;1;2022;2;5;15;25;25025;250250;20;119;\N;31;0;1;0;5;00;0;1;0.9496409893035889;0;g;mi
1,1,2022,2,5,15,25,25025,250250,19,31,0,5,0,5,00;1;1;2022;2;5;15;25;25025;250250;19;119;\N;31;0;5;0;5;00;0;1;0.0024370900355279446;0;g;mi
1,1,2022,2,5,15,25,25025,250250,19,31,0,2,0,5,00;1;1;2022;2;5;15;25;25025;250250;19;119;\N;31;0;2;0;5;00;0;1;0.0479217991232872;0;g;mi
1,1,2022,2,5,15,25,25025,250250,19,31,0,1,0,5,00;1;1;2022;2;5;15;25;25025;250250;19;119;\N;31;0;1;0;5;00;0;1;0.9496409893035889;0;g;mi
1,1,2022,2,5,15,25,25025,250250,18,31,0,5,0,5,00;1;1;2022;2;5;15;25;25025;250250;18;119;\N;31;0;5;0;5;00;0;1;0.0024370900355279446;0;g;mi
1,1,2022,2,5,15,25,25025,250250,18,31,0,2,0,5,00;1;1;2022;2;5;15;25;25025;250250;18;119;\N;31;0;2;0;5;00;0;1;0.0479217991232872;0;g;mi
1,1,2022,2,5,15,25,25025,250250,18,31,0,1,0,5,00;1;1;2022;2;5;15;25;25025;250250;18;119;\N;31;0;1;0;5;00;0;1;0.9496409893035889;0;g;mi
1,1,2022,2,5,15,25,25025,250250,17,31,0,5,0,5,00;1;1;2022;2;5;15;25;25025;250250;17;119;\N;31;0;5;0;5;00;0;1;0.0024370900355279446;0;g;mi
```

Table J-10 MOVES3.1 Example Output File


```
1,1,2022,2,5,15,25,25025,250250,17,31,0,2,0,5,00;1;1;2022;2;5;15;25;25025;250250;17;119;\N;31;0;2;0;5;00;0;1;0.0479217991232872;0;g;mi
1,1,2022,2,5,15,25,25025,250250,17,31,0,1,0,5,00;1;1;2022;2;5;15;25;25025;250250;17;119;\N;31;0;1;0;5;00;0;1;0.9496409893035889;0;g;mi
1,1,2022,2,5,15,25,25025,250250,16,31,0,5,0,5,00;1;1;2022;2;5;15;25;25025;250250;16;119;\N;31;0;5;0;5;00;0;1;0.0024370900355279446;0;g;mi
1,1,2022,2,5,15,25,25025,250250,16,31,0,2,0,5,00;1;1;2022;2;5;15;25;25025;250250;16;119;\N;31;0;2;0;5;00;0;1;0.0479217991232872;0;g;mi
1,1,2022,2,5,15,25,25025,250250,16,31,0,1,0,5,00;1;1;2022;2;5;15;25;25025;250250;16;119;\N;31;0;1;0;5;00;0;1;0.9496409893035889;0;g;mi
1,1,2022,2,5,15,25,25025,250250,15,31,0,5,0,5,00;1;1;2022;2;5;15;25;25025;250250;15;119;\N;31;0;5;0;5;00;0;1;0.0024370900355279446;0;g;mi
1,1,2022,2,5,15,25,25025,250250,15,31,0,2,0,5,00;1;1;2022;2;5;15;25;25025;250250;15;119;\N;31;0;2;0;5;00;0;1;0.0479217991232872;0;g;mi
1,1,2022,2,5,15,25,25025,250250,15,31,0,1,0,5,00;1;1;2022;2;5;15;25;25025;250250;15;119;\N;31;0;1;0;5;00;0;1;0.9496409893035889;0;g;mi
1,1,2022,2,5,15,25,25025,250250,14,31,0,5,0,5,00;1;1;2022;2;5;15;25;25025;250250;14;119;\N;31;0;5;0;5;00;0;1;0.0024370900355279446;0;g;mi
1,1,2022,2,5,15,25,25025,250250,14,31,0,2,0,5,00;1;1;2022;2;5;15;25;25025;250250;14;119;\N;31;0;2;0;5;00;0;1;0.0479217991232872;0;g;mi
1,1,2022,2,5,15,25,25025,250250,14,31,0,1,0,5,00;1;1;2022;2;5;15;25;25025;250250;14;119;\N;31;0;1;0;5;00;0;1;0.9496409893035889;0;g;mi
1,1,2022,2,5,15,25,25025,250250,13,31,0,5,0,5,00;1;1;2022;2;5;15;25;25025;250250;13;119;\N;31;0;5;0;5;00;0;1;0.0024370900355279446;0;g;mi
1,1,2022,2,5,15,25,25025,250250,13,31,0,2,0,5,00;1;1;2022;2;5;15;25;25025;250250;13;119;\N;31;0;2;0;5;00;0;1;0.0479217991232872;0;g;mi
1,1,2022,2,5,15,25,25025,250250,13,31,0,1,0,5,00;1;1;2022;2;5;15;25;25025;250250;13;119;\N;31;0;1;0;5;00;0;1;0.9496409893035889;0;g;mi
1,1,2022,2,5,15,25,25025,250250,12,31,0,5,0,5,00;1;1;2022;2;5;15;25;25025;250250;12;119;\N;31;0;5;0;5;00;0;1;0.0024370900355279446;0;g;mi
1,1,2022,2,5,15,25,25025,250250,12,31,0,2,0,5,00;1;1;2022;2;5;15;25;25025;250250;12;119;\N;31;0;2;0;5;00;0;1;0.0479217991232872;0;g;mi
1,1,2022,2,5,15,25,25025,250250,12,31,0,1,0,5,00;1;1;2022;2;5;15;25;25025;250250;12;119;\N;31;0;1;0;5;00;0;1;0.9496409893035889;0;g;mi
1,1,2022,2,5,15,25,25025,250250,11,31,0,5,0,5,00;1;1;2022;2;5;15;25;25025;250250;11;119;\N;31;0;5;0;5;00;0;1;0.0024370900355279446;0;g;mi
1,1,2022,2,5,15,25,25025,250250,11,31,0,2,0,5,00;1;1;2022;2;5;15;25;25025;250250;11;119;\N;31;0;2;0;5;00;0;1;0.0479217991232872;0;g;mi
1,1,2022,2,5,15,25,25025,250250,11,31,0,1,0,5,00;1;1;2022;2;5;15;25;25025;250250;11;119;\N;31;0;1;0;5;00;0;1;0.9496409893035889;0;g;mi
1,1,2022,2,5,15,25,25025,250250,10,21,0,5,0,5,00;1;1;2022;2;5;15;25;25025;250250;10;119;\N;21;0;5;0;5;00;0;1;0.0006571990088559687;0;g;mi
1,1,2022,2,5,15,25,25025,250250,10,21,0,2,0,5,00;1;1;2022;2;5;15;25;25025;250250;10;119;\N;21;0;2;0;5;00;0;1;0.007095689885318279;0;g;mi
1,1,2022,2,5,15,25,25025,250250,10,21,0,1,0,5,00;1;1;2022;2;5;15;25;25025;250250;10;119;\N;21;0;1;0;5;00;0;1;0.992247998714447;0;g;mi
1,1,2022,2,5,15,25,25025,250250,9,21,0,5,0,5,00;1;1;2022;2;5;15;25;25025;250250;9;119;\N;21;0;5;0;5;00;0;1;0.0006571990088559687;0;g;mi
1,1,2022,2,5,15,25,25025,250250,9,21,0,2,0,5,00;1;1;2022;2;5;15;25;25025;250250;9;119;\N;21;0;2;0;5;00;0;1;0.007095689885318279;0;g;mi
1,1,2022,2,5,15,25,25025,250250,9,21,0,1,0,5,00;1;1;2022;2;5;15;25;25025;250250;9;119;\N;21;0;1;0;5;00;0;1;0.992247998714447;0;g;mi
```


Source: CMT and Massport, 2024.

J.4.5 Fuel Storage/Handling and Miscellaneous Sources Throughputs

The " other source" category in the 2022 ESPR includes sources such as fuel storage/handling, boilers, snow melters, emergency generators, heaters, and firefighter training activities.

As in previous years, VOC emissions from fuel storage/handling were calculated using methods based on U.S.EPA's AP-42[26] document. Calculations account for evaporative emissions from breathing losses, working losses, and spillage from aboveground storage tanks, underground storage tanks, and aircraft refueling.

Emissions from the "miscellaneous" source category (i.e., stationary sources including the Central Heating and Cooling Plant boilers, other boilers, emergency generators, snow melters, space heaters, and sources associated with the fire training facility) were estimated using emission factors from U.S.EPA's AP-42 and

26 U.S. Environmental Protection Agency, "AP-42: Compilation of Air Pollutant Emission Factors," updated March 22, 2022, https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors.

NO_X Reasonably Available Control Technology (RACT) compliance testing combined with the actual 2022 fuel throughputs of the stationary sources to obtain emissions of VOCs, NO_X, CO, and $PM_{10}/PM_{2.5}$. Emissions from fire training fuel used at Logan Airport (i.e., Tek Flame®) was calculated using default emission factors from AEDT and actual annual fuel usage.

Table J-11 presents Logan Airport's fuel storage/handling and stationary sources fuel throughputs by fuel category for the 2022 analysis year and, for comparison purposes, also includes years 2019 through 2021. The table also provides data for the Future Horizon Year. Throughputs for years prior to 2019 are provided in the *2020/2021 EDR*.

Table J-11 Fuel Storage/Handling and Stationary Sources Fuel Throughputs by Fuel Type[1]

Source	Fuel Type	2019	2020	2021	2022	Future
Fuel Storage/ Handling	Jet Fuel	542,314,657	220,004,260	302,650,342	443,381,606	579,678,349
	Aviation Gas[2]	430,155	238,339	296,120	550,441	719,648
	Auto Gas	7,411,444	3,204,579	4,840,631	6,099,594	159,493
	Diesel	1,270,852	773,590	660,178	1,023,860	26,772
Miscellaneous Sources5	Natural Gas	515,029,176	407,657,000	401,934,668	357,840,873	16,531,426
	Heating Oil No. 2[3]	52,491	20,435	16,534	0	0
	ULSD	165,208	87,553	123,608	178,007	38,288
	Fire Training Fuel[4]	7,375	6,460	7,757	9,236	7,639

Source: Massport, 2024.
All throughputs are in gallons except for natural gas which is represented in cubic feet.
Aviation gasoline throughput based on AEDT.
Massport is no longer using Heating Oil No. 2 instead it has converted to ultra-low sulfur diesel (ULSD).
Fire training fuel consist of Tek Flame® and aviation gasoline.
Includes fuel throughputs from boilers, heaters, emergency generators, snowmelters and fire training activities.

J.4.6 Greenhouse Gas Inputs and Emission Factors

The Massachusetts Executive Office of Energy and Environmental Affairs (EEA) has published the *MEPA* [Massachusetts Environmental Policy Act] *Greenhouse Gas Emissions Policy and Protocol*.[27] These guidelines require the quantification of greenhouse gases (GHGs) for certain proposed projects and the identification of measures to avoid, minimize, or mitigate increases in GHGs.[28] Even though the purpose of the *2020/2021 EDR* is not the assessment of a proposed project(s) and is therefore not subject to the GHG

27 Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs, Revised MEPA Greenhouse Gas Emissions Policy and Protocol, effective May 5, 2010, https://www.mass.gov/files/documents/2016/08/rp/ghg-policy-final-summary.pdf.

28 These GHGs are comprised primarily of carbon dioxide CO_2, methane CH_4, nitrous oxides N_2O, and three groups of fluorinated gases (i.e., sulfur hexafluoride [SF_6], hydrofluorocarbons [HFCs], and perfluorocarbons [PFCs]). GHG emission sources associated with airports are generally limited to CO_2, CH_4, and N_2O.

policy, Massport has prepared an emission inventory of GHG emissions directly and indirectly associated with Logan Airport.

In April 2009, the Transportation Research Board ACRP published Report 11. The guidebook provides recommended instructions to airport operators on how to prepare an airport-specific GHG emissions inventory.[29] The 20222 and Future Planning Horizon GHG emissions estimates for Logan Airport are prepared for aircraft (emissions occurring within the ground taxi/delay mode and up to 3,000 feet in altitude), GSE, APU, motor vehicles, a variety of stationary sources, and emissions that result from the generation of electricity. Aircraft cruise emissions that occur above 3,000 feet in altitude are not estimated. The GHG emission estimates were prepared following the EEA, ACRP, and ACI ACA Program guidelines and emission factors considered appropriate for preparing GHG inventories that are approved by the U.S.EPA and available within the GHG Emissions Factors Hub database.[30]

Airport GHG emissions are calculated the same way as emissions of the criteria air pollutants/precursors, are calculated. In other words, emissions are calculated using input data such as activity levels or material throughput rates (e.g., fuel usage, VMT, electrical consumption) that are applied to appropriate emission factors (in units of GHG emissions per gallon of fuel).

For the 2022 GHG emission estimates, the input data were either based on Massport records or data and information derived from the latest version of the FAA's AEDT. The Future Planning Horizon GHG emission estimates were based on forecasted data and represent a conservative analysis. **Table J-12** summarizes the data and information used to prepare the 2022 and Future Planning Horizon GHG emission inventories.

Estimated total GHG emissions at Logan Airport from 2007 through 2021 are provided in the Boston Logan International Airport *2020/2021 EDR*, published in November 2022.

Table J-12 GHG Inventory Input Usage Data

Activity	Fuel Type	2022	Future	Units	Source
Aircraft					
Aircraft Taxi	Jet A[1]	19,464,653	23,992,716	gallons	AEDT 3e
	AvGas[2]	58,556	43,404	gallons	AEDT 3e
Engine Startup	Jet A	460,757	598,980	gallons	AEDT 3e
Aircraft AGL to 3,000 feet	Jet A[1]	23,653,193	33,083,207	gallons	AEDT 3e

29 National Academies of Sciences, Engineering, and Medicine 2009, Transportation Research Board, Airport Cooperative Research Program, Report 11: *Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories*, 2009, Washington, DC: The National Academies Press, https://nap.nationalacademies.org/catalog/14225/guidebook-on-preparing-airport-greenhouse-gas-emissions-inventories.

30 U.S. Environmental Protection Agency, GHG Emissions Factors Hub (26 March 2020) for the 2020 analysis, and GHG Emissions Factors Hub (15 September 2021) for the 2021 analysis, https://www.epa.gov/climateleadership/ghg-emission-factors-hub.

Table J-12 GHG Inventory Input Usage Data

Activity		Fuel Type	2022	Future	Units	Source
		AvGas[2]	89,214	50,076	gallons	AEDT 3e
Aircraft Support Equipment						
Ground Service Equipment (GSE)		Diesel	737,205	19,276	gallons	Massport
		Gasoline	664,574	17,377	gallons	Massport
		Propane	114	3	gallons	Massport
		CNG	0	0	ft3	Massport
Auxiliary Power Units (APU)		Jet A	1,070,671	799,657	gallons	AEDT 3e
Motor Vehicles						
On-airport Vehicles[4]		Composite[3]	58,886,481	58,041,091	VMT	Massport
On-airport Parking/Curbsides		-	2,288,664	2,751,631	hours	Massport
Massport Shuttle Bus		CNG	168,919	250,401	GEG	Massport
		Diesel	Defleeted in 2014		gallons	Massport
Massport Express Bus		Diesel	400,156	0	gallons	Massport
NABI Articulated Buses		Diesel	121,000	0	gallons	Massport
Massport Fire Rescue		Diesel	9,275	9,275	gallons	Massport
Massport Fleet Vehicles	Fueled Onsite	Gasoline	167,325	0	gallons	Massport
		Diesel	53,735	0	gallons	Massport
	Fueled Offsite	Gasoline	133,804	0	gallons	Massport
Off-airport Vehicles[4]	Public	Composite[3]	128,941,855	163,960,023	VMT	Massport
	Airport Employees	Gasoline	3,725,925	3,051,076	VMT	Massport
	Tenant Employees	Gasoline	52,292,961	42,821,532	VMT	Massport
Other Sources						
Boilers and Space Heaters		ULSD	22,748	0	gallons	Massport
		Natural Gas	352	17	million ft^3	Massport
Generators		ULSD	28,443	38,288	gallons	Massport

Table J-12 GHG Inventory Input Usage Data

Activity		Fuel Type	2022	Future	Units	Source
Snow melters		ULSD	126,815	0	gallons	Massport
		Natural Gas	6	0	million ft^3	Massport
Fire Training Facility		Tekflame	7,861	6,680	gallons	Massport
		AvGas	1,375	958	gallons	Massport
Electrical Consumption	Massport	-	18,882,411	20,901,623	kWh	Massport
	Tenant/Common Area	-	158,395,949	175,334,199	kWh	Massport

Sources: Massport and CMT, 2024.

Notes: AGL – above ground level; AvGas – Aviation Gasoline; CNG – compressed natural gas; ft^3 – cubic feet; GEG – gasoline equivalent gallons; kWh – kilowatt hours; ULSD – ultra low sulfur diesel; VMT – vehicle miles traveled; AEDT – Aviation Environmental Design Tool.

1 Jet A density of 6.84 pounds per gallon.

2 AvGas density of 6.0 pounds per gallon.

3 Composite means gasoline, diesel, and ethanol-fueled motor vehicles.

4 Excludes VMT associated with electric vehicles and accounts for public transportation usage.

Emission factors were obtained from the latest available versions of U.S.EPA's MOVES and GHG Emission Factors Hub. **Table J-13** provides the emission factors for CO_2, N_2O, and CH_4 that were used to prepare the 2022 and Future Planning Horizon inventories.

Table J-13 GHG Emission Factors

Sources	Year	Fuel	CO_2	N_2O	CH_4	Units
Aircraft[1]	2022/Future	Jet A	21.5	0.00066	-[4]	lb/gallon
		AvGas	18.3	0.00024	0.01556	lb/gallon
Ground Support Equipment (GSE)/ Auxiliary Power Units (APUs)[1]	2022/Future	Diesel	22.5	0.00108	0.00037	lb/gallon
		Gasoline	19.4	0.00055	0.00569	lb/gallon
		Propane	12.5	0.00013	0.00062	lb/gallon
Motor Vehicles[1,2]	2022	Composite	205	0.00204	0.00500	g/mile
			2,842	0.04780	0.04000	g/hour-vehicle
		Gasoline	204	0.00197	0.00500	g/mile
			2,825	0.04649	0.03900	g/hour-vehicle
	Future	Composite	164	0.00166	0.00273	g/mile
			2,234	0.03903	0.02047	g/hour-vehicle
		Gasoline	163	0.00165	0.00270	g/mile

Table J-13 GHG Emission Factors

Sources	Year	Fuel	CO_2	N_2O	CH_4	Units
			2,220	0.00388	0.02027	g/hour-vehicle
Buses	2022/Future	Diesel	22.5	0.00018	0.00090	lb/gallon
		Gasoline	19.4	0.00018	0.00084	lb/gallon
Stationary Sources[1]	2022/Future	Natural Gas	120	0.00023	0.00226	lb/1000 ft^3
		ULSD	22.5	0.00018	0.00090	lb/gallon
Fire Training Facility[1]	2022/Future	Tekflame[3]	12.5	0.00013	0.00062	lb/gallon
		AvGas	18.3	0.00024	0.01556	lb/gallon
Electrical Consumption[1]	2022/Future	-	0.53	0.00001	0.00007	lb/kWh

Sources: Massport and CMT, 2024.

Notes: CNG – compressed natural gas; ULSD – Ultra Low Sulfur Diesel; CO_2 – carbon dioxide; N_2O – nitrous oxides; CH_4 – methane; g- grams; ft^3 – cubic feet; kWh – kilowatt hour; lb – pound.

1 U.S. Environmental Protection Agency, GHG Emissions Factors Hub (April 2022).

2 U.S. Environmental Protection Agency, MOVES3.1.

3 As propane.

4 Contributions of CH_4 emissions from commercial aircraft are reported as zero. Years of scientific measurement campaigns conducted at the exhaust exit plane of commercial aircraft gas turbine engines have repeatedly indicated that CH_4 emissions are consumed over the full emission flight envelope [Reference: Aircraft Emissions of Methane and Nitrous Oxide during the Alternative Aviation Fuel Experiment, Santoni et al., Environ. Sci. Technol., July 2011, Volume 45, pp. 7075-7082]. As a result, U.S.EPA published that: "…methane is no longer considered to be an emission from aircraft gas turbine engines burning Jet A at higher power settings and is, in fact, consumed in net at these higher powers." [Reference: U.S.EPA, Recommended Best Practice for Quantifying Speciated Organic Gas Emissions from Aircraft Equipped with Turbofan, Turbojet, and Turboprop Engines, May 27, 2009 [EPA-420-R-09-901], http://www.epa.gov/otaq/aviation.htm]. In accordance with the following statements in the 2006 IPCC Guidelines (IPCC 2006), FAA does not calculate CH_4 emissions for either the domestic or international bunker commercial aircraft jet fuel emissions inventories. "Methane (CH_4) may be emitted by gas turbines during idle and by older technology engines, but recent data suggest that little or no CH_4 is emitted by modern engines." "Current scientific understanding does not allow other gases (e.g., N_2O and CH_4) to be included in calculation of cruise emissions." (IPCC 1999).

J.5 GHG Emissions Normalized by Building Area

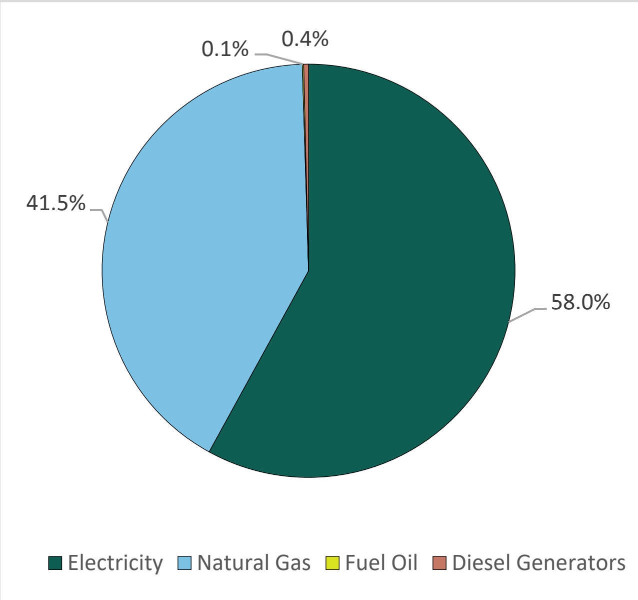
A building's energy use intensity, which is a measure of energy consumption per square foot. Massport is undertaking a reassessment of square footage across the Airport at the time of this filing, and thus accurate square footage data are not available for the *2022 ESPR*. Without accurate square footage data, the EUIs are not useful in displaying energy use intensity; therefore, this metric will be provided in future iterations of the EDRs and ESPRs, pending the update to the square footage assessment. Overall trends from 2007 to 2021 have shown a decrease in thousand British Thermal Unit (kBTU). These data demonstrate that Logan Airport is operating more efficiently over time, shifting to cleaner fuel sources, and serving more passengers in a larger building footprint with less energy. The following Massport initiatives have contributed to this success:

- Commitment to the Sustainable and Resiliency Design Standards and Guidelines (SRDSGs);

- Constructing and operating facilities to LEED® standards and other sustainability-rating systems;
- On-going energy efficiency projects, such as converting to light-emitting diode (LED) lighting and upgrading to energy-efficient heating, ventilation, and air conditioning (HVAC) equipment; and
- Installation of on-site renewable energy sources, including solar and wind.

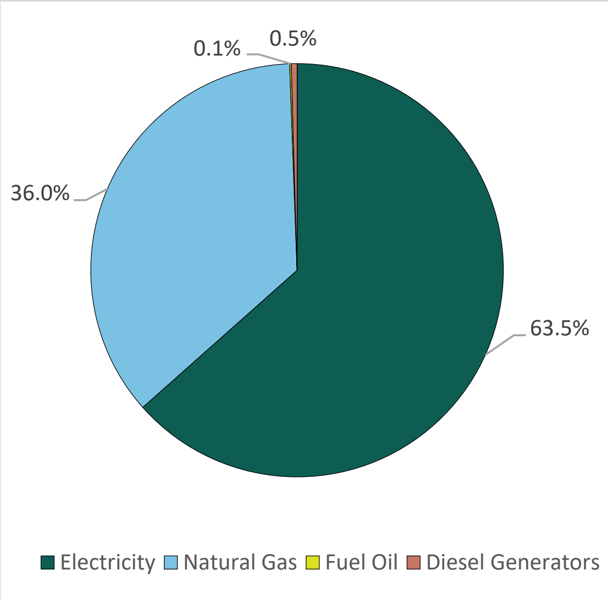
Building energy is provided from three sources: natural gas, fuel oil, and electricity, and also by diesel generators in times when emergency backup is needed. **Figure J-1** and **Figure J-2** show building energy by source and building GHG emissions by source.

Figure J-1 FY 2020 Building Energy Sources



Source: Massport, 2022

Figure J-2 FY 2020 Estimated Building GHG Emission Sources



Source: Massport, 2022

J.6 GSE Alternative Fuels Conversion

For the 2022 and Future Planning Horizon analyses, GSE emissions were calculated using AEDT emission factors in combination with the 2017 TIM survey, AEDT's default TIM data, and the GSE fuel types obtained from the 2022 Logan Airport Vehicle Aerodrome Permit Applications. Use of the data from the 2017 TIM survey and the applications provide the most up-to-date GSE fleet operational and fuel mix characteristics (including alternative fuels and electric-powered GSE). **Table J-14** presents the emission reductions of criteria air pollutants/precursor pollutants due to the use of GSE alternative fueled vehicles (AVFs) from 2019 to 2022. Emission reductions due to the use of AVFs at Logan Airport prior to 2019 are provided in the *2020/2021 EDR*.

Table J-14 GSE Alternative Fuel Conversion Summary (kg/day)

Year	Pollutant	Percent Reduction	Emissions without Reduction	Reduction from AFVs	Emissions with Reduction
2019	VOCs	6.6%	22	1	21
	NO_X	2.5%	152	4	148
	CO	11.5%	449	52	397
	$PM_{10}/PM_{2.5}$	1.7%	14	<1	14
2020	VOCs	10.3%	10	1	9
	NO_X	9.0%	33	3	30
	CO	12.7%	255	32	223
	$PM_{10}/PM_{2.5}$	8.1%	2	<1	2
2021	VOCs	12.3%	12	2	11
	NO_X	10.9%	38	4	34
	CO	15.1%	326	49	277
	$PM_{10}/PM_{2.5}$	10.0%	3	<1	3
2022	VOCs	13.8%	20	2	17
	NO_X	12.9%	56	6	49
	CO	17.3%	533	78	454
	$PM_{10}/PM_{2.5}$	12.8%	4	<1	3

Source: CMT and Massport, 2024.

Notes: Emission reductions may reflect rounding.

VOC – volatile organic compounds; NO_X – nitrogen oxides; CO – carbon monoxide; $PM_{10}/PM_{2.5}$ – particulate matter equal to or less than 10 microns in diameter (PM_{10}) and equal to or less than 2.5 microns in diameter ($PM_{2.5}$); and AFVs – alternative fuel vehicles.

J.7 Future Planning Horizon Sustainable Aviation Fuel (SAF) Reduction Methodology

The primary GHG emission reductions associated with the use of SAF occur over the lifecycle of the fuel. Generally, the lifecycle emissions of a fuel include the production, extraction, transport, and final burning of the fuel into exhaust.

The ICAO has developed the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which is a global market-based measure and cooperative international approach of initiatives to reduce GHG emissions in aviation. Through CORSIA, ICAO determines if fuels are CORSIA Eligible Fuels (CEF) and develops associated default life cycle emission reduction values for each CEF. GHG reductions from CEFs vary by feedstock and the fuel conversion process.

Additionally, the international standards organization, ASTM, has certified six fuel conversion processes for SAF use in aircraft based on the fuel feedstock and the associated technical specifications required to produce the fuel. ICAO has a set of procedures and requirements for a type of SAF to be certified as a CEF, and within the process, ICAO develops a life cycle emissions value (LSf). The LSf is a factor for each CEF that is used in the equation below to calculate the life cycle emissions reduction. The LSf is ratioed with a baseline life cycle emission factor (LC) for conventional aviation fuels (i.e., avgas and Jet-A). The LSf and LC both have units of grams of CO_2e per unit of energy in megajoules (g/CO_2e). Additionally, each fuel conversion process has an associated Fuel Conversion Factor (FCF) that is also applied. The emission reductions (ER) for GHGs are computed for metric tons of CO_2e based on the mass of the fuel consumed (MS) using the equation below:

$$ER = FCF \times [MS \times (1 - (LS_f/LC))]$$

For the purposes of computing GHG emissions for the *2022 ESPR*, it will be assumed that the fuel consumed by aircraft will be in line with the FAA's projected percentage of aviation fuels that is expected to be SAF by the year 2030, which amounts to 10 percent. The variables for the equation above were determined based on the range of available SAF types currently being used in the United States. There are currently 14 CEFs that are produced in the U.S., and include feedstocks such as herbaceous energy crops, switchgrass, soybean oil, camelina oil, corn grain, and poplar. Based on a composite of U.S. SAF types, SAF usage for the Future Horizon Year will result in reductions of 43,707 MT CO_2e (see **Table 8-12** of Chapter 8, *Air Quality and Greenhouse Gas Emissions*).

J.8 Air Quality and GHG Emission Reduction Efforts

As part of implementing and advancing its on-going air quality management strategy for Logan Airport, Massport has established goals and objectives to address air emissions from Airport operations, including the minimization of Airport-related emissions through the reduction of GSE and Massport vehicle fleet emissions. This section presents an update on these initiatives at Logan Airport. This section further highlights updates on other on-going Logan Airport-related air quality and emission reduction efforts and current studies on aviation-related air quality and public health issues. $MTCO_2e$

J.8.1 Alternative Fuel Vehicles (AFV) Program

A component of Massport's Air Quality Management Program is the AFV Program. The AFV Program is designed to replace Massport's conventionally fueled fleet with alternatively fueled or powered vehicles, when feasible, to help reduce emissions associated with Logan Airport operations. Massport operates more than 100 vehicles powered by propane, E85 flex fuel, diesel/electric hybrid, gasoline/electric hybrid, and plug-in electric.

Table J-16 shows the number of Massport AFVs by vehicle type in 2022, not including GSE. As discussed in Chapter 1, *Introduction and Executive Summary,* several projects, and programs support AFVs at Logan Airport including:

- Massport continues its partnership with the MBTA to offer free Silver Line boardings at the Airport. The reduced dwell times and faster travel times through the terminal area led Massport to extend the free-fare program indefinitely. The MBTA operates ten Silver Line buses purchased by Massport in 2023 with Massport paying operating costs for portions of the Silver Line service directly servicing Airport Terminals.
- Operation for almost two decades of one of the largest privately operated, publicly accessible, CNG stations in New England.
- Massport is facilitating the replacement of gas- and diesel-powered ground service equipment with electric GSE (eGSE), if commercially available. In 2020, Massport was awarded an FAA Voluntary Airport Low Emission (VALE) Program grant for charging infrastructure at Terminal E and installing 10 eGSE charging stations at Signature Aviation Building 14.
- Massport provides more than 100 hybrid, EV, and AFV-only on-Airport parking spaces spread out among the Terminal and Economy Garage in preferred parking locations. Since 2007, Massport has offered preferred parking for customers driving hybrid and AFVs. Twenty-seven of these spaces provide EV charging locations convenient to the Terminals. While normal parking rates apply, there is currently no cost for electricity use. Real-time availability of spaces can be found on Massport's website (https://www.massport.com/logan-airport/getting-to-logan/parking). Currently, there are more than 100 charging ports installed at Logan Airport and its Logan Express sites.
- As part of its long-range emission reduction strategy, Massport is working with the airlines to replace conventional gasoline- and diesel-powered GSE with electric alternatives.
- At the time of this filing, Massport is piloting renewable diesel.

Table J-16 Massport's AFV Fleet Inventory at Logan Airport

Fuel Type	Vehicle	2022 Total Fleet Inventory
Diesel/Electric Hybrid	Shuttle Bus[1]	42
Compressed Natural Gas (CNG)	CNG NABI Bus[2]	31
Gasoline/Electric Hybrid	Ford C-MAX	1
Propane	Ford Taurus	1
E85 Flex Fuel	Explorer	5
	F-150	5
	F-250	6
	F-350	4
Plug-in Electric Hybrid	Chevy Volt[3]	8
	Ford C-MAX	1

Table J-16 Massport's AFV Fleet Inventory at Logan Airport

Fuel Type	Vehicle	2022 Total Fleet Inventory
Electric	Chevy Bolt	1
Total		**105**

Source: Massport, 2024.

1 The 32 diesel/electric hybrid shuttle buses, added to the fleet in 2013, replaced the diesel rental car buses. The MBTA recently procured and began operating a new fleet of Silver Line buses, and Massport purchased ten buses for the SL1 route between South Station and the Logan Airport terminals. Massport will purchase ten new Silver Line buses as part of a forthcoming (Spring 2023) MBTA procurement.

2 The CNG NABI buses replaced the 26 aging CNG shuttle buses.

3 The Chevy Volt plug-in electric hybrid vehicles replaced the CNG Honda Civics.

J.8.2 Massport Goal to the Net Zero Roadmap by 2031

In 2021, Massport prepared the Net Zero Roadmap by 2031, the goal is to reduce carbon emissions across all facilities and become Net Zero by 2031, coinciding with the Authority's 75th anniversary. The Roadmap to Net Zero focuses on 100% of the GHG emissions directly controlled by Massport-owned facilities, equipment, and purchased electricity, with continued influence in areas the Authority does not control. The plan outlines the steps Massport will take to reduce emissions within the decade, directly benefiting neighboring communities and further preparing the Authority for the impacts of climate change.

To reach this ambitious goal of achieving Net Zero GHG, Massport is evaluating a number of options, these include:

- Improving energy efficiency in buildings through design standards and operational controls.
- Transitioning to clean fuel sources such as renewable electricity, renewable natural gas, etc.
- Generating as much renewable energy as possible on-site and making off-site renewable energy purchases.
- Acquiring renewable energy credits, renewable identification numbers, and carbon offsets as a transition strategy, for the fossil fuel sources that cannot be reduced, electrified, or switched to renewable energy in the near-term.
- Implementing all remaining facility-specific initiatives identified to ultimately reach net zero.

For any areas where emissions cannot be reduced to zero, Massport will invest in carbon offsets to reach the target. Massport expects to be Net Zero without offsets by 2040. Carbon offsets are investments in GHG-reducing projects, such as a solar farm, which diminish the impact of an organization's own GHG emissions. Massport's aim would be to purchase offsets that benefit local projects within the Commonwealth.

Components of the phased plan controlled by Massport include items like upgrading lighting systems across all facilities to LEDs, which has already been started, to rehabilitating Logan Airport's Central Heating Plant, upgrading the Logan Express and shuttle bus fleet to electric vehicles, and installing more solar panels and renewable energy sources.

J.9 Air Quality Studies

Numerous air quality-related studies have taken place in the vicinity of Logan Airport. **Figure J-3** illustrates the approximate study location for these studies.

J.9.1 Massachusetts Department of Public Health Study

In 2004, the Massachusetts Legislature appropriated funds for the Department of Public Health (DPH) to undertake an assessment of the potential health impacts of Logan Airport in the East Boston section of the city and any other communities located within a five-mile radius of the Airport, with a focus on noise and air quality. This study was completed in May 2014 and consisted of an epidemiological survey combined with computer modeling of noise levels and air pollution concentrations. Massport has cooperated in this effort by providing funding to complete the study and Airport operational data in support of the study. In the spring of 2011, Massport also gave technical assistance in support of the DPH study by providing geographic information systems (GIS) analysis of the roadway network in and around Logan Airport in a format compatible with FAA's EDMS. Massport is working with DPH and the East Boston Neighborhood Health Center on implementing DPH recommendations related to Massport.

In response to the DPH study recommendations, Massport has renewed an agreement to provide funding to the East Boston Neighborhood Health Center to help expand the efforts of their Asthma and Chronic Obstructive Pulmonary Disease (COPD) Prevention and Treatment Program in East Boston and Winthrop that provides services including screenings for children, distribution of asthma kits, and home visits, among others.

The findings from this study can be viewed from DPH website at: https://www.mass.gov/doc/logan-airport-health-study-english-0/download.

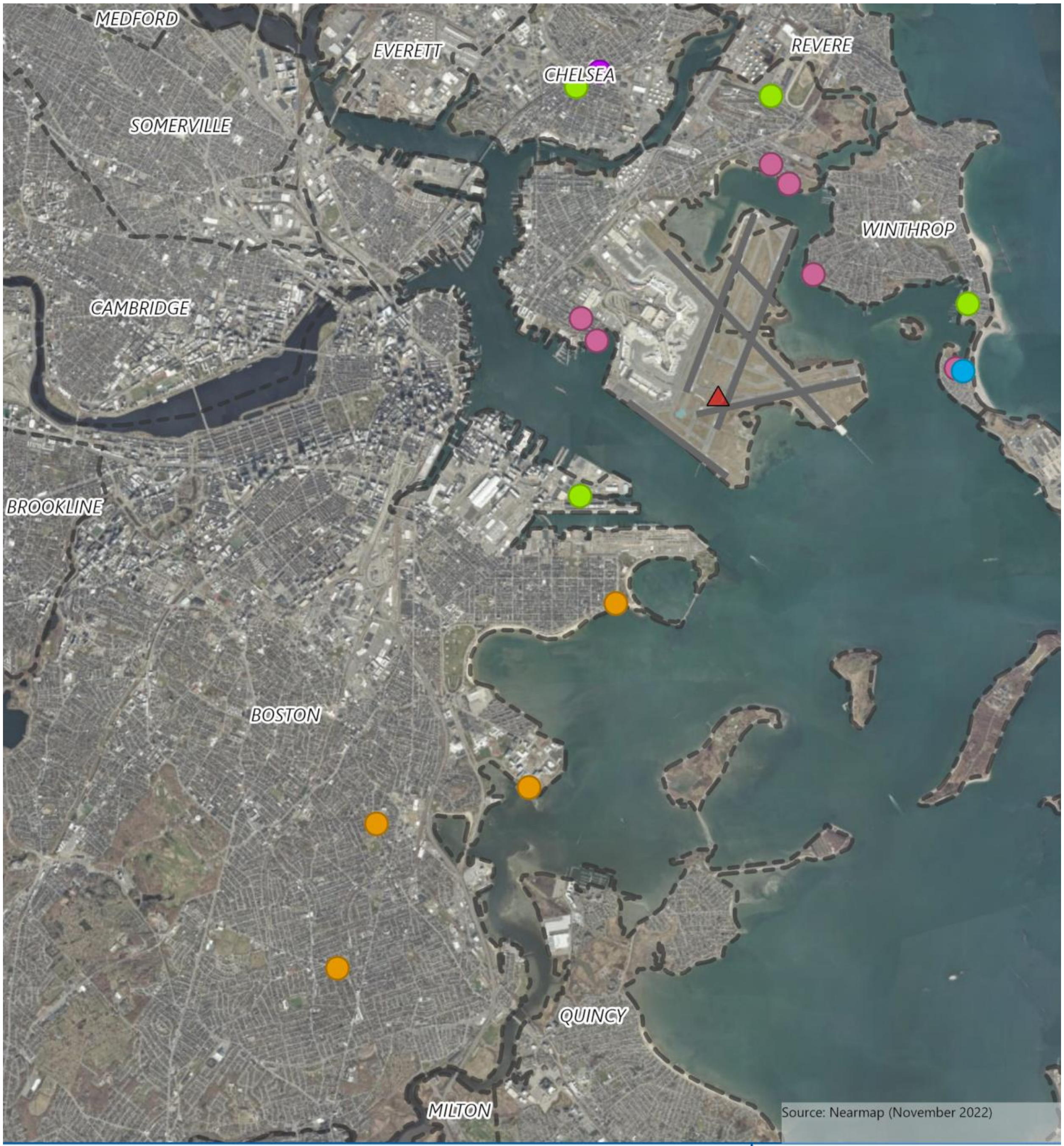


Figure J-5 Location of Air Quality Studies within Vicinity of Airport

2022 Environmental Status and Planning Report

Airport Reference Point
Tufts - Hudda et al. 2020
Olin, Air Inc., and Aerodyne Study
BU/Tufts FAA ASCENT Research
BU - Chung et al. 2023
Tufts - Mueller et al. 2022
Municipal Boundary

0 0.75 1.5 Miles

J.9.2 Recent Studies on Impacts of Aviation Emissions on Air Quality and Public Health

Massport continues to stay apprised of studies regarding the impact of aviation on air quality and public health. A recent study conducted by Tufts University, *Impacts of Aviation Emissions on Near-Airport Residential Air Quality*,[31] examined CO, CO_2, NO, NO_2, $PM_{2.5}$, UFPs, and BC at a residence near Logan Airport. The residence was located under a flight trajectory of the most utilized runway configuration. The study showed that gaseous and particulate pollutant concentrations were higher at the residence when it was downwind compared to when it was not.

Olin College is collaborating with Air Inc. and the Town of Winthrop to monitor air quality in the community. Monitors were placed in Winthrop to continuously measure pollutants such as CO, CO_2, nitric oxide (NO), NO_2, and O_3, as well as the mass concentration of PM_{10}/$PM_{2.5}$, and all relevant meteorological conditions. This study is on-going and Massport will continue to provide operational data and collaborate as needed.

Additionally, as discussed in previous sections, the University of Southern California and the University of Washington conducted two recent studies. The study performed by the University of Southern California indicated that there could be adverse health effects following exposure to airport and roadway traffic-related UFPs near Los Angeles International Airport. The study led by the University of Washington was conducted to understand the air quality impacts of air traffic for communities located near and below the flight paths of Seattle-Tacoma International Airport. The findings show key differences exist in the particle size distribution and the BC concentration for roadway and aircraft features.

Furthermore, research is underway for the update of TRB's ACRP Report 135: *Understanding Airport Air Quality and Public Health Studies Related to Airports* to include the latest information on the impact of airport operations (e.g., aircraft, GSE, ground transportation, and stationary sources) on air quality and public health. This research would aid airport operators in responding to concerns about air quality at airports and in their vicinity.

J.9.3 Single Engine Taxiing

Single-engine taxiing is one measure that is being used by air carriers to help reduce fuel use and emissions. As a result, Massport supports the use of single-engine taxiing when it can be done safely, voluntarily, and at the discretion of the pilot. Massport has conducted three surveys of Logan Airport air carriers (2006, 2009, and 2010) to understand the extent single-engine taxiing is used at Logan Airport. In addition, Massport was an active member of the FAA Partnership for Air Transportation Noise and Emissions Reduction (PARTNER) program on reducing noise and emissions.[32] In 2009, Massport offered to

31 Neelakshi Hudda et al, "Impacts of Aviation Emissions on Near-Airport Residential Air Quality," Environ. Sci. Technol. 2020, 54, 8580−8588, doi.org/10.1021/acs.est.0c01859.

32 The Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER) — was a leading aviation cooperative research organization headquartered at the Massachusetts Institute of Technology (MIT). An FAA Center of Excellence, PARTNER was sponsored by the FAA, NASA, Transport Canada, the U.S. Department of Defense, and the U.S.EPA. In December

facilitate a more detailed survey of pilots at Logan Airport by MIT to better understand the use of single-engine taxiing. MIT completed its survey and issued a paper in March 2010, which was provided in the *2009 EDR*. The MIT survey confirms earlier Massport survey findings that single-engine taxiing is an important operational measure used by airlines to conserve fuel and is extensively used at Logan Airport. MIT issued a paper in January 2011 reporting on a control strategy to minimize airport surface congestion, and thus taxiing time, by regulating the rate at which aircraft are pushed back from their gates. Massport continues to support the practice of single/reduced-engine taxiing and the use of idle reverse thrust.

MIT and the Center for Air Transportation Systems Research developed a methodology to account for single-engine taxi procedures during the taxi-in or -out modes.[33,34,35] Some of the single-engine taxi challenges noted in these studies include: (1) excessive thrust and associated issues; (2) maneuverability problems particularly related to tight taxiway turns and weather; (3) problems starting the second engine; and (4) distractions and workload issues. Thus, pilots do not use single-engine taxiing during each aircraft operation in practice, and when they do use it, it is not for the entire operation. Pilots use single-engine taxiing even less often when taxiing out.

When applying the MIT methodology and available data (such as aircraft pilot surveys) to the 2022 Logan Airport aircraft operational data, the results show a savings of approximately 2,075,172 gallons of jet fuel. This translates to a reduction of approximately 20,398 metric tons of CO_2e emissions associated with this initiative in 2022.

J.9.4 Engagement in Aviation-Related Environmental Issues

Massport maintains memberships and active participation in organizations that address aviation-related environmental issues, including air quality. These include environmental committees for TRB, the American Association of Airport Executives (AAAE), and the Airports Council International-North America (ACI-NA).

J.9.5 Black Carbon (BC)

Particulate matter of all sizes is comprised of multiple components, one of the more significant being BC. BC particles, also referred to as soot, form because of incomplete combustion, particularly at the higher temperatures at which aircraft burn fuel, making BC emissions common from aircraft. BC from aviation activities largely contributes to smaller particulate matter particles (i.e., $PM_{2.5}$ and UFPs). $PM_{2.5}$ is classified as a criteria air pollutant by U.S.EPA and regulated by NAAQS.

2015, PARTNER completed its Center of Excellence mandate and research. The ASCENT FAA Center of Excellence is now conducting similar research. Currently Massport is a member of the ASCENT Advisory Committee.

33 Massachusetts Institute of Technology. 2010. A Survey of Airline Pilots Regarding Fuel Conservation Procedures for Taxi Operations.

34 Massachusetts Institute of Technology. 2008. Opportunities for Reducing Surface Emissions through Airport Surface Movement Optimization.

35 Center for Air Transportation Systems Research. Analysis of Emissions Inventory for Single Engine Taxi-out Operations. 2009.

BC is known to have negative impacts on both human health and the environment. According to U.S.EPA, BC is associated with respiratory distress, cardiovascular disease, cancer, and birth defects. A 2009 study using air quality monitors near an airport showed that airports can contribute from 24 to 28 percent of total BC within 4 kilometers.[36] However, modeling studies, commonly used to ascertain the extent of impacts on human health and the environment, have shown the level of contribution by an airport to be less, only on the order of 2 to 5 percent. Researchers are working on understanding the reasons for this discrepancy. It may be an indication that emission estimates from airports need improvement.[37] A very recent study (September 2022) states that due to the complexity and cost of the instrumentation and the lack of reference modeling protocol, data availability on BC is limited.[38]

To fully understand the extent of impacts from airport-related BC emissions, much more research is needed. It is important for research to focus on improving emissions estimates of BC from airports and improved modeling studies. In addition to the U.S.EPA and other performing BC-related studies, the FAA also conducts BC research through the ASCENT program.

J.9.6 Ultrafine Particles (UFPs)

Within the field of air quality, airborne particles are collectively categorized as PMs and subdivided into size categories based on their diameters. These divisions are total suspended particles (TSP) with diameters ranging from 2.5 to 40 micrometers (µm), coarse particles PM_{10} with diameters ranging from 2.5 to 10 µm, fine particles $PM_{2.5}$ with diameters less than 2.5 µm, and UFPs with diameters less than 0.1 µm. Most of these particles originate from the exhaust gases generated by fossil fuel-powered engines and other high-temperature combustion sources including aircraft.

Under the CAA, U.S.EPA has established NAAQS for six criteria air pollutants including PM_{10} and $PM_{2.5}$. Outdoor concentrations within U.S.EPA standards are considered safe for the public. Presently, UFPs (by themselves) are not regulated ambient air pollutants. UFPs cannot be considered part of $PM_{2.5}$ because $PM_{2.5}$ regulates by a mass per volume concentration, and UFPs have a comparatively negligible mass. Any eventual UFP regulation would likely be regulated by particle count (or particle number concentrations).

On December 18, 2020, the U.S.EPA published a final action in the Federal Register detailing the agency's review of the NAAQS for PM_{10}/$PM_{2.5}$. UFP is addressed in the supplemental information of the notice. In their review of the PM_{10}/$PM_{2.5}$ NAAQS, the agency determined that due to significant uncertainties and limitations, as well as the limited availability of air monitoring data, that the $PM_{2.5}$ NAAQS would be retained as the indicator for UFP.[39]

---

36 Dodson R. E.; Houseman E. A.; Morin B.; Levy J. I. 2009. *An analysis of continuous black carbon concentrations in proximity to an airport and major roadways.* Atmos. Environ, 43243764–3773.

37 Arunachalam S.; Valencia A.; Yang D.; Davis N, Baek B.H.; Dodson R.E.; Houseman A.E.; Levy J.I. 2011. *Comparing Monitoring-Based and Modeling-Based Approaches for Evaluating Black Carbon Contributions from a US Airport.* Air Pol. Mod, 619-623.

38 J.Rovira; J.A.Paredes-Ahumada; J.M.Barceló-Ordinas; J.García-Vidal; C.Reche; Y.Sola; P.L.Fung; T.Petäjä; T.Hussein; M.Viana; September 2022. *Non-linear Models for Black Carbon Exposure Modelling Using Air Pollution Datasets*. Environmental Research Volume 212, Part B.

39 Federal Register, Volume 85, No. 244, Page 82684.

Studies conducted at Zurich Airport in Switzerland and London Heathrow Airport in England have demonstrated that UFP dispersion is highly dependent on wind speed and direction with UFP particle counts being on the order of 10 times higher when measured downwind of the airports.[40,41] A study conducted at Brussels Airport in Belgium demonstrated the UFP emissions from the airport can significantly impact concentrations up to 7 kilometers (4.3 miles) away from the source.[42] These studies have begun to explain the dispersion characteristics of UFPs from airports, but specific health studies to assess impacts of UFPs from airport sources have yet to be conducted.

A study performed by the University of Southern California demonstrated adverse health effects following exposure to airport-related and roadway traffic-related UFPs near Los Angeles International Airport. To understand the distinct health impacts associated with each source, a source apportionment analysis was conducted.[43] The University of Washington conducted a *Mobile ObserVations of Ultrafine Particles (MOV-UP) study* of air traffic-related air quality impacts for communities located below and near the flight paths of Seattle-Tacoma International Airport. The findings show key differences exist in the particle size distribution and the black carbon (BC) concentration for roadway and aircraft features. These differences are important because they help distinguish between the spatial impact of roadway traffic and aircraft UFP emissions using a combination of mobile monitoring and standard statistical methods.[44]

In 2021, as part of the Center for Air Climate and Energy Solutions (CACES), a team from the University of Washington and Virginia Tech developed the first national model estimate for airborne UFP concentrations. The model will ultimately lead to a better understanding of UFP effects on health and could one day impact air pollution policy.[45]

Massport is supportive of cooperative research efforts that are being funded by the FAA and co-led by Washington State University and the Massachusetts Institute of Technology (MIT), which are known as the FAA Center of Excellence for Alternative Jet Fuels and Environment, Aviation Sustainability Center (ASCENT).[46] The primary purpose of the research is the measurement of aviation emissions and their contribution to ambient levels of air pollution. As part of the studies, ACSCENT is measuring UFPs in the vicinity of Logan Airport to determine spatial and short-term temporal variations in the contribution of aviation emissions to ground level air pollutant concentrations. They are also constructing regression

40 Fleuti, E., Maraini, S., Bieri, L., 2017. *Ultrafine Particle Measurements at Zurich Airport.* Flughafen Zurich AG.

41 Masiol, M., Harrison, R. M., Vu, T. V., and Beddows, D. C. S. *Sources of Submicrometre Particles Near a Major International Airport,* Atmos. Chem. Phys. Discuss., doi.org/10.5194/acp-2017-150, in review, 2017.

42 Peters, J., Berghmans, P., and Frijns, E. 2016. *Ultrafine Particles and Black Carbon monitoring in the surroundings of Brussels Airport.* Brussels Environmental Agency.

43 Habre, Rima et al. "Short-term effects of airport-associated ultrafine particle exposure on lung function and inflammation in adults with asthma." *Environment international,"* vol. 118 (2018): 48-59, doi:10.1016/j.envint.2018.05.031.

44 University of Washington, Department of Environmental & Occupational Health Sciences, *Mobile ObserVations of Ultrafine Particles: The MOV-UP study report*, December 2019, https://deohs.washington.edu/sites/default/files/Mov-Up%20Report.pdf.

45 Provat K. Saha et al, High-Spatial-Resolution Estimates of Ultrafine Particle Concentrations across the Continental United States, Environmental Science & Technology (2021). DOI: 10.1021/acs.est.1c03237.

46 U.S. DOT, Federal Aviation Administration, Center of Excellence for Alternative Jet Fuels & Environment. https://ascent.aero/.

models using measured data from the years 2017 and 2018 to determine the contributions of aviation sources to UFP and BC.[47]

In 2023 as part of the TRB Annual and Mid-Year Meetings the following presentations on UFP research studies were given:

- Changes in Ultrafine Particle Concentrations near a Major Airport Following Reduced Transportation Activity during the COVID-19 Pandemic by Sean Mueller et al., 2022.
- Air Quality Impacts of Aviation Activities at a Mid-sized Airport in Central Europe by Ivonne Trebs et al., 2023.

The Mueller et al. study shows the effect of pandemic-related mobility changes on UFP counts in a near-airport community in the U.S. and distinguishes aviation-related and ground transportation source contributions. Notably, this study is an ASCENT supported project.

Additionally, the Trebs et al study performed at a European airport concludes that UFP counts at the studied airport decline at daytime despite significant flight activities during that same time period. The study states that this decline is due to efficient turbulent mixing (high wind speeds and solar radiation) during daytime, causing depletion of nucleation mode particle numbers whereas at nighttime there is a presence of stable nocturnal boundary layer, where pollutants are accumulated.

Massport is also cooperating with Boston University, Tufts University, and other researchers in identifying aircraft-specific related UFPs in an urban environment with non-airport related sources. This research is on-going in the East Boston area and Massport continues to contribute by providing Logan Airport operational and other pertinent data.

J.9.7 Climate Change Adaptation and Resiliency

Massport has a comprehensive resiliency initiative to maximize business continuity amid various human and natural threats. Massport’s efforts are guided by the following goals:

- Improve resiliency for overall infrastructure and operations.
- Restore operations during and after disruptive events in a safe and economically viable time frame.
- Create robust feedback loops that allow innovative solutions as conditions change.
- Inform operations and policy, and implement design/build decisions, through the application of sound scientific research and principles that consider threats, vulnerabilities, and cost-benefit calculations.
- Become a knowledge-sharing exemplar of a forward-thinking, resilient port authority.

47 ASCENT Project 018 2020 Annual Report. https://s3.wp.wsu.edu/uploads/sites/2479/2021/04/ASCENT-Project-018-2020-Annual-Report.pdf.

- Work with key influencers and decision-makers to strengthen understanding of the human, national, and economic security implications of extreme weather, changing climate, and anthropogenic threats to Massport's facilities and the region.

These initiatives are described in Chapter 2, *Sustainability, Outreach, and Environmental Justice*.

J.9.8 Statewide, National, and International Initiatives

Advancements on the national and international levels to decrease Airport-related air emissions have continued to focus primarily on three initiatives: the advanced quantification of particulate matter and hazardous air pollutants (HAPs) emissions from aircraft engines; the continued phasing-in of AFV; and the implementation of GHG emissions reduction strategies. These initiatives are briefly described below.

- **Particulate Matter and Hazardous Air Pollutant Research** – Conducted by the ICAO, FAA, U.S.EPA, and others, research continues to better characterize $PM_{10}/PM_{2.5}$ and HAPs emissions (including Pb) from aircraft engines. Similarly, air quality monitoring efforts at other airports were also conducted at various locations to advance what is known about ambient levels of these air pollutants in the vicinities of airports. Massport continues to closely track these issues through its involvement in aviation industry organizations such as ACI-NA and AAAE.
- **AFV Conversions** – Airlines and other GSE users are continually replacing their older fossil-fueled vehicles and equipment with more fuel-efficient, low- and non-emitting (e.g., electric) technologies. Airport-fleet vehicles are also being converted to alternative fuels (e.g., electric, propane). In response, GSE and automobile manufacturers are offering a wider selection of AFVs, many of which are designed specifically for airport use. Massport continues to support the conversion of fossil-fueled vehicles and equipment to alternative, electric, or lower-emitting fuels. Massport is replacing all commercially-available diesel-powered GSE with all-electric. In 2018, U.S.EPA awarded a $541,817 grant under the Diesel Emission Reduction Act (DERA) to Massport to replace gas- and diesel-powered GSE at Logan Airport in a collaborative effort to reduce diesel emissions and improve air quality. This grant will allow Massport to assist American Airlines with the replacement of 25 pieces of diesel-powered GSE with all-electric versions. This grant will be used in conjunction with an FAA grant Massport received in the fall of 2018 to install eGSE charging stations for the Terminal B Optimization Project. In 2019, Massport was awarded by U.S.EPA under DERA a $990,000 grant to replace 44 diesel-powered GSE with all-electric baggage tractors, belt loaders, and push-back tugs. Massport contributed a $1,210,000 match. Massport is also collaborating with the MassCEC to study opportunities to enable conversion of the ride-for-hire fleet (RideApp, Rental Car Taxi, and limousine vehicles) that serves Logan to transition to electric vehicles. In early 2022, MassCEC provided a grant to initiate this work and support Logan Airport's expansion of EV charging infrastructure. Over 200 EVs are available to rent at the Airport.[48]

48 Mogavero, Matthew. "Massport and MassCEC Celebrate Electric Vehicle Grant - Over 200 Electric Vehicles Currently Available To Rent At Logan Airport." MassCEC, July 27, 2022. https://www.masscec.com/press/massport-and-masscec-celebrate-electric-vehicle-grant-over-200-electric-vehicles-currently.

- **Sustainable Aviation Fuel (SAF)** – International Air Transport Association (IATA) approved a resolution for the governments to continue implementing the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). To achieve carbon-neutral growth, this initiative sets a cap on net CO_2 emissions generated from international aviation at 2020 levels. Airlines are also encouraged to use biofuels, or other SAFs, as a fuel efficiency measure.[49] SAFs are a renewable/cleaner substitute for fossil jet fuels that reduce carbon emissions and improve the air quality. In May 2019, United Airlines agreed to purchase up to 10 million gallons of cost-competitive, commercial-scale, sustainable aviation biofuel over the next two years. Currently, every United Airlines flight out of Los Angeles International Airport are powered by biofuel. United Airlines has renewed its contract with Boston's World Energy, a biofuel producer, to help achieve its commitment to reducing its GHG emissions by 50 percent by 2050.[50] In September 2021, jetBlue announced plans to speed up its transition to SAF with an offtake agreement with SG Preston, a leading bioenergy developer. With the addition of this SG Preston agreement to its previous SAF commitments, jetBlue is well ahead of the pace on its target to convert 10 percent of its total fuel usage to SAF on a blended basis by 2030. The airline will reach nearly 18 percent SAF usage by the end of 2023 when delivery of SAF under this agreement is expected. jetBlue is doubling its previous SAF commitment with SG Preston, which was first announced in 2016 as one of the largest SAF purchase agreements in aviation history.[51] As part of the Net Zero plan, Massport will also try to focus on GHG emissions that it does not directly but can possibly influence. One such example of an area of potential influence would be to enable the use of SAF at Logan. It is estimated that more than 99 percent of airline emissions and approximately 50 percent of airport emissions worldwide are related to the combustion of jet fuel. This past fall, President Biden announced a goal for U.S. companies to produce at least 3 billion gallons of SAF per year by 2030 and, by 2050, sufficient SAF to meet 100 percent of aviation fuel demand, which is currently projected to be around 35 billion gallons per year. Massport will work to enable use of SAF at their three airports and encourage the airline partners to transition to this alternative fuel while longer-term strategies are evaluated, approved, and adopted.
- **Climate Change Technology Standards**[52] – In October 2010, the 37th Assembly (Resolution A37-19) requested the development of an ICAO CO_2 emissions standard. Following six years of development, ICAO's Committee on Aviation Environmental Protection (CAEP) at its tenth meeting recommended an airplane CO_2 emissions certification standard. This new standard is part of the ICAO "Basket of measures" to reduce GHG emissions from the air transport system, and it is the first global technology standard for CO_2 emissions for any sector with the aim of encouraging more fuel-efficient

---

49 Biofuels international, IATA resolution urges airlines to switch to sustainable aviation fuels. June 3, 2019, https://biofuels-news.com/display_news/14744/iata_resolution_urges_airlines_to_switch_to_sustainable_aviation_fuels/.

50 Good News Network, As Only US Airline to Use Biofuel on Regular Basis, All United Flights from LA Are Now Powered by Biofuel. June 10, 2019. https://www.goodnewsnetwork.org/united-airlines-flights-from-la-powered-by-biofuel/.

51 jetBlue Accelerates Transition to Sustainable Aviation Fuel (SAF) With Plans for the Largest-Ever Supply of SAF in New York Airports for a Commercial Airline, Sep 29, 2021, http://mediaroom.jetblue.com/investor-relations/press-releases/2021/09-29-2021-132310033.

52 International Civil Aviation Organization, Environmental Protection, "Climate Change Technology Standards," 2020. https://www.icao.int/environmental-protection/Pages/ClimateChange_TechnologyStandards.aspx.

technologies in airplane designs. After adoption by the ICAO Council, the new airplane CO_2 emissions certification standard was published as an official CO_2 standard in 2017. The CO_2 standard applies to subsonic jet and turboprop airplanes that are "new type" designs from 2020. It also applies to "in-production" airplanes from 2023 that are modified and meet a specific change criterion. This is subsequently followed up by a production cut-off in 2028, which means that in-production airplanes that do not meet the standard can no longer be produced beyond 2028 unless the designs are modified to comply with the standard.

- **Massachusetts Clean Energy and Climate Plan (CECP) for 2050** – The 2050 CECP is the Commonwealth of Massachusetts' comprehensive and aggressive plan to achieve Net Zero GHG emissions in 2050. The Plan is aimed at reducing statewide gross GHG emissions by at least 85% below the 1990 baseline level. The 2050 CECP charts out the way Massachusetts will achieve the emissions limit and sub-limits in 2050 by building a future in which the heat in homes, power in vehicles, and the electric grid can all operate with minimum reliance on fossil fuels. Information on the Plan and its policies can be found at: https://www.mass.gov/info-details/massachusetts-clean-energy-and-climate-plan-for-2050#2050-emissions-limit-and-sublimits-.