Air Quality Procedures
For Civilian Airports
& Air Force Bases

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PREFACE

Air quality assessments for proposed Federal actions are required for compliance with the *National Environmental Policy Act*, the *Clean Air Act* and other environment-related regulations and directives. This handbook is a comprehensive guide intended to assist the air quality analyst/environmental specialist in assessing the air quality impact of Federal Aviation Administration and the United States Air Force actions at airports and air bases. Furthermore, it provides guidance, procedures and methodologies for use in carrying out such assessments.

This section presents a glossary of terms and definitions. Section One provides general background information, including a brief discussion of Federal and State regulations. Section Two describes the assessment process including information on the various agencies involved in airport and air base studies. Emissions and dispersion assessments are presented in Sections Three and Four. Section Five covers both general and transportation conformity. Section Six addresses mitigation/control measures. The appendices provide additional supporting information including a summary of environmental documents, a project reviewer's checklist, analyses, and calculations.

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GLOSSARY

This section discusses basic terms and definitions used in assessing the air quality impacts from airport actions. It also includes some key conversion factors, which are used in analyzing aviation data.

Advisory Council on Historic Preservation (ACHP)
An independent Federal agency that is responsible for regulations implementing the National Historic Preservation Act, reviewing agency compliance, commenting on agency undertakings and their effects and reporting to Congress.

Affected Environment
The section of an environmental document (e.g. Environmental Impact Statement or Environmental Assessment) which describes the resource categories (e.g. air, water, flora, fauna, historic sites, etc.) that are affected or potentially affected by the proposed action and any alternative.

Air Quality
Ambient pollutant concentrations and their temporal and spatial distribution.

Air Quality Control Region (AQCR)
An EPA designated interstate or intrastate geographic region that has significant air pollution or the potential for significant air pollution and, due to topography, meteorology, etc., needs a common air quality control strategy. The region includes all the counties that are affected by or have sources that contribute directly to the air quality of that region.

Air Quality Data Base
A collection of information on the ambient air quality that existed within an area during a particular time period. This data is usually collected and published by the State Air Pollution Control Agency.

Air Quality Model
An algorithmic relationship between pollutant emissions and pollutant concentrations used in the prediction of a project's pollutant impact.

Air Quality Monitor
A device for measuring pollutant concentrations. One such device is a Non-Dispersed Infrared Analyzer used to record carbon monoxide concentrations.

Air Quality Standard
A legal requirement for air quality, usually expressed in terms of maximum allowable pollutant concentration, averaged over a specified interval.

Ambient Concentrations
Initial concentration sensed/measured at a monitoring/ sampling site.

Ambient Monitoring — Systematic measurements of characteristics (e.g. pollutant concentration and wind velocity) of the air at a fixed location.

Area of Potential Effects — Under Section 106 of the National Historic Preservation Act, area in which undertaking may affect any historic or cultural resources.

Area Source — The agglomeration of many sources that have low emission rates spread over a large area that are too numerous to treat individually. An example of this type of source would be a parking lot.

Atmospheric Stability — The resistance to or enhancement of vertical air movement related to vertical temperature profile.

Attainment Area — An area that meets NAAQS for a particular pollutant.

Averaging Time — A period over which measurements of air quality parameters are taken. Air quality standards are specified for averaging times of one, three, eight and twenty four hours, as well as one year.

Background Concentration — Pollutant concentrations due to (1) natural sources, (2) nearby sources other than the one(s) currently under consideration and (3) unidentified sources.

Calm — For purpose of air quality modeling, calm is used to define the situation when the wind is indeterminate with regard to speed or direction.

Carbon Monoxide (CO) — A colorless, odorless, toxic gas produced by the incomplete combustion of organic materials used as fuels. CO is emitted as a by product of essentially all combustion. Idling and low speed mobile source operations, such as aircraft taxiing are the most prevalent CO emission sources commonly found at airports.

Categorical Exclusion (CE or CATEX) — A category of actions that do not individually or cumulatively have a significant effect on human environment based on agency experience. CE's have been found to have no such effect in procedures adopted by a Federal agency in implementation of these regulations (40 CFR 1507.3) and do not require preparation of an environmental assessment (EA), a FONSI, or an EIS.

CFRs — Code of Federal Regulations.

Clean Air Act (CAA) — The Federal law regulating air quality. The first Clean Air Act (CAA), passed in 1967, required that air quality criteria necessary to protect the public health and welfare be developed. Since 1967, there have been several revisions to the CAA. The Clean Air Act Amendments of 1990 represent the fifth major effort to address clean air legislation.

Clean Air Act Amendments of 1990 (CAAA)
The Clean Air Act Amendments of 1990 (CAAA) represent the fifth major effort to address clean air legislation. Revisions include significant strengthening of Clean Air Act, especially by adding detailed requirements for Federal actions to conform to State Implementation Plans (SIP), expanding the list of hazardous air pollutants from eight to 189, and strengthening the operating permit program.

Complex Terrain
Terrain exceeding the height of the stack being modeled.

Conformity
The act of meeting Section 176(c)(1) of the CAAA that requires Federal actions to conform to the SIP for air quality. The action may not increase the severity of an existing violation nor can it delay attainment of any standards.

Connected Actions
Actions that are closely related and therefore should be discussed in the same environmental document. Actions are connected if they automatically trigger other actions which may require an EIS; if they cannot or will not proceed unless other actions are taken previously or simultaneously; and if they are interdependent parts of a larger action and depend on the larger action for their justification.

Control
The ability to regulate, in some way, the emissions from a Federal action. The ability to regulate can be demonstrated directly through the use of emissions control equipment on a boiler or indirectly through the implementation of regulation or conditions in the nature of activity that must be established in permits of approvals or by design of the action. An example of indirect control is limiting vehicle emissions by controlling the size of a parking facility.

Control Strategy
A combination of limiting measures designed to achieve the aggregate reduction of emissions.

Cooperating Agency
A cooperating agency may be any Federal agency that has jurisdiction by law or special expertise with respect to any potential environment impact involved in a proposal for legislation or Federal action that significantly affects the quality of the human environment. A cooperating agency may also be a state or local agency of similar qualifications or, when the effects influence a reservation, an Indian Tribe. By agreement with the lead agency, an Indian Tribe may become a cooperating agency.

Criteria Pollutants
The six pollutants listed in the CAA that are regulated by the EPA through the NAAQS because of their health and/or environmental effects. They are: nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), ozone (O_3), particulate matter (PM-10) and lead (Pb).

Cumulative Impact	Impacts on the environment which result from the incremental impact of the action when added to other past, present and reasonable foreseeable future actions regardless of what agency (Federal or no-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time.
Day	Calendar day.
De Minimis	So small as to be negligible or insignificant. If an action has de minimis emissions (Conformity Rule 40 CFR part 93.153c), then a conformity determination pursuant to the CAA of 1990 is not required.
Description of the Proposed Action and Alternatives (DOPAA)	The first Air Force document required by the proponent of an action to initiate the EIAP. The DOPAA is documented with AF Form 813 and is the basis for all follow-on environmental analyses.
Diffusion	The gradual mixing of molecules of two or more pollutants as a result of random thermal motion.
Direct Effect	An effect that is caused by the implementation and/or operation of an action that occurs at the same time and place. These type of effects are also often referred to as primary effects.
Direct Emissions	Direct emissions are those caused by or initiated by the implementation and/or operation of an action, and that occur at the same time and place as the action.
Dispersion	The process by which atmospheric pollutants disseminate due to wind and vertical stability.
DOD	Department of Defense.
Driving Cycle	A profile of velocity versus time, specified for determining vehicular emission rate. This cycle would include periods of stopping, acceleration, cruising and deceleration.
Emission Factor	The rate at which pollutants are emitted into the atmosphere by one source or a combination of sources.
Emission Inventory	A complete list of sources and rates of pollutant emissions within a specific area and time interval.
Enplanements	The number of passengers on departing aircraft.
Environmental Assessment (EA)	A concise public document that provides sufficient data, evidence, and analysis to determine if Federal agency should prepare an EIS for an action or issue a FONSI. An EA is not necessary in cases where the Federal agency has decided to prepare an EIS. An EA can be prepared at any time to aid agency decision making.

Environmental Impact Analysis Process (EIAP)	The Air Force process for complying with NEPA and CEQ regulations.
Environmental Impact Statement (EIS)	An EIS is a detailed, concise public document required for major Federal actions likely to have significant effects on the human environment. The document may be directly prepared, without first doing an EA, if the action will have significant environmental impacts. An EIS provides the public and decision makers with clear, written documentation of potential significant environmental effects of the proposed action, and reasonable alternatives including the no action alternative.
Environmental Planning Function (EPF)	The Air Force organization at the base, major command or field operating agency that manages the EIAP including evaluation and completion of Air Force environmental forms, identifies environmental quality standards that relate to the action being evaluated, and prepares environmental documents and related logistical information.
Environmental Protection Committee (EPC)	The Air Force organization at the base, major command, air staff or field operating agency that implements the requirement to monitor, attain and maintain compliance with environmental regulations; ensures the training of appropriate personnel in the EIAP; reviews environmental policy; facilitates coordination; and serves as a steering group to monitor the overall conduct of the environmental protection program. The EPC also evaluates environmental concerns raised by proposed Air Force actions and ensures that they are addressed in any decision-making process including NEPA and EIAP.
EPA	U.S. Environmental Protection Agency.
FBO	A private operator that may conduct refueling, aircraft or ground support equipment services for others at the airport.
Federal Action	Actions with effects that may be major and potentially subject to Federal control and responsibility. Federal actions tend to fall into four categories: adoption of official policy, adoption of formal plans, adoption of programs and approval of projects, whether approved by permit or other regulatory decision. See 40 CFR 1508.16 for additional information.
Finding of No Significant Impact (FONSI)	A FONSI is a document which briefly presents evidence of why Federal agency has determined that a proposed action, not otherwise categorically excluded, will not have a significant impact on the environment. The FONSI justifies why the preparation of an EIS is unnecessary. The FONSI must include the EA or be attached to the EA, or a summary of it, and reference any other associated environmental documents. The FONSI should state all mitigation that will be undertaken, if any.

Frequency Distribution A curve of the percentage frequency of occurrence of each value that a variable may take on.

Fugitive Dust Dust discharged to the atmosphere in an unconfined flow stream such as that from unpaved road, storage piles and heavy construction operations.

Gaussian Model A pollutant dispersion model based on the Gaussian dispersion equation, which assumes a constant fractional decrease in concentration per unit distance in the crosswind and vertical direction from a stationary or moving center of dispersion.

Hydrocarbons (HC) Total hydrocarbons excluding methane and ethane. These gases represent unburned and wasted fuel. They come from incomplete combustion of gasoline and from evaporation of petroleum fuels.

IAS Indicated air speed.

Indirect Control Control of air quality by altering activities that influence the rate and distribution of emissions (e.g., traffic patterns, land use). Indirect control contrasts with direct control at the source of emissions (e.g. devices on automobiles or smoke stack).

Indirect Effect Effects that are caused by the implementation and/or operation of an action, that occur later in time or are further removed by distance from the action, but which are still reasonable foreseeable. Often referred to as secondary effects.

Indirect Emissions Indirect emissions are those caused by the implementation and/or operation of an action, are reasonably foreseeable, but which occur later in time and/or are farther removed in distance from the action itself. Under General Conformity, indirect emissions are further limited to those indirect emissions that the responsible Federal agency can "practicably control and will maintain control over due to a continuing program responsibility of the Federal agency."

Indirect Source Any structure or installation which attracts an activity which creates emission of pollutants. For example, a shopping center, an airport or a stadium.

Inventory See "Emission Inventory".

Inversion A thermal gradient created by warm air situated above cooler air. An inversion suppresses turbulent mixing and thus limits the upward dispersion of polluted air.

Lead (Pb) A heavy metal that, when ingested or inhaled, affects the blood forming organs, kidneys and the nervous system. The chief source of this pollutant at airports is the combustion of leaded aviation gasoline in piston-engine aircraft.

Lead Agency — The agency preparing or having taken primary responsibility for preparing the EIS.

Line Source — A long, narrow source of emissions such as roadway or runway.

Local Meteorology — The weather conditions, temperature, wind velocity, mixing height, cloud cover, etc. that exist in a particular area.

LTO — LTO refers to an aircraft's landing and takeoff (LTO) cycle. One aircraft LTO is equivalent to two aircraft operations (one landing and one takeoff). The standard LTO cycle begins when the aircraft crosses into the mixing zone as it approaches the airport on its descent from cruising altitude, lands and taxis to the gate. The cycle continues as the aircraft taxis back out to the runway for takeoff and climbout as its heads out of the mixing zone and back up to cruising altitude. The five specific operating modes in a standard LTO are: approach, taxi/idle-in, taxi/idle-out, takeoff, and climbout. Most aircraft go through this sequence during a complete standard operating cycle.

Macroscale — Large scale analysis involving distances starting from 100 to several thousand kilometers and averaging times of one to several days.

Maintenance Area (MA) — Any geographic area of the United States previously designated nonattainment pursuant the CAA Amendments of 1990 and subsequently redesignated to attainment.

Memorandum of Agreement (MOA) — A MOA is prepared to document commitments for mitigating adverse impacts on properties eligible for or listed in the National Register of Historic Places.

MAP — MAP refers to the number of million annual passengers for a facility (counted as enplanements and deplanements, including transfers but excluding through passengers).

Mesoscale — Medium scale analysis involving distances of 1 to 100 kilometers and averaging times of one to twenty-four hours.

Meteorological Variables — Wind speed and direction, mixing height temperature, pressure, degree of turbulence, sunlight intensity, humidity and precipitation.

Microscale — Small scale analysis involving distances up to approximately one kilometer and averaging times up to several tens of minutes.

Mitigation — This term is defined in 40 CFR 1508.20. It includes: (1) avoiding the impact altogether by not taking a certain action or parts of an action or finding a new site; (2) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and (5) compensating for the impact by replacing or providing substitute resources or environments.

Mixing Height	The height of the completely mixed portion of atmosphere that begins at the earth's surface and extends to a few thousand feet overhead where the atmosphere becomes fairly stable. See also "inversion".
Mobile Source	A moving vehicle that emits pollutants. Such sources include airplanes, automobiles, trucks and ground support equipment.
Modal Emissions Factors	Vehicular emissions factors for individual modes of operation. For aircraft, these modes are takeoff, climbout, approach and taxi.
Model	A quantitative or mathematical representation or simulation which attempts to describe the characteristics or relationships of physical events.
Monitoring Site	A location of a measurement device in a monitoring network.
MSL	Mean Sea Level.
$\mu g/m^3$	Micrograms per cubic meter.
National Ambient Air Quality Standard (NAAQS)	Air Quality standards established by the EPA to protect human health (primary standards) and to protect property and aesthetics (secondary standards).
National Environmental Policy Act (NEPA)	An Act established to declare a national policy that will encourage productive and enjoyable harmony between society and the environment; to promote efforts that will prevent or eliminate damage to the environment and the biosphere, and stimulate the health and welfare of man; and to enrich the understanding of the ecological systems and natural resources important to the nation.
Nitrogen Oxides (NO_x)	A poisonous and highly reactive gas produced when fuel is burned at high temperatures causing some of the abundant nitrogen in the air to burn also. At airports this pollutant is emitted by automobiles, aircraft engines, electric power plants and other combustion equipment. Takeoff and climbout are the significant NO_x producing modes of aircraft operation.

Nonattainment Area (NAA)	Any geographic area of the United States that is in violation of any NAAQS and therefore has been designated as nonattainment under the CAA.
Notice of Availability (NOA)	A notice printed in the *Federal Register* announcing that an EIS is available for public comment.
Notice of Intent (NOI)	A brief notice placed in the *Federal Register* by the Federal agency noting that the agency will prepare an EIS. The NOI describes the proposed action and possible alternatives, details the proposed scoping process (i.e., location and time of meetings), and provides the name and address of a point of contact within the Federal agency to answer questions about the proposed action and the EIS.
Ozone (O_3)	A colorless, toxic gas formed by the photochemical reactions in the atmosphere of VOCs with the oxides of nitrogen. Ozone commonly is referred as "Smog". Ozone is not emitted directly by any airport.
Pasquill Stability Classification	A method of classifying atmospheric stability based on incoming solar radiation and wind speed. The stability classifications range from A stability (extremely unstable conditions) to F stability (moderately stable conditions).
Plume	The spreading pollutants emitted by a fixed source such as a smokestack.
PM-10	PM-10, a criteria pollutant, are fine particles less than 10 micrometers in diameter. PM-10 includes solid and liquid material suspended in the atmosphere formed as a result of incomplete combustion. Aircraft are the primary source of PM-10 emissions at airport.
Point Source	A pollutant source that is fixed to the ground and that releases pollutants through a relatively small area. Common stationary sources at airport include boilers, heaters, incinerators and fuel storage tanks.
PPM	Parts per million (10^6) by volume.
Precursor	A chemical compound that leads to the formation of a pollutant. HC and NO_x are precursors of photochemical oxidants.
Preferred Model	A refined model that is recommended for a specific type of regulatory application.
Prevention of Significant Deterioration (PSD) Area	A geographic area that contains air which is relatively clean and not in violation of NAAQS. The emissions in these area are regulated to prevent degradation of its air quality.
Primary Pollutant	Chemical contaminants which are released directly to the atmosphere by a source.

Primary Standard	A NAAQS set to protect human health.
Receptor	A location at which ambient air quality is measured or estimated.
Record of Decision (ROD)	The decision document, prepared after the EIS, that states what the decision is, identifies all alternative considered by the lead agency in reaching its decision, and states whether all practicable means to avoid or minimize environmental harm have been adopted, and if not, why not.
Regionally Significant	Under General Conformity Rule, when a Federal action's direct and indirect emissions exceed 10 percent of the total emissions inventory for a particular criteria pollutant in an nonattainment or maintenance area.
Scoping	An early and open process (that invites the participation of affected Federal, state and local agencies, any affected Indian tribe, the proponent of the action and other interested persons) that determines the issues to be addressed in an environmental document and identifies relevant and/or significant issues related to a proposed action.
Screening Technique	A relatively simple analysis technique to determine if a given source is likely to pose a threat to air quality. Concentration estimates from screening techniques are conservative.
Secondary Pollutant	Atmospheric contaminants formed in the atmosphere as a result of such chemical reactions, as hydrolysis, oxidation and photochemistry.
Secondary Standard	A NAAQS set to protect human welfare.
Similar Actions	Actions, when viewed with other reasonably foreseeable or proposed actions, that have similarities that provide a basis for evaluating their environmental consequences altogether (in one document), such as common timing or geography.
Simple Terrain	An area where terrain features are all lower in elevation than the top of the stack of the source.
Simulation Model	A mathematical description of a real physical and/or chemical process. The responses of the model to input parameter variations are analogous to those of the real processes.
Smog	A common term for ozone.
Stability	A property of the atmosphere which determines the amount of vertical mixing.

State Historic Preservation Officer (SHPO)	A person appointed by a governor, under an ACHP approved historic preservation program, that provides expert advice to Federal agencies.
Stable Layer	A layer of air in which very little mixing takes place.
State Implementation Plan (SIP)	The strategy to be used by a state to control air pollution in order that the NAAQS will be met. EPA regulations require that each state devise such a plan or the EPA will impose its own plan for that state.
Stationary Source	A source of pollutants which is immobile. Such sources include power plants, individual heater, incinerators, fuel tanks, ARFF training, facilities and solvent degreasers, among others.
Sulfur Dioxide (SO_2)	This is a corrosive and poisonous gas produced mainly from the burning of sulfur containing fuel. Very little SO_2 is emitted from any aviation sources.
Surface Layer	The layer of air near the ground, generally 1 to 100 meters high, where surface features (e.g. trees, buildings) affect atmospheric turbulence and diffusion.
Thrust	A measure of the power generated by turbine engines. Thrust is measured in pounds (force) or kiloNewtons (kN). 1kN = 4,450 lb.
Tiering	Already published environmental analyses (EAs and EISs) of broader scope that are incorporated by reference in support of a specific project assessment or statement as a method of reducing paperwork to the best advantage of the NEPA and EIAP process.
Total Organic Gases (TOG)	This term includes all hydrocarbon compounds in an emission sample. See also HC and VOC. These terms are <u>not</u> interchangeable.
Total Suspended Particulate (TSP)	These are solid or liquid particles small enough to remain suspended in air. They range widely in size from particles visible as soot or smoke to those too small to detect except with an electron microscope.
Tribal Historic Preservation Officer (THPO)	A person appointed by a tribal government, under an ACHP approved historic preservation program, that provides expert advice to Federal agencies.
Transportation Control Plan (TCP)	A plan specifying measures to regulate the emission of pollutants from mobile sources.
Turbulence	Unsteady and irregular motions of air in the atmosphere.

Undertaking

Under the National Historic Preservation Act, any Federal action that may affect properties eligible for or listed in the National Register of Historical Places.

Vehicle Miles Traveled (VMT)

The sum of distances traveled by all motor vehicles in a specified region. VMT is equal to the total number of vehicle trips multiplied by the trip distance (measured in miles). This sum is used in computing an emission inventory for motor vehicles.

Volatile Organic Compounds (VOCs)

VOCs are created when fuels or organic waste materials are burned. Most HCs are presumed to be VOCs in the regulatory context, unless otherwise specified by the EPA.

Conversion Factors for Common Measures of Organic Air Pollutants

The aircraft engine emissions data referred to throughout this report exclude methane and ethane and are designated "total hydrocarbon" or HC. When methane and ethane are included, this is commonly referred to as "total organic gases" (TOG) or "total organic compounds" (TOC). These differences are artifacts of the different analytical techniques used to measure the pollutants. Neither measure is equivalent to EPA's commonly used "volatile organic compounds" or VOC. The following factors should be used to convert between these terms. The TOG and VOC equations may be reversed to convert from TOG to VOC and VOC to HC.

	Air Taxi & Commercial	Military	General Aviation
TOG =	VOC*1.1167	VOC*1.1147	VOC*1.1347
VOC =	HC*1.0947	HC*1.1046	HC*0.9708

1. INTRODUCTION

The air quality handbook was first published in 1982 by the Federal Aviation Administration (FAA) and the United States Air Force (USAF). This handbook provides additional and updated guidance to the air quality analyst/environmental specialist in assessing the air quality impact of a Federal project.

The procedures in this handbook are consistent with all current Federal air quality laws and regulations affecting aviation including the *National Environmental Policy Act*, Council on Environmental Quality regulations, *Clean Air Act* , as amended, and other related statutes, regulations, directives and orders. Most of the procedures and analyses discussed in this handbook apply to both airports and air bases. This handbook only addresses airport and air base actions within the U.S., its territories and possessions. Although this handbook does not cover actions abroad, many of the calculation methodologies and resources are still applicable. In addition, many of the references identified do address actions abroad and can be consulted for further information.

1.1 Regulatory Context

Air quality assessments for proposed Federal actions may be necessary for compliance with the requirements of the *National Environmental Policy Act*, the *Clean Air Act*, and other environment-related regulations and directives. There are Federal regulations and orders that establish air quality requirements applicable to both airports and air bases, as well as U.S. Department of Transportation (DOT)/FAA- or U.S. Department of Defense (DOD)/USAF-specific regulations and orders that cover aspects of air quality at airports or air bases, respectively. DOT and FAA orders can be obtained from the DOT Warehouse (Reference 56). DOD and USAF documents can be obtained from the National Technical Information Service (NTIS) (Reference 31). In addition to Federal requirements, many states and/or local areas have air quality requirements that may address airports and air bases. Relevant general, DOT/FAA-specific, and DOD/USAF-specific Federal requirements and documents are summarized below, along with a brief discussion of possible state and/or local requirements.

1.1.1 Federal Requirements and Documents- General

National Environmental Policy Act of 1969 (NEPA) **-** *NEPA* and its amendments, establish a broad national policy to protect the quality of the human environment and provide for the establishment of a Council on Environmental Quality. The act provides polices and goals to ensure that environmental considerations are given careful attention and appropriate weight in all decisions of the Federal Government. The *NEPA* environmental review process addresses impacts on the "natural world," such as air and water quality. It also addresses impacts on the human environment, such as noise, induced socioeconomic impacts, and land uses that result from Federal actions. It should reflect a thorough review of all relevant environmental factors, utilizing a systematic, interdisciplinary approach. Federal actions potentially subject to *NEPA* include grants, loans, contracts, leases, construction, research, rulemaking and regulatory actions, certifications, licensing, and permitting.

NEPA encourages and facilitates public involvement in the decisions by the Federal Government which affect the quality of the human environment. Federal agencies must assess and disclose the potential environmental impacts of proposed Federal actions.

NEPA requires all agencies of the Federal Government to:

I. Utilize a systematic, interdisciplinary approach in planning and decision-making that will ensure the integrated use of natural and social sciences,

II. Identify and develop methods and procedures in consultation with CEQ to ensure that environmental amenities and values may be given appropriate consideration in decision-making, use ecological and scientific information, disclose information to public and respond to public comments, and

III. In every recommendation or report on an action that affects the quality of the human environment include a detailed statement on

   A. the environmental impact of the proposed action,
   B. any adverse environmental effects that cannot be avoided should the proposal be implemented,
   C. alternatives to the proposed action,
   D. the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
   E. any irreversible and irretrievable commitments of resources should the proposed action be implemented.

Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of the NEPA - The CEQ regulations implement the procedural provisions of NEPA.

In general, the CEQ regulations require a Federal agency to evaluate the potential environmental effects of a major action prior to its implementation and notify and involve the public in the agency's decision-making process. The regulations emphasize the importance of integrating the *NEPA* process into early project planning, and of consulting with the appropriate Federal, State, and local agencies early in the proceeding. The regulations also identify and describe the appropriate environmental documents (e.g., Environmental Assessment, Finding of No Significant Impact, Environmental Impact Statement) that serve to document compliance with *NEPA* requirements.

Executive Orders - There are several Executive Orders relating to *NEPA* that are general in nature, but should be consulted as they may affect an action's impact analysis. The following are examples of these orders *Executive Order 11514: Protection and Enhancement of Environmental Quality* (Reference 17) and *Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (Reference 18*). Executive Order 11593: Protection and Enhancement of the Cultural Environment* (Reference 93*).*

Clean Air Act (CAA) - In 1967, the first *CAA* provided authority to establish air quality standards. Since the original act, subsequent efforts have established revisions that are more stringent and comprehensive, culminating in the *Clean Air Act Amendments of 1990 (CAAA)*. Principal features of the *CAAA* include a comprehensive strategy to achieve and maintain National Ambient Air Quality Standards (NAAQS) for specified criteria pollutants (ozone, carbon monoxide, particulates, sulfur dioxide, nitrogen dioxide, and lead, which are discussed in more detail below), further reductions in mobile source emissions, regulation of air toxics (e.g., hazardous air pollutants (HAPs)), establishment of a new acid rain control scheme, the phase-out of production and sale of ozone-depleting chemicals (e.g., chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs)), and new enforcement sanctions.

Ambient air quality standards represent a critical element in the national environmental regulatory structure, and many of the most conspicuous environmental issues in the public arena relate to efforts on the part of regulators and the regulated community to attain these standards. Ground-level ozone, for example, poses a significant concern in many locations. Extensive regulations govern air emissions of so-called “ozone precursors,” including nitrogen oxides and volatile organic compounds, in these regions. Each state with an ozone nonattainment region has developed a State Implementation Plan (SIP) with regulations that range from limiting industrial emissions of specific pollutants to regulations governing emission sources from manufacturing, transportation, and other sectors. Typically, a SIP addresses other nonattainment pollutants in a manner similar to that described for ozone.

The CAA and its amendments and its associated regulations are largely implemented by the States state level. Many states, as well as local jurisdictions, have additional State requirements pertaining to air pollution. As a result, air pollution control regulations can be quite complex and site- or area-specific.

The *CAA* and its associated regulations address air pollution control in two ways: an air quality-based approach and a technology-based approach, with the former being the most important for the purpose of this discussion. EPA has implemented the air quality approach by establishing a set of national ambient air quality standards for six “criteria pollutants:” ozone, carbon monoxide (CO), particulate matter (PM-10), sulfur oxide (SO_x), nitrogen dioxide (NO_x), and lead. States must identify geographic areas, termed “nonattainment” areas, that do not meet these air quality standards.

For nonattainment areas, the affected state must develop a state implementation plan (SIP) that includes a variety of emission control measures that the state deems necessary to ensure attainment of the standards in the future. Although developed initially by the state and local air pollution control officials, SIPs must be adopted by municipal and state governments and then approved by EPA. Once a SIP is fully approved, it (and any emissions control measures) is legally binding under both state and federal law, and may be enforced by either government. Many states have designated nonattainment areas and, subsequently, have adopted a SIP. If a SIP already exists, it must be revised as necessary to include and address emission control measures necessary to ensure attainment. An area previously designated nonattainment pursuant to the *CAA Amendments of 1990* and subsequently re-designated to attainment is termed a “maintenance” area. A maintenance area has a “maintenance” plan, or revision to the applicable SIP, to ensure attainment of the air quality standards.

General Conformity Rule - A key component of the *CAAA* strategy to achieve and maintain the NAAQS is the concept of “conformity,” required in Section 176(c)(1) of the *CAAA*. Conformity is intended to ensure that the Federal government does not take, approve, or support actions that are in any way inconsistent with a State’s plan to attain and maintain the NAAQS for criteria pollutants. The *CAAA* define conformity to a SIP as demonstrating consistency with the SIP’s “purpose of eliminating or reducing the severity and number of violations of the national ambient air quality standards and achieving expeditious attainment of such standards.” For example, from a practical standpoint this means that emission increases that result from an airport project should not exceed the emission forecast or budget included in a SIP for that airport.

A transportation conformity determination is required for any highway or transit project which is proposed to receive funding assistance and approval through the Federal-Aid Highway program or the Federal mass transit program, OR requires Federal Highway Administration (FHWA) or Federal Transit Administration (FTA) approval for some aspect of the project, such as connection to an interstate highway or deviation from applicable design standards of the interstate system. 40 C.F.R. Part 51, Subpart T. This includes any facilities serving regional activity centers and other regional needs and regionally significant airport access projects.

Some additional regulations emanate from the National Historic Preservation Act of 1966, as amended (NHPA). This act requires Federal agencies to comply with provisions of the NHPA as well as with other historic preservation laws.

The requirement to consult the NHPA is triggered when a Federal undertaking may affect properties eligible for inclusion into or listing on the National Register of Historic Places. Consultations occur with the State and tribal Historic Preservation Officers and other interested parties. Air pollution can significantly affect historic properties. Therefore, compliance with historical preservation laws should be anticipated.

If eligible or listed properties occur in the area of potential effects and the undertaking is likely to adversely affect these properties, then an MOA is negotiated to mitigate. Otherwise, the Federal agencies must obtain concurrence from the SHPO and TPO for a “no effect” or “no adverse effect” determination.

1.1.2 Federal Requirements and Documents - DOT/FAA-Specific

DOT Order 5610.1C: ***Procedures for Considering Environmental Impacts* -** This order (Reference 55) establishes procedures for consideration of environmental impacts, including those affecting air quality, in decision-making on proposed DOT actions. It provides instructions for implementing *NEPA*, supplementing the CEQ regulations by applying them to DOT programs, which include FAA actions. The order also provides instructions for implementing relevant environmental laws and executive orders (e.g., the *Clean Air Act*, the *Department of Transportation Act of 1966*, the *National Historic Preservation Act of 1966*, Executive Order 12114).

49 U.S.C. 47106(c)(1)(B) as amended (formerly sections 509(b)(5) and (b)(7) of the *Airport and Airway Improvement Act of 1982* as amended) - This code (Reference 1) provides that a grant application for an airport project involving the location of the airport, runway, or major runway extension, will not be approved unless the State certifies that there is reasonable assurance that the project will be located, designed, constructed, and operated in compliance with applicable air quality standards.

49 U.S.C., Subtitle I, Section 303 (formerly DOT Section 4 [f]) -Section 4(f) of the *DOT Act* establishes the policy that “special effort should be made to preserve the natural beauty of the countryside and public park and recreation lands, wildlife and waterfowl refuges, and historic sites.” This act only applies to DOT agencies. It requires that the DOT cooperate and consult with States and other selected Federal departments to develop transportation plans and programs that include measures to maintain or enhance the natural beauty of lands.

FAA Order 5050.4, and any subsequent amendments, *Airport Environmental Handbook.* This order establishes guidance for FAA procedures for processing environmental assessments, findings of no significant impact, and environmental impact statements for airport development proposals and other airport actions as required by various laws and regulations. It is recommended for airport personnel, sponsors, and others involved in airport actions when considering environmental impacts, because it contains detailed guidance on preparing the technical assessment of individual environmental impacts including air quality (Reference 63). Compliance with the order constitutes compliance with FAA order 1050.1 for airport actions.

FAA Order 1050.1, and any subsequent amendments: *Policies and Procedures for Considering Environmental Impacts* - This order (Reference 62) provides FAA policies and procedures for implementing *NEPA*, DOT Order 5610.1C, and other environment-related statutes, directives, and orders. The order clarifies the *NEPA* process in terms of planning, procedures, content and format, and public participation. It provides an overview of the various *NEPA* assessment documents, including Categorical Exclusions (CEs), Environmental Assessments (EAs), Findings of No Significant Impact (FONSIs), Environmental Impact Statements (EISs), and Records of Decision (RODs), as well as *NEPA* processing requirements.

Air quality is one of the environmental areas covered in this document. The discussion on air quality addresses relevant statutes, regulations, oversight agencies, requirements, FAA responsibilities, thresholds, and analysis of significant impacts.

When airport personnel, sponsors, and others involved in airport actions are considering environmental impacts, this order recommends using FAA Order 5050.4: *Airports Environmental Handbook*, which constitutes compliance with FAA Order 1050.1 for airport actions.

1.1.3 Federal Requirements and Documents - DOD/USAF-Specific

DOD Directive 6050.1: ***Environmental Effects in the United States of DOD Actions* -** This directive (Reference 45) implements the CEQ regulations discussed above and provides the policy and procedures for including environmental considerations in the decision-making process on DOD actions within the United States. The directive includes policy, responsibilities, how to determine if an Environmental Assessment (EA) or Environmental Impact Statement (EIS) is needed, EA content and format, and categorical exclusions.

U.S. Air Force Policy Directive (AFPD) 32-70: *Environmental Quality* - This directive (Reference 42) establishes the Air Force's policy in achieving and maintaining environmental quality and compliance with *NEPA* and Executive Order 12114. It addresses development and implementation of an Air Force Environmental Quality Program, establishes environmental authorities and responsibilities, and lists directives and laws implemented by this policy.

U.S. Air Force Instruction (AFI) 32-7061: *Environmental Impact Analysis Process (EIAP)* - This instruction (Reference 41), formerly Air Force Regulation (AFR) 19-2, implements AFPD 32-70 and describes specific tasks and procedures for the EIAP both within the United States and abroad. This instruction also identifies directives and instructions with further environmental requirements.

Environmental Impact Analysis Process*: Desk Reference* **-** This document (Reference 43), a guide prepared to assist Air Force staff in complying with the requirements of the *NEPA*, provides helpful reference materials that discuss these requirements in more detail. Sample documents are provided in attachments. Appropriate use of the reference helps to ensure that the environmental effects of proposed actions are considered in accordance with applicable requirements.

1.1.4 State and/or Local Requirements

In addition to Federal requirements, there often are state and/or local air quality requirements applicable to airport. These requirements vary widely from location to location, and are more appropriate to address on a project-by-project basis. Examples of state and/or local air quality requirements applicable to airport projects are state indirect source thresholds, state-level environmental assessments, approved state general conformity rules, and state and local ambient air quality standards. The analyst/specialist is directed to review state and local regulations at various points throughout the handbook and as early in the assessment process as possible.

2. AIR QUALITY ASSESSMENT PROCESS

As Federal agencies, the FAA and U.S. Air Force are required under the *NEPA* to prepare an environmental document(e.g., EIS, EA, or categorical exclusion) for major federal actions that have the potential to effect the quality of the human environment. An air quality assessment prepared for inclusion in a NEPA environmental document, or as a separate reporting document, (e.g., conformity determination), should include an analysis and conclusions which addresses the attainment and maintenance of established air quality standards (e.g., National Ambient Air Quality Standards, air toxic requirements).

In addition to Federal requirements there may be State and local air quality requirements to abide by. These requirements can include, but are not limited to, provisions such as state indirect source regulations, environmental policy acts, and local ambient air quality standards[1].

This section discusses the key steps, the agencies and individuals, and the screening thresholds involved in the air quality assessment process. The procedures discussed in this section are consistent with those provided in FAA Order 1050.1, and any subsequent amendments: *Policies and Procedures for Considering Environmental Impacts* and U.S. Air Force Instruction 32-7061: *EIAP*. These procedures ensure compliance with *NEPA*, *CAAA*, and 49 U.S.C. 47106(c)(1)(B). There are recommended and required time periods associated with many steps (for example, mandatory public comment periods); consult the appropriate agency document (i.e., FAA Order 1050.1/5050.4, and any subsequent amendments or USAF Instruction 32-7061) for more information.

2.1 Assessment Process Steps

The process for assessing the air quality impacts of FAA and USAF proposed actions involves the following key steps*:

- Project definition,
- Inventory of emissions,
- Indirect source review,
- Assessment of transportation and general conformity with SIP, and
- Assessment of NAAQS.

Fortunately for the air quality analyst/environmental specialist, not all of the steps are required for every action. Many projects at airports and air bases are too small to require detailed air quality analysis and only a few projects are both broad enough in scope and located in nonattainment or maintenance areas such that the full complement of analyses described in this handbook would be required. Screening techniques that streamline the process for many air quality assessment actions are available and discussed later in this section (Section 2.3). Figure 1 provides a detailed look at the assessment process and includes some decision points that may allow a particular project to bypass certain steps. As Figure 1 indicates, analysis of projects located in nonattainment and maintenance areas is more complex than for projects in attainment areas.

[1] This handbook only discusses state and local requirements in general terms. Actual requirements must be considered on an individual project basis.

* These key steps have various "sub-steps" that are performed, including evaluating applicable screening thresholds and dispersion modeling. The second key step, inventory of emissions, may be a separate analysis or "sub-step" under another key step (e.g., conformity or NAAQS Assessment).

The following sub-sections discuss the key steps of an air quality assessment process. Figures 1 & 2 summarize the types of air quality analyses often required for airport and air base projects and indicates the different projects that require each type of analysis.

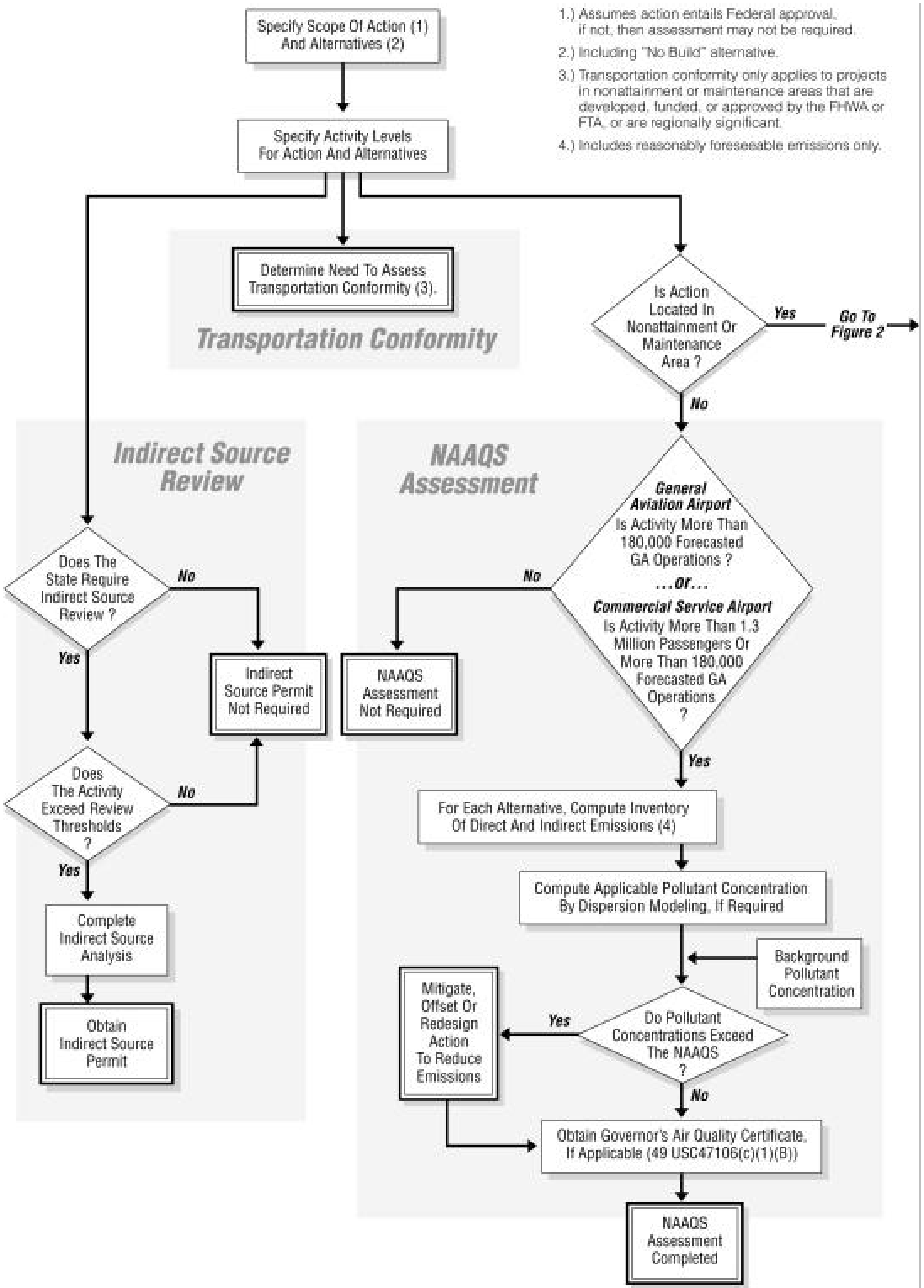

Figure 1. Air Quality Assessment Process for Airports and Air Bases - Part 1

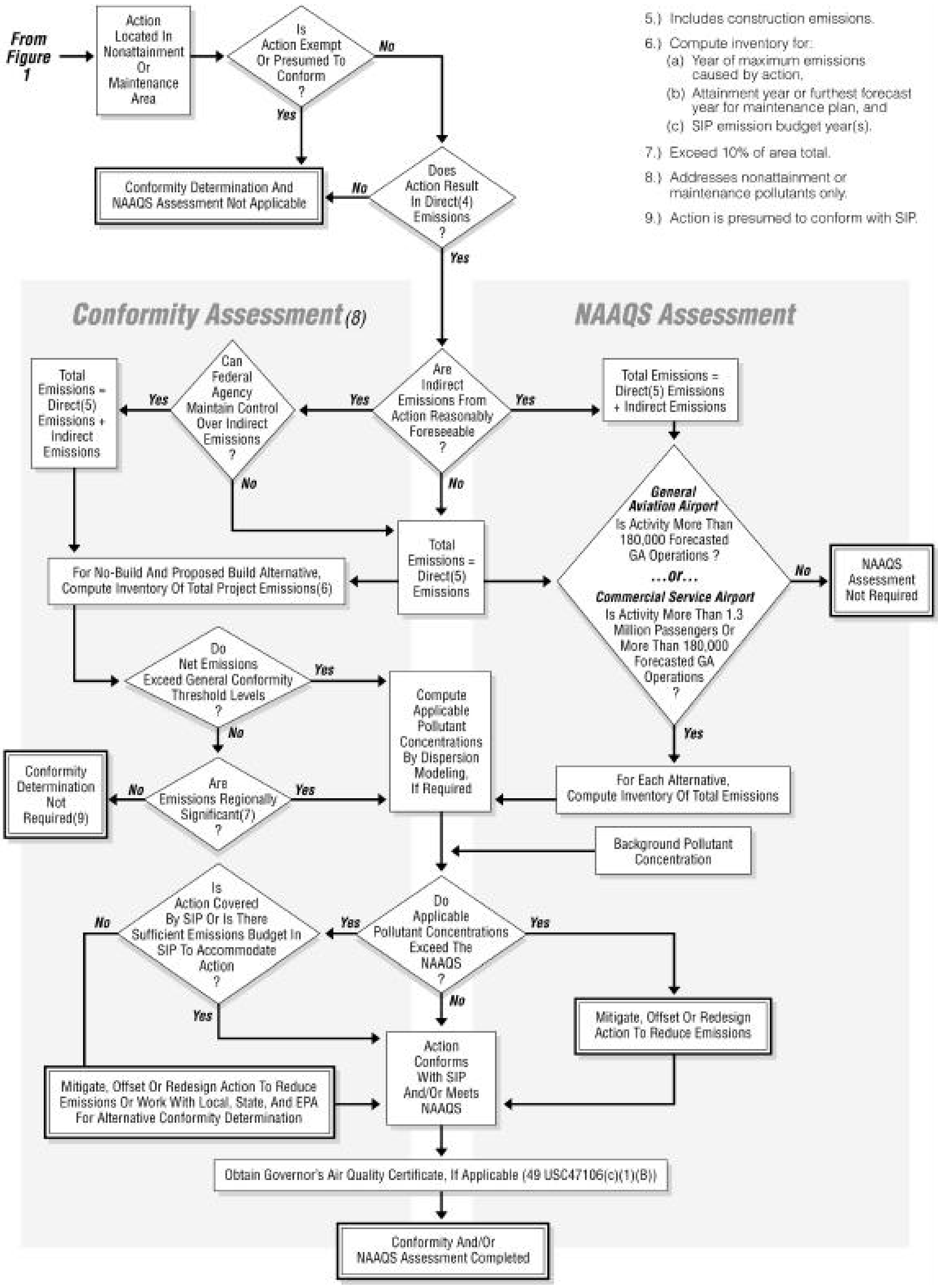

Figure 2. Air Quality Assessment Process for Airports and Air Bases - Part 2

2.1.1 Project Definition

The first step of the air quality assessment process, illustrated in Figure 1, is to define the scope and alternatives of the project or Federal action (if not already accomplished through the EA/EIS scoping process). This provides the structure and definition to guide subsequent data collection and analysis activities. Reasonable project options should be identified, including “build” and “no-build” alternatives.

“Build” alternatives reflect projected airport or air base related operations after a project’s completion. The “no-build” alternatives reflect projected airport or air base related operations as they are projected to be in the future without the project’s implementation. The “build” and “no-build” alternatives are compared to identify the project’s overall environmental impacts.

2.1.2 Emission Inventory

An emission inventory provides a first indication of the magnitude of a proposed project’s potential environmental impact. The emission inventory provides the total amount or mass of pollutants generated by all sources affected by the projects during a specified period of time (e.g., tons per year). An inventory may include both direct and indirect emissions. See section three for a detailed discussion. The emission inventory often is used as the basis for further analysis (e.g., SIP, NAAQS, conformity process). Individual pollutants of concern at airports and air bases primarily[2] include CO, NO_x, particulate matter less than 10 micrometers in diameter (PM-10), HC, and in some cases SO_x. Developing an emission inventory involves considerable data collection reflecting the level of activity at the airport or air base and the specific emission sources present.

The scenarios for which an emission inventory must be calculated vary depending on the analysis being performed (e.g. conformity, NAAQS, or SIP process). For a conformity assessment, only the “build” and “no-build” emissions are analyzed (including construction emissions, which are the projected temporary emissions resulting from project construction). The difference between the two emission inventories, in turn, equate to the emissions directly attributable to the project. While it is feasible to calculate project emissions directly, rather than as the difference between two cases, this is recommended only for screening project options. Changes that affect congestion or delay for aircraft or ground access vehicles have many secondary effects that are difficult or impossible to calculate directly. Conversely, for a NAAQS assessment, emissions must be estimated for <u>each reasonable</u> “build” and “no-build” alternative.

“Build” and “no-build” emission inventories should be prepared for the same year. It often will be necessary to calculate emission impacts for future attainment years as well as for the year during which the total direct and indirect emissions are greatest. In addition, an emissions inventory will represent the <u>net</u> emissions, which is the sum of emission increases and decreases.

[2] Analyses routinely do not consider the pollutant lead (Pb) since airports and air bases typically are not a significant source of lead emissions. The chief source of lead at airports and air bases is the combustion of leaded aviation gasoline in piston-engine aircraft. An analysis may need to consider lead if an airport or air base has a significant amount of emissions from the combustion of leaded aviation gasoline in piston-engine aircraft.

The type of emissions to include in each scenario also vary depending on the analysis being performed. For example, under conformity regulations, emissions included in the inventory are limited to those that the Federal agency can "practicably control and will maintain control over due to a continuing program responsibility of the Federal agency" (Reference 7).

Emission inventories can be very complex and difficult to calculate. For a more detailed discussion on creating an emissions inventory, see Section Three.

2.1.3 Indirect Source Review

Some states require a review of emissions from indirect sources. In general, indirect sources are stationary sources that attract or may attract sources of pollution (e.g., vehicles) and thus indirectly cause the emission of air contaminants. Such indirect sources include airports as well as highways and roads, parking facilities, sports and entertainment facilities, and office buildings. The definition of indirect source may vary slightly by state. At this writing, indirect source review requirements are required only for projects in certain parts of California, Connecticut, Minnesota, New York, North Carolina, Oregon, Utah, Vermont, and Wisconsin.

The states that require indirect source review generally establish thresholds that serve as guidelines for applying these rules. For example, a state may require indirect source review for all projects that increase the total airport passengers by more than 100,000 passengers, add 1,000 new parking spaces, or increase aircraft operations by 1,000. Projects that exceed these thresholds could be required to complete an indirect source analysis and obtain an indirect source permit. See Appendix J for more information on state threshold criteria for indirect source review.

2.1.4 Conformity

The FAA and USAF as Federal agencies are required to assure that an applicable proposed action in a non-attainment or maintenance area "conforms" to any relevant State Implementation Plan (SIP). This entails determining whether the emissions caused by the action at the airport or air base are consistent with the state's plan to meet the Federal air quality standards. Federal actions subject to conformity are divided into two categories: transportation conformity and general conformity.

A transportation conformity determination is required for any highway or transit project which is proposed to receive funding assistance and approval through the Federal -Aid Highway program or the Federal mass transit program, OR requires Federal Highway Administration (FHWA) or Federal Transit Administration (FTA) approval for some aspect of the project, such as connection to an interstate highway or deviation from applicable design standards on the interstate system. 40 C.F.R. Part 51, Subpart T. Under such circumstances either the FHWA or the FTA would be responsible for completing the transportation conformity determination not the FAA or USAF. A transportation conformity determination is NOT required for INDIVIDUAL PROJECTS which are NOT FHWA/FTA projects EXCEPT that Section 51.450 applies where the highway or transit project is of REGIONAL SIGNIFICANCE.

Pursuant to Section 51.392, a project is of regional significance when it is on a facility which serves regional transportational needs (such as access to and from the area outside the region, major activity centers in the regions, major planned developments such as new retail malls, sport complexes, etc., or transportation terminals as well as most terminals themselves) AND would normally be included in the modeling of a metropolitan area's transportation network, including at a minimum all principal arterial highways and all fixed guideway transit facilities that offer an alternative to regional highway travel. Projects of regional significance, REGARDLESS OF FUNDING SOURCE, must comply with Section 51.450.

A transportation conformity determination is also required where a Metropolitan Planning Organization (MPO) is involved in the development, funding, or approval of a transportation plan, program, or project. An MPO is an organization designated as being responsible, together with the State, for conducting and continuing , cooperative, and comprehensive planning process under 23 U.S.C. 134 and 49 U.S.C. 1607.

Although neither the FAA nor the USAF are directly responsible for assessing Transportation Conformity, there are coordination requirements concerning off-site impacts of motor vehicles and conformity determinations for local and regional planning. Since Transportation Conformity ultimately is not the FAA's nor the USAF's responsibility, it only is discussed briefly in this handbook, (See Section five).

General conformity applies to all other actions in non-attainment or maintenance areas not specifically covered by transportation conformity. To determine whether general conformity requirements apply to an action, the agency in charge must consider the nonattainment and maintenance status of the area, the exemptions from and presumptions to conformity, the project's emissions, and the regional significance of the project's emissions. The current conformity rule only applies to actions located in nonattainment and maintenance areas.

Subsequently, when evaluating conformity applicability, the first question is whether the action is located in an area this is in nonattainment or maintenance for any of the six criteria pollutants found at 40 C.F.R. Section 51.853 (b) (1) & (2) [93.153 (b) (1) & (2)]. The second step is to determine whether the proposed action falls under an exemption or presumption of conformity as identified in the regulations. A conformity determination is not required where a federal action is exempt from the requirements. A conformity determination is not required for a federal action that is presumed to conform ONLY where said action is also not "regionally significant" 40 C.F.R. Section 51.853 (j) [93.153 (j)]. If the federal action is neither presumed to conform nor exempt, then the agency must determine whether for each pollutant the total direct and indirect emissions in a nonattainment area caused by the federal action is equal or exceeds any threshold emission levels (rates) identified in 40 C.F.R. Section 51.853 (b) (1) or (2) [93.153.(b) (1) & (2)]. A conformity determination is not required where the air pollutant emissions of a federal action do not equal or exceed the threshold emission levels but only when said action is also not regionally significant. 40 C.F.R. Section 51.853 (I) [93.153 (i)] (defined below). However, it is assumed that a conformity assessment is not required for an airport or air base action that is presumed to conform since it is unlikely that the emission levels would be regionally significant.

The general conformity threshold emission levels are based on the proposed project's net annual emissions (proposed federal action emission levels minus the no action emission levels), which is the sum of direct (including construction) and indirect emissions. Similar to indirect source requirements, the conformity regulations limit the inclusion of indirect emissions to those that "are caused by the federal action, but may occur later in time and/or may be farther removed in distance from the action itself but are still reasonably foreseeable" and "the federal agency can practicably control and will maintain to control over due to a continuing program responsibility of the Federal agency" 40 C.F.R. Section 51.853 [93.152].

Lastly, even if a Federal action does not exceed the threshold emission levels, it still is subject to a general conformity determination if it is regionally significant[3]. The Federal action is considered "regionally significant" if the total of direct and indirect emissions of any pollutant from a Federal action represents 10% or more of a maintenance or nonattainment area's total emissions of that pollutant. An action that is "regionally significant" must meet the requirements

[3] It is unlikely that an airport or air base action that does not exceed the threshold emission levels would be regionally significant.

of Section 51.850, and 51.855 through 51.860 [93.150, 93.155 through 93.160]. In other words, a conformity determination will be required. See 40 C.F. R. Section 51.853 (i) & (j) [93.153 (i) & (j)]. See Section **Five** for more information on General Conformity.

To determine conformity, applicable pollutant concentrations are computed by dispersion modeling, combined with background pollutant concentrations, and compared with NAAQS for exceedance. If pollutant concentrations do not exceed the NAAQS, the action conforms. If NAAQS are exceeded, two alternatives apply: The action can be demonstrated to conform by coordinating an alternative conformity determination with the local, State, and EPA representatives, or the Federal action can be mitigated, offset, or redesigned to reduce overall emissions. See Section Five for more information on General Conformity.

Determination that a Federal action conforms with the applicable implementation plan does not exempt the action from meeting other requirements of the applicable implementation, NEPA or the CAA. If both an environmental document and a conformity document are required, the conformity documentation or procedures can be combined with the environmental document or procedures (e.g., the conformity determination can be included in an Environmental Impact Statement, or public notices can be combined), or the documents can be prepared separately.

2.1.5 NAAQS Assessment

Air quality is assessed based on a comparison of the NAAQS for each criteria pollutant with the projected pollutant concentrations at the airport or air base. To determine whether the NAAQS must be assessed, the Federal agency first must consider whether the action is an advisory, emergency, or excluded activity. Some Federal actions are advisory in nature (e.g., an airspace determination) and do not require an air quality impact analysis or documentation. An emergency action is an action undertaken in the case of an emergency, disaster, or other similar great urgency. Categorically excluded activities do not individually or cumulatively have a significant effect on the human environment based on agency experience (e.g., issuance of airport planning grants) and do not require preparation of an environmental document. Lists of specific advisory, emergency, and excluded activities are provided in the FAA Order 1050.1 and 5050.4 and/or the USAF *EIAP: Desk Reference*. If the action is an advisory, emergency , or excluded activity, no further action is required.

If the action is not an advisory, emergency, or an excluded activity, screening techniques are used to evaluate whether performing an NAAQS assessment should be considered. *If the action is in a nonattainment or maintenance area and exempt or presumed to conform under conformity requirements, it is assumed that a NAAQS assessment is not required for an airport or air base action (since it is unlikely the action's pollutant concentrations would exceed the NAAQS).* If the action is in a nonattainment or maintenance area, but it is not exempt or presumed to conform, the screening technique (based on passengers and operations) outlined in the threshold analysis discussion following should applied. If the action is in an attainment area, this screening technique also should be applied. See the threshold analysis discussion following for more information.

If a NAAQS assessment is needed, the airport's or air base's "build" and "no-build" emissions are inventoried for each reasonable alternative. The inventory should include both direct and indirect emissions (see section 3 for a more thorough discussion). For this analysis, indirect emissions are not limited to those that the Federal agency can practicably control (as under conformity). The airport's or air base's emissions for the proposed build case then are translated into pollutant concentrations using a dispersion model. This step is very data and computation intensive and may need to be performed for both "general" airport pollutant concentrations and/or intersection pollutant concentrations.

Assessing NAAQS for "general" airport concentrations requires identifying all emission sources at the airport or air base by individual location, quantifying their peak and temporal emission rates, analyzing the emissions in the context of local weather (which could include hourly conditions of a year or more), and determining the resulting pollutant concentration at receptor sites in the vicinity of the airport.

If congestion increases at off-airport or air base highway intersections due to increased traffic coming to the airport or air base due to an airport/air base action, CO emissions may exceed the NAAQS. As a result, special intersection analysis should be performed to determine the likelihood of a violation occurring as a result of the airport or air base project. For an intersection assessment, the pollutant concentrations would be analyzed at each applicable intersection. For EPA guidance on a methodology for evaluating air quality impacts at one or more roadway intersections where vehicle traffic will cause or contribute to increased emissions of carbon monoxide (CO) see EPA's *Guideline For Modeling Carbon Monoxide From Roadway Intersections*. For an intersection assessment, state or regional air quality regulatory staff or the regional transportation planning staff should be consulted.

Once dispersion modeling has been performed, pollutant concentrations are combined with background pollutant concentrations and compared to the NAAQS. If concentrations do not exceed the NAAQS, an air quality certificate is obtained from the Governor (if applicable) and the assessment is complete. If pollutant concentrations do exceed the NAAQS, emissions must be mitigated or offset, or the action redesigned to reduce emissions.

2.2 Assessment Process Participants

Many different agencies and individuals must be involved when assessing the air quality impact of a project, since Federal, State, and local requirements all must be considered. This coordination, and subsequent analysis, are time consuming and need to be addressed early in the assessment process. Common participants include the airport sponsor or USAF, the FAA, the EPA, the State, the local air quality management district (AQMD), the local metropolitan planning organization (MPO), contractors, and the public. These participants contribute to various stages of the assessment process such as information gathering, scoping meetings, developing modeling consensus, and obtaining consensus on air quality analysis and conformity determination. The airport sponsor's or USAF's responsibilities include defining the project and alternatives and preparing environmental documents. The FAA, as well as the USAF, have the responsibility to analyze the environmental impacts associated with the proposed Federal airport action. Agency documents previously referenced also contain guidance on agency offices/personnel to contact during this process.

2.3 Screening Thresholds

Many projects at airports and air bases are too small to require a detailed air quality analysis and only a few projects are both broad enough in scope and located in nonattainment areas such that the full complement of analyses described in this document would be required. To determine which of the steps identified in section 2.1 will be required, applicable screening threshold levels are reviewed. The performance an Emissions Inventory is dependent on how the analysis is to be used to fulfill Indirect Source Review, Conformity, NAAQS or other requirements.

The following sub-sections define the threshold levels for Indirect Source Review, Transportation Conformity, General Conformity and NAAQS. In addition to summarizing air quality analyses that often are required for different projects, Figure 2 also addresses the specific threshold levels.

2.3.1 Indirect Source Review

Indirect source review requirements are state-specific and at this writing are required only for projects in certain parts of California, Connecticut, Minnesota, New York, North Carolina, Oregon, Utah, Vermont, and Wisconsin. Typically, thresholds are set for secondary measures of emissions rather than calculated emissions. Common thresholds are: number of added parking spaces, total parking spaces, increased highway trips, total highway trips, increased aircraft LTOs, and total aircraft LTOs. Appendix J, State Indirect Source Review Regulations, summarizes the threshold values for the states having indirect source review requirements as of this writing.

Key To Indicated Analysis

- ■ – Probably Required
- ▲ – Possibly Required
- ❍ – Unlikely or Unrelated

Abbreviations

- ADT – Average Daily Traffic
- MAP – Million Annual Passengers
- GA – General Aviation
- AT – Air Taxi

* *State specific requirements; thresholds are illustrative.*

Project Type

Analysis Type	Measure	Threshold	New Airport	New Terminal	Expanded Terminal	New Runway	Extended Runway	New Or Expanded Parking Facility	New Or Expanded On-Airport Access Roadway	New Or Expanded Off-Airport Access Roadway	New Interchange to Existing Off-Airport Roadway	Base Conversion	Military Basing of Additional Aircraft, Assets, and Personnel	New Airside Improvements to Increase Capacity or Reduce Congestion	Support Facility Construction or Expansion (e.g. power plant or fuel tank)
Inventory Emissions															
Facility Baseline / No Build			■	■	■	■	■	■	■	■	■	■	■	■	▲
Facility with Project as Built			■	■	■	■	■	■	■	■	■	■	■	■	■
Construction Activity			■	■	■	■	■	■	■	■	■	▲	▲	■	■
Indirect Source Review*															
	Added Parking Spaces	500 spaces	■	■	▲	■	▲	■	❍	❍	❍	▲	▲	❍	❍
	Total Parking Spaces	2,000 spaces	■	■	▲	■	▲	■	❍	❍	❍	▲	▲	❍	❍
	Increased Highway Trips	10,000 ADT	■	■	▲	■	▲	▲	▲	▲	❍	▲	▲	▲	❍
	Total Highway Trips	20,000 ADT	■	■	▲	■	▲	▲	▲	▲	❍	▲	▲	▲	❍
	Total Annual LTOs	50,000 LTOs	■	■	■	■	■	❍	❍	❍	❍	■	■	■	❍
	Total Annual Passengers	1 MAP	■	■	■	■	■	❍	❍	❍	❍	■	■	■	❍
Conformity															
Transportation			■	▲	▲	▲	❍	❍	■	■	■	❍	❍	❍	❍
General	Attainment Status	See Table 1 for thresholds	■	■	▲	■	■	▲	❍	❍	❍	■	■	■	❍
NAAQS Assessment															
General	Based on combination combination of million of annual passengers and thousands of annual GA & AT Operations	Consider dispersion modeling for CO emissions if: 3.5 – (1.346 *MAP+ 0.0194* GA&AT Operations) < 0	■	❍	❍	■	▲	❍	❍	❍	❍	■	■	▲	❍
Intersection Analysis	Level of service at intersection	Consider dispersion modeling for CO emissions if level of service is D, E, or F	■	▲	❍	▲	❍	❍	■	■	■	▲	▲	▲	❍

Figure 3. Air Quality Analysis Guidelines and Thresholds

2.3.2 Transportation Conformity

Transportation conformity determinations are required for all nonattainment and maintenance area highway or transit projects that are developed, funded or approved by the Federal Highway Administration or Federal Transit Administration for some aspect of the project. Transportation conformity also applies to projects that are “regionally significant”. A “regionally significant” project is a transportation project that is on a facility serving regional transportation needs and would normally be included in the modeling of a metropolitan areas transportation network. In the case of an airport or air base in a nonattainment or maintenance area, almost any roadway or transit project off the airport or air base boundary will require transportation conformity analysis and will likely be included in the region’s transportation plan. Even if an access project is not expected to use highway or transit funds, certain provisions of the transportation conformity rule may apply to the project. These projects must be included in the regional emissions analysis for a transportation plan or TIP (40 CFR 93.130 and 40 CFR 51.452).

In addition, no agency that receives Federal highway or transit funds may approve a “regionally significant” highway or transit project, regardless of the funding source, unless either it comes from a conforming plan and TIP, is in the regional emissions analysis supporting the currently conforming TIP, or meets other tests (40 CFR 93.129 and 40 CFR 51.450). This analysis applies only to the pollutant(s) for which the area is nonattainment or maintenance.

2.3.3 General Conformity

As discussed previously, general conformity only applies to proposed projects at airports and air bases located in nonattainment and maintenance areas. In addition to this, the General Conformity Rule contains exemptions from and presumptions of conformity. For applicable projects, general conformity determinations are required if the project’s net annual emissions exceed established threshold rates. The threshold rates vary by pollutant and the area’s nonattainment and maintenance status. Table 1, General Conformity Threshold Rates, summarizes the threshold values. However, even an action that is presumed to conform or that does not exceed emission thresholds, is still subject to conformity requirements if it is “regionally significant”. (It is unlikely that an airport or air base action that is presumed to conform or does not exceed the threshold emission levels would qualify as “regionally significant”.) If the direct and indirect emissions from the Federal action exceed 10 percent of the total emissions inventory for a particular criteria pollutant in a nonattainment or maintenance area, the action is considered to be a “regionally significant” activity and conformity requirements to apply. Section Five contains more specific information on Conformity issues.

Non-attainment Status	**VOCs (Ozone Nonattain-ment Areas)**	**NO_x (Ozone Nonattain-ment Areas)**	**Carbon Monoxide (CO)**	**Sulfur or Nitrogen Oxides (SO_2 or NO_x)**	**Particulate Matter (PM)**
Extreme	10	10	NA	NA	NA
Severe	25	25	NA	NA	NA
Serious	50	50	100	NA	70
Marginal (inside an ozone transport region)	50	100	NA	NA	NA
Marginal (outside an ozone transport region)	100	100	NA	NA	NA
Moderate (inside an ozone transport region)	50	100	100	100	100
Moderate (outside an ozone transport region)	100	100	100	100	100
Maintenance (inside an ozone transport region)	50	100	100	100	100
Maintenance (outside an ozone transport region)	100	100	100	100	100

Table 1: General Conformity Threshold Rates

(tons per year)

2.3.4 NAAQS Assessment - General

A comparison of the actions' resulting air quality with NAAQS should be considered if pollutant levels are likely to exceed the NAAQS. The number of passengers at larger commercial airports and the level of general aviation and air taxi operations at smaller airports are likely to be good indicators of potential pollutant concerns. For airports, a main pollutant of concern from an air quality standpoint is CO. Cars and aircraft (especially GA) emit moderate amounts of CO while they are idling or taxiing, respectively. Significant road congestion or airport ground delays could potentially cause CO emissions to approach the NAAQS. Actions that would not increase airport capacity, lead to increased congestion of roadways or airfields, or relocate aircraft or vehicular activity closer to sensitive receptors are not likely to exceed the NAAQS for CO. For deciding whether or not a NAAQS assessment should be considered, the total number of airport passengers and general aviation/air taxi operations should be evaluated. If the level of annual enplanements exceeds 1,300,000 (or 2.6 MAP), the level of general aviation and air taxi activity exceeds 180,000 operations[4] per year or a combination thereof, a NAAQS assessment should be considered. These levels were estimated based on a parametric analysis of concentrations produced by aircraft and other airport sources. The relation between these two factors is incorporated into Equation 1 (Illustrated in Figure 4). The equation can be used as a guide for determining whether a NAAQS assessment should be considered.

$$3.5 - (1.346 \times \text{Million Annual Passengers} + 0.0194 \times \text{General Aviation \& Air Taxi LTOs}) < 0$$

Equation 1: Dispersion Modeling Threshold

If the above equation is not true, a NAAQS assessment does not have to be considered. Otherwise, a NAAQS assessment (including dispersion modeling) should be considered. To determine if a NAAQS assessment should be performed, the nature of the project should be considered in consultation with state or regional air quality regulatory staff. The nature of the project must be considered since special project concerns and characteristics or high background levels of CO may suggest that a NAAQS assessment is indicated at lower activity levels or not at all.

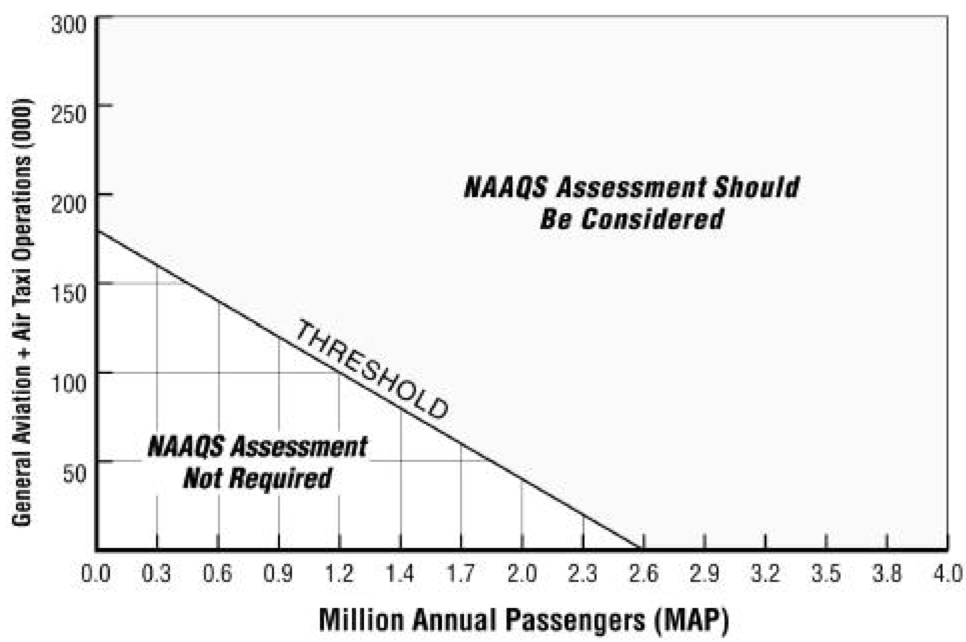

Figure 4. Airport Activity Threshold For NAAQS Assessment

4 Operations based on an LTO cycle. One landing and one takeoff equal 1 LTO.

2.3.5 NAAQS Assessment - Roadway Intersection Analysis

If a project has the potential to adversely affect the air quality at a roadway intersection (e.g. by significantly increasing traffic volume), CO emissions may exceed the NAAQS. In such cases, a comparison with the NAAQS should be considered. Intersections with the highest traffic volumes and lowest Level-of-Service (LOS) ratings are considered and selected for modeling. LOS ratings measure the operating conditions at the intersection and how these conditions affect traffic volume, signal timing, and related congestion delays. There are six LOS rankings: LOS A through LOS F. LOS A is the highest ranking relating to delays of less than 5.0 seconds per vehicle. LOS F is the lowest, describing operations with delays greater than 60.0 seconds per vehicle. If the top intersections selected for modeling do not show an exceedance of the NAAQS, it is assumed that none of the other intersections will exceed either. Intersections that should be considered for modeling are called Critical intersections. Critical intersections have LOS ratings of D, E, or F or are intersections that have dropped to those levels due to increased traffic volumes or to construction related to a new project in the vicinity.

Intersection modeling may be required based on other special considerations or indications. State or regional air quality regulatory staff or the regional transportation planning staff should be consulted. For EPA guidance on a methodology for evaluating air quality impacts at one or more roadway intersections where vehicle traffic will cause or contribute to increased emissions of carbon monoxide (CO), please refer to EPA's *Guideline For Modeling Carbon Monoxide From Roadway Intersections* (Reference 74).

3. EMISSIONS ASSESSMENT

3.1 Introduction

After defining a proposed project and any alternatives, creating an emission inventory is an important step in assessing air quality. An emissions inventory provides a first indication of the magnitude of a proposed project's potential environmental impact. An emissions inventory provides the total amount or mass of pollutants generated by emission sources during a specified period of time (e.g., tons per year). To determine the emission inventory of an airport or air base, emissions are calculated for all relevant sources and operators and then totaled. Potential sources of emissions at airports and air bases include aircraft, ground support equipment, ground access vehicles, stationary sources, and construction activities[5]. Examples of potential operators include the FAA, the Air Force, the airport authority, airlines, fixed base operators (FBOs), rental car agencies, or individual passengers or employees.

The emissions inventory can be created for various purposes. It can be used to compare various proposed project alternatives (e.g., "build" and "no-build" alternatives), a proposed project's emissions to the total emissions of the local air quality area, or a proposed project's emissions to regulatory thresholds (e.g., general conformity thresholds). The inventory may also be used as part of the State Implementation Plan (SIP) emission inventory.

An inventory may include both direct and indirect emissions. Direct emissions are those emissions that are caused or initiated by a Federal action and occur at the same time and place as the action. Indirect emissions are those that are caused by a Federal action, but may occur later in time and/or may be farther removed in distance from the action itself but are still reasonably foreseeable. Under conformity, indirect emissions are further limited to those that the Federal agency can practicably control and will maintain control over due to a continuing program responsibility of the Federal agency. Motor vehicle emission that result from passengers or employees coming to the airport or air base are the most typical indirect emissions. An example of motor vehicle emissions that are indirect emissions of an action is a planned airport capacity increase that is expected to generate additional passenger traffic to the airport (i.e., caused by the action and foreseeable). In this example, the indirect emissions would be the sum of the motor vehicle emissions resulting from new passenger and employee traffic for an average commute trip distance (as well as any emissions decrease due to a reduction in vehicle traffic). Vehicle emissions while on the airport's property would be included in direct emissions and would be excluded from indirect emissions to avoid double counting.

This section summarizes the various types of emissions sources and models available to aid in the calculation of an emission inventory.

[5] Construction activity is short-term and temporary in nature. Examples include construction of a new or modified runway, roadway, parking facility, or terminal. Emission sources, calculation methodologies, and data inputs vary slightly when evaluating construction impacts.

3.2 Emission Sources

3.2.1 Aircraft

The sources of aircraft emissions addressed in this handbook are: commercial aircraft, general aviation and air taxi aircraft, and military aircraft.

Commercial aircraft are operated on a scheduled basis by civilian international, national, regional and commuter air carriers. Commercial aircraft also are operated on an unscheduled basis by civilian charter operators. In addition to aircraft, emission sources related to air carrier aircraft operations include auxiliary power units (APUs) and ground support equipment (GSE), discussed separately below.

General aviation aircraft are privately owned and operated on a non-scheduled basis at a variety of facilities ranging from commercial airports to small privately owned airstrips. Air taxis are non-air carrier commercial operators that fly scheduled service carrying passengers and freight on a limited basis. The smaller general aviation and air taxi aircraft generally do not require APUs and GSE.

Military aircraft are operated by the Department of Defense (DOD). Military aviation includes the full spectrum or aircraft types, ranging from high performance jet fighters to large transports to small piston engine aircraft. Most military aircraft operations occur at DOD-operated air bases, but certain operations can take place at civilian airports as well. Examples of such activity include National Guard or active duty military aircraft based at a civilian facility and military transports shuttling personnel to a civilian airport. Emissions from military aircraft encompass those occurring at both military and civilian facilities. Civil aircraft also may shuttle personnel between a military and civilian facility. The emissions of civil aircraft operations at DOD-operated air bases also are attributed to the air base. Emission sources related to military aircraft include APUs and GSE, discussed separately below.

A significant consideration for airport and air base emission inventories is that aircraft not only operate on the ground but emit pollutants, during their flight in the atmosphere. Due to atmospheric mixing, some of these emissions affect ground level pollutant concentrations. The portion of the atmosphere that is completely mixed begins at the earth's surface and may extend to a height of a few thousand feet. The volume is often referred to as the mixing zone or inversion layer. The height to which the mixing zone extends is called the mixing height. All pollutant emissions in the mixing zone must be accounted for in a complete airport or air base emissions inventory.

The aircraft operations of interest within the mixing zone are defined as those in the landing and takeoff (LTO) cycle. The standard LTO cycle begins when the aircraft enters the mixing zone as it approaches the airport on its descent from cruising altitude, lands and taxis to the gate. The cycle continues as the aircraft taxis back out to the runway, takes off, and climbs out of the mixing zone and back up to cruising altitude. The five specific operating modes in a standard LTO are: approach, taxi/idle-in, taxi/idle-out, takeoff, and climbout. Most aircraft go through this sequence during a complete standard operating cycle. Some aircraft and operations may go through a slightly different sequence during a non-standard operating cycle. Non-standard sequences combine or eliminate certain modes. For example, helicopters combine takeoff and climbout modes.

For a detailed discussion of the aircraft emissions calculation methodology and data inputs see Appendix D. Models that can be used to calculate the aircraft portion of an emissions inventory are the *Emissions and Dispersion Modeling System* and *FAA's Aircraft Engine Emission Database*, which are both described in Section 3.3.

3.2.2 Auxiliary Power Units

An auxiliary power unit (APU) is a component of a large aircraft and essentially is a small turbine engine. An APU generates electricity and compressed air to operate the aircraft's instruments, lights, ventilation, and other equipment while the main aircraft engines are shut down. It also is used to provide power for starting the main aircraft engines. APU's burn jet fuel and create exhaust emissions like larger aircraft engines. APUs are common on both commercial and military aircraft; they are not common on air taxis and smaller civil aircraft.

During a typical LTO cycle, the APU is turned on as the aircraft taxis from the runway to the gate or parking space. It remains in use while the aircraft is parked, unless an alternative source of electricity and preconditioned air is made available. In such cases, the APU is reactivated at least five to ten minutes before the aircraft leaves the gate or parking space so that it will be able to provide power for starting the aircraft's main engines. Typically, the APU is turned off after the main engines have been started, prior to takeoff.

For a detailed discussion of the APU emissions calculation methodology and data inputs see Appendix E. The only model available for calculating the APU portion of an emissions inventory is the *Emissions and Dispersion Modeling System,* described in Section 3.3.

3.2.3 Ground Support Equipment or Aerospace Ground Equipment

A variety of ground equipment service larger commercial and military aircraft while they unload and load passengers and freight at an airport or air base. As a group, this equipment is known as ground support equipment (GSE) at civilian airports and aerospace ground equipment (AGE) at military air bases.

GSE and AGE primarily consist of the following equipment: aircraft tugs, air start units, loaders, tractors, air-conditioning units, ground power units, cargo moving equipment, service vehicles, buses, cars, pickups and vans. The equipment that service civilian and military aircraft vary slightly based on the types of aircraft and operations occurring at an airport versus an air base. GSE that operate at civilian airport, but typically are not part of the military AGE population, are baggage tractors and belt loaders. An AGE type that operates at a military air base, but typically is not part of a civilian GSE population, is a weapons loader.

There also is a variety of ground equipment that service airports or air bases. This equipment may be assigned to various departments of the facility including administration, emergency response, police department, operations, engineering and construction, automotive, mechanical maintenance, and landscaping/gardening. The types of equipment servicing an airport or air base vary from cars and pick-ups to generators and lawn mowers. There also are GSE associated with the maintenance of the airport that can have a seasonal and regional variability, such as snow plows. This airport equipment also is included in a GSE or AGE inventory.

For a detailed discussion of the GSE or AGE emissions calculation methodology and data inputs see Appendix F. The only model available for calculating the GSE or AGE portion of an emissions inventory is the *Emissions and Dispersion Modeling System*, described in Section 3.3.

3.2.4 Ground Access Vehicles

Ground access vehicles (GAV) encompass all on-road or highway vehicle trips generated by the airport or air base action. GAV include all vehicles traveling to and from, as well as within the airport or air base (excluding those GSE or AGE used for servicing the aircraft and airport or air base). On-road and highway vehicles include privately-owned vehicles, military government-owned vehicles, rental cars, shuttles, buses, taxicabs and trucks.

Due to varying emission characteristics, the EPA (Reference 81) divides on-road vehicles into eight categories based: on duty cycle (i.e., light or heavy duty), fuel (i.e., gasoline or diesel), and type (i.e., vehicle, truck, or motorcycle):

- light-duty gasoline-fueled passenger cars,
- light-duty gasoline fueled trucks with a gross vehicle weight (GVW) rating of 6000 pounds or less,
- light-duty gasoline-fueled trucks with a GVW between 6001 and 8500 pounds,
- heavy-duty gasoline-fueled vehicles with a GVW exceeding 8500 pounds,
- light-duty diesel-fueled passenger cars,
- light duty diesel-fueled trucks with a GVW of 8500 pounds or less,
- heavy-duty diesel-fueled vehicles with a GVW exceeding 8500 pounds, and
- motorcycles (vehicles with no more than three wheels in contact with the ground and curb weight less than 1500 pounds).

There are both on-airport and off-airport emission from GAV. To capture the total emissions from GAV, the full round-trip operation of the vehicle is tracked, from the time the vehicle is started at its point of origin (e.g., an employee's home), arrives at the airport or air base location (e.g., an airport parking lot or the main terminal), departs the airport or air base location, and reaches its point of destination. Usually, due to the lack of detailed GAV trip data, an average trip distance is used to represent full round-trip operation of GAVs.

For a detailed discussion of the GAV emissions calculation methodology and data inputs see Appendix G. Models that can be used to calculate or contribute to the GAV portion of an emissions inventory are the *Emissions and Dispersion Modeling System*, *MOBILE5a*, *EMFAC*, and *PART5*, which are described in Section 3.3.

3.2.5 Stationary Sources

Stationary sources of air emissions at airports and air bases consist of both combustion and non-combustion sources. Typical sources include: boilers, space heaters, emergency generators, incinerators, fire training facilities, aircraft engine testing facilities, fuel storage tanks, painting operations, deicing operations, solvent degreasers and sand/salt piles.

The combustion sources tend to produce a variety of air pollutants that are released to the atmosphere with combustion gases. These pollutants include: HC, CO, NO_x, PM-10 and SO_2. The venting of combustion gases to the atmosphere results in the emission of these pollutants, although emissions may be reduced through the use of air pollution control techniques or devices at the source.

Airports and air bases operate boilers and space heaters to fulfill much of their heating and power generation requirements. These stationary combustion sources burn several different fuel types, most commonly fuel oil, diesel, natural gas, or occasionally jet fuel. Coal combustion is limited to large heating and power plants on some air bases.

Emergency generators at airports and air bases typically are fixed in place and located throughout the site to provide supplementary or emergency power. These generators are likely powered by gasoline or diesel-fueled reciprocating engines.

Incinerators at airports and air bases likely are small industrial or commercial combustors for the disposal of food wastes (e.g., from international flights) or other refuse. Large municipal waste combustors (MWC) are unlikely to be operated at airports or air bases.

Some major airports and air bases operate on-site aircraft rescue and fire fighting (ARFF) training facilities. In these facilities, fuel is burned in a pit or a mockup of an aircraft to simulate emergency situations that may occur at the site. The amount of fuel burned and time of burning depend upon the particular training exercise being performed and type of equipment in use.

Aircraft engine testing also is performed at some airports and air bases as part of regular aircraft maintenance cycles. In general, testing at commercial airports is limited to uninstalled engines in enclosed test cells. These tests are often performed following overhaul or repair of the engine to determine air worthiness, engine safety performance and fuel efficiency. During the test, the engine is mounted in a special enclosed cell that restricts noise but allows air to flow through at speeds simulating aircraft flight. Engine thrust and other essential performance parameters are measured as the engine is taken through a sequence of power settings. At military bases, a large part of aircraft engine testing is also performed in enclosed test cells, but engines also are routinely tested when they are attached to the aircraft. This “trim” testing is commonly performed on the airfield apron or pad, with no additional noise or emission controls.

The non-combustion stationary sources at airports and air bases tend to emit only one type of pollutant instead of the full range produced by combustion sources. Many sources have evaporative emissions of HC as the only air pollution of concern. Sand and salt piles, on the other hand, emit particulate matter to the atmosphere during loading, unloading and wind erosion of the piles.

Airports and air bases may store large quantities of jet fuel, aviation gasoline, diesel fuel and other fuel types in storage tanks on site. Evaporative HC emissions from the tanks occur during fuel loading and unloading as well as during daily expansion and contraction of the tank contents due to ambient temperature changes.

A variety of coating and painting operations also are performed at airports and air bases. Roadway and runway maintenance requires the occasional application of paint, and some aircraft maintenance facilities may include aircraft painting. These operations usually result in the evaporation of HC from the various coatings and solvents used.

In inclement weather, deicing of aircraft and runways is performed at many airports and air bases. In addition, some aircraft such as the DC-9 must be deiced year-round at all airports and air bases because it’s fuel lines are close to the skin of the aircraft, possibly resulting in the formation of ice during the flight. Deicing fluid contains ethylene glycol or other HC that can evaporate upon application to the aircraft or runway.

Solvent degreasing units are regularly used for aircraft and ground vehicle maintenance, paint stripping and other miscellaneous activities utilizing organic solvents. Solvent degreasers use organic solvents to remove fats, oils, grease, wax or soil from various metal, glass or plastic items. There are two types of solvent degreasers commonly used: cold cleaning and open-top vapor degreasers. Cold cleaning operations use alcohol, ketones and petroleum distillates as solvents for parts cleaning through immersion, brushing, spraying or flushing. Open-top vapor systems are boiling degreasers that clean by the condensation of solvent on the surface of parts being cleaned. Each of these operations causes HC emissions due to evaporation of the solvent.

Finally, many airports and air bases store salt and sand piles on-site for use in maintaining roads and runways during inclement weather. Particulate matter emissions can occur during loading and unloading of the piles and through wind erosion of the pile material.

For a detailed discussion of the stationary source emissions calculation methodologies and data inputs see Appendix H. Models that can be used to calculate or contribute to the stationary source portion of an emissions inventory are the *Emissions and Dispersion Modeling System*, *TANKS*, and *WIND*, which are described in the following available models discussion.

3.3 Available Models

***Emissions and Dispersion Modeling System (EDMS)* -** The EPA and FAA preferred guideline model, *EDMS* (Reference 57), can be used to assess air pollution at airports and air bases. The FAA and the USAF jointly developed the *EDMS*, a computer program for taking inventory of emissions from aircraft, ground support equipment, aerospace ground equipment, vehicular traffic, training fires, and miscellaneous stationary sources. For all sources, the program allows users the ability to specify peak hours or annual activities to examine. If an hourly activity is given, the program uses specified operational profiles (duty cycles) to derive an annual activity. Based on the annual activity, the model can compute an emissions inventory for annual emissions of five pollutants: CO, HC, NO_x, SO_2, and PM-10.

The *EDMS* database stores emission factor data for aircraft in the form of aircraft engine emission factors and aircraft-engine combinations. Aircraft operations are considered on an LTO cycle basis with four distinct modes: approach, climbout, takeoff, and taxi. The *EDMS* also stores GSE and AGE emission factors and default assignments of GSE and AGE to different aircraft types. GSE and AGE operating times are specified in minutes per aircraft LTO. Vehicular emission factors obtained from the EPA's *MOBILE5a* and *PART5* programs are stored for the years 1988 to 2010, 14 different vehicle speeds, and temperatures from 0 to 100 degrees Fahrenheit in 5 degree increments. To accommodate changing regulations, the user is allowed the option of entering their own vehicular emission factor data. Additionally, emission factor information for three different aviation fuels is stored for calculating training fire emissions. There are several major categories of stationary sources for which emission factor data are stored in the database. These major categories are power/heating plants, incinerators, fuel storage tanks, surface coating facilities, and solvent degreasers. Under each category several sub-categories are defined. For miscellaneous stationary sources not found in the database, users have the option to input their own emission factors.

The output of the emissions inventory portion of the model lists the calculated pollutant emission totals in summary by source categories and in detail by each source.

***EMFAC* -** *EMFAC* (Reference 14) is California's version of a motor vehicle emissions model. Default values and assumptions are appropriate for California-specific data. *EMFAC* is similar to *MOBILE5a*, although emissions are trip based and not VMT based. See the *MOBILE5a* discussion for more information.

***FAA Aircraft Engine Emission Database (FAEED)* -** *FAEED* (Reference 60) is a computerized emission inventory calculation procedure developed by the FAA with support from EPA. For analysis limited to aircraft, *FAEED* can be used to compute aircraft engine exhaust emissions for any time period, activity level, or common aircraft type.

To calculate exhaust emissions using *FAEED*, the main data inputs needed are aircraft model, engine model, and number of LTOs. Air carrier, airport, or air base information also may be needed in some cases. If site-specific engine and time in mode information is not available, the model provides default data from EPA's *Procedure for Emission Inventory Preparation*, Volume IV, Chapter 5. The model lists possible engine models for each aircraft type and the associated national market share, which can be used to choose a surrogate engine if site-specific data is not available. The output of the emissions computation portion of the model is a calculated emissions summary listing pollutant emissions, LTOs, and times in mode by each aircraft and engine combination in the given inventory.

***MOBILE5a* -** The EPA specifies that the most current version of the MOBILE motor vehicle emissions model should be used to develop highway vehicle emission indices and emission inventories. At the time of this writing (1996) the most current version of the motor vehicle emissions model is *MOBILE5a* (Reference 76). The analysis considers traffic volumes and movements within the terminal area and surrounding airport area. The model is designed to account for the effect of numerous vehicle parameters on the volume of exhaust and evaporative pollutants emitted. EPA's *Procedures for Emission Inventory Preparation,* Volume IV, Chapter 3 contains recommendations and suggestions with regard to determining appropriate MOBILE inputs, although it is not a substitute for the model's user's guide (Reference 88).

Inputs to the model include basic emission rate, fleet characteristics, fuels characteristics, and control programs data. Default values for most input data are built into the EPA's motor vehicle emissions model, but are not likely to be directly applicable to a restricted airport or air base analysis. The output of the model lists inputs and options chosen, emission indices for each of EPA's eight vehicle types, and emission indices for all eight vehicle types combined. Emission indices are calculated for **HC**, **CO**, and **NO_x**. If vehicle emission indices calculated using MOBILE are to be part of an airport or air base inventory being developed using the EDMS, the EDMS model will provide the user with the option to enter the emission indices developed using the MOBILE model.

***PART5* -** The EPA's *PART5* model (Reference 80) should be used in the analysis of the particulate air pollution impact of in-use gasoline-fueled and diesel-fueled motor vehicles. The model calculates particle emission indices (including **PM-10**, **SO_2**, and **lead**) in grams per mile from on-road automobiles, trucks, and motorcycles. The emission indices calculated include exhaust particulate, exhaust particulate components, brakewear, tirewear, and reentrained road dust, which are required for PM-10 inventories and analyses. The required inputs and optional inputs are described in detail in the *PART5* user's guide (Reference 72). *PART5* contains default values that can be used for most data required for the calculation of the emission indices, although they are not likely to be directly applicable to a restricted airport or air base analysis. If vehicle emission indices calculated using *PART5* are to be part of an airport or air base inventory being developed using the *EDMS*, the *EDMS* model will provide the user with the option to enter the emission indices developed using the *PART5* model.

***TANKS* -** *TANKS* is an EPA computer model developed using the methodology and tank information presented in Section 7.1, Volume I of *Compilation of Air Pollutant Emission Factors*. When provided with data inputs, the program estimates annual emissions of evaporative hydrocarbons from a single storage tank. Output from the program can be given as a total figure for annual emissions, or a detailed breakdown of emissions by month, fuel component, and cause of emissions (standing storage or working emissions). For many required variables, such as fuel vapor pressure and climatic data, *TANKS* provides default values based on the fuel type or location specified. If more detailed information is available to the user, *TANKS* allows the input of that information so that default values are not used. It is strongly recommended that *TANKS* be used instead of manually following the *Compilation of Air Pollutant Emission Factors* methodology because the program is much easier to use and employs the same EPA-recommended methodology for calculating storage tank emissions.

WIND **-** EPA has developed the *WIND* computer model for estimating the wind erosion emissions from material piles based on the methodologies described in Section 13.2.5 of Volume I of *Compilation of Air Pollutant Emission Factors*. *WIND* calculates total particulate emissions from a single storage pile per inputs provided by the user.

4. DISPERSION ASSESSMENT

4.1 Introduction

The intent of a dispersion analysis is to assess the air pollutant concentrations at or near the airport or air base resulting from the emissions inventoried in the emission assessment. These pollutant concentrations are calculated to determine whether emissions from the site result in unacceptably high air pollution levels downwind. This section provides a discussion of the dispersion assessment.

Dispersion modeling has become an important part of the air permitting process. Under CAA, the proposed installation or modification of a major stationary emission source now requires dispersion modeling to show the effects of the proposed action on a community's air quality. The pollutant concentrations computed by a dispersion model are compared with the NAAQS or other relevant air quality standards to determine whether or not a source of emissions is likely to result in unacceptably high pollutant levels.

The dispersion model develops a mathematical approximation of future pollution levels resulting from aircraft or airport / air base actions. The input parameters may include source emissions, meteorological conditions, topography, etc. The meteorological parameters are used to find the direction of pollutant transport, the receptors which will be affected and the most probable and worst pollutant concentrations which can be expected at these receptors.

Several key pollutants are commonly considered in dispersion modeling at airports and air bases including CO, PM-10, NO_x, and possibly SO_2 and HC.

CO emissions at airports and air bases arise from aircraft, ground vehicles and stationary combustion sources. Although these sources are widespread, ambient CO concentrations may be high in locations where vehicles slow down and idle, such as roadway intersections. Dispersion analysis of areas surrounding each intersection of concern, both on and off the airport or air base, is commonly performed to determine whether an increase in vehicular traffic can result in congestion that produces locally high concentrations of CO that violate the NAAQS. Such dispersion analysis of intersections is performed using computer models that take into account the number and type of vehicles, their operating mode, their movement, and the length of delay (Reference 74).

Particulate emissions arise from aircraft, ground vehicles, stationary combustion sources and fugitive dust sources such as sand piles. However, these particulate emissions are rarely at levels that would approach the NAAQS unless special circumstances, such as a high background particulate level, were present. In such cases, PM-10 can be included in the dispersion model.

A NAAQS exists for NO_2, which is the primary component of NO_x emitted from combustion sources. The emissions inventory described in Section Three of this document provides emissions of NO_x that may be included in the dispersion model. Significant NO_x sources at airports and air bases are: aircraft, ground vehicles and some stationary combustion sources. Because minor components of NO_x (e.g., NO and N_2O) are fairly rapidly converted to NO_2 in the atmosphere, NO_x emissions are reported on the basis of the molecular weight of NO_2 (Reference 71), and may be assumed to be entirely composed of NO_2 unless more detailed test data is available. In most cases, NO_2 levels above the air quality standards are not expected to result from airport emissions.

Sulfur dioxide emissions at airports and air bases come from the low levels of sulfur in jet fuel, aviation gasoline, diesel and stationary combustion source fuels. However the SO_2 levels produced are very low and are not likely to result in violations of the NAAQS in the area surrounding the airport or air base. SO_2 may be included in the dispersion modeling if necessary.

There is no NAAQS for hydrocarbons, as a result HC is not commonly included in site-specific dispersion modeling. However, HC and NO_x in the atmosphere are precursors to the formation of ozone, which does have an NAAQS standard. Ozone is typically not included in the airport or air base dispersion models because its formation in the atmosphere is difficult to model on a local scale, and because the effects of elevated ozone concentrations are generally felt on a regional rather than a local level.

In summary, dispersion modeling at airports is usually concerned with calculating local CO levels, and may be expanded to include PM-10, $NO_{x,}$ SO_2 and HC if circumstances warrant their inclusion.

Depending upon the goals of the dispersion modeling effort, one of two types of models may be selected: screening models or refined models. Screening models use simplified emissions and meteorological inputs to provide a snapshot of the likely worst-case air quality scenario. Refined models require detailed input on emissions and climate to provide air quality estimates for a large number of time periods, typically each hour of a given year. Refined models are often required by regulatory agencies because they capture a wide range of meteorological and operating conditions. Many computer models used for dispersion calculations can operate in both screening and refined mode so only a single model is needed to perform both types of calculations.

For a detailed discussion of the dispersion methodology, inputs, and data sources, please see Appendix I.

4.2 Dispersion Inputs

Inputs required for a dispersion modeling run include various characteristics of each emission source, meteorological parameters, local topography and receptor locations.

4.2.1 Emissions Sources

Dispersion models require several pieces of information about each emission source being included in the model. The output of a detailed emissions inventory should provide source type and emissions of each pollutant for each time period being investigated.

4.2.2 Meteorology

Dispersion of pollutants in the atmosphere is largely dependent upon meteorological conditions such as wind speed and direction, atmospheric stability and mixing depth. Wind speed and direction are the most important parameters in the modeling of dispersion of pollutants in air. Atmospheric stability is related to the turbulence of the atmosphere, and is determined by a combination of wind speed, cloud cover and solar radiation. In unstable atmospheric conditions, high turbulence and associated vertical mixing produce a peak ground-level pollutant concentration near the emission source. Whereas in a stable atmospheric conditions, a low level of vertical mixing results in low ground-level steady-state concentrations near the source. In most cases, the most unstable atmospheric conditions occur during daylight hours, with low wind speeds and high solar radiation. The most stable atmospheric conditions occur at night, during times of low wind speeds and clear skies. Finally, the mixing layer height has the effect of restricting vertical diffusion of pollutants. Generally, the height of the mixing layer ranges between 1,000 ft and 4,000 ft.

4.2.3 Topography

The terrain in the vicinity of airports and air bases is usually quite flat because of the requirement for a level runway, approach and climbout area. Dispersion models can take advantage of this property of airport and air base locations to make the simplifying assumption that the terrain is flat. This assumption allows the model to use the Gaussian approximation without modifications that would increase the computational requirement.

Some sources, such as training fires, stacks, and painting operations, produce emission sin the form of a buoyant plume. These can have an impact on air quality much farther downwind than the flat area surrounding an airport. In such cases, topography may play a role in altering the downwind dispersion of the plume and may be included in the dispersion analysis. Dispersion models designed for use in complex terrain (i.e., terrain that rises above the level of the plume) or intermediate terrain (i.e., terrain that rises above the stack height but not above the plume elevation) are available. For these models, an additional input of a digitized terrain grid file is necessary.

4.2.4 Receptors

Receptors are defined by the user as those areas in which pollutant concentrations in air are to be calculated. If an overall view of pollutant concentration on and off site is desired, then a grid of receptors should be defined. For many applications, however, only those location defined as "sensitive" (e.g. where the public is likely to come into contact with emissions) may be modeled in order to reduce the computational requirement. For a complex emissions scenario such as an airport, reducing the number of receptors may be necessary because each receptor defined may add hours to the computational time.

4.3 Available Models

The following are EPA-preferred models, which are those models that do not require a rigorous demonstration of applicability each time they are used.

Emissions and Dispersion Modeling System (EDMS) **-** The *EDMS* (Reference 57) is the EPA and FAA preferred guideline model to calculate emissions and model dispersion at airports. *EDMS* is jointly developed by the FAA and the USAF. The model includes an emissions inventory section, which was described in Section Three of this document, and a dispersion modeling section. The heart of the dispersion model is the Gaussian dispersion equation, which takes an emission rate from a source and calculates one hour concentrations of key criteria pollutants in the air at each receptor location.

In addition to the source activity, the dispersion portion of the model requires input on source coordinates and the hourly variation of emissions (using operational profiles). The program allows the user to import weather data files from the National Climatic Data Center and also allows the user to create their own weather files. In running the model for dispersion, the user is allowed the flexibility of choosing a weather file as well as a range of weather hours within that file. During run execution, a progress meter displays the run status.

Line source algorithms are used for aircraft, APU, and vehicle roadway operations. GSE activity and stationary sources are treated as point sources. Vehicle parking lots are treated as area sources. The ability to toggle sources in and out of a given study allows for enhanced analysis capabilities when running dispersion. *EDMS* also incorporates a graphical view of the airport or air base, plotting runways, runway queues, aircraft gates, roadways, parking lots, stationary sources, and receptors in relation to each other.

The output of the dispersion section of *EDMS* is the hourly averaged concentration of pollutants at each receptor for the chosen duration of weather hours. Concentrations averaged over 3, 8, and 24 hour periods also are given for comparison with NAAQS.

CAL3QHC - *CAL3QHC* is the EPA recommended model for analyzing CO impacts at roadway intersections and is available on EPA's *Support Center for Regulatory Air Models Bulletin Board System (SCRAM)* (Reference 83). The model combines the EPA model for estimating the concentrations of nonreactive pollutants from highway traffic, *CALINE3* (Reference 4), with a traffic model to calculate delays and queues that occur at signalized intersections. It can be used in a screening or refined mode. The latest version of the MOBILE model should be used for emissions input to *CAL3QHC*. The EPA user's guide to the model is *User's Guide for CAL3QHC Version 2: A Modeling Methodology for Predicting Pollutant Concentrations near Roadway Intersections* (Reference 86), also available on *SCRAM*. For EPA guidance on a methodology for evaluating air quality impacts at one or more roadway intersections where vehicle traffic will cause or contribute to increased emissions of carbon monoxide (CO) see EPA's *Guideline For Modeling Carbon Monoxide From Roadway Intersections*.

Industrial Source Complex Model (ISC3) - ISC3 is an EPA preferred model for assessing pollutant concentrations from a wide variety of sources associated with an industrial source complex. It is a steady-state Gaussian plume model that can account for: settling and dry deposition of particles; downwash; area, line, and volume sources; plume rise as a function of downwind distance; and separation of point sources. ISC3 operates in both long-term and short-term modes. ISC3 is appropriate for the following applications: industrial source complexes, rural or urban areas, flat or rolling terrain, transport distances less than 50 kilometers, 1-hour to annual averaging times, and continuous toxic air emissions. The model is available on EPA's *Support Center for Regulatory Air Models Bulletin Board System (SCRAM)* (Reference 83). The basis ISC3 model is valid for simple terrain (i.e., terrain does not rise above the stack height). Variations on the ISC3 model exist for special situations, such as complex terrain.

A variety of other dispersion models have been developed for use in regulatory applications ranging from highways to stack sources to regional ozone modeling. Most are based on some form of the basic Gaussian approximation, although some of the more recent models use sophisticated numerical modeling techniques to simulate more complex phenomena. Some of these models are labor-intensive; for example, the Urban Airshed Model requires the user to input hourly emissions of all sources within the region of interest. Table 2 presents a list of other EPA-preferred models. The table shows that much of the model development and application activity has focused on stacks as emission sources, with comparatively little emphasis on dispersion modeling of mobile source emissions.

Model Name	Type	Applicability
CALINE3	Gaussian	Highway emissions
Climatological Dispersion Model (CDM)	Gaussian	General stack sources
Gaussian-Plume Multiple Source Air Quality Algorithm (RAM)	Gaussian	General stack sources
Industrial Source Complex Model (ISC3)	Gaussian	General stack sources; Complex terrain
Urban Airshed Model (UAM)	3-D numerical	Urban ozone modeling
Offshore and Coastal Dispersion Model (OCD)	Gaussian	Pollutant transport over water and coastal areas
Complex Terrain Dispersion Model Plus Algorithms for Unstable Situations (CTDMPLUS)	Gaussian	General stack sources; Complex terrain

Table 2: Other EPA Preferred Air Quality Models[6]

[6] Source: Appendix A: Summaries of Preferred Air Quality Models of Code of Federal Regulations Title 40 Part 51, Appendix W "Guideline on Air Quality Models (Revised)" (Reference 8).

5. CONFORMITY

The concept of conformity is a key component in the attainment of national air quality standards, and an important concept to consider when assessing the air quality impact of FAA or USAF actions in nonattainment or maintenance areas. In large part, the administration and enforcement of air pollution regulations are delegated to individual states. (A SIP is a plan that provides for implementation, maintenance, and enforcement of the NAAQS.)

The *CAA Amendments of 1977* stated that no Federal agency could engage in, support in any way, provide financial assistance for, license, permit, or approve any activity that did not "conform" to a SIP after its approval or promulgation. Although the amendments addressed the association of Federal agency activities with a SIP, they did not define "conformity" in detail.

The *CAA Amendments of 1990* (Reference 5) remedied this situation by defining conformity and expanding the scope and content of the relevant provisions. A Federal agency responsible for an applicable action is required to determine if the action "conforms" to the applicable SIP, by ensuring that the action does not:

- Cause or contribute to new violations of any NAAQS,
- Increase the frequency or severity of existing violations of any NAAQS, or
- Delay the timely attainment of any NAAQS or any required interim emission reductions or milestones.

Federal actions subject to conformity are divided into two categories: transportation conformity actions and general conformity actions. Transportation conformity actions are Federal actions in nonattainment and maintenance areas related to transportation plans, programs, and projects that are developed, funded, or approved under title 23 U.S.C. or the Federal Transit Act (49 U.S.C. 1601 *et seq.*), or are regionally significant. Transportation conformity actions must meet the procedures and criteria of the Transportation Conformity Rule [40 Code of Federal Regulations (CFR) Part 51, Subpart T]. General conformity actions are all other Federal actions in nonattainment and maintenance areas that are not covered by the Transportation Conformity Rule. General conformity actions must meet the procedures and criteria of the General Conformity Rule (40 C.F.R. Part 51, Subpart W; 40 C.F.R. Part 93 Subpart B), effective January 31, 1994 (Reference 7). Most Federal actions at airports are general conformity actions. Roadways and transit construction, generally off airport property, that is developed, funded, or approved by the Federal Highway Administration (FHWA) or Federal Transit Administration (FTA) are transportation conformity actions. Discussions of conformity in this document refer to general conformity, unless otherwise noted.

Each state must submit to the EPA criteria and procedures for assessing the conformity of Federal actions to its SIP. Once a revised SIP that includes conformity rules is submitted and approved by EPA, State rules can be applied. However, until EPA approves the State rules, the Federal rule at 40 CFR part 93 should be applied. States may set forth more stringent requirements (e.g., lower threshold levels), but conformity requirements then must apply to non-Federal as well as Federal entities.

The General Conformity Rule consists of three major parts: applicability, analysis, and procedure. These three parts are discussed below, as well as integration with the *NEPA* (Reference 30) process and relevant references and sources of more detailed conformity information.

5.1 Applicability

For applicable actions, a Federal agency must make a determination that a Federal action conforms to the applicable implementation plan in accordance with the General Conformity Rule before the action is taken. To determine whether conformity requirements apply to an action, the agency must consider the following criteria: the nonattainment and maintenance status of the area; exemptions from and presumptions to conformity; the project's emissions in comparison to threshold levels; and the regional significance of the project's emissions.

Nonattainment and Maintenance Areas. The current conformity rule only applies to nonattainment areas and maintenance areas. The *CAA* establishes air quality standards (the NAAQS) for pollutants, called criteria pollutants. A nonattainment area (NAA) is any geographic area of the United States that is in violation of any NAAQS and, therefore, has been designated as nonattainment under the *CAA*. States are required to develop revised State Implementation Plans (SIPs) for such areas, with adequate control measures to achieve attainment within specified deadlines. A maintenance area (MA) is any geographic area of the United States previously designated nonattainment pursuant to the *CAA Amendments of 1990* and subsequently redesignated to attainment, subject to the requirement to develop a maintenance plan under the *CAA*. Such an area must develop a maintenance plan, which is a revision to the applicable implementation plan, meeting the requirements of the *CAA*. Unclassifiable ("Cannot be classified") areas are not subject to the current conformity rules.

Exemptions and Presumptions. The rule contains exemptions from and presumptions to conformity. Federal actions for which it is necessary to perform a thorough air quality analysis in order to comply with other statutory requirements (e.g., actions subject to the New Source Review program, remedial activities under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)) are considered to conform with the applicable SIP. Federal actions that would result in no emissions increase or a *de minimis* emissions increase are exempt from the conformity process. The rule identifies a list of actions that would result in no emissions increase or an increase in emissions that is clearly *de minimis*. Examples include air traffic control activities and adopting approach, departure, and enroute procedures for air operations; routine installation and operation of aviation and maritime navigational aids; participating in "air shows" and "fly-over" by military aircraft; routine monitoring and /or sampling of air, water, soils, effluent, etc.; continuing and recurring activities such as permit renewals where activities currently being conducted; rulemaking and policy development and issuance; routine movement of mobile assets such as aircraft; routing operation of facilities, mobile assets and requirement; routing maintenance and repair activities; administrative actions; and, land transfers. See Determining Conformity of General Federal Actions to State or Federal Implementation Plans, 58 Fed. Reg. 63214, 63229 (November 30, 1993). However, actions that are exempt or presumed to conform still must evaluate whether the emissions are considered "regionally significant," discussed below.

Threshold Emission Levels. Annual threshold rates of emissions were established in the General Conformity Rule to focus conformity requirements on those Federal actions with the potential to have significant air quality impacts. Threshold levels are established in Title 40 §93.153(b) and vary according to the type of pollutant and the severity of the nonattainment/ maintenance area. The project's emissions (proposed project emissions minus no action emissions) are compared to these threshold levels. Table 3 and Table 4 list the threshold levels applicable to nonattainment areas and maintenance areas, respectively. Conformity emission thresholds refer to the total of direct and indirect emissions, which "means the sum of direct and indirect emissions increases and decreases caused by the Federal action; i.e., the 'net' emissions considering all direct and indirect emissions."

Direct emissions are those caused by or initiated by the Federal action, and that occur at the same time and place as the action. Indirect emissions are those (a) "caused by the Federal action, but may occur later in time and/or may be farther removed in distance from the action itself but are still reasonably foreseeable" and (b) that "the Federal agency can practicably control and will maintain control over due to a continuing program responsibility of the Federal agency."[7] Examples of "controlling" or regulating emissions are through the use of emissions control equipment on a boiler (direct control) or through the implementation of regulations or conditions on the nature of activity that may be established in permits or approvals or by the design of the action (indirect control). A Federal agency controlling the level of vehicle emissions by controlling the size of the parking facility and setting requirements for employee trip reductions is an example of one such situation. Mitigation measures in this scenario may include reducing commuting through ride-sharing, flexible work hours, vanpooling, free transit passes, parking surcharges, or telecommuting. The portion of emissions which are exempt or presumed to conform under Title 40 §93.153 (c), (d), (e), or (f) are not included in the "total of direct and indirect emissions." Temporary emissions (e.g., project construction emissions) also must be included in the emissions calculations for a conformity determination. However, these emissions only have to be accounted for during the construction phase and not over the time frame of the project.

A conformity determination is required when the annual net total of direct and indirect emissions from a Federal action occurring in a nonattainment or maintenance area equals or exceeds the annual threshold levels. If a Federal action's emissions are below threshold levels, then the action does not need a conformity determination and is presumed to conform with the applicable SIP, as long as the action is not regionally significant (described below).

[7] *Caused by* means emissions that would not otherwise occur in the absence of the Federal action. *Reasonably foreseeable* emissions are "projected future indirect emissions that are identified at the time the conformity determination is made; the location of such emissions is known and the emissions are quantifiable." *Control* means the ability to regulate (directly or indirectly) the emissions from the Federal action.

Criteria Pollutant	**Nonattainment Status**	**Tons/Year**
Ozone (VOCs or NO_x)	Serious NAAs	50
	Severe NAAs	25
	Extreme NAAs	10
	Other ozone NAAs outside an ozone transport region (OTR)	100
	Marginal and Moderate NAAs inside an OTR: VOC NO_x	 50 100
CO	All NAAs	100
SO_2	All NAAs	100
NO_2	All NAAs	100
PM-10	Moderate NAAs	100
	Serious NAAs	70
Lead	All NAAs	25

Table 3 : **Threshold Levels For Nonattainment Areas (NAAs) ***

Criteria Pollutant	**Nonattainment Status**	**Tons/Year**
Ozone (VOCs)	MAs inside an ozone transport region (OTR)	50
	MAs outside an OTR	100
Ozone (NO_x)	All MAs	100
CO	All MAs	100
SO_2	All MAs	100
No_x	All MAs	100
PM-10	All MAs	100
Lead	All MAs	25

Table 4 : **Threshold Levels For Maintenance Areas (MAs)**

- Source: General Conformity Rule (40 CFR Part 93, Subpart B), effective January 31, 1994 (Reference 7).

- **Regional Significance.** If a Federal action does not exceed the threshold levels or is presumed to conform, it may still be subject to a general conformity determination. If the total of direct and indirect emissions of any pollutant from a Federal action represent 10 percent or more of a maintenance or non-attainment area's total emissions of that pollutant, the action is considered to be a "regionally significant" activity and conformity rules apply. If an action in a nonattainment area is below the thresholds or presumed to conform and <u>not</u> regionally significant, then the conformity requirements do not apply and no official reporting is required. Parts of the overall Federal action that are exempt from conformity requirements (e.g., emission sources covered by New Source Review) should not be included in the analysis. The purpose of the regionally significant requirement is to capture those Federal actions that fall below threshold levels, but have the potential to impact the air quality of a region. I*t is unlikely that an airport or air base action that is presumed to conform would be regionally significant.*

5.2 Analysis

The general conformity rule requires that each Federal agency taking an action subject to this rule must make its own conformity determination and be able to justify its application of the conformity requirements. When a project involves multiple Federal agencies, a Federal agency has the option of using the conformity analysis of another Federal agency, if the action and the impacts analyzed are the same as those for the project for which a conformity determination is required. The Federal agency must consider comments from any interested parties.

The analysis must be based on the latest planning assumptions derived from population, employment, and travel data acquired from the local metropolitan planning organization (MPO) in the area where the Federal action is planned to occur. The latest and most accurate emission estimation techniques must be applied, unless written approval to employ modifications or substitutions is obtained from the EPA regional administrator. These emissions estimation techniques include motor vehicle emission models used to prepare or revise the SIP, and emission factors for non-motor vehicle sources, databases, and models specified and approved by the EPA. It is recommended that the Federal agency consult with State and local air quality officials early in the conformity decision-making process to determine the appropriate criteria to use. Consultation also will assure that the most up-to-date models, emission factors, and population estimates are being used, as well as identify the MPOs from which to obtain any traffic or demographic data needed for the regional significance analysis.

Additionally, the EPA encourages Federal agencies to notify State and local air quality officials of any project that needs a conformity determination so that it can be specifically included in an attainment demonstration or emissions budget. This is one straightforward method of determining conformity. Other common, straightforward criteria for demonstrating conformity are: (1) determining that the total direct and indirect emissions from the action for the future years do not increase emissions with respect to the baseline emissions if the state does not have an EPA approved revision to the relevant SIP attainment or maintenance demonstration since 1990; and (2) obtaining a state's written commitment to review the SIP in the future to accommodate the emissions from a Federal action. Conditional general conformity determinations are not permitted under the regulations. A combination of criteria may be used to demonstrate conformity (e.g., one criteria may be used to show conformity for ozone and another criteria for other pollutants). If mitigation measures, in combination with emissions offsets, are selected as the conformity criteria option, measures and offsets should result in no net increase in emissions (i.e., it is not enough to offset emissions to the threshold levels). Emission offsets have to occur at the same time as the emission increases for which the offsets are necessary. All offsets must be quantifiable, consistent with the applicable SIP attainment and reasonable further progress (RFP) demonstrations, surplus to reductions required by and credited to other applicable

SIP provisions, enforceable at both the State and Federal levels, and permanent within the time frame specified by the program.

5.3 Procedure

A conformity determination for an action is a Federal responsibility. No documentation or public participation is required if an applicability analysis finds emissions are not reasonably foreseeable, cannot be controlled and maintained by the Federal Agency, or exempt, or are below the threshold and not regionally significant, or presumed to conform and not regionally significant, than no conformity determination or public participation is required. It is advisable to note any *de minimis* finding in the EA or EIS. For actions that require a conformity determination, certain documentation and public participation is required. The Federal agency must provide a 30-day notice of the Federal action and draft conformity determination to the appropriate EPA region and State and local air control agencies. The Federal agency must make public its draft conformity determination by placing a notice by prominent advertisement in a daily newspaper of general circulation in the area affected by the action and by providing 30 days for written public comment prior to taking any formal action on the draft determination. The same requirement also applies to the final conformity determination.

5.3.1 Conformity Steps Summary

The following is a summary of the steps taken when addressing conformity.

- Define the scope of the Federal action to include timing and location,
- Determine if the action is in a nonattainment or maintenance area
- Determine if the action is exempt or presumed to conform
- Determine criteria pollutants of concern based on the attainment status of the Air Quality Control Region,
- Calculate emissions based on the scope,
- Review net emission changes for threshold levels and regional significance, and
- Determine conformity for applicable criteria pollutants.

5.3.2 Conformity and *NEPA*

The conformity process is separate from the *NEPA* process. It is up to each agency to determine the best ways to integrate the conformity and *NEPA* processes. However, the conformity analysis can be completed concurrently with the *NEPA* analysis, and linkage between the two is allowed. This may be an efficient and convenient approach. There are certain requirements for *NEPA* that are not required under conformity. For example, *NEPA* requires the development of reasonable alternative actions, whereas conformity does not (conformity only requires analysis of the proposed alternative). In this case, it may be a more realistic approach to perform a conformity analysis for only the one alternative selected instead of for all alternatives. At a minimum, when the specific alternative is selected in the *NEPA* process, the conformity air quality analyses should be performed as appropriate. A joint notification and public participation process also is possible, as long as the requirements for each regulation are met.

5.4 References/Sources

Additional guidance on EPA's interpretation of the General Conformity Rule and answers to common general conformity questions is provided in EPA's *General Conformity Guidance: Questions and Answers* (Reference 73) and EPA's *New General Conformity Q's & A's* (Reference 77). Guidance also is provided in the Policy and Guidance section of Title I and the *CAAA* bulletin board of the EPA Office of Air Quality Planning and Standards (OAQPS) *Technology Transfer Network (TTN)* bulletin board system (Reference 85). Guidance documents also can be obtained from the appropriate EPA Regional Office.

6. MITIGATION/CONTROL MEASURES

There are various measures that airlines and airports can take to improve the environmental performance of their operations. This section briefly describes several possible emission reduction measures that can be applied to aircraft, GSE, and APU operations. These measures are identified so that they may be factored into an air quality analysis when used by an airline(s) or the airport. Currently, there are some airports and airlines that are implementing these measures not only for emission reductions but for non-environmental benefits like cost reductions. However, each measure has certain constraints that limit its full implementation. This section also describes the factors that should be considered when evaluating and implementing a specific measure.

6.1 Aircraft

This section describes modified operating procedures that can be used to reduce aircraft engine emissions. In general these procedures do not require additional equipment or aircraft modifications. Since these procedures may require changes to an airline's standard operating practices and may not be feasible in all weather conditions or at all airports, they should always be implemented at the discretion of the pilot in command.

6.1.1 Single/Reduced Engine Taxiing

Most aircraft are able to taxi and idle with less than all engines running. Operating less engines during taxi and idle reduces the associated emissions substantially. The engine(s) in use operates at a higher power than it would otherwise, but this is at a somewhat more efficient point on its power curve. The remaining engines must run for about two minutes prior to takeoff power to achieve thermal stability, as well as two minutes prior to shutdown after landing to cool down. Despite the operating time required for thermal stability, most of the taxi and idle time would be with a reduced number of engines operating. Many airlines have employed this measure where feasible since the early 1970s. Because reduced engine taxi and idle is feasible for certain aircraft at most airports from a safety standpoint, it is currently employed extensively for fuel conservation and economic reasons. For those aircraft that are amenable to reduced engine taxi and idle, this measure provides the safety and control needed while still reducing HC and CO emissions.

However, the implementation of reduced engine taxi/idle varies and is not always feasible. The number of engines that can be reduced during reduced engine taxi and idle varies by aircraft type due to the location of the engines, aircraft weight, and aircraft size. For some aircraft reduced engine taxi and idle is not feasible at all due to control and safety concerns. Directional control problems could occur in these aircraft because of the adverse, unbalanced thrust that may be created by using less than all engines. Safety concerns include ground personnel and equipment hazards that may be created when the operating engine(s) is brought to the power level necessary to initiate movement of these aircraft. Other factors such as weather, taxi surface, taxi slope, ramp congestion, and individual airline practices also affect safe reduced engine taxi/idle and require on-the-spot judgment of the pilot in command. Under Federal Aviation Regulations (FAR), the pilot in command of the aircraft is responsible for the safety of the passengers, crew members, cargo, and the airplane. Therefore, any procedure introduced to taxi or idle an aircraft with less than the full complement of engines is at the discretion of the pilot. If back blast endangers persons or property, it is a violation of the FAR for which the pilot would be subject to FAA disciplinary action.

6.1.2 Derate Takeoff Power

Aircraft are designed to have adequate power to takeoff under extreme conditions such as very hot days when they are fully loaded with passengers, cargo, and fuel. When the conditions do not require full power, a derated takeoff procedure can be used to limit the engine thrust to the minimum necessary. By operating the engines at a lower power setting, the NO_x emissions can be reduced.

From a safety standpoint, a derated takeoff is feasible for most aircraft. Reduced power takeoffs currently are being used by most air carriers to enhance engine life and to increase fuel conservation and engine reliability time. A number of large airlines currently rely on the Central Air Data Computer's (CADC's) computations to determine takeoff throttle settings. This computed value depends on various aircraft, runway, meteorological, and regulatory variables. This computed throttle setting is often in the range 0.75 to 0.90, but still well below 1.0 (or 100%). The lower throttle setting limit is often established by the FAA regulatory requirements to ensure an aircraft's minimal climb out angle maintains a safety margin that accounts for engine failure. Thus, takeoff throttle settings almost always exceed climb out values independent of the length of the runway. Certain FAA procedures are already in place to deal with derated takeoffs. FAA Advisory Circular (AC) No. 25-13, *Reduced and Derated Takeoff Thrust (Power) Procedures*, describes the requirements when using reduced power for takeoff. AC No. 91-53a, *Noise Abatement Departure Profiles*, is applicable to operators of large turbojet airplanes. Within the provisions of this AC, each airport can define the departure procedures that best serves their community from a noise impact perspective.

Site-specific factors such as wind, weather conditions, aircraft type, and aircraft weight are critical considerations to plan for when performing a derated takeoff. They influence a pilot's decision as to when a derated takeoff may be safely implemented. In addition, noise abatement procedures and length of the runway at some airports require full power for all takeoffs. If derated takeoff is used, it should remain within the discretion of the pilot in command.

6.1.3 Reduce Use of Reverse Thrust

After aircraft land, they often rely on engine thrust reversal to slow the aircraft to taxi speed. Reverse thrust normally is used to reduce the time on the active runway after landing and to reduce maintenance costs incurred with brake repair and replacement. On long runways, it is possible to eliminate reverse thrust and slow the aircraft using only the wheel brakes. Reverse thrust is a high power operation for engines and a source of NO_x emissions. Eliminating the use of reverse thrust reduces NO_x emissions. In some cases, this may occur at the expense of slightly higher HC emissions if taxi time is increased because a runway turnoff is missed or more time is needed for the landing aircraft to exit the runway. If the time needed for the landing aircraft to exit the runway is increased, it also may increase the taxi/idle time (and emissions) of aircraft awaiting takeoff and landing.

Use of reverse thrust is a matter of safety. It is used at the discretion of the pilot in command of the aircraft. Many factors are involved in the decision to use reverse thrust including runway length and width, runway surface conditions, weather conditions, aircraft type, the pilot's desire for a smooth landing, location of intersections for turning off of the runway, taxi way condition and congestion (i.e., other traffic), and proximity of aircraft following on final approach.

6.2 Auxiliary Power Units

Emissions from APUs can be reduced by turning off the APU while an aircraft is docked at the gate. Turning off the APU reduces fuel combustion. When available at the gate, a 400 Hz ground power system and ventilation air source often provide a reasonable alternative to using an APU to support normal aircraft operations. These fixed systems operate at a greater energy efficiency than an APU and substantially reduce pollutant emissions. In addition, the emissions attributable to the generation of electricity for use by the fixed systems usually are generated at an off-airport electric power plant. The emissions generated at the power plant are lower due to higher efficiency and emission controls. Often the cost of the fuel saved is greater than the cost of electricity. For more information on APU emission reductions, see the FAA and EPA's *Technical Data to Support FAA's Advisory Circular on Reducing Emissions from Commercial Aviation* (Reference 52) or visit the EPA's Office of Mobile Sources (OMS) On-line Bulletin Board System (Reference 75).

6.3 Ground Support Equipment

GSE commonly are fueled by gasoline or diesel, termed conventional fuels. Replacing conventional fueled GSE with GSE that operate on other fuels is the most effective way to reduce GSE emissions. Alternatives to gasoline and diesel include compressed natural gas (CNG), liquefied natural gas (LNG), liquefied petroleum gas (LPG - commonly propane), and electricity. Many different types of GSE are commercially available that operate on alternative fuels or electricity. From an emissions perspective, equipment originally designed to use these fuels give much better environmental performance than equipment that is converted from using a conventional fuel to use an alternative fuel or electricity. Benefits of changing from a conventional fuel to an alternative fuel or electricity can be evaluated by comparing the emission factors of two engines of the same size that use different fuels. With electric equipment there are no emissions from the equipment itself, although some emissions are released by the power plant that generates the electricity. Power plant emissions generally are small and often are emitted outside of the local area. Electric GSE have the lowest amount of emissions attributed to them (in comparison with conventional fueled, CNG, LNG, and LPG GSE). Therefore, replacing conventional fueled GSE with electric GSE results in the greatest emission reduction. For more information on GSE emission reductions see the FAA and EPA's *Technical Data to Support FAA's Advisory Circular on Reducing Emissions from Commercial Aviation*.

7. REFERENCES

This section provides a list of documents, models, and sources referenced in the handbook. The reference list also identifies how to obtain or contact the reference (e.g., a publication number). Following the reference list is an annotated reference list, which includes a brief summary of each reference.

7.1.1 Reference List

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7.1.2 Annotated Reference List

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An EPA preferred air quality model for general stack sources in complex terrain and applicable to all stability conditions.

11. Council on Environmental Quality, 722 Jackson Place NW, Washington, DC 20006; (202) 395-5750.

A national environmental council established by the National Environmental Policy Act of 1969 (NEPA). Duties of the council include assisting and advising the President in the preparation of the Environmental Quality Report required by *NEPA*, analyzing the quality of the environment with regard to the achievement of the policy set forth in the *NEPA*, reviewing and appraising the programs and activities of the Federal Government in light of policy set forth in *NEPA*, and conducting investigations, studies, surveys, research, and analyses relating to environmental quality.

12. Defense Technical Information Center (DTIC). Cameron Station, Building 5, Alexandria, Virginia 22304-6145, (703) 274-6886.

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Orders all Federal agencies to “initiate measures needed to direct their policies, plans, and programs so as to meet national environmental goals.”

18. Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.

Requires each Federal agency to weigh high disproportionate adverse effects of its programs, policies, and activities on the human health or environment of minority and low-income populations.

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In this letter, Mr. Garska provided emission factors for ethylene glycol emissions from both aircraft and runway deicing, and the assumptions behind the calculation of those factors.

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An EPA preferred air quality model for estimating concentrations of relatively stable pollutants from point and area sources in a rural or urban setting.

21. Green, W., J. Mowinski, and G. Swanborough, 1987. *Modern Commercial Aircraft*.

An illustrated directory of the world’s civil airliners currently in service and under development.

22. Industrial Source Complex Model (ISC3), NTIS Computer Product or available on EPA’s *Support Center for Regulatory Air Models (SCRAM) Bulletin Board System*, a component of EPA’s *Technology Transfer Network (TTN)*.

An EPA preferred air quality model for assessing pollutant concentrations from a wide variety of sources associated with an industrial source complex.

23. Jagielski, Kurt D., and Robert J. O’Brien, July 1994. *Calculation Methods for Criteria Air Pollutant Emission Inventories*, USAF Occupational and Environmental Health Directorate, Air Force Material Command, Brooks AFB, Texas, July 1994.

An Air Force guidance manual for the development of criteria air pollutant emission inventories of an installation’s mobile, area, and stationary point sources.

24. Jet Information Services, Inc., Annual Publication. *World Jet Inventory*, 18711 198th Avenue N.E., Woodinville, Washington 98072-8840, (206) 844-9140.

A summary of the commercial jet airplane fleet. Information is supplied for airlines, private operators, government agencies, manufacturers, and leasing companies. Data is provided on the fleet (e.g., operator or owner, manufacturer, airplane model-series, world region), airplane orders and deliveries, fleet history, fleet totals, and age distribution.

25. Joynt, D., Symtron, Inc. Letter to P. Forward, EEA, Inc., dated February 12, 1996.

Source of propane VOC and PM emission factors for uncontrolled fuel burning in training fires. Emission factors for propane firefighter training facilities given in this letter were based on Robert S. Levine, “Soot and Minor Constituent Emissions from Propane Firefield Runs of 24 Nov. 1992,” memorandum to C. Lenhoff and D. King, AAI Corporation, National Institute of Standards and Technology, Dec. 9, 1992.

26. Levine, Robert S., National Institute of Standards and Technology. Memorandum to C. Lenhoff and D. King, AAI Corporation dated Dec. 9, 1992. Subject: *Soot and Minor Constituent Emissions from Propane Firefield Runs of 24 Nov. 1992*

27. Lister, D. H. and R. J. Murrell, Defence Research Agency, United Kingdom. *ICAO Engine Exhaust Emissions Databank, First Edition, Draft - December 1993*, prepared for the International Civil Aviation Organization (ICAO).

A database of exhaust emissions of engines intended for subsonic and supersonic propulsion applications, for which information is available. An example of a detailed engine data sheet is provided in Attachment 2.

28. McGraw-Hill Publication, Annual Mid-March Aerospace Forecast Issue. “Aviation Week & Space Technology.”

The annual issue provides specifications on U.S. and international aircraft and engines such as U.S. commercial passenger transports, U.S. general aviation aircraft, U.S. gas turbine engines, U.S. reciprocating engines, international aircraft, and multinational gas turbines. Attachment 3 provides an example page from the U.S. commercial passenger transport specifications.

29. National Climatic Data Center (NCDC), 151 Patton Avenue, Asheville, NC 28801-5001, (704) 259-0682. Branch of the National Oceanic and Atmospheric Administration (NOAA).

NCDC is a source for climatic information recorded at most airports and other weather stations. Dispersion models and some emissions inventory models (such as WIND) accept as input climatic information stored electronically in NCDC format or in some cases, published NCDC data that must be manually entered into the program. For dispersion models, NCDC provides diskettes containing surface weather measurements (NCDC format #1440) and mixing height (NCDC format #9689) that are used in electronic format by the models. A possible alternative to the NCDC is the National Meteorological Center, (301) 763-8298.

30. *National Environmental Policy Act of 1969 (NEPA)*, as amended, 42 USC 4321-4347 (Public Law 91-190).

NEPA establishes a broad national policy to protect the quality of the human environment. The act provides polices and goals to ensure that environmental considerations are given careful attention and appropriate weight in all decisions of the Federal Government. *NEPA* was enacted to ensure that environmental impacts and associated public concerns are considered in decisions on major Federal action. An act also provides for the establishment of the Council on Environmental Quality.

31. National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, Virginia 22161, (703) 487-4650, URL http://www.fedworld.gov/ntis/ntishome.html.

NTIS is a source for U.S. and foreign government-sponsored research and development results, business information, and engineering solutions.

32. Office of Combustion Technology, GE Aircraft Engines, One Neumann Way MD A309, Cincinnati, Ohio 45215-6301, (513) 774-4438.

33. Office of Certification & Airworthiness, Commercial Engine Business, United Technologies Pratt & Whitney, 400 Main Street, East Hartford, Connecticut 06108, (203) 565-2269.

34. Offshore and Coastal Dispersion Model (OCD), available on the Support Center for Regulatory Air Models (SCRAM) Bulletin Board System, a component of EPA's Technology Transfer Network (TTN).

    OCD determines the impact of offshore emissions from point, area, or line sources on the air quality of coastal regions. The model incorporates overwater plume transport and dispersion as well as changes that occur as the plume crosses the shoreline.

35. Perry, Steven G. et al., October 1990. User's Guide to CTDMPLUS: Volume 2. The Screening Mode (CTSCREEN), EPA/600/8-90/087, available on EPA's Support Center for Regulatory Air Models (SCRAM) Bulletin Board System, a component of EPA's Technology Transfer Network (TTN).

    The user's guide to the screening mode of the CTDMPLUS.

36. Section 4(f) of the Department of Transportation Act of 1966 (49 U.S.C. 303).

    The Secretary shall not approve any program or project which requires the use of any publicly owned land from a public park, recreation area, or wildlife and waterfowl refuge of national, State, or local significance as determined by the Federal, State, or local officials having jurisdiction therof, of any land from a historic site of national, State, or local significance as so determined by such official unless:

    1. there is no feasible and prudent alternative to the use of such land, and
    2. such program includes all possible planning to minimize harm to such park, recreational are, wildlife, and waterfowl refuge, or historic site resulting from such use.

    49 U.S.C. Section 303. Any part of a publicly owned park, recreation are, refuge, or historic site is presumed to be significant unless a statement of insignificance relative to the whole park or site has been issued by the Federal, state, or local official having jurisdiction therof. If there is no physical taking but there is the possibility of constructive use of section 4 (f) land, then the FAA should determine if the activity associated with the proposal would substantially interfere with or is compatible with the normal activity associated with this land. The proposed action would be compatible if it would not affect the normal activity or aesthetic value of a public park, recreational are, refuge or historic site. When so construed, the action would not constitute use and would not, therefore, invoke section 4 (f). See FAA Order 5050.4A, page 36-37.

    "Use" of land for purposes of section 4 (f) is to be construed broadly; it is not limited to the concept to a physical taking, but includes areas that are significantly and adversely affected by a project. See Department of Transportation Order No. 5610.1A, Para. 9 (c) (1), 36 Fed. Reg. 23681 (1971). Activities not located directly on a public park, recreation area, wildlife or waterfowl refuge, or a historic site are also governed by Section 4 (f) if they could d create sufficiently serious impacts that would substantially impair the value of the 4 (f) site in terms of it's prior significance and enjoyment. This can be considered constructive use. See 34 C.F.R. Section 771.135 of the Federal Highway Administration Regulation for guidance.

37. Taylor, Michael, 1990. *Commercial Transport Aircraft*.

Provides specifications and technical data for commercial transport aircraft.

38. Taylor, Michael, 1987. Encyclopedia of Modern Military Aircraft.

An illustrated encyclopedia of military aircraft currently in service. Information provided includes aircraft history, special features, performance data, and versions of each aircraft type.

39. Tennis, Michael W., July 1992. *Impact of Battery-Powered Electric Vehicles on Air Quality in the Northeast States*. Prepared for Northeast States for Coordinated Air Use Management (NESCAUM).

40. Turner, D. Bruce, U.S. Environmental Protection Agency, October 1981. “Workbook of Atmospheric Dispersion Estimates,” *APTI Course 423: Dispersion of Air Pollution - Theory and Model Application, Selected Readings Packet*, EPA 450/2-81-011.

41. U.S. Air Force. Air Force Instruction 32-7061: *The Environmental Impact Analysis Process*.

This instruction, formerly Air Force Regulation (AFR) 19-2, implements AFPD 32-70 and describes specific tasks and procedures for the EIAP both within the United States and abroad. This instruction also identifies directives and instructions with further environmental requirements.

42. U.S. Air Force. Air Force Policy Directive 32-70: *Environmental Quality*.

This directive establishes the Air Force’s policy in achieving and maintaining environmental quality and compliance with *NEPA* and Executive Order 12114. It addresses development and implementation of an Air Force Environmental Quality Program, establishes environmental authorities and responsibilities, and lists directives and laws implemented by this policy.

43. U.S. Air Force. Environmental Impact Analysis Process: Desk Reference.

A guide prepared to assist Air Force staff in complying with the requirements of the NEPA, provides helpful reference materials that discuss these requirements in more detail; sample documents are provided in attachments. Appropriate use of the reference helps to ensure that the environmental effects of proposed actions are considered in accordance with applicable requirements.

44. U.S. Air Force, 1995. *The Engine Handbook*, San Antonio Air Logistics Center, Kelly AFB, Texas.

This handbook is a reference of current Air Force engines. Engine covered include gas turbine engines (both aeronautical and ground based), reciprocating engines, and auxiliary power units. Engine data provided includes aircraft and engine combinations and number of engines per aircraft.

45. U.S. Department of Defense. DOD Directive 6050.1: *Environmental Effects in the United States of DOD Actions*.

This directive implements the CEQ regulations discussed above and provides the policy and procedures for including environmental considerations in the decision-making process on DOD actions within the United States. The directive includes policy, responsibilities, how to determine if an Environmental Assessment (EA) or Environmental Impact Statement (EIS) is needed, EA content and format, and categorical exclusions.

46. U.S. Department of Defense, July 1993. *DOD Federal Implementation Plan Database Report*, AESO Report Number 07-93, Aircraft Environmental Support Office, San Diego, California.

Aircraft flying, ground, and generation equipment operational information collected on DOD installations to aid the U.S. EPA with their preparation of a Federal Implementation Plan (FIP) for the three southern California air districts that are in severe nonattainment status.

47. U.S. Department of Defense, July 1993. *DOD Federal Implementation Plan Emissions Report: Draft*, AESO Report Number 08-93, Aircraft Environmental Support Office, San Diego, California.

Emissions data for aircraft flying, ground, and generation equipment information collected on DOD installations to aid the U.S. EPA with their preparation of a Federal Implementation Plan (FIP) for the three southern California air districts that are in severe nonattainment status. This report supplements the *DOD Federal Implementation Plan Database Report*.

48. U.S. Department of Defense, 1993. Mobile Source Data for Military Activities in the Federal Implementation Plan (FIP) Areas: Draft.

Mobile source data collected on DOD installations to aid the U.S. EPA with their preparation of a Federal Implementation Plan (FIP) for the three southern California air districts that are in severe nonattainment status.

49. U.S. Department of Transportation, 1988. *A Microcomputer Pollution Model for Civilian Airports and Air Force Bases—Model Application and Background*, FAA Report No. FAA-EE-88-5 or USAF Report No. ESL-TR-88-55 available from NTIS or DTIC, Federal Aviation Administration, funded jointly with the United States Air Force Engineering and Services Center, Tyndall Air Force Base, Florida.

50. U.S. Department of Transportation, August 1988. *A Microcomputer Pollution Model for Civilian Airports and Air Force Bases—Model Description*, FAA Report No. FAA-EE-88-4, USAF Report No. ESL-TR-88-53, NTIS Report No. AD-A199003, Federal Aviation Administration, funded jointly with the United States Air Force Engineering and Services Center, Tyndall Air Force Base, Florida.

This report provides the technical description of the model. It identifies the key design features and describes the type of meteorological information the dispersion portion of the model can accept. The report also presents the results of running EDMS on a number of different microcomputers and compares EDMS results with those of comparable models. The appendices elaborate on the above information and list the source code. This report can be obtained either from the National Technical Information Service (NTIS) or from the Defense Technical Information Center (DTIC).

51. U.S. Department of Transportation, June 1993. *A Microcomputer Pollution Model for Civilian Airports and Air Force Bases—User's Guide* (includes Supplement "A"), FAA Report No. FAA-EE-91-3, USAF Report No. ESL-TR-91-31, Federal Aviation Administration, funded jointly with the United States Air Force Engineering and Services Center, Tyndall Air Force Base, Florida.

This is the final version of the EDMS User's Guide. It contains special instruction for performing air quality assessments at airports and air bases. The report also provides a 94-step example problem to familiarize the user with the model. This report can be obtained either from the National Technical Information Service (NTIS) or from the Defense Technical Information Center (DTIC).

52. U.S. Department of Transportation and U.S. Environmental Protection Agency, 1996. *Technical Data to Support FAA's Advisory Circular on Reducing Emissions from Commercial Aviation*, Federal Aviation Administration (See Reference 70).

An advisory circular to encourage continuing progress in reducing emissions in the commercial aviation sector. The document includes technical data needed to evaluate the reduction of emissions.

53. U.S. Department of Transportation, Annual Report. *Airport Activity Statistics of Certificated Route Air Carriers*, NTIS Publication, Federal Aviation Administration and Research and Special Programs Administration.

The report provides data compiled from information reported to the DOT by large certificated route air carriers. The report includes a list of aircraft departures by airport, air carrier, and aircraft type in Table 7. Attachment 4 provides an example page from Table 7.

54. U.S. Department of Transportation. *Airport Master Record*, FAA Form 5010-1, Federal Aviation Administration.

The agency's record of the landing facility indicated. General, runway, lighting/approach aid, obstruction, landing length, services, facility, based aircraft, and operations data are included on the form. Attachment 5 contains an *Airport Master Record* for Ontario International Airport in California, as an example.

55. U.S. Department of Transportation. DOT Order 5610.1C: *Procedures for Considering Environmental Impacts*, Federal Aviation Administration, available from the DOT Warehouse.

This order provides FAA policies and procedures for implementing *NEPA*, DOT Order 5610.1C, and other environment-related statutes, directives, and orders. The order clarifies the *NEPA* process in terms of planning, procedures, content and format, and public participation. It provides an overview of the various *NEPA* assessment documents, including Categorical Exclusions (CEs), Environmental Assessments (EAs), Findings of No Significant Impact (FONSIs), Environmental Impact Statements (EISs), and Records of Decision (RODs), as well as *NEPA* processing requirements.

56. U.S. Department of Transportation. DOT Warehouse, 3341-Q 75th Avenue, Landover, MD 20785; (301) 322-4961.

A source of DOT documents, such as DOT orders.

57. U.S. Department of Transportation. *Emissions and Dispersion Model System (EDMS)*, Federal Aviation Administration (FAA), available from FAA Office of Environment and Energy.

EDMS is a complex source emissions and dispersion model for use at civilian airports and Air Force air bases. The model operates in both a refined and a screening mode. Attachment 6 contains an example emissions outputs.

58. U.S. Department of Transportation, October 1993. *Emissions Model for Ground Support Equipment: User's Guide*, FAA Report No. FAA-EE-93-2, USAF Report No. AL/EQ/1-993/0025, Federal Aviation Administration, sponsored jointly with the United States Air Force Armstrong Laboratory, Tyndall Air Force Base, Florida.

This report describes how to change ground support equipment (GSE) input parameters of the Emissions and Dispersion Model System (EDMS). EDMS is an air quality impact assessment tool for airports and air bases. The GSE extension of EDMS adds the capability to estimate, inventory, and report emissions from diesel and gas-powered GSE. This user's guide provides a brief overview of GSE hardware and operations. It also demonstrates how to use GSE options by guiding the user through a sample problem.

59. U.S. Department of Transportation, Annual Report. *FAA Air Traffic Activity*, NTIS Report, Federal Aviation Administration, Office of Aviation Policy, Plans, and Management Analysis.

    This publication provides terminal and en route air traffic activity data of the National Airspace System. An example page from one report table on airport operations is provided in Attachment 7.

60. U.S. Department of Transportation. *FAA Aircraft Engine Emissions Database (FAEED)*, Office of Environment and Energy, Federal Aviation Administration, available on EPA's *Office of Mobile Sources (OMS) Bulletin Board System*, a component of EPA's *Technology Transfer Network (TTN)*.

    FAEED is an automated (computerized) menu-driven procedure for calculating an aircraft emissions inventory.

61. U.S. Department of Transportation. *FAA Aircraft Engine Emissions Database: Users Guide*, Office of Environment and Energy, Federal Aviation Administration, available on EPA's *Office of Mobile Sources (OMS) Bulletin Board System*, a component of EPA's *Technology Transfer Network (TTN)*.

    The user's guide for the *FAA Aircraft Engine Emissions Database (FAEED)*. The user's guide provides an overview of the model structure, inputs, and outputs.

62. U.S. Department of Transportation. FAA Order 1050.1: *Policies and Procedures for Considering Environmental Impacts*, Federal Aviation Administration, available from the DOT Warehouse.

    This order provides Federal Aviation Administration policies and procedures for implementing the National Environmental Policy Act, Order Department of Transportation 5610.1C, Procedures for considering Environmental Impacts, and other environmental related statutes, directives, and orders.

63. U.S. Department of Transportation, October 8, 1985. FAA Order 5050.4: *Airport Environmental Handbook*, Federal Aviation Administration, available from the DOT Warehouse.

    Although dated, this 1985 order is recommended for airport personnel, sponsors, and others involved in airport actions when considering environmental impacts, because it contains detailed guidance on preparing the technical assessment of individual environmental impacts (including air quality). Compliance with the order constitutes compliance with DOT Order 1050.1 for airport actions.

64. U.S. Department of Transportation. Form 41, Schedule T-3 - Airport Activity Statistics, Federal Aviation Administration, data tape is available from the DOT/Volpe National Transportation Systems Center, 55 Broadway, Kendall Square, Cambridge, MA 02142.

The data tape provides data reported to the DOT on Form 41, Schedule T-3 by large certificated route air carriers. Data includes aircraft departures by airport, air carrier, and aircraft type. This data also is provided in Table 7 of the DOT *Airport Activity Statistics of Certificated Route Air Carriers* report.

65. U.S. Department of Transportation, Annual Report. *General Aviation Activity and Avionics Survey*, Federal Aviation Administration, Office of Management Systems.

    This report presents the results of the annual General Aviation Activity and Avionics Survey. The report contains activity and avionics information of U.S. registered general aviation aircraft, such as active aircraft, annual flight hours, and average flight hours.

66. U.S. Department of Transportation. Office of Aviation Policy, Plans, and Management Analysis, Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591.

67. U.S. Department of Transportation. Office of Environment and Energy, Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591.

68. U.S. Department of Transportation, Annual Report. *Terminal Area Forecasts*, FAA Publication, Federal Aviation Administration, Office of Aviation Policy, Plans, and Management Analysis.

    This report presents historical and forecast data for over 800 public use airports. For each airport, detailed historical and forecast data are provided by operator type: air carrier, air taxi/commuter, general aviation, and military.

69. U.S. Environmental Protection Agency. *Air Emissions Species Manual*, EPA Report No. EPA-450/2-90-001a.

70. U.S. Environmental Protection Agency. *Clearinghouse for Information on Emission Factors Bulletin Board System (CHIEF BBS)*, Office of Air Quality Planning and Standards, a component of EPA's *Technology Transfer Network (TTN)*. To access the *CHIEF BBS* through the *TTN* bulletin board system with a modem dial (919) 541-5742. Set communications to XModem, 8 Bit System, NO Parity, and 1 Stop Bit. Research Triangle Park, North Carolina.

    The *CHIEF BBS* provides information on air pollutant emission factors, including the latest version of the *Compilation of Air Pollutant Emission Factors,* EPA Report AP-42. Emissions Inventory Models such as *TANKS* and *WIND* are also available for downloading.

71. U.S. Environmental Protection Agency. *Compilation of Air Pollutant Emission Factors*, EPA Report No. AP-42.

    Provides air pollutant emission factors, related emission calculation input data, and emission calculation procedures for emission sources. Stationary point and area sources are addressed in Volume I. Mobile sources are covered in Volume II.

72. U.S. Environmental Protection Agency, February 1995. *Draft User's Guide to PART5: A Program for Calculating Particle Emissions from Motor Vehicles*, EPA Publication No. EPA-AA-AQAB-94-2, National Motor Vehicle and Fuels Emission Laboratory, Office of Mobile Sources.

    The user's guide provides an overview of the PART5 model structure, inputs, outputs. The guide also provides example data.

73. U.S. Environmental Protection Agency, July 13, 1994. *General Conformity Guidance: Questions and Answers*, Office of Air Quality Planning and Standards.

This question and answer guidance document contains issues raised at the general conformity workshop held in Virginia on March 7-8, 1994. The document addresses frequently asked general conformity questions.

74. U.S. Environmental Protection Agency, January 1972. *Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States*, NTIS Report Number PB-207103, Research Triangle Park, North Carolina.

    Source of typical mixing height data.

75. U.S. Environmental Protection Agency, July 30, 1993. MOBILE5 Information Sheet #2: *Estimating Idle Emission Factors Using MOBILE5*, available on EPA's *Office of Mobile Sources (OMS) Bulletin Board System*, a component of EPA's *Technology Transfer Network (TTN)*.

    MOBILE5 Information Sheets are a series of documents intended to give users detailed information about techniques that can be used to more accurately model highway mobile sources emission and avoid potential errors. The information sheet describes the difficulty in calculating idle emissions and provides a remedy using MOBILE5.

76. U.S. Environmental Protection Agency. MOBILE5a, NTIS Computer Product No. PB95-500179 (IBM PC) or PB95-500187 (Macintosh), or available on EPA's *Office of Mobile Sources (OMS) Bulletin Board System*, a component of EPA's *Technology Transfer Network (TTN)*.

    The motor vehicle emissions model specified by EPA to be used to develop highway vehicle emission factors and emission inventories is MOBILE. At the time of this writing (1996), MOBILE5a is the most current version of the MOBILE motor vehicle emissions model.

77. U.S. Environmental Protection Agency, October 19 1994. *New General Conformity Q's & A's*, Office of Air Quality Planning and Standards.

    This question and answer document addresses additional general conformity questions not included in the EPA *General Conformity Guidance: Questions and Answers* document.

78. U.S. Environmental Protection Agency, November 1991. *Non-road Engine and Vehicle Emissions Study*, Certification Division, Ann Arbor, Michigan.

79. U.S. Environmental Protection Agency. *Office of Mobile Sources Bulletin Board System (OMS BBS)*, a component of EPA's *Technology Transfer Network (TTN)*. To access the *OMS BBS* through the *TTN* bulletin board system with a modem dial (919) 541-5742. Set communications to XModem, 8 Bit System, NO Parity, and 1 Stop Bit. Research Triangle Park, North Carolina.

    The *OMS BBS* provides information pertaining to mobile source emissions, including regulations, test results, models, and guidance.

80. U.S. Environmental Protection Agency. PART5, available on EPA's *Office of Mobile Sources (OMS) Bulletin Board System*, a component of the EPA *Technology Transfer Network (TTN)*.

    A model for use in the analysis of the particulate air pollution impact of in-use gasoline-fueled and diesel-fueled motor vehicles.

81. U.S. Environmental Protection Agency, 1992. *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 3: Emissions from Highway Vehicles.

Describes the procedures for calculating emissions from highway vehicles.

82. U.S. Environmental Protection Agency, 1992. *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 5: Emissions from Aircraft.

Describes the procedures for calculating emissions from civilian and military aircraft within an inventory area.

83. U.S. Environmental Protection Agency. *Support Center for Regulatory Air Models Bulletin Board System (SCRAM BBS)*, Office of Air Quality Planning and Standards, a component of the EPA *Technology Transfer Network (TTN)*. To access the *SCRAM BBS* through the *TTN* bulletin board system with a modem dial (919) 541-5742. Set communications to XModem, 8 Bit System, NO Parity, and 1 Stop Bit. Research Triangle Park, North Carolina.

The *SCRAM BBS* provides regulatory air quality model computer code, meteorological data, documentation, as well as modeling guidance.

84. U.S. Environmental Protection Agency. TANKS, available on EPA's Clearinghouse for Information on Emission Factors Bulletin Board System (CHIEF BBS), a component of EPA's Technology Transfer Network (TTN).

A computerized procedure for calculating the sum of hydrocarbon emissions from above-ground and below-ground fuel storage tanks.

85. U.S. Environmental Protection Agency. *Technology Transfer Network (TTN)*, Office of Air Quality Planning and Standards. To access the *TTN* bulletin board system with a modem dial (919) 541-5742. Set communications to XModem, 8 Bit System, NO Parity, and 1 Stop Bit. Research Triangle Park, North Carolina.

The *TTN* is a network of electronic bulletin boards that provides information and technology exchange in different areas of air pollution control, ranging from emission test methods to regulatory air pollution models. The service is free, except for the cost of using the phone.

86. U.S. Environmental Protection Agency, 1992. User's Guide for CAL3QHC Version 2: A Modeling Methodology for Predicting Pollutant Concentrations near Roadway Intersections, EPA Publication No. EPA-454/R-92-006, Research Triangle Park, NC.

The user's guide for the CAL3QHC model used to predict pollutant concentrations near roadway intersections.

87. U.S. Environmental Protection Agency, 1990. *User's Guide for the Urban Airshed Model, Volumes I-VII*; EPA Publication Nos. EPA-454/B-90-007a-c, d®, and EPA-454/B93-004e-g; NTIS Publication Nos. PB 91-131227, PB 91-131235, PB 91-131243, PB 93-122380, PB 91-131268, PB 92-145382, and PB224849; Research Triangle Park, NC.

The user's guide for the Urban Airshed Model (UAM), which is the EPA preferred air quality model for photochemical or reactive pollutant modeling applications involving entire urban areas.

88. U.S. Environmental Protection Agency, March 1993. *User's Guide to MOBILE5a: Mobile Source Emissions Model*, NTIS Report No. PB95-100509.

The user's guide for the MOBILE5a model, which calculates motor vehicle emission factors.

89. Urban Airshed Model (UAM), NTIS Computer Product or available on EPA's Support Center for Regulatory Air Models (SCRAM) Bulletin Board System, a component of EPA's Technology Transfer Network (TTN).

An EPA preferred air quality model for photochemical or reactive pollutant modeling applications involving entire urban areas.

90. Webb, Sandy, Energy and Environmental Analysis, Inc., (703) 528-1900, June 10, 1991. Memorandum to Rich Wilcox, EPA/Office of Mobile Sources. Subject: *General Aviation Generalized Emission Indexes*.

This memorandum discusses the derivation of generalized exhaust emissions factors for general aviation and air taxi aircraft.

91. WIND, available on EPA's Clearinghouse for Information on Emission Factors Bulletin Board System (CHIEF BBS), a component of EPA's Technology Transfer Network (TTN).

An EPA computer program that estimates the wind erosion emissions from material piles.

92. Weast, Robert C. (ed.), 1982. *CRC Handbook of Chemistry and Physics, 63rd Edition*, CRC Press, Boca Raton.

General reference book for chemical and physical data.

93. Executive Order 11593: Protection and Enhancement of Cultural Environment, May 13, 1971.

Requires Federal agencies to provide leadership in preserving, restoring and maintaining the historic and cultural environment of the Nation.

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Appendix A: Air Quality Environmental Documents

Appendix A: Air Quality Environmental Documents

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Appendix A. Air Quality Environmental Documents

A1. REQUIRED DOCUMENTS

There are various environmental documents required for implementation of the *National Environmental Policy Act of 1969*, as amended, *(NEPA)* (Reference 30) that may contain air quality information and analysis. The primary types of air quality environmental documents are Environmental Assessments, Findings Of No Significant Impact, Environmental Impact Statements, Records Of Decision, Air Force Forms, and Conformity Determinations. The following briefly describes each type of environmental document and identifies sources of more detailed document information. As indicated in the following document descriptions, some of the documents only apply to USAF actions. The remaining documents apply to both the FAA and USAF.

A1.1 Air Force (AF) Form 813: Preliminary Environmental Impact Analysis

AF Form 813 is the first document prepared for USAF actions. The form is prepared to aid in the development of the assessment, providing information on the proposed action and its alternatives, purpose, and potential environmental effects. The current AF Form 813 consolidates former AF Forms 813 and 814. Certain sections of the document are prepared by the proponent and the Environmental Planning Function. A copy of AF Form 813 is provided in Attachment A-1.

A1.2 Environmental Assessment (EA)

An EA is an environmental document that may be prepared for a Federal agency action. It is a concise document with the purpose of:

1) Briefly providing sufficient evidence and analysis for determining whether to prepare an environmental impact statement or finding of no significant impact;
2) Aiding an agency’s compliance with *NEPA* when no environmental impact statement is necessary, identifying better alternatives and mitigation measures; and
3) Facilitating preparation of an environmental impact statement when one is necessary.

If from initial review the proposed action can not be classified as a categorical exclusion or a decision has not been made to directly prepare an Environmental Impact Statement (EIS), an EA is prepared. If it is concluded that the action will have no significant impacts on the environment, the Federal agency prepares a Finding Of No Significant Impact (FONSI). Conversely, if the action is determined to have significant impacts on the environment, the Federal agency prepares an Environmental Impact Statement. In addition, some agencies may expressly provide page guidelines. A detailed description of the EA process and content are provided in FAA Order 1050.1: *Policies and Procedures for Considering Environmental Impacts* (Reference 62) and 5050.4: *Airport Environmental Handbook* (Reference 63) and in USAF Instruction 32-7061: *The Environmental Impact Analysis Process (EIAP)* (Reference 41) and the *Environmental Impact Analysis Process (EIAP): Desk Reference* (Reference 43) for air base actions.

A1.3 Finding Of No Significant Impact (FONSI)

A FONSI is a document prepared for a Federal agency action that will not have a significant effect on the environment. In the document, the Federal agency briefly explains the reasons why an action will not have a significant effect on the environment and, therefore, preparation of an Environmental Impact Statement is not required. In addition to this statement, the FONSI must include, summarize, or attach and incorporate by reference the Environmental Assessment. A detailed description of the FONSI content is provided in FAA Order 1050.1 and 5050.4, and in USAF Instruction 32-7061 and the *EIAP: Desk Reference* for air bases.

A1.4 Environmental Impact Statement (EIS)

An EIS is a detailed document required of all Federal actions likely to have significant effects on the environment. If the action will have significant environmental impacts, a Federal agency may decide to directly prepare an EIS for an action (without first preparing an Environmental Assessment). A detailed discussion of the EIS content and process are contained in FAA Order 1050.1 and 5050.4, and in USAF Instruction 32-7061 and the *EIAP: Desk Reference* for air bases.

A1.5 Record Of Decision (ROD)

A ROD is a concise public document that a Federal agency is required to prepare, stating the final decision on a proposed major Federal action and the alternatives considered by the Federal agency. A ROD can be used to set forth the conditions required for the approval of the action and to state mitigation measures. A ROD is a separate document that must be made available to the public through appropriate public notice following the completion of the Environmental Impact Statement. An overview of the ROD process is provided in FAA Order 1050.1 and 5050.4, and the USAF Instruction 32-7061 and the *EIAP: Desk Reference* for air bases.

A1.6 Conformity Determination

Federal Aviation Administration and Air Force actions fall mostly under the General Conformity Rule (Reference 7). A conformity determination states if and how an action conforms to the applicable State Implementation Plan (SIP). Conformity to a SIP is defined as demonstrating consistency with the SIP's "purpose of eliminating or reducing the severity and number of violations of the national ambient air quality standards and achieving expeditious attainment of such standards."

A 30-day notice that describes the proposed action and the Federal agency's draft Conformity Determination on the action must be provided to required recipients and placed by prominent advertisement in a daily newspaper of general circulation in the areas affected by the action. The agency also must provide 30 days for written public comment prior to taking any formal actions on the draft determination. This comment period may be concurrent with any other public involvement, such as that which occurs in the *NEPA* process.

A notice of the final Conformity Determination must be provided to the required recipients and placed by prominent advertisement in a daily newspaper of circulation in the areas affected by the action within 30 days of the final Conformity Determination

The Conformity Determination may be included in the Environmental Impact Statement for an action. However, the determination must be issued prior to issuance of an agency FONSI or Record of Decision.

Attachment A-1

REQUEST FOR ENVIRONMENTAL IMPACT ANALYSIS		*Request Control Symbol* *RCS:*
INSTRUCTIONS: *Section I to be completed by Proponent: Section II and III to be completed by Environmental Planning Function. Continue on separate sheets as necessary. Reference appropriate item number (s).*		
SECTION I - PROPONENT INFORMATION		
1. TO (Environmental Planning Function)	2. FROM (*Proponent organization and functional address symbol)*	2a. Telephone No.
3. TITLE OF PROPOSED ACTION		
4. PURPOSE AND NEED FOR ACTION (*Identify decision to be made and need date)*		
5. DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVE (*DOPAA) (Provide sufficient detail for evaluation of the total action.)*		
6. PROPONENT APPROVAL (*Name and Grade)*	6a. SIGNATURE	6b. DATE

SECTION II - PRELIMINARY ENVIRONMENTAL SURVEY. (*Check appropriate box and describe potential environmental effects including cumulative effects.) (+ = positive effect: O = no effect: - = negative effect: U = unknown effect)*	+	O	-	U
7. AIR INSTALLATION COMPATIBLE USE ZONE/LAND (Noise, accident potential, encroachment, etc.)				
8. AIR QUALITY (Emissions, attainment status, state implementation plan, etc.)				
9. WATER RESOURCES (Quality, quantity, source, etc.)				
10. SAFETY AND OCCUPATIONAL HEALTH (Asbestos/radiation/chemical exposure, explosives safety quantity-distance, etc.)				
11. HAZARDOUS MATERIALS/WASTE (Use/storage/generation, solid waste, etc.)				
12. BIOLOGICAL RESOURCES (Wetlands/floodlands, flora, fauns, etc.)				
13. CULTURAL RESOURCES (Native American burial sites, archeological, historical, etc.)				
14. GEOLOGY AND SOILS (Topography, minerals, geothermal., installation Restoration Program, seissmicity, etc.)				
15. SOCIOECONOMIC (Emolevment/ population projections, school and local fiscal imposts, etc.)				
16. OTHER (Potential impacts not addressed above.)				

SECTION III - ENVIRONMENTAL ANALYSIS DETERMINIATION		
17.		PROPOSED ACTION QUALIFIES FOR CATEGORICAL EXCLUSION (CATEX) ______________: OR
		PROPOSED ACTION DOES NOT QUALIFY FOR A CATEX: FURTHER ENVIRONMENTAL ANALYSIS IS REQUIRED

18. REMARKS		
19. ENVIRONMENTAL PLANNING FUNCTION CERTIFICATION (Name and Grade)	19a. Signature	19b. Date

AF FORM 813. AUG 93 (*ED-V1) (PerFORM PRO)* THIS FORM CONSOLIDATES AF FORMS 813 AND 814 PREVIOUS EDITIONS OF BOTH FORMS ARE OBSOLETE PAGE 1 OF PAGE(S)

Appendix B: Project Reviewer's Check List

Appendix B: Project Reviewer's Check List

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Appendix B: Project Reviewer's Check List

B1 OVERVIEW

This appendix contains a recommended check list for anyone reviewing the air quality analysis of a proposed airport or air base project to follow. In the following checklist, any references to "airport" means any airport or air base and a "project" means a Federal airport or air base action, unless specified otherwise (e.g., for military air base projects only).

B1.1 Projection Definition / Inventory of Emissions

1. Was the project scope adequately defined (project impact on fleet mix and aircraft operations, possible increases in airside/landside congestion, need for additional GSE, parking lot expansions, and similar changes) ?
2. Were state and local air quality agencies and the EPA contacted for coordination on the air quality analysis?
3. Were all recommended project alternatives appropriately defined and considered?
4. Was the airport activity level specified so that all types of emissions (direct and indirect, including temporary) could be quantified and each project alternative (including the "no build" alternative) adequately evaluated?
5. Were airport emission inventories computed for all types of emissions (direct and indirect, including temporary) and each project alternative (including the "no build" alternative)?
6. Was one of the project alternatives identified as the proposed project?

B1.2 Indirect Source Review

7. Does the State require indirect source review? If yes, continue to item 8. If no, an indirect source permit is not required.
8. If the State requires indirect source review, does the airport activity exceed the State's indirect source review thresholds? If yes, complete an indirect source analysis and obtain an indirect source permit if required. If no, an indirect source permit is not required.

B1.3 Transportation Conformity

9. Is any part(s) of the proposed project related to transportation plans, programs, and projects developed, funded, or approved under title 23 U.S.C., the proposed project must meet the procedures and criteria of the Transportation Conformity Rule.

B1.4 General Conformity

10. Is the airport in a nonattainment area (NAA) or maintenance area (MA) for any criteria pollutant (CO, NO_2, PM-10, ozone)? If yes, continue to item 11. If no, a conformity assessment is not required; proceed to item 25 (NAAQS analysis).

11. Is the proposed project exempt from general conformity or presumed to conform for general conformity (see 40CFR§93.153)? If exempt, a conformity determination is not required. If presumed to conform, proceed to item 16. If no, continue to item 12.
12. Are indirect emissions from action reasonably foreseeable and can the Federal agency practically control and maintain control over them due to a continuing program responsibility of the Federal agency? If yes, total project emissions equal direct plus indirect emissions (including temporary emissions). If no, total project emissions equal direct emissions (including temporary emissions).
13. For the proposed project, were the annual net emissions of the project calculated for:
    a. total emissions (including temporary) of no-build and proposed build alternatives,
    b. the year of maximum project emissions,
    c. the attainment year, or furthest forecast year for the maintenance plan, and
    d. SIP emission budget years?
14. Was the analysis based on the latest planning assumptions derived from population, employment, and travel data acquired from the local metropolitan planning organization (MPO), and the latest and most accurate emission estimation techniques applied (unless written approval is obtained)?
15. Do the annual net emissions of the proposed project exceed the general conformity threshold levels (see 40CFR§93.153(b))? If yes, proceed to item 17. If no, continue to item 16.
16. Are the annual net emissions of the proposed project regionally significant (exceed 10% of the area total emissions)? If yes, continue to item 17. If no, a conformity assessment is not required for the project; proceed to item 25 (NAAQS assessment).
17. For the proposed action, were the applicable pollutant concentrations computed by dispersion modeling?
18. Were appropriate background pollutant concentrations included in the dispersion analysis?
19. Do airport pollutant concentrations, when combined with the background pollutant concentration, exceed NAAQS? If yes, continue to item 20. If no, action conforms; continue to item 23 (conformity determination).
20. Is the proposed project specified in the applicable state implementation plan (SIP) or is there a sufficient emissions budget in the SIP to accommodate the action's emissions? If yes, the project conforms, coordinate with state/local agencies; proceed to item 23 (conformity determination). If no, continue to item 21.
21. Were local and state air quality agencies and EPA consulted for an alternative conformity determination? If yes, the project conforms, proceed to item 23 (conformity determination). If no, continue to item 22.
22. Were emissions mitigated or offset or the project redesigned to reduce direct, indirect, or construction/temporary emissions such that the project does conform with the provisions of the SIP? If yes, proceed to item 23 (conformity

determination). If no, the project must be redefined and reevaluated such that it does conform to the SIP.

23. Has a conformity determination been prepared? If it is a draft conformity determination, was:
    a. a 30-day notice of the action and the draft determination provided to the appropriate EPA region and State and local air control agencies,
    b. the draft determination made available to the public to allow opportunity for review and comment,
    c. the draft determination made public by placing a notice by prominent advertisement in a daily newspaper of general circulation in the area affected by the proposed project, and
    d. a 30-day public comment period provided prior to taking any formal action on the draft determination?

24. If it is a final conformity determination, was it made public within 30 days of the final determination by placing a notice, by prominent advertisement, in a daily newspaper of general circulation in the area affected by the action?

B1.5 NAAQS Analysis

25. Does the airport emissions inventory with the proposed project (proposed project emissions minus no project emissions) exceed the passenger/activity threshold established to indicate a need for National Ambient Air Quality Standard (NAAQS) review? If yes, continue to item 25. If no, no further action is required.

26. Are emissions reasonably foreseeable? If yes, continue to item 26. If no, no further action is required.

27. For proposed build action, was dispersion modeling performed on all applicable airport emissions (direct and indirect, including construction) to calculate a resulting pollutant concentration at appropriate receptor sites?

28. Were appropriate background pollutant concentrations included in the analysis?

29. Do airport pollutant concentrations, when combined with the background pollutant concentration, exceed NAAQS or any state or local standard? If yes, continue to item 29. If no, finalize analysis, document, and coordinate with state/local agencies and EPA.

30. Can emissions be mitigated or offset or the project redesigned to reduce direct or indirect emissions (including temporary emissions such as construction emissions) such that the combined airport and background pollutant concentrations are below the NAAQS or any state or local standard? If yes, finalize analysis, document and coordinate with state/local agencies and EPA. If no, the project must be redefined and reevaluated such that it does not exceed NAAQS or any state or local standard.

Appendix C: Key Pollutants

Appendix C: Key Pollutants

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Appendix C: Key Pollutants

C1 Summary

The EPA has identified six pollutants, termed "criteria pollutants," that cause or contribute to air pollution and could endanger the public health or welfare. These pollutants are addressed by the key statutes and regulations identified above, including the *National Environmental Policy Act of 1969 (NEPA)* (Reference 30), Council on Environmental Quality regulations (Reference 9), the *Clean Air Act (CAA) as amended* (Reference 5), and the General Conformity Rule (Reference 7). The six criteria pollutants are:

- Ozone (O_3),
- Carbon monoxide (CO),
- Particulates (PM-10),
- Sulfur dioxide (SO_2),
- Nitrogen dioxide (NO_2), and
- Lead (Pb).

The EPA established numerical air quality standards under the *CAA* for these criteria pollutants that are to be applied uniformly throughout the U.S. These standards are termed the National Ambient Air Quality Standards (NAAQS). A region's air quality is determined by comparing ambient air pollution levels with the appropriate NAAQS for each criteria pollutant. An area, or air quality control region, that violates the NAAQS for a particular pollutant anywhere within the region is designated as being in "nonattainment" for that pollutant (e.g., an area may be designated as nonattainment for ozone and carbon monoxide). Most major urban areas with heavy industrialization have levels of certain pollutants that exceed the NAAQS. The NAAQS for ozone is most commonly exceeded; roughly 100 areas are designated as nonattainment for ozone.

The *1990 CAA Amendments* established a new classification of nonattainment areas for ozone, carbon monoxide, and particulates on the basis of the severity of present pollution levels (e.g., moderate and serious for carbon monoxide). Based on the classification, deadlines for achieving attainment were set. Table C-1 lists the averaging periods and primary standards for the criteria pollutants. Primary standards define the air quality required to prevent any adverse impact on human health.

In addition to national standards for these pollutants, some states and local air districts have established air quality standards that are stricter than the NAAQS. States and local standards should be verified early in the air quality assessment process by contacting the appropriate agencies. Appendix J addresses State Indirect Source Review (ISR) regulations.

The criteria pollutants are discussed below, including the impact of aviation sources on pollutant levels.

Table C-1: National Ambient Air Quality Standards (NAAQS)

(as of November 15, 1990)

Pollutant	**Averaging Period**	**Standard**[1]
Ozone (O_3)	1-hour average	0.120 ppm (235 $\mu g/m^3$)
Carbon Monoxide (CO)	8-hour average	9 ppm (10 mg^3)
	1-hour average	35 ppm (40 mg^3)
Particulate Matter (PM-10)	24-hour average	150 $\mu g/m^3$
	annual arithmetic mean	50 $\mu g/m^3$
Sulfur Dioxide (SO_2)	24-hour average	365 $\mu g/m^3$
	annual arithmetic mean	0.03 ppm (80 $\mu g/m^3$)
Nitrogen Dioxide (NO_2)	annual arithmetic mean	0.053 ppm (100 $\mu g/m^3$)
Lead (Pb)	annual arithmetic mean	1.5 $\mu g/m^3$

C1.1 Ozone (O_3)

Ozone (O_3), commonly referred to as "smog," is formed in the atmosphere rather than being directly emitted from sources. Ozone forms as a result of volatile organic compounds (VOCs) and oxides of nitrogen (NO_x) reacting in the presence of sunlight in the atmosphere. Ozone levels thus are highest in warm-weather months. VOCs and NO_x are termed "ozone precursors" and their emissions are regulated in order to control the creation of ozone.

VOCs are created when fuels or organic waste materials are burned. Examples of significant VOC emission sources at airports and air bases are aircraft, ground support equipment, and ground access vehicles. VOC emissions from these sources are highest during low power settings such as aircraft and vehicle idle. Other emission sources include aerosol sprays, dry cleaning operations, paints, and solvents. Most hydrocarbons are presumed to be VOCs in the regulatory context, unless otherwise specified by the EPA. In the emission inventory calculations presented in this document, VOC emissions are not calculated directly, but instead are estimated from calculated hydrocarbon emissions. See the VOC definition in the Glossary for the conversion factors to apply to total hydrocarbon emissions to convert them to VOC emissions.

Two types of nitrogen oxides are emitted into the atmosphere in significant quantities: nitric oxide (NO) and nitrogen dioxide (NO_2). NO is formed during high-temperature combustion processes when nitrogen and oxygen react in the presence of air. NO_2 is formed when NO reacts with atmospheric oxygen (O_2), and is regulated separately as a criteria pollutant (see discussion below). When both chemical compounds are emitted, they are referred to collectively as total oxides of nitrogen (NO_x). Significant NO_x sources at airports and air bases are aircraft and

[1] Refers to primary standards, which define the air quality required to prevent any adverse impact on human health.

gasoline-powered ground access vehicles. The significant NO_x-producing modes of aircraft operation are takeoff and climbout. Other emission sources include boilers and electric power plants.

Ozone damages lung tissue, reduces lung function, and sensitizes the lungs to other irritants. Scientific evidence indicates that ambient levels of ozone not only affect people with impaired respiratory systems (e.g., asthmatics), but also healthy adults and children. Ozone may produce adverse health effects such as chest discomfort, coughing, nausea, respiratory tract and eye irritation, and decreased pulmonary functions.

C1.2 Carbon Monoxide (CO)

Carbon monoxide (CO) is an odorless, colorless, and poisonous gas. Most CO is formed as a result of incomplete combustion of organic materials used as fuel (e.g., gasoline, coal, wood). The most significant sources of emissions at airports and air bases are aircraft and ground access vehicles. CO emissions from these sources are highest during incomplete combustion, during idling and low speed mobile source operations, such as aircraft taxi and vehicle idle, which are the most prevalent CO emission sources commonly found at airports and air bases. Other examples of CO sources at airports and air bases are ground support equipment and combustion stationary sources.

CO enters the bloodstream and reduces oxygen delivery to the body's organs and tissues. Its most serious effects occur at high concentrations, and therefore it tends to be a localized problem. CO may produce adverse health effects such as headaches, work capacity impairment, learning ability impairment, dizziness, weakness, nausea, vomiting, loss of muscular control, increasing and decreasing respiratory rates, collapse, unconsciousness, or death. The health threat from CO is most serious for those who suffer from cardiovascular disease. Healthy individuals also can be affected, but only at higher concentrations.

C1.3 Particulates (PM-10)

Particulate matter includes solid and liquid material suspended in the atmosphere. Particulates form as a result of incomplete combustion. Particulate emission rates are somewhat higher at low power rates than at high power rates since combustion efficiency improves at higher engine power. Most particulate material is not inhaled because of its large size. PM-10, fine particles less than 10 micrometers in diameter, are likely to be responsible for adverse health effects. They are not easily filtered from the air by the body and subsequently are inhaled into the lungs. Therefore, in 1987, the EPA replaced the earlier total suspended particulate (TSP) standard with a standard for PM-10. Examples of PM-10 include dust, fog, and fumes. The level of PM-10 in the atmosphere is largely affected by wind and rainfall conditions. Aircraft are the primary source of PM-10 emissions at airports and air bases. Other airport and air base PM-10 sources include ground access vehicles, industrial operations, construction vehicles, and construction activities.

PM-10 may produce adverse health effects including effects on breathing and respiratory symptoms, aggravation of existing respiratory and cardiovascular disease, alterations in the body's defense systems against foreign materials, damage to lung tissue, carcinogenesis, and premature mortality. The elderly, children, individuals with chronic obstructive pulmonary or cardiovascular disease, influenza, and asthma are most likely to be sensitive to the effects of fine particulate matter.

C1.4 Sulfur Dioxide (SO_2)

Sulfur oxides (SO_x) are gases produced from industrial processes (e.g., the burning of sulfur-containing fuels such as coal and oil). Emissions of SO_x depend entirely on the sulfur content of the fuel. Approximately 95 percent of sulfur oxides are sulfur dioxide (SO_2). SO_2 is a relatively stable, colorless gas with a strong suffocating odor. Very little SO_2 is emitted from any aviation source.

Exposure to high concentrations of SO_2 may produce adverse health effects such as throat and lung irritations, swelling and accumulation of fluid in the throat and lungs, nasal bleeding, and aggravation of existing respiratory and cardiovascular disease. People most sensitive to SO_2 include asthmatics, individuals with cardiovascular disease or chronic lung disease (e.g., bronchitis, emphysema), children, and the elderly. In addition, SO_2 and nitrogen oxides are the major precursors for acid rain.

C1.5 Nitrogen Dioxide (NO_2)

Nitrogen dioxide (NO_2) is a poisonous, reddish-brown to dark brown gas with an irritating odor. As discussed above in the context of ozone, NO_2 forms when nitric oxide (NO) reacts with atmospheric oxygen (O_2). Most sources of NO_2 are man-made sources; the primary source of NO_2 is high-temperature combustion. Significant sources of NO_2 at airports and air bases are boilers, aircraft operations, and vehicle operations. NO_2 emissions from these sources are highest during high-temperature combustion, such as aircraft takeoff mode.

NO_2 may produce adverse health effects such as nose and throat irritations, coughing, choking, headaches, nausea, stomach or chest pains, and lung inflammations (e.g., bronchitis, pneumonia). The effects of short-term exposure are still unclear, but continued or frequent exposure to concentrations higher than those normally found in the ambient air may cause increased incidence of acute respiratory disease in children.

C1.6 Lead (Pb)

Lead (Pb) is a heavy metal solid that is bluish-white to silvery gray in color. Lead occurs in the atmosphere as lead oxide aerosol or lead dust. Historically a significant source of lead in the air at airports and air bases was ground access vehicles operating on leaded gasoline. The amount of lead emissions from vehicles has decreased, however, due to the significant Federal controls on leaded gasoline and the resultant increase in the use of unleaded gasoline in catalyst-equipped cars. Currently, the chief (but typically insignificant) source of this pollutant at airports and air bases is the combustion of leaded aviation gasoline in piston-engine aircraft.

In the body, lead accumulates in blood, bone, and soft tissue. Because it is not readily excreted, lead also affects the kidneys, liver, nervous system, and blood-forming organs. Lead may produce adverse health effects such as fatigue, sleep disturbance, headache, aching bones and muscles, constipation, abdominal pains, decreased appetite, and permanent nervous system damage. High levels of exposure to lead may lead to seizures, coma, or death. Fetuses, infants, and children are especially susceptible to low doses of lead.

Appendix D: Aircraft Emission Methodology

Appendix D: Aircraft Emission Methodology

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Appendix D: Aircraft Emission Methodology

D1. OVERVIEW

This appendix discusses the emissions inventory calculation methodology, data inputs, and data sources for three types of aircraft emission sources: commercial, general aviation and air taxi, and military aircraft.

D2. COMMERCIAL AIRCRAFT

Commercial aircraft are operated by domestic and foreign air carriers. Foreign carrier aircraft operations can range from a few charter operations to a significant portion of an airport's total scheduled operations. The methodology in Section D2.1 can be applied for the aircraft operations of both domestic and foreign air carriers. Section D2.2 addresses the sources of data inputs for both domestic and foreign operations.

D2.1 Methodology

The EPA has set forth procedures for calculating exhaust emission inventories of commercial aircraft standard LTO cycle operations. Exhaust emissions are calculated for one complete LTO cycle of each aircraft type by knowing the emission factors for the aircraft's specific engines at each power setting or mode of operation, as well as the time spent in each mode. Then the activity of aircraft for the inventory period can be applied to calculate their total emissions. This emissions calculation procedure is presented in EPA's *Procedure for Emission Inventory Preparation*, Volume IV, Chapter 5 (Reference 82). Currently, no information is available on calculating evaporative-related emissions (e.g., refueling emissions) from commercial aircraft. Evaporative related emissions are small due to the low vapor pressure of the fuel and quick-connect refueling nozzles.

This EPA procedure addresses emissions for five operating modes of a standard LTO cycle: approach, taxi/idle-in, taxi/idle-out, takeoff, and climbout. A sixth operating mode, reverse thrust, often is included in a standard LTO cycle but is not included in EPA's procedure. After aircraft land, engine thrust reversal typically is used to slow the aircraft to taxi speed (otherwise the aircraft is slowed using only the wheel brakes). Reverse thrust is now considered by EPA as an official mode and should be included in calculation procedures as a sixth operating mode when applicable. Since reverse thrust engine operating conditions are similar to takeoff, time spent in reverse thrust should be combined with takeoff mode emission indices and fuel flow as a means of accounting for reverse thrust mode emissions. Aircraft reverse thrust typically is applied for 15-20 seconds on landing.

The emissions calculation methodology presented in EPA's *Procedure for Emission Inventory Preparation* estimates emissions for HC, CO, NO_x, SO_2, and PM-10. The NO_x emission factors provided in EPA's procedures should be used to calculate a NO_x emissions inventory that is used to compare against NO_2 emission standards. (When both nitric acid (NO) and NO_2 are emitted, they are referred to collectively as total oxides of nitrogen, or NO_x.)

D2.2 Data Sources

D2.2.1 Aircraft type and number of LTOs

Sources of site-specific aircraft fleet and activity data include published references, records of aircraft and airport operators, and the Department of Transportation (DOT). Domestic carrier aircraft fleet and activity data by airport and airline are reported to the FAA by certificated route air carriers on FAA Form 41, Schedule T-3s: Airport Activity Statistics. FAA T-3 data are available on data tape (Reference 64) or in FAA's *Airport Activity Statistics of Certificated Route Air Carriers* (Reference 53). The data also includes activity information for certificated route air carrier operations at military air bases. Foreign carrier aircraft operations are available from the DOT Bureau of Transportation Statistics. Conducting on-site activity monitoring and contacting individual airports for data are alternative options for collecting domestic and foreign data on aircraft type and operating frequency.

D2.2.2 Engine Type and Number

Site-specific engine data are not readily available, although it should be used if obtainable. If the specific engine type is not known for an aircraft but the aircraft operator is known, an appropriate surrogate engine can be chosen based on the operator's national fleet. Domestic and foreign airline fleet data that includes aircraft engine models are published in Bucher & Co.'s *JP Airline-Fleets International* (Reference 2) and Jet Information Service's *World Jet Inventory* (Reference 24). If the aircraft operator is not known, typical aircraft-engine combinations are provided in EPA's *Procedure for Emission Inventory Preparation*, Volume IV, Chapter 5. Finally, on-site collection of engine type data is feasible but not recommended due to the difficulty in identifying specific engine models.

D2.2.3 Engine Emission Indices and Engine Fuel Flow

Emission indices (i.e., emission factors) and average fuel consumption rates for aircraft engines are listed by operating mode in EPA's *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 5 and in the ICAO *Engine Exhaust Emissions Databank* (Reference 27). Generally, emission factors are listed in pounds of pollutant per 1000 pounds of fuel consumed and fuel flow is listed in pounds per minute. Only EPA's *Procedures* document provides particulate emission factors, and data are available for only a few engines. A recent investigation of particulate emissions by EPA indicates that the particulate emission factors can be used to calculate reasonable estimates of PM-10 emissions from these engines. Until further data is available, PM-10 emission factors of engines for which no data is available should be assumed to be zero. The EPA Office of Mobile Sources should be contacted for additional guidance. Neither source provides SO_x emission factors. A SO_x emission factor of 0.54 lb/1000 lb can be used for most air carrier aircraft, which is based on a national average sulfur content of aviation fuels.

As mentioned above, reverse thrust mode is not included in EPA's methodology. There also are no specific reverse thrust emission factors available. Takeoff emission indices and fuel flow should be used as inputs for calculating emissions from reverse thrust (as well as takeoff) mode.

D2.2.4 Time in Mode

There are six possible operating modes of aircraft standard LTO cycles: approach, taxi/idle-in, taxi/idle-out, takeoff, climbout, and reverse thrust (if applicable). the time an aircraft operates in each mode depends on a variety of factors and should be adjusted to represent local conditions when possible. Approach and climbout times in mode vary based on the local mixing height.

The methodology for determining approach and climbout is described in EPA's *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 5 Taxi time is highly site- and situation-specific. Potential sources of site-specific taxi/idle times include aircraft operators and the FAA. The FAA compiles monthly taxi data received from aircraft operators for many airports. These aircraft taxi time data are available from FAA's Office of Aviation Policy, Plans and Management Analysis (Reference 66). On-site monitoring of taxi times over an extended period also is a feasible means of estimating this data. The time spend in takeoff mode is fairly standard and will not vary much from location to location. Therefore, a standard default time usually is used in emission calculations. Default takeoff times are provided for several aircraft categories in EPA's *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 5. If reverse thrust is used on aircraft landing, it typically is applied for approximately 15 seconds. Unless site-specific data is available, 15 seconds should be used as a default reverse thrust time in mode for LTOs that include reverse thrust on landing.

D3. GENERAL AVIATION AND AIR TAXI AIRCRAFT

D3.1 Methodology

The following discusses the procedures for calculating standard and non-standard LTO exhaust emission from general aviation and air taxi aircraft, as well as general aviation aircraft evaporative emissions.

There are two approaches for calculating exhaust emissions from standard operations of general aviation and air taxi aircraft. The approach used above in Section D2.1 to calculate emissions from standard operations of commercial air carrier aircraft (i.e., presented in EPA's *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 5) also can be used for standard operations of general aviation and air taxi aircraft. Due to the nature and tracking of general aviation and air taxi operations and operators, often it is difficult to find the detailed information on aircraft mix and activity needed to estimate emission using this detailed approach. Where detailed information on specific aircraft mix and activity is unavailable, the EPA alternative methodology can be used. The alternative methodology uses "generalized" emission indices, in pounds per LTO, to estimate emissions. Separate generalized emission indices are provided in EPA's *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 5 for general aviation aircraft and air taxi aircraft. The generalized emission indices are based on default values for key data inputs and a representative general aviation or air taxi fleet mix.

Not all aircraft operations follow the standard LTO cycle. The more detailed EPA procedure can be adjusted for the non-standard conditions and used to calculate emissions from non-standard operations of general aviation and air taxi aircraft. An example of non-standard operations are practice touch-and-goes. In a touch-and-go, the taxi/idle mode is eliminated, the approach and climbout modes shortened, and a "return flight" mode is added (to allow the pilot to turn around and repeat the procedure). To calculate the emissions from a touch-and-go, the taxi/idle mode should be eliminated from the calculations. Rather than reducing the approach and climbout times and then adding additional time for circling the airfield, the full approach and climbout times should be used (assuming this will account for the additional flight time within the mixing zone).

Most general aviation aircraft are powered by piston engines, which are fueled by aviation gasoline (AvGas). Aviation gasoline has a much higher volatility than jet fuel and the fuel tanks are vented to the atmosphere resulting in significant HC evaporation. Evaporative emissions are associated with refueling, pre-flight safety procedures, and fuel venting due to diurnal temperature changes. The EPA methodology for calculating refueling losses is provided in an EPA Office of Air and Radiation memorandum from Mary Manners to Susan Willis dated October 20, 1996; Subject: *Revised Methodology for Calculating the Refueling Losses for General Aviation Aircraft*. The following equations, **Error! Reference source not found.** and **Error! Reference source not found.** ***(Mariano this should be Equation D-2)*** , developed for the EPA, should be used for quantifying HC evaporative emissions from general aviation aircraft pre-flight safety procedures and fuel venting. [Note: These calculations are *not* to be used for turbine engines.]

$$E_T = 0.20\ \text{lb}/LTO_L \times LTO$$

Where: E_T - total HC emissions, in pounds, resulting from pre-flight safety checks
LTO_L - number of landing and takeoff cycles by piston-engine aircraft during the period of interest, excluding landing and takeoff cycles by itinerant aircraft

Equation D- 1: Emissions from Pre-Flight Safety Checks

$$E_T = 0.15\ \text{lb/day/based aircraft} \times A_b \times D$$

Where: E_T - total HC emissions, in pounds, resulting from diurnal losses
A_b - number of aircraft based in the region of interest
D - number of days in the period of interest

Equation D- 2: Emissions from Diurnal Temperature Changes

D3.2 Data Sources

The calculation data inputs vary based on the calculation methodology used. If the detailed calculation methodology is being utilized to calculate exhaust emissions, data inputs needed are aircraft type and number of LTOs, engine type and number, engine emission indices and fuel flow, and time in mode. If the alternative, generalized calculation methodology is being used to calculate exhaust emissions, data inputs needed are number of LTOs and the generalized emission factors. For evaporative emissions from pre-flight safety checks and diurnal temperature changes, total piston-engine aircraft LTOs and number of based aircraft are needed. Inputs for calculating refueling losses are discussed in the EPA Office of Air and Radiation memorandum from Mary Manners to Susan Willis dated October 20, 1996; Subject: *Revised Methodology for Calculating the Refueling Losses for General Aviation Aircraft*.

D3.2.1 Aircraft Type and Number of LTOs

Site-specific aircraft fleet and activity data (i.e., LTOs by aircraft type for an airport or air base) is not readily available. Potential sources of site-specific aircraft fleet and activity data include sampling and aircraft and airport operators. Potential sources of site-specific local and total activity (i.e., local or total LTOs for an airport or air base) include records of aircraft or airport operators. Local and total activity by airport are available from FAA *Airport Master Records* (Form 5010-1) (Reference 54) or FAA *Air Traffic Activity* (Reference 59). FAA *Airport Master Records* also provide activity data for operations at military air bases.

D3.2.2 Engine Type and Number

Site-specific engine type and number data is not readily available. Potential sources of site-specific engine type and number data include sampling and aircraft operators. Default, typical aircraft-engine combination data is provided in EPA's *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 5. On-site collection of engine type data is feasible but not recommended due to the difficulty in identifying specific engine models.

D3.2.3 Engine Emission Indices and Fuel Flow

Emission index and fuel flow data for a limited number of general aviation and air taxi aircraft engines is included in EPA's *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 5 and in the *ICAO Engine Exhaust Emissions Databank*. Generally, emission factors are listed in pounds of pollutant per 1000 pounds of fuel consumed and fuel flow is listed in pounds per minute. If engine-specific data is not available or sufficient, generalized emission indices, in pounds per LTO, also are provided in EPA's *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 5.

D3.2.4 Time in Mode

The five operating modes of aircraft standard LTO cycles are approach, taxi/idle-in, taxi/idle-out, takeoff, and climbout. The methodology for adjusting approach and climbout is described in EPA's *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 5. Potential sources of site-specific taxi/idle times include aircraft operators, airport operators and on-site measurement. The time spend in the takeoff mode is fairly standard and will not vary much from location to location. A standard default time is usually used in emission calculations. Takeoff default times are provided for several aircraft categories in EPA's *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 5.

D3.2.5 Based Aircraft

Potential sources of site-specific based aircraft data include sampling and airport operators. Total number of based aircraft by airport also is available from FAA *Airport Master Records*.

D4. MILITARY AIRCRAFT

D4.1 Methodology

The following discusses the procedures for calculating standard and non-standard LTO exhaust emissions from military aircraft, whether occurring at a civil or military facility. The USAF document *Calculation Methods for Criteria Air Pollutant Emission Inventories* (Reference 23) also should be consulted for further guidance. Currently, no information is available on calculating evaporative-related emissions (e.g., refueling emissions) from military aircraft. Evaporative related emissions are small due to the low vapor pressure of the fuel and quick-connect refueling nozzles.

Procedures are set forth in EPA's *Procedures for Emission Inventory* Preparation, Volume IV, Chapter 5 for calculating military aircraft exhaust emission inventories of standard LTO operations, which is the same detailed procedure used for commercial, general aviation, and air taxi aircraft. Emissions are calculated for one complete LTO cycle of each aircraft type by knowing the emission indices for the aircraft's specific engines at each power setting or mode of operation, as well as the time spent in each mode. The activity of aircraft for the inventory period can then be applied to calculate their total emissions.

This EPA procedure addresses emissions from five operating modes of a standard LTO cycle: approach, taxi/idle-in, taxi/idle-out, takeoff, and climbout. A sixth operating mode, reverse thrust, often is included in a standard LTO cycle but is not included in EPA's procedure. After aircraft land, engine thrust reversal typically is used to slow the aircraft to taxi speed (otherwise the aircraft is slowed using only the wheel brakes). Reverse thrust is now considered by EPA as an official mode and should be included in calculation procedures as a sixth operating mode when applicable. Since reverse thrust engine operating conditions are similar to takeoff, time spent in reverse thrust should be combined with takeoff mode emission indices and fuel flow as a means of accounting for reverse thrust mode emissions.

The emissions calculation methodology presented in EPA's *Procedure for Emission Inventory Preparation* estimates emissions for HC, CO, NO_x, SO_2, and PM-10. The NO_x emission factors provided in EPA's procedures should be used to calculate a NO_x emissions inventory that is used to compare against NO_2 emission standards. (When both nitric acid (NO) and NO_2 are emitted, they are referred to collectively as total oxides of nitrogen, or NO_x.)

Not all aircraft operations follow the standard LTO cycle. The more detailed EPA procedures, adjusted for the non-standard conditions, also can be used to calculate emissions from non-standard operations of military aircraft. Examples of non-standard operations include pilot training, engine operation/testing, and the addition of an afterburn mode. In a training touch-and-go operation, the taxi/idle mode is eliminated, the approach and climbout modes shortened, and a "return flight" mode added (to allow the pilot to turn around and repeat the procedure). To calculate the emissions from a touch-and-go, the taxi/idle mode should be eliminated from the calculations. Rather than reducing the approach and climbout times and then adding additional time for circling the airfield, the full approach and climbout times should be used (assuming this will account for the additional flight time within the mixing zone).

D4.2 Data Sources

D4.2.1 Aircraft Type and Number of LTOs

For those operations that occur at military facilities, this data should be obtained from the base operations sections. If the operation occurs at a civilian facility, this data should be obtained from the individual airport.

D4.2.2 Engine Type and Number

A potential source of site-specific engine type and number data is the base operations section of the air base where the operation occurred or the air base where the aircraft is stationed. If site-specific data is not available, default, typical aircraft-engine data is provided in the EPA's *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 5 and the USAF's *The Engine Handbook* (Reference 44).

D4.2.3 Engine Emission Indices and Fuel Flow

Emission indices (i.e., emission factors) and average fuel consumption rates for aircraft engines are listed by operating mode in EPA's *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 5. Generally, emissions indices are listed by operating mode in pounds of pollutant per 1000 pounds of fuel consumed and fuel flow is listed in pounds per minute. EPA's

Procedures document provides particulate emission factors, but data are available for only a couple engines. A recent investigation of particulate emissions by EPA indicates that the particulate emission factors can be used to calculate reasonable estimates of PM-10 emissions from these engines. Until further data is available, PM-10 emission factors of engines for which no data is available should be assumed to be zero. The EPA Office of Mobile Sources should be contacted for additional guidance.

The Air Force is in the process of converting from JP-4 to JP-8 fuel. This conversion is expected to continue Air Force-wide through 1998. The effort was undertaken to increase survivability of air crews and aircraft and to standardize fuel type with allies (e.g., NATO). JP-8 is essentially commercial grade Jet A-1 aviation kerosene. Because it vapor pressure is much lower than that of JP-4, the potential for fire and explosion is significantly reduced. As of this writing, specific criteria pollutant emission indices for the various flight operation modes are not available for JP-8. Average emission index data for engines by operating mode for JP-4 is included in EPA's *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 5. Information on the environmental impact of the JP-4 to JP-8 conversion expected by the Air Force is provided in *Calculation Methods for Criteria Air Pollutant Emission Inventories* (Reference 23).

D4.2.4 Times in Mode

The operating modes of a military aircraft standard LTO cycle are the same as for civil aircraft, although the power settings may be different. There are six possible operating modes: approach, taxi/idle-in, taxi/idle-out, takeoff, climbout, and reverse thrust. The power settings for a civil aircraft standard LTO cycle are takeoff at 100%, climbout at 85%, approach at 30%, taxi/idle at 7%, and reverse thrust at 80-100%. For military aircraft, examples of possible alternative power settings are takeoff at afterburner power and takeoff or climbout at military, intermediate, or IRP. Taxi time is highly site- and situation-specific. Potential sources of site-specific taxi/idle times include sampling and the air base operations department. Approach and climbout times in mode vary based on the local mixing height. The methodology for adjusting approach and climbout times is provided in EPA's *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 5. Takeoff time in mode is fairly standard. Default takeoff times are provided for several aircraft categories in EPA's *Procedures for Emissions Inventory Preparation*, Volume IV, Chapter 5. If reverse thrust is used on aircraft landing, sampling should be conducted or the air base operations department should be consulted to estimate the reverse thrust time in mode. For non-standard LTO cycles, the times in mode should be adjusted for site-specific conditions (e.g., taxi/idle mode times and power settings should be adjusted for touch-and-go cycles).

Appendix E: Auxiliary Power Unit Emission Methodology

Appendix E: Auxiliary Power Unit Emission Methodology

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Appendix E: Auxiliary Power Unit Emission Methodology

E1. METHODOLOGY

A methodology was developed for calculating emissions from auxiliary power units (APUs) based on the methodology for calculating aircraft exhaust emissions, which is provided in EPA's *Procedures for Emission Inventory Preparation* (Reference 82). APU emissions are calculated for one complete LTO cycle of each aircraft type. Calculation inputs are the emission factors and fuel flow for the aircraft's specific APU model and the amount of APU usage during the course of the full aircraft LTO. Equation E-1 assumes each aircraft type has one APU. If a particular aircraft has multiple APUs, then the equation must be multiplied by the number of APUs on the aircraft in question.

$$\mathbf{E_{ij} = T * (FF_j / 1000) * (EI_{ij})}$$

Equation E-1: APU Emissions from a Single LTO

Where:

E_{ij}	-	emissions of pollutant i, in pounds, produced by the APU model installed on aircraft type j for one LTO cycle
T	-	operating time per LTO cycle, in minutes
FF_j	-	fuel flow, in pounds per minute, for each APU used on aircraft type j
EI_{ij}	-	emission index for pollutant i, in pounds of pollutant per one thousand pounds of fuel, for each APU used on aircraft type j
i	-	pollutant type (HC, CO, NO_x, SO_2)
j	-	aircraft type (e.g., B-737, MD-11)

Using Equation E-1, APU emissions per LTO can be calculated for multiple aircraft types and any period of time (e.g., day, month, year). Total APU emissions can be calculated using Equation E-2. Equation E-2 multiples the APU emissions per LTO for a given aircraft type and operating time (determined using the above equation) by the number of corresponding LTOs, then sums the emissions over all aircraft types.

$$\mathbf{E_{Ti} = \quad \Sigma (EI_{ij} \times LTO_j)}$$

Equation E-2 : Total APU Emissions

Where:

E_{Ti}	-	total APU emissions of pollutant i, in pounds, produced by all aircraft types in question
EI_{ij}	-	emission index for pollutant i, in pounds of pollutant per one thousand pounds of fuel, for each APU used on aircraft type j
LTO_j	-	number of landing and takeoff cycles for aircraft type j during the inventory period

E2. DATA SOURCES

E2.1 APU Model

The particular APU model that is installed on an aircraft must be determined to select the emission indices used in calculating the emissions. Individual aircraft operators at airports or the air base's operations department are potential sources of site-specific APU model information. If site-specific information is not available, the FAA and EPA's *Technical Data to Support FAA's Advisory Circular on Reducing Emissions from Commercial Aviation* (Reference 52) lists APU models commonly found on commercial aircraft. For military aircraft, default data is provided in the USAF's *The Engine Handbook* (Reference 44) or the latest version of EPA's *Compilation of Air Pollutant Emission Factors*, Volume II (Reference 71), which list several military aircraft and their common APU models.

E2.2 Emission Indices and Fuel Flow

Emission indices and fuel flow vary by APU model. APU emission indices generally are in pounds of pollutant per 1000 pounds of fuel consumed. APU fuel flow typically is in pounds per minute of usage. Emission indices and fuel flow are provided for several APU models in the FAA and EPA's *Technical Data to Support FAA's Advisory Circular on Reducing Emissions from Commercial Aviation* (Reference 52). Potential sources of additional emission index and fuel flow data are APU engine manufacturers. Where emission indices and fuel flow are unavailable for a specific APU, data for an alternative unit of the same or similar horsepower should be used.

E2.3 Operating Time

The APU operating time for the full aircraft LTO must be known to calculate emissions. This includes time the APU operates while parked at a gate or parking space, during aircraft or APU maintenance, and during aircraft taxi, approach, or climbout. APU operating time varies by LTO, aircraft, operator, and airport. Potential sources of site-specific APU operating time data are individual aircraft operators at airports or the air base's operations department. If no information is available, surveys of operators could be conducted. If site-specific information is not available, an airline, airport, or air base average APU operating time can be used.

As a last resort, if APU operating time data is not available, a conservative estimate would be to assume the APU runs the entire time the aircraft is on the ground. If the aircraft total ground time is not available, the rough estimate of a one hour turn around time at the gate can be added to aircraft taxi time. See the commercial aircraft or military aircraft inventory section for more information on aircraft taxi data.

E2.4 Aircraft Fleet and Activity

See the commercial aircraft or military aircraft inventory section in Appendix D for more information on aircraft fleet and activity.

Appendix F: Ground Support Equipment and Aerospace Ground Equipment Emission Methodology

Appendix F: Ground Support Equipment and Aerospace Ground Equipment Emission Methodology

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Appendix F: Ground Support Equipment and Aerospace Ground Equipment Emission Methodology

F1. OVERVIEW

A wide variety of ground equipment services large aircraft while they are unloading and loading passengers and freight at an airport or air base. The following is a list of common Ground Support Equipment (GSE) and Aerospace Ground Equipment (AGE) types, along with a brief description.

- **Air Start Units —** Provide large volumes of compressed air to an aircraft's main engines for starting. Air start units are also called air compressors.
- **Air Conditioning Units —** Provide conditioned air to ventilate and cool parked aircraft.
- **Aircraft Tugs —** Tow aircraft in the terminal gate area or on the tarmac. They also tow aircraft to and from hangers for maintenance. These are broken into two categories: tugs for narrow body aircraft and tugs for wide body aircraft.
- **Baggage Tractors —** Equipment used at airports to haul baggage between the aircraft and the terminal.
- **Belt Loaders —** Mobile conveyor belts used at airports to move baggage between the ground and the aircraft hold.
- **Buses —** Shuttle personnel between facility locations.
- **Cargo Moving Equipment —** Various types of equipment employed to move baggage and other cargo around the facility and to and from aircraft. This category includes forklifts, lifts, and cargo loaders.
- **Cars** — Move personnel around the facility.
- **Deicers —** Vehicles used to transport, heat, and spray deicing fluid.
- **Ground Heaters —** Mobile units that provide heated air to heat the parked aircraft.
- **Ground Power Unit (GPU) —** Mobile ground-based generator units that supply aircraft with electricity while they are parked at the facility. GPUs also are called generators.
- **Light Carts —** Mobile carts that provide light.
- **Other —** Small miscellaneous types of equipment commonly found at facilities such as compressors, scrubbers, sweepers, and specialized units.
- **Pickups —** Move personnel and equipment around the facility.
- **Service Vehicles —** Specially modified vehicles to service aircraft at facilities. This category includes fuel trucks, maintenance trucks, service trucks, lavatory trucks, and bobtail tractors (a truck body that has been modified to tow trailers and equipment).
- **Vans** — Move personnel and equipment around the facility.
- **Weapons Loader —** Equipment employed at air bases to move weapons, such as bombs, between the ground and the aircraft hold.

There is also a wide variety of equipment that services the airport. This equipment may be assigned to various departments of the facility including administration, emergency response, police department, operations, engineering and construction, automotive, mechanical maintenance, and landscaping/gardening. The types of equipment servicing the airport vary from cars and pick-ups to generators and lawn mowers. This equipment is also included in the GSE or AGE inventory.

While GSE and AGE are commonly fueled by gasoline or diesel, many different types of GSE and AGE are commercially available that operate on alternative fuels or electricity. Examples of alternative fuels are compressed natural gas, liquefied natural gas, and liquefied petroleum gas (commonly propane). Different fuels have different emission characteristics for the same piece of equipment.

There are both exhaust and evaporative-related emissions from GSE and AGE. The following discusses the methodology, data inputs, and data sources for calculating exhaust emissions from GSE and AGE. For information on calculating evaporative-related emissions from GSE and AGE (e.g., refueling losses), see the California Air Resources Board 1995 publication titled *Documentation of Input Factors for the New Off-Road Mobile Source Emissions Inventory Model.*

F2. METHODOLOGY

This section discusses the methodology for calculating exhaust emissions from GSE and AGE that service aircraft as well as airports and air bases.

For aircraft GSE and AGE, exhaust emissions from each GSE/AGE type is calculated using site-specific GSE/AGE type and usage information combined with non-site-specific inputs (e.g., brake horsepower, load factor, emissions indices). Emissions from each GSE/AGE type are totaled to obtain the total emissions inventory. This methodology can be used to calculate the pollutant emissions from an individual type of equipment for one LTO of a given aircraft type or for the entire inventory period independent of aircraft type based on the period the equipment usage represents (e.g., hours of use required for the equipment type to service one LTO of an aircraft type or for the entire inventory period). If the equipment usage is based on the hours required to service one LTO of an aircraft type, the activity for each aircraft type is applied to the GSE or AGE emissions per LTO calculated to obtain the total inventory emissions for conventional and alternative fuel GSE or AGE. This approach is very flexible since emissions can be calculated for as many or as few aircraft and LTOs as desired and for any inventory period. If total usage hours for the inventory period (e.g., hours per year) are used, it is not necessary to apply aircraft activity to the resulting emissions.

For airport GSE and air base AGE, GSE or AGE types and corresponding usage required for the entire inventory period are needed. This type and usage information is then combined with the remaining inputs to the emissions calculation to obtain GSE or AGE emissions for the given inventory period. In general, only limited calculation input data is readily available, as discussed below in Section F3.

Two calculation procedures are discussed below: a conventional/alternative fuel equipment procedure and an electric equipment procedure. A separate calculation procedure is provided for electric GSE and AGE since emissions attributable to the generation of electricity used by the equipment are calculated (instead of from the equipment itself). Once emissions are calculated for all conventional and alternative fuel GSE or AGE as well as electric GSE or AGE, the emissions are summed to obtain the total inventory emissions. For air bases, the USAF document *Calculation Methods for Criteria Air Pollutant Emission Inventories* (Reference 23) also should be consulted for further guidance.

F2.1 Conventional and Alternative Fuel GSE/AGE

For conventional and alternative fuel GSE and AGE, the factors that determine the quantity of pollutant emitted are the brake horsepower, load factor, usage, and emission index. Equation F-1 can be used to calculate the pollutant emissions from an individual type of equipment for one LTO of a given aircraft type or for the entire inventory period independent of aircraft type based on the period the equipment usage represents (e.g., hours of use required for the equipment type to service one LTO of an aircraft type or for the entire inventory period).

$$\mathbf{E_{it} = (BHP_t \times LF_t \times U_t \times EI_{it}) \times CF}$$

Equation F-1: Conventional and Alternative Fuel GSE/AGE Emission Calculation

Where:

E_{it}	-	emissions of pollutant i, in pounds, produced by GSE or AGE type t
BHP_t	-	average rated brake horsepower (BHP) of the engine for equipment type t
LF_t	-	load factor utilized in ground support operations for equipment type t
U_t	-	hours of use for equipment type t (e.g., to service one LTO of an aircraft type or for the entire inventory period)
EI_{it}	-	emission index for pollutant I, in grams per BHP-hr, which is specific to a given engine size and fuel type
i	-	pollutant type (e.g., HC)
t	-	equipment type (e.g., diesel air start unit)
CF	-	0.0022046 unit conversion factor from grams to pounds

F2.2 Electric GSE/AGE

Use of electric GSE or AGE produces no emissions at the airport or air base but generating the electricity needed to operate them does. When electricity is used at an airport or air base to recharge an electric vehicle, local or regional power plants are generating additional electricity to meet this demand. In the case of electric GSE or AGE, the emissions attributable to the generation of electricity for use by the equipment are calculated.

Since emissions associated with electric GSE or AGE occur at the power plant rather than at the point where the equipment is used, the methodology identified above for conventional and alternative fuel GSE and AGE is modified somewhat. For each type of electric GSE or AGE, emissions are calculated based on the emission indices of the electric power plant and the amount of electricity consumed or hours of GSE/AGE usage. Or

Eit **= BHPt x LFt x Ut (EIit x CFBHP x CFR)**

Equation F-2 calculates the pollutant emissions attributable to an individual type of electric equipment. As with the conventional and alternative fuel methodology above, the equation can be used to calculate emissions for one LTO of a given aircraft type or for the entire inventory period based on the period the equipment usage represents (e.g., hours of use required for the equipment type to service one LTO of an aircraft type or for the entire inventory period).

$$E_{it} = MWH_t \times EI_{it}$$

Or

$$E_{it} = BHP_t \times LF_t \times U_t\ (EI_{it} \times CF_{BHP} \times CF_R)$$

Equation F-2: Electric GSE and AGE Emission Calculation

Where:

E_{it}	-	emissions of pollutant i, in pounds, attributable to the use of GSE or AGE type t
MWH_t	-	megawatt hours of electricity consumed by equipment type t (e.g., to service one LTO of an aircraft type or for the entire inventory period)
EI_{it}	-	emission index for pollutant i, in pounds per megawatt hour of electricity consumed
BHP_t	-	average rated brake horsepower (BHP) of the engine for equipment type t
LF_t	-	load factor utilized in ground support operations for equipment type t
U_t	-	hours of use for equipment type t (e.g., to service one LTO of an aircraft type or for the entire inventory period)
i	-	pollutant type (e.g., HC)
t	-	equipment type (e.g., electric baggage tug)
CF_{BHP}	-	0.000746 unit conversion factor from megawatt hours to horsepower hours
CF_R	-	1.125 recharge conversion factor

F3. DATA SOURCES

Data inputs and sources vary somewhat for the conventional and alternative fuel GSE/AGE and electric GSE/AGE emissions calculation procedures. The following identifies the data inputs and sources for calculating emissions from conventional and alternative fuel GSE and AGE as well as electric GSE and AGE. For air bases, the USAF document *Calculation Methods for Criteria Air Pollutant Emission Inventories* (Reference 23) also should be consulted for further guidance.

F3.1 Conventional and Alternative Fuel GSE/AGE

F3.1.1 GSE/AGE Type

GSE/AGE type refers to the equipment (e.g., baggage tug) and fuel (e.g., diesel) type. Potential sources of site-specific GSE/AGE type information are individual aircraft operators for aircraft GSE, the airport operator for airport GSE, or the air base's operations department for air base AGE. For military aircraft, common AGE applications are provided in the USAF's *The Engine Handbook* (Reference 44).

F3.1.2 Usage

Usage refers to the hours of use for a specific equipment type either to service one LTO of a specific aircraft type or for the entire inventory period. Potential sources of site-specific aircraft GSE/AGE usage information are individual aircraft operators at airports or the air base's operations department. If site-specific data is not available, default aircraft GSE hours per year usage data is provided in the FAA and EPA's *Technical Data to Support FAA's Advisory Circular on Reducing Emissions from Commercial Aviation* (Reference 52).

For airport or air base GSE/AGE the airport operator or air base's operations department can be contacted or default hours per year usage data can be obtained from the *Nonroad Engine and Vehicle Emissions Study (NEVES)* (Reference 78).

F3.1.3 Brake Horsepower

Potential sources of site-specific brake horsepower data are aircraft operators for aircraft GSE, the airport operator for airport GSE, and the air base operations department for AGE. If site-specific information is not available, the FAA and EPA's *Technical Data to Support FAA's Advisory Circular on Reducing Emissions from Commercial Aviation* (Reference 52) lists brake horsepower commonly found on on-road and aircraft GSE/AGE and the *NEVES* lists brake horsepower commonly found on off-road airport and air base GSE/AGE. Default data also may be available from equipment manufacturers.

F3.1.4 Load Factor

Potential sources of site-specific GSE/AGE load factor information are individual aircraft operators for aircraft GSE at airports, the airport operator for airport GSE, or the air base's operations department. If site-specific information is not available, the FAA and EPA's *Technical Data to Support FAA's Advisory Circular on Reducing Emissions from Commercial Aviation* lists load factors commonly found on on-road and aircraft GSE/AGE and the *NEVES* lists load factors commonly found on off-road airport and air base GSE/AGE. Default data also may be available from equipment manufacturers.

F3.1.5 Emission Indices

Emission indices are available for aircraft and airport/air base GSE and AGE. Off-road aircraft GSE emission indices for HC, NO_x, CO, and PM are listed in *Regulatory Strategies for Off-Highway Equipment* (Reference 16) and *Feasibility of Controlling Emissions from Off-Road, Heavy-Duty Construction Equipment* (Reference 15). These emission indices also are provided in the FAA and EPA's *Technical Data to Support FAA's Advisory Circular on Reducing Emissions from Commercial Aviation*. This document also provides SO_2 emission indices for off-road aircraft GSE and on-road GSE emission indices developed by EEA for FAA. Airport non-road emission indices are provided in the *NEVES*.

F3.2 Electric GSE/AGE

F3.2.1 GSE/AGE Type

GSE/AGE type refers to the equipment (e.g., baggage tug) and fuel (i.e., electric) type. Potential sources of site-specific GSE/AGE type information are individual aircraft operators at airports, the airport operator, or the air base's operations department. For military aircraft, common AGE applications are provided in the USAF's *The Engine Handbook*.

F3.2.2 Usage

Usage can either be in hour (e.g., hours per LTO, hours per year) or megawatt hour units. Usage refers to the hours used or megawatt hours of electricity consumed by a specific equipment type either to service one LTO of a specific aircraft type or for the entire inventory period. Potential sources of site-specific GSE/AGE usage information are individual aircraft operators at airports, the airport operator, or the air base's operations department.

F3.2.3 Emission Indices

Emissions generated at the power plant vary from region to region throughout the U.S. based on the power generation technology, fuel used, and emission controls. Table F-1 presents Emission indices for electric power production for all of the U.S. as well as for the Ozone Transport Region (OTR), states outside the OTR and California. The OTR consists of the District of Columbia, Maryland, parts of northern Virginia (e.g., Alexandria, Arlington County, Fairfax, Fairfax County, Falls Church, Loudoun County, Manassas, Manassas Park, Prince William County, and Stafford County), and all states north (e.g., Pennsylvania, Delaware, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine). The factors relate emissions at a power plant to electricity used at an airport, air base, or other location connected to the power distribution system. The emission indices are based on the regional mix of electricity generation technology and assume an 8% power loss in the transmission and distribution system.

Region	**Emission Index (lbs/MWh)**[1]		
	HC	**CO**	**NO_x**
Ozone Transport Region[2]	0.03	0.33	0.88
California	0.04	0.44	0.31
Other U.S.	0.03	0.34	3.97
Total U.S.:	0.03	0.36	3.52

Table F-1: Emissions From Electric Power Consumption[3]

[1] Represents pounds of pollutant emitted at the point of power generation per megawatt hour of electricity consumed in 2000.

[2] Source: *Impact of Battery-Powered Electric Vehicles on Air Quality in the Northeast States* (Reference 39)

[3] Source: EEA unless otherwise noted. Data has been adjusted to account for 8% transmission and distribution losses.

Appendix G: Ground Access Vehicles Emission Methodology

Appendix G: Ground Access Vehicles Emission Methodology

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Appendix G: Ground Access Vehicles Emission Methodology

G1. METHODOLOGY

Ground access vehicles (GAVs) produce exhaust, evaporative and idling emissions. The activity of GAVs is separated into two categories: roadway and parking lot. In general, roadway activity consists of the segment of GAV operations that occur on roadways (both on- and off-airport). Parking lot activity refers to the segment of GAV operations that occur in airport and air base parking lots. Parking lot activity does not include vehicles that enter parking lots but are not customers and do not stop (e.g., parking lot and rental car shuttle buses).

The general guidance for calculating emissions from on-road or highway vehicles is provided in EPA's *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 3 (Reference 81). The EPA specifies that the MOBILE and PART5 motor vehicle emissions models be used to develop highway vehicle emission indices and emission inventories. The user guides for EPA motor vehicle emission models (References 72 and 88) also provide additional guidance. Many factors influence motor vehicle emissions including vehicle age, vehicle travel speed and distance, vehicle operating mode, fuel characteristics, control programs, and local ambient conditions. The influence of these factors is constantly changing as technology continues to evolve.

Due to the complex process of determining emission indices, simplified descriptions of the exhaust, evaporative-related, and idling emissions calculation methodologies are provided below. It is possible to estimate both exhaust and evaporative-related emissions using just the exhaust calculation methodology if "combined" emission indices (i.e., combined exhaust and evaporative emission indices) are used. An emission estimate based on combined emission indices will not be as accurate since default assumptions are used in the emission index development. The EPA's *Procedures for Emission Inventory Preparation* should be consulted for a more detailed description of the methodologies. For air bases, the USAF document *Calculation Methods for Criteria Air Pollutant Emission Inventories* (Reference 23) also should be consulted for further guidance.

G1.1 Emissions

G1.1.1 Exhaust Emissions

The exhaust emission calculation methodology can be simply described as multiplying the pollutant emission index for a desired average speed and the designated study year against the distance traveled against the volume of traffic. Emissions must be calculated separately for different years of interest, since emission indices change by year. This calculation can be performed for each EPA vehicle category or for all vehicles using composite inputs. This calculation can be used to determine emissions for any time period (e.g., day, week, month, year) by adjusting the number of trips. Equation G-1 shows the simplified description of the exhaust emissions calculation methodology. As mentioned above, motor vehicle emissions vary based on local ambient conditions (e.g., CO is high in colder weather). If the time period of interest includes both warm and cold weather seasons, the emissions should be calculated for each season to obtain accurate emission estimates.

$$E_i = EI_{isy} \times D \times T \times CF$$

Equation G-1: GAV Exhaust Emissions

Where:	E_i	-	emissions of pollutant i, in pounds, produced by the vehicles of interest in the given time period
	EI_{isy}	-	emission index, in grams per mile, for pollutant i and a specified speed s and year y
	D	-	distance traveled, in miles, by the vehicles of interest
	T	-	number of vehicle trips of interest
	i	-	pollutant type (e.g., HC)
	s	-	average vehicle speed, in miles per hour
	y	-	designated study year
	CF	-	0.0022046 unit conversion factor from grams to pounds
	Note:		Distance traveled (D) times number of vehicle trips (T) also is known as vehicle miles traveled (VMT)

G1.1.2 Evaporative-Related Emissions

In addition to exhaust emissions from GAV operations, there also are evaporative-related emissions of hydrocarbon. There are six types of evaporative-related emissions calculated for GAVs: crankcase, refueling losses, running losses, hot soak, diurnal, and resting losses. The six types of evaporative-related emissions can be divided into two categories: operating or resting. Operating emissions occur while a vehicle is operating, and are applicable to every trip. Operating emissions result from both roadway and parking lot vehicle activity. Resting emissions only occur when the vehicle is at rest, and are applicable to vehicle trips including a vehicle stop. The six types of evaporative-related emissions are listed in the table below by category. Each type of evaporative-related emissions is discussed in more detail below.

Table G-1 : Types Of Evaporative-Related Emissions

Operating Emissions[1]	Resting Emissions[2]
Crankcase	Hot Soak
Refueling Losses	Diurnal
Running Losses	Resting Losses

- **Crankcase -** Crankcase emissions occur while a vehicle is operating and, therefore, are dependent on vehicle miles traveled. Crankcase emissions result from fuel displacement.
- **Refueling Loss -** Refueling loss emissions are the spillage and displacement of fuel vapor from the vehicle fuel tank to the atmosphere when gasoline-fueled vehicles are refueled. Stage II and on-board vapor recovery systems are being implemented to control refueling losses. Refueling loss emissions usually are calculated using the gallons of fuel dispensed. For ground access vehicles that operate and refuel only on the airport, such as fleet vehicles (e.g., parking lot shuttle buses, rental car shuttle buses, airport fleet

[1] Operating emissions occur for every vehicle trip (i.e., result from both roadway and parking lot vehicle activity).

[2] Resting emissions only occur for vehicle trips including a vehicle stop (i.e., only result from parking lot vehicle activity including a park).

vehicles), all fuel consumed is attributable to the airport and the fleet operator typically knows the amount of fuel dispensed and consumed. For other ground access vehicles that also are operated for purposes other than accessing the airport (e.g., passenger vehicles, employee vehicles), attributing the refueling losses of all gasoline in the vehicle tank would overestimate those airport-related emissions. To more accurately estimate refueling losses of those vehicles that also operate for non-airport purposes, emissions are estimated using only the gallons of fuel used to access the airport (as discussed in section G2. Data Sources, below). Refueling emissions also can be calculated based on vehicle miles traveled, but will be less accurate due to inherent assumptions regarding inputs.

- **Running Loss -** Running loss emissions are similar to hot soak emissions; both are heat-related, evaporative emissions that occur while the vehicle is being operated. Running loss emissions are negligible at first, but increase significantly as trip duration lengthens.
- **Hot Soak -** Hot soak emissions occur at the end of each vehicle trip as elevated operation temperatures lead to continued evaporation after a vehicle has been parked (e.g., in an airport parking lot).
- **Diurnal -** Diurnal emissions also occur while the vehicle is parked during periods of rising ambient temperatures. Total diurnal emissions are calculated using two equations: partial/full-day and multiple-day. The partial/full-day equation calculates diurnal emissions from vehicles that are at rest for a day or less (e.g., in a short-term parking lot, employee parking lot, or the first day of a multiple-day parking lot). The multiple-day equation calculates diurnal emission from vehicles that are at rest for multiple days (e.g., in a long-term parking lot). For multiple-day parking lots, emissions from the first day of rest are calculated using the partial/full-day equation. Emissions from the remaining days of rest (i.e., the second day of rest and longer) are calculated using the multiple-day equation.
- **Resting Loss -** Resting loss emissions occur while the vehicle is at rest (e.g., in a parking lot) and result from the permeability of fuel system components. Resting emissions are calculated using the number of hours the vehicles are at rest. Resting evaporative emissions also can be calculated based on vehicle miles traveled, but will be less accurate due to inherent assumptions regarding inputs.

Simplified procedures for calculating these evaporative-related emissions from GAV are presented below. These calculations can be used to determine emissions for any time period of a year (e.g., day, week, month, year) by adjusting the applicable number of trips or miles traveled. As mentioned above, motor vehicle emissions vary based on local ambient conditions (e.g., CO is high in colder weather). If the time period of interest includes both warm and cold weather seasons, the emissions should be calculated for each season to obtain an accurate emissions estimate. In addition, emissions must be calculated separately for different years of interest, since emission indices change by year.

These procedures do not illustrate how to determine the emission indices, which are based on multiple other inputs. See the MOBILE user's guide (Reference 88) for more information on the calculation of emission indices. Similar calculation methodologies are grouped together below, although different emission indices are needed for each type of calculation.

$$E_T = EI \times D \times T \times CF$$

Equation G-2: Crankcase or Running Losses

Where:

E_T	-	total hydrocarbon emissions, in pounds, resulting from crankcase or running losses of the vehicle of interest in the given time period
EI	-	emission index, in grams per mile
D	-	distance traveled, in miles
T	-	number of vehicle trips
CF	-	0.00220446 unit conversion factor from grams to pounds

$$E_T = EI_G \times G \times CF$$

or

$$E_T = EI_D \times D \times T \times CF$$

Equation G-3: Refueling Losses

Where:

E_T	-	total hydrocarbon emissions, in pounds, resulting from refueling losses of the vehicles of interest in the given time period
EI_G	-	emission index, in grams per gallon of fuel dispensed
EI_D	-	emission index, in grams per mile
G	-	gallons of fuel dispensed (that are used for airport access)
D	-	distance traveled, in miles
T	-	number of vehicle trips
CF	-	0.00220446 unit conversion factor from grams to pounds

$$E_T = EI \times T \times CF$$

Equation G-4: Hot Soak

Where:

E_T	-	total hydrocarbon emissions, in pounds, resulting from hot soak of the vehicles of interest in the given time period
EI	-	emission index, in grams per trip
T	-	number of vehicle trips for which a soak period exists (i.e., vehicle trips with a stop, such as in a parking lot)
CF	-	0.0022046 unit conversion factor from grams to pounds

$$E_T = EI \times N \times T \times CF$$

Equation G-5: Diurnal (Partial/Full-Day or Multiple-Day of Rest)

Where:

E_T	-	total hydrocarbon emissions, in pounds, resulting from diurnal losses of the vehicles of interest in the given time period
EI	-	emission index, in grams per vehicle day
N	-	number of days of rest (for partial/full-day calculations, number of days equals 1)
T	-	number of vehicle trips (i.e., vehicles) for which a diurnal loss period exists (i.e., vehicle trips with a stop, such as in a parking lot)
CF	-	0.0022046 unit conversion factor from grams to pounds

$$E_T = EI_R \times R \times H \times T \times CF$$
or
$$E_T = EI_D \times D \times T \times CF$$

Equation G-6: Resting Losses

Where:

E_T	-	total hydrocarbon emissions, in pounds, resulting from resting losses of the vehicles of interest in the given time period
EI_R	-	emission index, in grams per hour of rest
EI_D	-	emission index, in grams per mile
R	-	days of rest
H	-	hours of rest per day to convert units from day to hours (assumed to be 24 hours/day)
D	-	distance traveled, in miles
T	-	number of vehicle trips for which a resting period exists (i.e., vehicle trips with a stop, such as in a parking lot)
CF	-	0.0022046 unit conversion factor from grams to pounds

G1.1.3 Idling Emissions

Idling emissions are calculated for vehicles with an extended idle time. Only extended idle times are considered, since a normal amount of idle time already is incorporated into the exhaust emission indices. The types of GAV that may have extended idle times at airports are passenger vehicles and taxicabs. At air bases, GAV that may have extended idle times are base transportation vehicles, such as buses or vans. Although the methodology and inputs are generally the same for calculating idling emissions as for exhaust emissions, there are a few minor modifications. These modifications are discussed in EPA's MOBILE5 Information Sheet #2: *Estimating Idle Emission Factors Using MOBILE5* (Reference 75).

G1.1.4 Activity Categories

As mentioned in the above methodology, when calculating emissions from GAVs, vehicle activity is divided into two categories: roadway and parking lot. The EPA procedures described above are applied to both roadway and parking lot activity. Important issues and considerations when applying the above procedures to roadways and parking lots are discussed below.

G1.1.4.1 Roadways

The above methodologies are used to determine GAV emissions from all vehicle roadway trips. Roadway trips are considered to have no significant stops that involve parking (e.g., in a parking lot). As a result, no resting evaporating emissions (e.g., hot soak, diurnal, and resting losses) are calculated for the roadway emission inventory. For vehicles accessing a parking lot as a customer to park (e.g., passenger vehicles, employee vehicles), any emissions generated from the parking lot travel should be included in the parking lot emissions inventory, discussed below. Conversely, for vehicles entering the parking lot but not parking (e.g., parking lot shuttle buses, rental car shuttle buses), parking lot travel is included in the roadway emissions inventory. It is important to apply this distinction consistently when calculating emissions so that emissions are not double counted.

For more accurate results, the procedures should be performed for each roadway segment and summed to determine total emissions. Often this is not an option due to the lack of detailed data inputs required. The alternative option is to perform the procedures for the entire roadway trip using an average trip length.

The applicable methodologies above should be applied separately for each type of private and fleet GAV accessing an airport or air base, since inputs (e.g., average distance traveled) vary by GAV type. GAV types at airports include passenger vehicles, employee vehicles, rental cars, shuttles (e.g., rental car, parking lot, hotel), buses, taxicabs, and trucks. At air bases, GAV types include privately-owned vehicles (POVs), government-owned vehicles (GOVs), and all other vehicles that are not military-registered.

G1.1.4.2 Parking Lots

The above methodologies also are used to determine GAV emissions from all vehicle parking lot trips. Each parking lot trip is considered to have a significant stop that involves parking (e.g., in a parking lot). As a result, unlike the roadway emissions inventory, resting evaporating emissions (i.e., hot soak, diurnal, and resting losses) are calculated for the parking lot emissions inventory. As mentioned above, the parking lot methodology only applies to vehicles accessing a parking lot as a customer to park (e.g., passenger vehicles, employee vehicles). It is important to apply this distinction consistently when calculating emissions so that emissions are not double counted.

For more accurate results, the procedures should be performed for each parking lot and summed to determine total emissions. Parking facilities can be categorized into three types: main terminal, employee, and off-airport public and private parking garages/lots. All parking lots should be considered, including airport rental car parking lots and main taxicab and limousine staging lots. Garage/lot characteristics such as short-term (i.e., two hours or less stay) or long-term parking patterns also should be considered for evaporative and vehicle cold and hot start (discussed below) purposes. Often the detailed data inputs required to perform the calculations on this level are available. For example, the amount of activity entering a parking lot is usually tracked for revenue purposes. If detailed data inputs are not available, the alternative option is to calculate parking lot emissions for all parking lots using average data inputs, although this will result in a less accurate emissions estimate.

G2. DATA SOURCES

The GAV emission calculation requires many inputs. The EPA's *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 3 contains recommendations and suggestions with regard to determining appropriate inputs, although in many cases there is no single correct recommendation that is best for all situations. The EPA procedures document should be consulted for a more detailed description of the numerous data inputs and sources. For air bases, the USAF document *Calculation Methods for Criteria Air Pollutant Emission Inventories* (Reference 23) also should be consulted for further guidance. A current traffic study for the airport or air base may already have determined many inputs to the emission calculation. The airport or the Civil Engineering (CE) Community Planning or Base Development section at an air base should be consulted in gathering the data. Unless otherwise noted, potential sources of the data inputs are the airport or air base operator, an airport or air base study (e.g., airport ground access study), a regional study (e.g., regional vehicle transportation study), and the MPO. Default values for some input data are built into the EPA's motor vehicle emissions models (i.e., *MOBILE5a* and *PART5*). Although the same general methodology and types of inputs are used to calculate the emissions from roadway and parking lot activity, the specific assumptions, data inputs, and default values are different, as discussed below. For many calculation inputs, detailed (e.g. average vehicle speed by roadway segment) or average (e.g., average vehicle speed over all roadway segments) data can be used. In each case, the detailed data inputs produce more accurate results. The following lists only a few of the many calculation inputs.

G2.1 Exhaust Emission Indices

There are HC, CO, NO_x, PM-10, and SO_2 exhaust emission indices applicable to GAVs. In addition, there are fugitive dust emission indices that represent reentrained road dust, which include exhaust emissions as well as brake-wear and tire-wear, applicable to GAVs. Due to a predominance of unleaded and diesel fueled vehicles, of which the lead content of the fuel is negligible, it is assumed that the lead emissions also are negligible. Vehicle emission indices are based on many inputs to the emissions calculation (e.g., cold/hot start percent, speed, study year) not referenced above in the simplified methodology. The EPA specifies that the MOBILE motor vehicle emissions model should be used to develop highway vehicle emission indices for HC, CO, and NO_x. The emission indices incorporate both moving and normal idling operational modes. The EPA specifies that the PART5 model should be used to develop highway vehicle emission indices for PM-10, SO_2, and fugitive dust. Some of the key emission index inputs are listed below.

G2.1.1 Cold/Hot Start Percent

The cold start percent refers to the percent of vehicle miles traveled while operating in "cold start" mode and not yet warmed-up. Any car that is turned off for more than 1 hour operates for a period of time while the vehicle is still cold. This period is typically defined as the first 8-10 minutes of vehicle travel. Conversely, the hot start percent is the percent of vehicle miles traveled in "hot start" mode, when a car is turned off for less than 1 hour. The percent of vehicle miles traveled in cold or hot mode affects emission indices. The cold or hot start occurs at the point of origin for roadways (e.g., a passenger's home) and in the parking lot when restarting the vehicle to exit.

G2.1.2 Speed

The rate of emissions is very sensitive to the vehicle speed. Average speeds must be determined separately for roadways and parking lots. An average speed for each roadway and parking lot results in a more accurate emission estimate.

G2.1.3 Year

The calendar year for which the emissions calculation is being performed defines which emission indices are to be calculated. There are different basic emission rates associated with each model year group, which are defined on the basis of applicable emission standards and emission control technologies. EPA's motor vehicle emissions models have the ability to model emission indices for the years 1960 through 2020.

G2.2 Evaporative-Related Emission Indices

EPA's motor vehicle emissions model *MOBILE5a* calculates GAV HC evaporative-related emission indices. Similar to exhaust emission indices, evaporative-related emission indices are based on many inputs to the emissions calculation (e.g., ambient temperature, fuel characteristics) not referenced above in the simplified methodologies.

G2.3 Vehicle Trips

The number of vehicle trips refers to *round trips*. For roadways, this is from the point of origin to an airport location and then on to the destination, which may be the same as the point of origin. A total number of vehicle roadway trips or total trips per roadway segment can be used depending on other inputs to the calculation. In parking lots a round trip is from the entrance of the parking lot to a parking space to the parking lot exit. As with roadways, the number of vehicle trips can be determined by individual parking lot or for all parking lots depending on other inputs to the calculation. Instead of using an average number of vehicles entering a parking lot, the average number of spaces filled for a parking lot can be used. Since not all vehicles accessing the airport enter a parking lot, the total number of trips input into the calculation is different for roadways and parking lots.

G2.4 Distance

Distance is the distance traveled by vehicles, in miles. For a more accurate emission estimate, the average distance is needed by EPA vehicle type and GAV type (e.g., passenger, employee). If detailed distance estimates are not available, an average for all vehicles can be used, although emission results will be less accurate. For roadways the distance is the average miles traveled from point of origin (e.g., an employee's home) to the airport or air base location (e.g., parking lot) to the point of destination (e.g., an employee's home). As discussed above, for vehicles stopping (e.g., parking in a parking lot), this distance does not include any miles traveled in a parking location. Conversely, for vehicles accessing a parking location but not stopping (e.g., a parking lot shuttle), this distance does include all miles traveled in the parking location. For parking lots, the distance for vehicles stopping in the parking location is the average miles traveled from the lot entrance to a parking space to the lot exit.

G2.5 Days of Rest

The days of rest refers to the number of days that a vehicle's engine is turned off (e.g., in an airport parking lot). For vehicles' trips that do not include a stop, the days of rest is 0.

G2.6 Fuel Dispensed

Using the amount of fuel dispensed in gallons is the EPA-recommended and most accurate method for determining refueling losses. EPA recommends determining the amount of fuel dispensed from total gasoline sales.

As discussed above, for ground access vehicles that only operate and refuel on the airport, such as fleet vehicles (e.g., parking lot shuttle buses, rental car shuttle buses, airport fleet vehicles), all fuel is consumed on the airport and the fleet operator typically knows the amount of fuel dispensed and consumed. For other ground access vehicles that also are operated for purposes other than accessing the airport (e.g., passenger vehicles, employee vehicles), attributing the refueling losses of all gasoline in the vehicle tank would overestimate those airport-related emissions. To more accurately estimate refueling losses of those vehicles that also operate for non-airport purposes, emissions are estimated using only the gallons of fuel used to access the airport. The gallons of fuel used to access the airport can be determined using the applicable average distance traveled (e.g., passenger average distance, employee average distance) and an average miles per gallon (mpg) estimate (e.g., 20 mpg).

G2.7 Age Distribution

The aging of highway vehicles causes deterioration in vehicle engines, vehicle exhaust systems, and catalytic devices, creating higher rates of exhaust emissions. The age distribution of the vehicles accessing an airport by GAV type (e.g., passenger vehicle, employee vehicle) and EPA vehicle type should be determined, especially for airports. The age distribution of airport GAVs is likely to vary from the general population, since flying is an indication of a degree of affluence. If an airport or air base GAV study or regional transportation study has not been conducted, an on-site vehicle survey may need to be conducted in order to collect this data. If site-specific data are not available, Federal Test Procedure (FTP) default values can be used, which are incorporated into the MOBILE model.

G2.8 Idle Time

At airports, vehicles (especially passenger vehicles) often idle for extended periods of time while dropping-off and picking-up passengers at the airport terminal. Although the vehicle emission indices incorporate both moving and *normal* idling operational modes, emissions due to *extended* idling are not included. Extended idling emissions are calculated using idle emission indices developed using the MOBILE model and the average idle time of vehicles. See EPA's MOBILE5 Information Sheet #2: *Estimating Idle Emission Factors Using MOBILE5* for more information.

G2.9 Ambient Temperature Range and Average

Both exhaust and evaporative emissions from vehicles are significantly influenced by the ambient temperatures under which they are operating. A site-specific temperature range and average temperature must be input into the model to accommodate for this effect. Temperature data is available from the National Climatic Data Center (Reference 29).

G2.10 Region

Vehicle emissions also are effected by the local altitude at which they are operating. The type of region, either low-altitude or high-altitude, is input into the model. For most situations, low-altitude is the appropriate choice. For those areas designated as high-altitude by the EPA or that lie substantially above 4000 feet mean sea level, high-altitude should be selected.

Appendix H: Stationary Emission Methodology

Appendix H: Stationary Emission Methodology

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Appendix H: Stationary Emission Methodology

H1 OVERVIEW

This section discusses the methodology for calculating emissions from stationary and area sources at airports and air bases. Detailed data is necessary for determining emissions from stationary and area sources. Many airports and air bases will have this information readily available since it is needed for Title V Operating Permits (or synthetic minor permits depending on the situation). For air bases, the USAF document *Calculation Methods for Criteria Air Pollutant Emission Inventories* (Reference 23) also should be consulted for further guidance.

Typical stationary and area sources at airports and air bases are listed in Table H-1.

Table H-1: Stationary And Area Emissions Sources

Combustion Sources	Non-Combustion Sources
Boilers Space Heaters Emergency Generators Incinerators Fire Training Facilities Aircraft Engine Testing	Fuel Storage Tanks Painting Operations Deicing Operations Solvent Degreasers Sand/Salt Piles

Emission indices referenced in this section are typically given as pounds of pollutant emitted to the atmosphere per a quantity of fuel or other material consumed. In some cases, the pollutants for which emission indices are provided do not match those included in the emissions inventory. For example, the scope of an airport emissions inventory may include CO, NO_x, SO_2, HC, and PM-10 emissions. However, for some operations, the EPA emission index is given as PM instead of PM-10, or as Volatile Organic Compounds (VOC) instead of HC or Total Organic Compounds (TOC). Guidance on the differences between the pollutants and interpretation of emission indices is given in the introduction to the EPA *Compilation of Air Pollutant Emission Factors* (Reference 71), also known as AP-42.

H2 COMBUSTION SOURCES

The basic methodology for calculating emissions from each of these sources is fairly simple; the quantity of fuel burned is multiplied by an emission index to determine the emission of each pollutant. These pollutants commonly include the NAAQS pollutants CO, SO_2, and PM-10. HC and NO_x emissions may also be included in the inventory, as they are precursors to the formation of ozone, another NAAQS pollutant.

This section is divided into five parts. The first considers emissions from boilers and space heaters. Emissions from these stationary and area combustion sources are estimated using emission indices developed for boilers as presented in Sections 1.1-1.5 of Volume I of the EPA *Compilation of Air Pollutant Emission Factors*. The second part describes the methodology and available information on calculating emissions from emergency generators. The third part considers emissions from small incinerators that are present on some airports and air bases. The fourth part of this section discusses pollutant emissions arising from live fire-fighting training exercises. The fifth and final part considers emissions associated with the testing of aircraft engines, either attached to the aircraft or isolated in a testing chamber.

H2.1 Boilers and Space Heaters

H2.1.1 Methodology

EPA provides emission indices for a wide range of boilers, but provides little emission information specific to space heaters. For the purposes of airport and air base emissions inventories, it can be assumed that the emission indices provided for boilers are applicable to space heaters of a comparable size and fuel type.

Pollutant emissions from boilers and space heaters can be calculated using a methodology based on fuel consumption rates and pollutant emission indices. Emissions of each pollutant are calculated by multiplying the fuel consumption rate by the emission index specific to each pollutant. This technique is repeated for each boiler or space heater on the airport or air base to obtain total emissions for these stationary combustion sources.

Total pollutant emissions from one stationary combustion source in this category may be estimated by applying Equation H-1:

$$\mathbf{E_{ti} = \Sigma\ (F\ x\ EI_i)}$$

Where:

E_{ti}	-	total emissions of pollutant i, in pounds, from the stationary source for given time period
F	-	total amount of fuel consumption for given time period; liquid fuels should be expressed in terms of thousand gallons, natural gas as million cubic feet (mcf), and coal as tons.
EI_i	-	emission index for pollutant i (pounds pollutant per thousand gallons, mcf, or ton of fuel)
i	-	pollutant (CO, NO_x, SO_2, PM or PM-10, HC)

Equation H-1: Total Pollutant Emissions for Stationary Combustion Source

The emission index is multiplied by the total fuel consumption to estimate pollutant emissions from the boiler or space heater. The accuracy of this methodology depends upon the ability to determine an appropriate emission index for each pollutant. The following section describes how to obtain EPA-approved emission indices for each combustion source.

H2.1.2 Data Sources

The particular data inputs required for the emissions calculation methodology for each source (e.g., boiler or space heater) are listed in paragraphs 2.1.2.1 through 2.1.2.7.

H2.1.2.1 Rate of Fuel Consumption

Calculations for the emissions from airport and air base stationary combustion sources depend on knowing the amount of fuel burned by those sources over the time period being studied. This information should be obtained from the airport operator or base operations department.

H2.1.2.2 Emission Indices

Emission indices for most stationary combustion sources found at airports and air bases are given in Sections 1.1-1.5 of Volume I of EPA's *Compilation of Air Pollutant Emission Factors*. Emission indices have been developed by EPA that take into consideration several factors that have a significant impact on pollutant emissions, including:

- Fuel type
- Fuel sulfur content
- Fuel ash content
- Boiler type
- Pollution control equipment

The emission indices are calculated by obtaining from Volume I of *Compilation of Air Pollutant Emission Factors* the uncontrolled emission index based on fuel type and boiler type, and correcting for the reduction of pollutants by any air pollution control equipment in operation. In addition, the SO_2 emission index is affected by the fuel sulfur content, and the PM emission index is affected by the fuel ash content. The methodology for obtaining the proper emission indices is expressed by Equation H-2.

$$\mathbf{EI_i = UI_i \times (1 - CF/100) \times FM_i}$$

Where:

EI_i	-	emission index for pollutant i (pounds of pollutant per thousand gallons, mcf, or ton of fuel)
UI_i	-	uncontrolled emission index for pollutant i (pounds of pollutant per thousand gallons, mcf, or ton of fuel)
CF	-	air pollution control factor (%)
FM_i	-	fuel modifier (fuel weight percent sulfur for SO_2 emission index; fuel weight percent ash for PM emission index; ignore for other pollutants)
i	-	pollutant (CO, SO_2, PM, NO_x, or HC)

Equation H-2: Emission Factors for Boilers and Space Heaters

H2.1.2.3 Fuel Type

All emission indices for boilers given in Volume I of *Compilation of Air Pollutant Emission Factors* depend upon the type of fuel burned. At airports and air bases, the most common fuel types are distillate fuel oil, residual fuel oil, diesel fuel, natural gas, and occasionally jet fuel. A small number of air bases may burn coal in large boilers. The type of fuel burned may be obtained from the airport operator, fuel supplier, or base operations department.

H2.1.2.4 Fuel Ash Content

To calculate an emission index for particulate matter, an estimate of the ash content of the fuel is often required. This may be obtained from the fuel supplier, airport operator, or base operations department, or may be taken from calculation of default ash content of fuels as described in Section 1.3 of Volume I of *Compilation of Air Pollutant Emission Factors*.

H2.1.2.5 Fuel Sulfur Content

To calculate an emission index for sulfur dioxide, an estimate of the sulfur content of the fuel is required. This may be obtained from the fuel supplier, airport operator, or base operations department.

H2.1.2.6 Combustion Source Equipment Type

Specific information on the type of equipment and fuel used for each boiler or space heater should be obtained from the airport operator or from the manufacturer. Equipment classification should conform with the categories specified in Volume I of *Compilation of Air Pollutant Emission Factors*. Two examples of boiler classifications given in the *Compilation of Air Pollutant Emission Factors* (for which uncontrolled emission indices are given) are “Distillate oil fired commercial/institutional/residential combustor” and “Natural gas-fired small industrial boiler.” Therefore, boilers are classified by fuel and equipment types by *Compilation of Air Pollutant Emission Factors*. Space heaters are not specifically discussed in Volume I of *Compilation of Air Pollutant Emission Factors*. For the purposes of airport and air base emissions inventories, it can be assumed that the emission indices provided for boilers are applicable to space heaters of a comparable size and fuel type.

H2.1.2.7 Air Pollution Control Factor

Information on air pollution control equipment and control efficiency should be obtained from the airport operator or base operations department. This figure should be expressed as a percent reduction from the uncontrolled emission level.

H2.2 Emergency Generators

Two methodologies are given here: EPA’s AP-42 method (paragraph 2.2.1), which calculates emissions based on the capacity rating of generator engines, and the U.S. Air Force’s method (paragraph 2.2.3), which calculates emissions based on the amount of fuel consumed. The choice of method is likely to rest upon the type of facility being studied (e.g., AP-42 for civilian airports, USAF method for military bases).

H2.2.1 Methodology (EPA AP-42)

Pollutant emissions from emergency generators are calculated using a methodology based on the generator capacity, generator usage rate, and pollutant emission indices. Emissions are calculated by multiplying the power capacity of each generator by the number of hours the generator was operated and by the emission index for each specific pollutant.

Total pollutant emissions from an emergency generator may be estimated by applying Equation H-3.

$$E_{ti}\ \Sigma\ [GC \times T \times UI_i \times (1 - CF/100)]$$

Where:

E_{ti}	-	total emissions of pollutant i, in pounds, from the emergency generator for inventory time period
GC	-	generator power capacity rating (horsepower)
T	-	time (in hours) generator was operated during inventory time period
UI_i	-	uncontrolled emission index for pollutant i (pounds pollutant per horsepower-hour of power output)
CF	-	air pollution control factor (%)
i	-	pollutant (CO, NO_x, SO_2, PM-10, HC)

Equation H-3: Pollutant Emissions for Emergency Generators (AP-42 Method)

H2.2.2 Data Sources (EPA AP-42)

The particular data inputs required for the emissions calculation methodology for each emergency generator are listed in the following paragraphs (2.2.2.1. through 2.2.2.4).

H2.2.2.1 Capacity of Generator Engine

Available from the manufacturer, airport operator, or base operations department. This should be expressed in terms of horsepower (or kilowatts, if metric emission indices from AP-42 are used).

H2.2.2.2 Time of Generator Use

Available from airport operator or base operations department. This should be expressed in hours of generator operation.

H2.2.2.3 Emission Indices

Uncontrolled emission indices for gasoline and diesel industrial engines are given in Section 3.3 of EPA's *Compilation of Air Pollutant Emission Factors.* The type of fuel burned should be available from the fuel supplier, airport operator, or base operations department.

H2.2.2.4 Air Pollution Control Factor

Information on any air pollution control equipment and control efficiency should be obtained from the airport operator or base operations department. This figure should be expressed as a percent reduction from the uncontrolled emission level. Air pollution control methods for emergency generators include steam injection, water injection, and selective catalytic reduction for NO_x control.

H2.2.3 Methodology (U.S. Air Force)

Pollutant emissions from emergency generators are calculated using a methodology based on the quantity of fuel burned and pollutant emission indices. Emissions are calculated by multiplying the quantity of fuel burned by the emission index for each specific pollutant.

Total pollutant emissions from an emergency generator may be estimated by applying Equation H-4:

$$E_{ti} = \Sigma [F \times UI_i \times (1 - CF/100)]$$

Where:

E_{ti}	-	total emissions of pollutant i, in pounds, from the emergency generator for given time period
F	-	total quantity of fuel burned, in thousands of gallons (or million cubic feet for natural gas), for given time period
UI_i	-	uncontrolled emission index for pollutant i (pounds pollutant per thousand gallons of fuel or mcf gas burned)
CF	-	air pollution control factor (%)
i	-	pollutant (CO, NO_x, SO_2, PM-10, HC)

Equation H-4: Pollutant Emissions for Emergency Generators (USAF Method)

H2.2.4 Data Sources (U.S. Air Force)

The particular data inputs required for the emissions calculation methodology for each emergency generator are specified in the following paragraphs (2.2.4.1 through 2.2.4.3).

H2.2.4.1 Quantity of Fuel Burned

Available from the fuel supplier, airport operator, or base operations department. This should be expressed in terms of thousands of gallons of fuel burned, or in the case of natural gas, million cubic feet.

H2.2.4.2 Emission Indices

Uncontrolled emission indices for emergency generators powered by reciprocating engines are given in

Table H-2. Note that for two of the emission indices, the percent of sulfur in the fuel must be obtained to calculate the emission indices. The type of fuel and sulfur content should be available from the fuel supplier, airport operator, or base operations department.

H2.2.4.3 Air Pollution Control Factor

Information on any air pollution control equipment and control efficiency should be obtained from the airport operator or base operations department. This figure should be expressed as a percent reduction from the uncontrolled emission level. Again air pollution control methods for emergency generators include steam injection, water injection, and selective catalytic reduction for NO_x control.

Fuel	Emission Indices (lb/10^3 gallons fuel or mcf gas)					
	CO	**PM**	**PM-10**	**NO_x**	**SO_2**[1]	**VOC**
Distillate Oil (Diesel)	130.0	42.5	32.0	604.0	141(S)	49.3
Kerosene/Naphtha (Jet Fuel)	102.0	33.5	32.0	469.0	128(S)	32.1
Gasoline (Mogas)	7128.0	11.4	6.2	185.0	123(S)	344.0
Natural Gas (lb/million cubic feet)	430.0	10.0	10.0	3400.0	840(S)	82.9
LPG (Propane or Butane)	129.0	5.0	5.0	139.0	91(S)	83.0
Residual/Crude Oil	102.0	33.5	30.8	469.0	152(S)	32.1

Table H-2: **Uncontrolled Emission Indices For Emergency Generators Powered By Reciprocating Engines**[2]

[1] Note: (S) signifies the fuel sulfur content, expressed as weight percent sulfur, which is multiplied by the coefficient given to obtain the emission index for SO_2.

[2] Source: Jagielski, Kurt D., and Robert J. O'Brien, *Calculation Methods for Criteria Air Pollutant Emission Inventories*, p. 80 (Reference 23). SO_2 emissions calculated by assuming all fuel sulfur is emitted as SO_2.

H2.3 Incinerators

H2.3.1 Methodology

Pollutant emissions from incinerators are calculated by multiplying the mass of waste burned by the emission index for each specific pollutant.

Total pollutant emissions from an incinerator may be estimated by applying Equation H-5:

$$\mathbf{E_{ti} = \Sigma\ [F \times UI_i \times (1 - CF/100)]}$$

Where:

E_{ti}	-	total emissions of pollutant i, in pounds, from the incinerator for given time period
F	-	total mass of waste burned, in tons, for given time period
UI_i	-	uncontrolled emission index for pollutant i, in pounds of pollutant per ton of waste burned
CF	-	air pollution control factor (%)
i	-	pollutant (CO, NO_x, SO_2, PM-10, HC)

Equation H-5: Pollutant Emissions for Incinerators

H2.3.2 Data Sources

The particular data inputs required for the emissions calculation methodology for each incinerator are listed in the following paragraphs (2.3.2.1. through 2.3.2.3).

H2.3.2.1 Mass of Waste Burned

Available from the airport operator or base operations section. This should be expressed in terms of tons of waste burned.

H2.3.2.2 Emission indices

Uncontrolled emission indices based on the type of incinerator are given in Section 2.1.7 of Volume I of the EPA *Compilation of Air Pollutant Emission Factors*. Uncontrolled emission indices for PM, SO_2, CO, TOC, and NO_x are provided. EPA provides emission indices for two types of industrial/commercial incinerators likely to be operated at airports: multiple chamber and single chamber. The type of incinerator design should be obtained from the airport operator or base operations section.

H2.3.2.3 Air Pollution Control Factor

Emissions from incinerators are sometimes controlled by scrubbers or gas-fired afterburners. Information on equipment and control efficiency should be obtained from the airport operator or base operations section. This figure should be expressed as a percent reduction from the uncontrolled emission level.

H2.4 Fire Training Facilities

H2.4.1 Methodology

ARFF training facilities are distinguished by the type of fuel burned in the simulations: approximately one half burns propane, and the other half burns jet fuel, diesel fuel, or gasoline. The former have been constructed in recent years due in part to concerns over the air emissions derived from the burning of jet fuel and other fuels. The burning of jet fuel and other fuels tends to produce a column of smoke (particulate matter) that can extend for miles, whereas emissions from the burning of propane are much less smoky.

Air pollutants from the burning of training fires at airports include PM, CO, NO_x, SO_2, and VOC. Emission indices for these pollutants depend upon the type of fuel burned, and have been estimated based on measured emissions from the uncontrolled burning of each fuel. Using these emission indices, total pollutant emissions from a training fire can calculated using the methodology given here.

The methodology for calculating emissions from training fires at airports is straightforward. The quantity of jet fuel burned in each fire is determined, and this is multiplied by the emission indices to calculate the total pollutant emissions to the atmosphere for each fire. Total emissions from one training fire are calculated using Equation H-6.

$$\mathbf{E_{ti} = \Sigma\ (QF \times EI_i)}$$

Where:

E_{ti}	-	total emissions of pollutant i, in pounds
QF	-	quantity of fuel burned in training fire (10^3 gallons)
EI_i	-	emission index (pounds of pollutant i emitted per 10^3 gallons of fuel burned)
i	-	pollutant (PM, CO, SO_2, NO_x, VOC)

Equation H-6: Total Emissions for Training Fires

H2.4.2 Data Sources

The following information is required to estimate pollutant emissions from training fires: total fuel consumption per fire and emission indices based on the quantity of fuel burned.

H2.4.2.1 Quantity of Fuel Burned Per Training Fire

Available from the aircraft rescue and fire fighting (ARFF) department, airport operator or base operations section. This figure should be expressed in terms of thousands of gallons.

H2.4.2.2 Emission Index

Error! Reference source not found. provides emission indices for each of the fuels commonly burned in ARFF training facilities. Emission indices are given in terms of pounds of pollutant per 1000 gallons of fuel burned.

Fuel	Emission Index ($lb/10^3$ gallons fuel)				
	CO	PM	NO_x	SO_2	VOC
Propane	34.8	117.2	6.4	0.02	31.8
JP-4	3584	960	26.88	3.8	128
JP-8	4487	1014	33.65	6.8	135

Table H-3: Emission Indices For Uncontrolled Fuel Burning in Training Fires[3]

H2.5 Aircraft Engine Testing

H2.5.1 Methodology

Pollutant emissions from aircraft engine testing are computed using a similar methodology to that given previously for the aircraft LTO cycle emissions. For each engine being tested, pollutant emission indices and fuel flow rates for each mode of aircraft operation are available from published data. During testing, the engine is taken through a sequence of power levels simulating actual flight conditions. Knowledge of the test times and fuel flow rates for each of these steps allows the calculation of emissions from each testing step. The methodology for calculating overall emissions from aircraft is expressed by Equation H-7:

$$\mathbf{E_{ti} = \Sigma\ (N \times TM_j \times FF_j/1000 \times EI_i)}$$

[3] Sources:

Propane:

PM, VOC: Letter from D. Joynt (Symtron, Inc.) to P. Forward (EEA, Inc.), February 12, 1996 (Reference 25). Emission indices given therein based on Robert S. Levine (National Institute of Standards and Technology) memorandum to C. Lenhoff and D. King, AAI Corporation, December 9, 1992 (Reference 26).

CO, NO_x: Estimate based on emission indices for flares given in Section 13.5 of Volume I of *Compilation of Air Pollutant Emission Factors*.

SO_2: *Compilation of Air Pollutant Emission Factors*, Volume I, Section 1.5, assuming propane sulfur content of 0.2 g/100 scf.

JP-4,8:

PM, VOC: Letter from D. Joynt (Symtron, Inc.) to P. Forward (EEA, Inc.), February 12, 1996. Emission indices given therein based on Robert S. Levine (National Institute of Standards and Technology) memorandum to C. Lenhoff and D. King, AAI Corporation, December 9, 1992. JP-8 data are estimates based on JP-4 test results.

CO, NO_x: Jagielski, Kurt D., and Robert J. O'Brien, *Calculation Methods for Criteria Air Pollutant Emission Inventories*, p. 14. JP-8 data are estimates based on JP-4 test results.

SO_2: Calculated by assuming all fuel sulfur emitted as SO_2. Fuel sulfur content for JP-4 taken as average for 1979-1989 from Dickson, Cheryl L. and Paul W. Woodward, *Aviation Turbine Fuels, 1989* (Reference 13). JP-8 sulfur content assumed equivalent to Jet A sulfur content, from same document.

Where:	E_{ti}	-	total emissions of pollutant i
	N	-	number of test cycles performed
	TM_j	-	average test time, in minutes per test, for mode j
	FF_j	-	fuel flow rate, in pounds per minute, while in testing mode j
	EI_i	-	emission index in pounds of pollutant i emitted per 10^3 lbs fuel burned
	i	-	pollutant (CO, PM-10, SO_2, NO_x, HC)
	j	-	testing mode

Equation H-7: Total Emissions for Aircraft Engine Testing

H2.5.2 Data Sources

Detailed data inputs are required to calculate emissions from aircraft engine testing. Data inputs and sources are listed in the following paragraphs (2.5.2.1. through 2.5.2.5).

H2.5.2.1 Number of Test Cycles Performed

Maintenance personnel should be consulted to determine the typical number of test cycles performed upon each aircraft.

H2.5.2.2 Test Time for Each Mode

Aircraft engine test time for each testing mode varies with the engine type, goals of the test, and equipment used. Site-specific information on test times should be obtained from the maintenance personnel performing the testing.

H2.5.2.3 Engine Fuel Flow

The default average fuel consumption rate, in pounds per minute, of an engine in each operational mode, is provided in EPA's *Procedures for Emission Inventory Preparation*, Volume IV, Chapter 5 (Reference 82) and in the *ICAO Engine Exhaust Emissions Databank* (Reference 27). For military aircraft, the EPA procedures document should be used.

H2.5.2.4 Engine Emission Indices

Pollutant emission indices for an aircraft engine are listed by operating mode, generally, in pounds of pollutant per 1000 pounds of fuel consumed. Average emission index data for engines by operating mode is included in EPA's *Procedures for Emission Inventory Preparation,* Volume IV, Chapter 5 (for both civil and military aircraft engines) and in the *ICAO Engine Exhaust Emissions Databank* (for civil aircraft engines only).

H2.5.2.5 Engine Type

Potential sources of site-specific data on engine types being tested include airline maintenance, base operations section, and sampling. If site-specific engine data for commercial airlines is not available but the aircraft operator is known, then an appropriate default engine can be chosen based on the operator's national fleet. Airline fleet data, including aircraft engine model, is published in Bucher & Co.'s *JP Airline-Fleets International* (Reference 2) and Jet Information Services' *World Jet Inventory* (Reference 24). If the aircraft operator is not known, default, typical aircraft-engine data is provided in EPA's *Procedures for Emission Inventory Preparation,* Volume IV, Chapter 5. For military aircraft, site-specific information on engine types being tested may be obtained from the maintenance section of the air base where testing occurs. Default aircraft engine data is also listed in the EPA document listed above.

H3 NON-COMBUSTION SOURCES

Each type of non-combustion stationary and area source requires a different methodology to be used for calculating the rate of emissions, as described in the following paragraphs.

H3.1 Fuel Storage Tanks

H3.1.1 Methodology

Table H-4 shows the “pathways” of HC emissions from the three types of fuel storage tanks commonly found at airports.

As Table H-4 shows, there are a number of “pathways” for evaporated HC to escape from fuel storage tanks and enter the atmosphere. Accurate calculation of emissions escaping through each of these pathways requires information on the tank structure, fuel type, meteorology, and operating practices. In general, fixed-roof tanks tend to be older and result in the greatest atmospheric emissions. The presence of a volume of vapor space above the level of liquid in the tank promotes evaporation of the fuel hydrocarbons and their subsequent release to the atmosphere through the breather valve. Tanks equipped with a floating roof are able to reduce evaporative emissions by eliminating the vapor space between the liquid level in the tank and the tank roof. However, some emissions do occur through various seals and openings and because fuel clings to the tank walls as the liquid level and roof are lowered.

Tank type	Standing Storage Emissions	Working Emissions
Fixed roof	**Breathing emissions:** Changes in temperature or pressure cause imbalance between internal and external vapor pressure. Breather valves are opened to equalize pressure, allowing emission of evaporated hydrocarbons.	**Displacement emissions:** During filling of tank, liquid displaces gas inside tank, forcing it to be expelled through the breather valve. **Air saturation emissions:** During fuel removal, air drawn into the tank becomes saturated with hydrocarbons and expands, thus causing an imbalance of vapor pressure with the atmosphere. This imbalance is relieved by venting to the atmosphere.
External floating roof	**Rim seal, roof fitting emissions:** Emissions occur from rim seals and roof fittings due to slight imbalances in internal and external vapor pressure. Exposure of floating roof to wind increases emission rate.	**Clingage emissions:** As roof is lowered during withdrawal, fuel clings to the tank walls and evaporates when exposed to the atmosphere. Evaporation rate increases with wind speed.
Internal floating roof	**Rim seal, deck fitting, deck seam emissions:** Emissions occur from rim seal, deck fitting, and deck seam due to slight imbalances in internal and external pressure. Lower emissions because roof is protected from wind.	**Clingage emissions:** As roof is lowered during withdrawal, fuel clings to the tank wall and evaporates. Wind does not increase the evaporation rate.

Table H-4: Pathways of Hydrocarbon Emissions To Atmosphere From Fuel Storage Tanks[4]

A methodology for calculating the sum of hydrocarbon emissions from above-ground and below-ground fuel storage tanks is given in Section 7.1, Volume I of EPA's *Compilation of Air Pollutant Emission Factors*. A wide range of storage tanks is covered in this document, including fixed roof, internal floating roof, external floating roof, variable vapor space, and pressure tanks. The general methodology is to identify each of the major pathways for hydrocarbons to escape from storage tanks to the atmosphere, and use available information to estimate emissions through each pathway. An overview of information requirements is given below. The two main categories of emissions are standing storage emissions, which result from changes in the surrounding temperature and barometric pressure, and working emissions, which result from the loading or withdrawal of fuel. In both cases, emissions result from higher pressure inside the tank than outside, causing the hydrocarbon vapor to escape through any available opening. Depending on the tank type, these openings or pathways include breather vents, rim seals, deck fittings, and deck seams.

[4] Sources: EPA's "Fuel Storage Tanks," *Compilation of Air Pollutant Emission Factors*, Volume I, Section 7.1. and Jagielski, Kurt D., and Robert J. O'Brien, *Calculation Methods for Criteria Air Pollutant Emission Inventories*, p. 14.

The general methodology for calculating storage tank hydrocarbon emissions may be expressed by Equation H-8:

$$\mathbf{E_{HC} = E_S + E_W}$$

Where:

E_{HC}	-	total hydrocarbon emissions from a single tank over a given time period
E_S	-	standing storage emissions from the tank
E_W	-	working emissions from the tank

Equation H-8: Hydrocarbon Emissions for Storage Tanks

The methodologies for calculating E_S and E_W are different for each tank type. These methodologies are described in the Section 7.1, Volume I of *Compilation of Air Pollutant Emission Factors*, and are implemented in the EPA computer model *TANKS* (Reference 84).

H3.1.2 Data Sources

A number of data sources are required for an accurate assessment of standing storage and working emissions from fuel storage tanks. These include the type of tank, physical dimensions of the tank, fuel type, climatic data, rate of fuel throughput, and other tank-specific characteristics. Detailed information on data requirements is given in Section 7.1, Volume I of *Compilation of Air Pollutant Emission Factors*. An overview of these requirements and the likely sources of obtaining this information is given in paragraphs 3.1.2.1. through 3.1.2.5.

H3.1.2.1 Type of Storage Tank

The three most common main types of fuel storage tanks are fixed roof, external floating roof, and internal floating roof tanks. Descriptions of the different tank types is given in Section 7.1, Volume I of *Compilation of Air Pollutant Emission Factors*. Tank information may be obtained from the airport operator, base operations department, fueling contractor, or by visual inspection.

H3.1.2.2 Fuel Type

Fuel vapor pressure and density for each storage tank are required to calculate emission losses. Specification of the type of fuel stored in the tank allows the use of default values for vapor pressure and density given in Section 7.1, Volume I of *Compilation of Air Pollutant Emission Factors* and included in the *TANKS* program.

H3.1.2.3 Climatic Data

Average wind speed, average daily ambient temperature range, average daily solar insulation, and average atmospheric pressure values are each required for the emission calculation. The EPA program *TANKS* contains a database of the necessary climatic information for over 250 cities in the United States, so that only the closest nearby city needs to be specified by the user.

H3.1.2.4 Fuel Throughput

An estimate of annual throughput of fuel for each tank should be obtained from the airport operator, fueling contractor, or base operations department.

H3.1.2.5 Tank-Specific Characteristics

Tank-specific characteristics used in calculating emission losses include one or more of the following: physical dimensions of the tank, type of seals, breather vent settings, tank paint color, number of vacuum breakers, number of columns, effective column diameter, deck fitting types, and deck seam length. This information may be obtained from the airport operator, fueling contractor, base operations department, tank manufacturer, or by visual inspection of the tank. In many cases, default values are given in *Compilation of Air Pollutant Emission Factors* and are incorporated into the *TANKS* program.

H3.2 Coating or Painting Operations

H3.2.1 Methodology

Painting operations emit volatile hydrocarbons (HC) to the atmosphere through evaporation of the paint vehicle, thinner, or solvent used to facilitate the application of the coatings. The main factor affecting HC emissions from painting operations is the volatile content of the coatings, which averages around 15% for water-based coatings to over 50% for solvent-based coatings[5]. Most, if not all, of the volatile portion of the coating evaporates during or following application. To reduce these emissions, paint manufacturers have reduced the VOC content of coatings in recent years. In addition, air pollution control equipment, such as activated carbon adsorption of hydrocarbon emissions or destruction of hydrocarbons in an afterburner, is available for use in some applications.

The methodology for calculating hydrocarbon emissions from painting operations is quite simple. For each type of coating fluid used in painting, the quantity of coating used is multiplied by the VOC content of the coating to obtain the total hydrocarbon emissions from the use of that coating. If any type of air pollution control equipment is in use, then the hydrocarbon emissions estimate is reduced to reflect the effects of the air pollution control. The methodology is expressed by Equation H-9:

$$\mathbf{E_{HC} = \Sigma\ [Q_i \times VOC_i \times (1 - CF/100)]}$$

Where:

E_{HC}	-	total volatile hydrocarbon emissions from painting operations
Q_i	-	total quantity of coating type i used in time period being studied (gallons)
VOC_i	-	VOC content for coating type i (lb VOC emissions/gallon)
CF	-	air pollution control factor (%)
i	-	coating type (paint, varnish/shellac, lacquer, enamel, primer)

Equation H-9: Hydrocarbon Emissions For Painting Operations

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[5] Jagielski, Kurt D., and Robert J. O'Brien, *Calculation Methods for Criteria Air Pollutant Emission Inventories*, pp. 60-61.

H3.2.2 Data Sources

To estimate the hydrocarbon emissions from painting facilities at an airport and air bases, four data inputs are required: the type of coating used, the quantity of coating used, an uncontrolled emission index, and an air pollution control factor (if applicable).

H3.2.2.1 Type of Coating

Coatings include paint, varnish and shellac, lacquer, enamel, and primer. The airport operator, maintenance department, aircraft operator, or base operations department should be able to provide information on the type of coatings used.

H3.2.2.2 Quantity of Coating

The quantity of each type of coating used should be obtained and expressed in gallons. Information on the quantity of coating used should be obtained from the base operations section or maintenance department.

H3.2.2.3 VOC Content (by volume)

Material Safety Data Sheets (MSDS) or coating manufacturers should be consulted to obtain the volatile content, expressed in terms of pounds per gallon of solvent or VOC's. If this information is unavailable, default values from Table H-5 may be used.

Surface Coating	VOC Content (lb/gal)
Paint (Solvent Base)	5.6
Paint (Water Base)	1.3
Enamel	3.5
Lacquer	6.1
Primer	6.6
Varnish/Shellac	3.3
Thinner	7.36
Adhesive	4.4

Table H-5: VOC Content Of Common Surface Coatings[6]

[6] Source: Jagielski, Kurt D. , and Robert J. O'Brien, Calculation methods for criteria Air Pollutants Emission Inventories, p.60.

H3.2.2.4 Air Pollution Control Factor

Air pollution control equipment such as activated carbon adsorption or afterburner destruction of the vapors is sometimes used in painting operations. Information on the demonstrated effectiveness of these control methods should be obtained from the airport maintenance section, base operations department, or equipment manufacturers.

H3.3 Deicing Operations

H3.3.1 Methodology

Hydrocarbon emissions result from the application of deicing fluid to both aircraft and runways. Common aircraft deicing fluids are a mixture of water and propylene glycol or ethylene glycol. These chemicals are slightly volatile and a small fraction of the chemical is likely to evaporate after the deicing fluid is applied. Other chemicals present in runway deicing fluids include urea and other organic and inorganic salts, most of which are unlikely to contribute to HC emissions.

A methodology for estimating HC emissions from aircraft and runway deicing operations based on emission indices from independent sources is presented here. Because of the different practices for deicing of runways and aircraft, these two operations are considered separately and have two different emission indices. A similar methodology is used for both cases, however. The mass of organic chemical consumed (commonly propylene glycol or ethylene glycol) is determined by multiplying the volume of deicing fluid consumed by the density of the fluid and by the concentration of the chemical in the fluid. The calculated mass of organic chemical consumed is multiplied by an emission index to determine the hydrocarbon emissions from the application of the deicing fluid. The overall methodology is expressed by Equation H-10:

$$\mathbf{E_{HC} = \Sigma\ [QF_j \times D_j \times (C_{ij}/100) \times EI_{ij}]}$$

Where:

E_{HC}	-	annual HC emissions from deicing activities (pounds)
QF_j	-	quantity of deicing fluid used per year in operation type j (gallons)
D_j	-	density of deicing fluid used in operation type j (pounds/gallon)
C_{ij}	-	concentration of chemical i in deicing fluid for operation type j (percent by weight)
EI_{ij}	-	emission index for chemical used in deicing operation type j (pounds HC emissions per pound of chemical consumed)
i	-	chemical present in deicing fluid (propylene glycol, ethylene glycol, or other organic compound)
j	-	deicing operation (runway or aircraft deicing)

Equation H-10: Hydrocarbon Emissions For Deicing Operations

H3.3.2 Data Sources

H3.3.2.1 Quantity of Deicing Fluid Used

Quantities should be expressed in gallons and separated into fluid used for aircraft and runway deicing. This data requirement should not pose a problem because the two operations are usually maintained separately. This information may be obtained from the airport operator, deicing contractor, or base operations department.

H3.3.2.2 Density of Deicing Fluid

This information may be obtained from the maintenance section, base operations department, fluid manufacturer, or by calculation. The density should be expressed as pounds per gallon of fluid. To calculate the density of the deicing fluid, Equation H-11 should be applied. The equation is performed for each component, and results are totaled to obtain the total density.

$$\mathbf{D = \Sigma\ [D_w \times (C_k/100) \times SG_k]}$$

Where:

D	-	density of deicing fluid (pounds per gallon)
D_w	-	density of water (8.345 pounds per gallon)
C_k	-	concentration of component k in deicing fluid (percent)
SG_k	-	specific gravity of component k; specific gravity is a dimensionless ratio of the weight of the chemical to the weight of water
k	-	components of deicing fluid (water, ethylene glycol, propylene glycol, urea, polymer additives, etc.)

Equation H-11: Density of Deicing Fluid

The concentration of each component in the deicing fluid should be obtained from the airport operator, deicing contractor, or fluid manufacturer. Concentrations for all fluid components, including water, should be obtained. Therefore if a solution is given as 48% propylene glycol, then the remainder of the solution (52%) is assumed to be water.

Specific gravity for common deicing fluid components is given in Table H-6.

Fluid Component	Specific Gravity (dimensionless)
Water	1.000
Ethylene Glycol	1.119
Propylene Glycol	1.036
Urea	1.323

Table H-6 : Specific Gravity of Common Deicing Fluid Components[7]

[7] Source: *CRC Handbook of Chemistry and Physics, 63rd Edition* (Reference 92).

A 50% ethylene glycol deicing fluid is considered as an example. The weight of the ethylene glycol component, following the above equation, is 8.345 pounds/gallon x (50/100) x 1.119 = 4.669 pounds ethylene glycol per gallon of fluid. The other component of the fluid is water, which is also 50% of the fluid by weight. The weight of the water component is 8.345 pounds/gallon x (50/100) x 1.000 = 4.173 pounds water per gallon of deicing fluid. The total density of the deicing fluid, then, is 4.669 + 4.173 = 8.842 pounds/gallon.

H3.3.2.3 Concentration of Chemical in Deicing Fluid (By Weight)

This information should be obtained from MSDS sheets, deicing contractor, or fluid manufacturer. Common solutions are 50% propylene glycol in water or 50% ethylene glycol in water. In many cases, different chemical formulations are used for runway and aircraft deicing.

H3.3.2.4 Emission indices

Emission indices for an ethylene glycol solution applied to a runway and to aircraft have been calculated (Reference 19). An emission index of 0.0067 pounds HC emissions per pound of ethylene glycol applied should be used for runway deicing, and an emission index of 0.00011 pounds HC emissions per pound of ethylene glycol applied should be used for aircraft deicing. One should be careful to note that emissions are given per pound of ethylene glycol rather than per pound of deicing fluid, which also contains water. Equation H-11 takes this into account by employing a concentration factor. The emission indices given for ethylene glycol solutions may also be applied to propylene glycol, which is somewhat less volatile than ethylene glycol.

H3.4 Solvent Degreasers

H3.4.1 Methodology

The use of organic solvents such as chlorinated hydrocarbons, petroleum distillates, ketones and alcohol results in the evaporation of volatile organic compounds (VOC’s) or other hydrocarbons, which are subsequently either disposed of as waste liquids or released to the atmosphere. If water-based alkaline wash systems are used for degreasing, no evaporation of VOC’s or other hydrocarbons occurs.

The methodology for estimating evaporative hydrocarbon emissions from the operation of solvent degreasers is presented here. The methodology is based on the assumption that all solvent consumed by a solvent degreasing unit is either disposed of as waste liquid or released to the atmosphere as hydrocarbon emissions. The emissions to the atmosphere, therefore, are estimated by calculating the difference between the volume of solvent consumed and the volume of solvent disposed as liquid, and multiplying this difference by the density of the solvent. This methodology is expressed by Equation H-12, which computes the hydrocarbon emission for one solvent degreaser:

$$E_{HC} = D \times (QC - QD)$$

Where:

E_{HC}	-	hydrocarbon emissions from solvent degreasing unit (pounds)
QC	-	quantity of solvent consumed in solvent degreaser in given time period (gallons)
QD	-	quantity of solvent disposed of as liquid in given time period (gallons)
D	-	density of solvent (pounds per gallon)

Equation H-12: Hydrocarbon Emission For Solvent Degreasers

H3.4.2 Data Sources

H3.4.2.1 Quantity of Solvent Consumed

This information, expressed in gallons, should be available from the operator of the solvent degreaser.

H3.4.2.2 Quantity of Solvent Disposed as Liquid

This information, expressed in gallons, should be available from the operator of the solvent degreaser. If no records on solvent disposal are available, then it should be assumed that 100% of the solvent consumed by the solvent degreaser is released to the atmosphere as hydrocarbon emissions.

H3.4.2.3 Density of Solvent

Available from the operator of the solvent degreaser, from the solvent manufacturer, or from Table H-7. Density should be expressed as pounds per gallon.

Solvent	Density (lb/gal)	Solvent	Density (lb/gal)	Solvent	Density (lb/gal)
Acetone	6.604	Ether	6.136	1,1,1-Trichloroethane	11.174
Alcohol (ethyl)	6.604	Isopropyl alcohol	6.555	Trichloro-ethylene	12.219
Alcohol (methyl)	6.751	Methylene Chloride	11.070	Turpentine	7.259
Carbon tetrachloride	13.315	Perchloro-ethylene	13.541	Water	8.345
Chloroform	12.432	Stoddard Solvent	6.497		

Table H-7: Density of Common Solvents Used in Solvent Degreasers[8]

[8] Source: *CRC Handbook of Chemistry and Physics, 63rd Edition*.

H3.5 Sand/Salt Piles

A methodology for estimating emissions from material storage piles is given in Sections 13.2.4 and 13.2.5 of Volume I of EPA's *Compilation of Air Pollutant Emission Factors*. Methodologies are provided for the two chief emissions sources associated with storage piles: batch loading and unloading of material, and wind erosion of the piles.

H3.5.1 Methodology - Material Loading and Unloading

The major source of particulate emissions during loading and unloading of piles occurs as material is dropped from a loader onto the pile or into a truck. A methodology for calculating the particulate emission index for these events is provided in Volume I of *Compilation of Air Pollutant Emission Factors*, requiring only mean wind speed, material moisture content, and cutoff particle size (i.e. 10 μm if PM-10 is desired). Particulate matter emissions are estimated by multiplying an emission index by the quantity of material transferred to or from the pile during the desired time period. This is expressed by Equation H-13:

$$\mathbf{E_{PM} = 2 \times TH \times EI}$$

Where:

E_{PM}	-	total particulate emissions from pile loading and unloading
2	-	factor representing number of drops material undergoes; once during loading and once during unloading
TH	-	total throughput of sand and salt stored in pile in given time period (tons)
EI	-	emission index, given as pounds of particulate matter emitted per ton of material undergoing drop operation

Equation H-13: Particulate Matter Emissions for Sand/Salt Piles

H3.5.2 Data Sources - Material Loading and Unloading

The EPA methodology for calculating emissions during loading and unloading of material piles requires mean wind speed, pile moisture content, and the quantity of material loaded and unloaded.

H3.5.2.1 Mean Wind Speed (m/s)

For this calculation, only one figure for the mean wind speed at the airport is required. This may be obtained from the National Climatic Data Center or from the weather station on site.

H3.5.2.2 Pile Moisture Content (%)

This information can be obtained by direct sampling of the piles, or from the maintenance or base operations section. Section 13.2.4 of Volume I of *Compilation of Air Pollutant Emission Factors* provides information on the moisture content of material types by industry, such as 7.4% for a sand pile located at a municipal landfill. This value may be used if moisture content of piles located on the site is not available.

H3.5.2.3 Quantity of Material Loaded and Unloaded (tons)

This information should be obtained from the maintenance or base operations department. Because the methodology takes into account both loading and unloading of the pile, the desired information is the material "throughput" for each pile.

H3.5.3 Methodology - Wind Erosion

The second major source of particulate emissions from sand and salt piles is wind erosion of the piles. A detailed methodology for calculating these emissions is given in Section 13.2.5 of Volume I of *Compilation of Air Pollutant Emission Factors*. This methodology calculates the amount of erosion particulate emissions from the pile by applying an "erosion potential function" to each surface of the pile. The erosion potential function is affected by the following parameters:

- Moisture content of stored material
- Silt content of stored material
- Number of loading/unloading events in given time period
- Percent of pile disturbed in each loading/unloading event
- Physical dimensions of pile
- Threshold friction velocity of the material (i.e. the wind velocity at which wind shear stress is great enough to cause particles to be released from the material surface)
- Surface roughness height of material (a measure of the resistance to wind flow near the surface of the material caused by unevenness or roughness of the material)
- Wind speed and direction

The methodology is too complex to be reduced to a single equation. Although it is possible to perform these calculations by hand, the number of computations required for each pile is very large. EPA has incorporated this methodology into a freely available computer program, named *WIND* (Reference 91). The use of this program is strongly recommended.

H3.5.4 Data Sources - Wind Erosion

The EPA methodology for calculating particulate emissions due to wind erosion of storage piles requires several pieces of information about each pile, as described in paragraphs 3.5.4.1 through 3.5.4.8. As some of these parameters are not commonly available for each storage pile, default values are given in Sections 13.2.4 and 13.2.5 of Volume I of *Compilation of Air Pollutant Emission Factors*.

H3.5.4.1 Moisture Content of Stored Material (%)

This information can be obtained by direct sampling of the piles, or from the maintenance or base operations section. Section 13.2.4 of Volume I of *Compilation of Air Pollutant Emission Factors* provides information on the moisture content of a sand pile located at a municipal landfill: 7.4%. This value may be used as a default if moisture content of piles located on the site is not available.

H3.5.4.2 Silt Content of Stored Material (%)

Silt content is a measure of the percentage of material that passes through a No. 200 sieve. This can be obtained by direct sampling of the pile or from the maintenance or base operations department if this information has been recorded. Section 13.2.4 of Volume I of *Compilation of Air Pollutant Emission Factors* provides the silt content of a sand pile stored at a municipal landfill: 2.6%. This value may be used as a default if silt content of piles located on the site is not available.

H3.5.4.3 Frequency of Loading/Unloading Events

Wind erosion is a factor of the number of times the surface of the pile is disturbed through loading or unloading events. Information on the frequency of loading and unloading events should be obtained from the maintenance or base operations section.

H3.5.4.4 Percentage of Pile Surface Disturbed in Loading/Unloading Events

The methodology for calculating wind erosion assumes that erosion occurs in those surfaces of the pile that have been disturbed by unloading and loading activity. An estimate of the percentage of the pile surface disturbed in each event must therefore be calculated based on the material throughput rate and pile size, or if possible, from information supplied by the operator. Both Section 13.2.5 of Volume I of *Compilation of Air Pollutant Emission Factors* and the *WIND* program and user's manual describe the specific informational requirements needed for these calculations.

H3.5.4.5 Physical Dimensions of the Pile

Required dimensions include overall pile shape description (either flat, conical, or oval flat-topped), as well as pile height and diameter, expressed in meters. This information is available through direct observation or from the maintenance or base operations section.

H3.5.4.6 Threshold Friction Velocity of the Stored Material

The threshold friction velocity is the wind velocity at which wind shear stress is great enough to cause particles to be released from the material surface. This information can be obtained by sampling of the pile surface according to a method described in the Section 13.2.5 of Volume I of *Compilation of Air Pollutant Emission Factors*. Default parameters based on material type are provided in *Compilation of Air Pollutant Emission Factors* if sampling is not possible; however, threshold friction velocity is not given for either sand or salt. A default figure of 1.02 m/s, measured for overburden material at a coal mine, may be used if no other source of information is available.

H3.5.4.7 Surface Roughness Height of Stored Material (cm)

The surface roughness height is a measure of the resistance to wind flow near the surface of the material caused by unevenness or roughness of the material. For some materials, default parameters based on material type are provided in Section 13.2.5 of Volume I of *Compilation of Air Pollutant Emission Factors*. As with threshold friction velocity, surface roughness height is not explicitly given for sand or salt. A default figure of 0.3 cm may be used, based on a measured value for overburden material at a coal mine.

H3.5.4.8 Wind Speed

Required information is the “fastest mile” of wind recorded daily for the time period being investigated. The fastest mile is the highest measured wind speed, expressed in miles per hour, at which air is measured by an anemometer to travel one mile. This data is available in electronic form in the Local Climatological Data Summaries (LCD’s), provided by the National Climatic Data Center (Reference 29) for most airport weather stations.

Appendix I: Dispersion Methodology

Appendix I: Dispersion Methodology

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Appendix I: Dispersion Methodology

I1 BACKGROUND

The methodology used in dispersion modeling is quite different from the emissions inventory methodologies given in this document. Whereas the latter achieve their results using information specific to the sources, dispersion models provide a consideration of the context of the emissions, including the atmosphere, topography, and location of sensitive areas, as illustrated in Figure I-1. Accordingly, the computational requirements for dispersion modeling are much greater than for emission inventory modeling. In practice, however, computer-based dispersion models act as a sort of "black box"; as long as data inputs are properly specified, the dispersion model performs the necessary calculations and produces a summary of pollutant concentrations at each receptor. However, the user of a dispersion model should have an understanding of the basic modeling concepts and limitations prior to using the model in regulatory applications.

This section provides an overview of the procedures in the dispersion modeling process as well as a discussion of the mathematics of dispersion modeling.

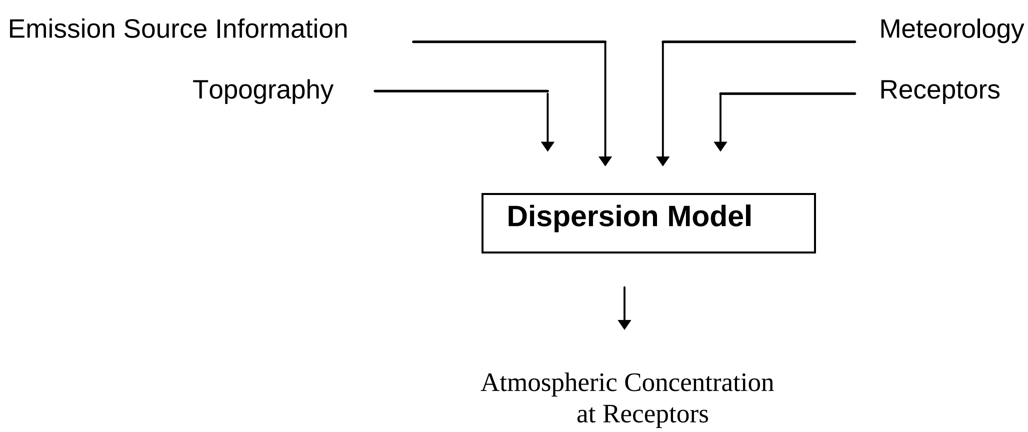

Figure I-1: Inputs and Outputs From Dispersion Modeling

The first step in dispersion modeling is to compile detailed information on the source or group of sources being modeled. This typically includes output from computer-based emission models, which should be properly formatted as input to the dispersion model. Additional information, such as source location coordinates and source geometry, is required by dispersion models. Second, local meteorological information is required, which typically is supplied by publicly available databases. For those locations with variable topography on or near the site, some dispersion models can accept as input a local topographic data set. However, the terrain around airports is usually flat enough to allow the modeler to ignore the effects of topography on pollutant dispersion.

Finally, receptor locations are identified by the user. These are the locations for which pollutant concentrations will be calculated by the model. If an overall view of the air quality on and off the site is required, then a grid of receptors may be used. If a small number of "sensitive" locations is the only area of interest, computational requirements may be reduced by specifying receptors only at those locations. "Sensitive" locations generally include any areas where the public is likely to be present — a key component for NAAQS assessments. Receptors may be located any distance away from the emission sources, but most models rely on relatively simple mathematical models that restrict the distance from the source for which a dispersion calculation may be considered accurate. Selection of receptor locations should follow the guidelines set forth below or as required by the appropriate regulatory agency.

For each time period specified, the contribution of each emission source to the concentration at each receptor must be calculated. Therefore if 50 separate sources are modeled at an airport, with 100 receptors specified, then 5,000 dispersion calculations must be made for each time period being modeled. This can lead to a very large computational requirement if a large number of time periods is modeled.

The output of a dispersion model is the average concentration of a pollutant or set of pollutants at each receptor over a specified time period, typically corresponding to the time periods required by NAAQS assessments. Depending on the pollutants modeled, the concentrations are given as a one-hour average, eight-hour average, 24-hour average, or annual arithmetic mean.

Computer-based dispersion models typically require the user to provide only the requested input data in the proper format; no understanding of the mathematics behind the model is necessary. However, the basics of dispersion modeling are presented below so that the reader may appreciate the techniques and limitations of these models.

Most dispersion models use a relatively simple mathematical approximation to estimate the steady-state concentration of pollutants at a receptor resulting from a single emission source, such as a boiler stack. Multiple emission sources are treated individually. A Gaussian approximation, as given in Equation I-1, has been found to simulate adequately the steady-state dispersion of pollutants from a continuous point source:

$$C(x;y;z;H) = \frac{Q}{2\pi\sigma_y\sigma_z u}\exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]\left\{\exp\left[-\frac{1}{2}\left(\frac{z-H}{\sigma_z}\right)^2\right]+\exp\left[-\frac{1}{2}\left(\frac{z+H}{\sigma_z}\right)^2\right]\right\}$$

Where:

C	-	point concentration at receptor, $\mu g/m^3$
H	-	effective height of emissions, m
Q	-	mass flow of contaminants from receptor, $\mu g/s$
u	-	wind speed, m/s
x,y,z	-	ground level coordinates of receptor, m
σ_y	-	standard deviation of plume concentration distribution in y plane, m
σ_z	-	standard deviation of plume concentration distribution in z plane, m

Equation I-1: Gaussian Approximation

A common simplification is to assume that all receptors are at ground level. This allows simplification of Equation I-1 to Equation I-2:

$$C(x;y;0;H) = \frac{Q}{\pi \sigma_y \sigma_z u} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right] \exp\left[-\frac{1}{2}\left(\frac{H}{\sigma_z}\right)^2\right]$$

Equation I-2: Gaussian Approximation (Receptors at Ground Level)

This model of pollutant dispersion makes several key assumptions. The main assumption is that the plume of dispersed pollutants follows a Gaussian distribution in both the horizontal and vertical planes, as illustrated in Figure I-2.

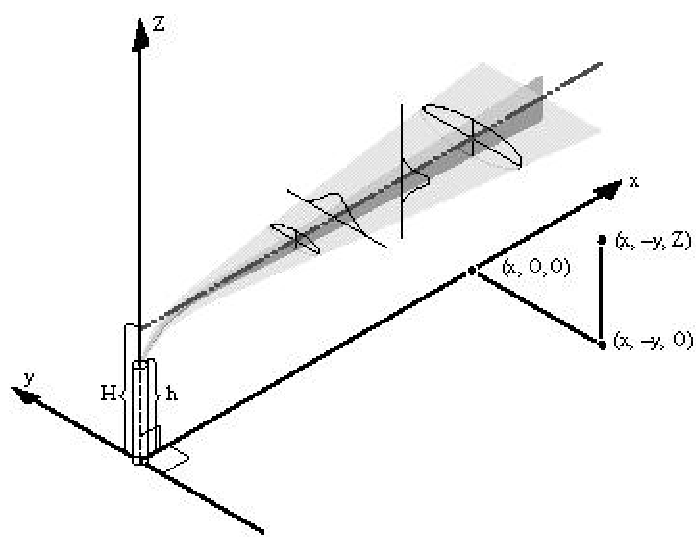

Figure I-2: Coordinate System Showing Gaussian Distributions in the Horizontal and Vertical Planes

Wind tunnel tests have shown this to be an adequate representation of some pollutant plumes, although in practice large variations from the ideal have been observed. The standard deviation factors σ_y and σ_z represent the degree of "spreading" of pollutants horizontally and vertically during plume movement. High standard deviation values would result from an unstable, turbulent atmosphere, whereas low values would occur in less turbulent atmospheric conditions. These factors are calculated using the Pasquill-Gifford stability classification system, described in paragraph 2.2.2.

Other assumptions include a constant wind speed from the negative-x direction, with no adjustment for changing wind speed with height; continuous emissions from a single point source at a rate indicated by the factor Q; upwind pollutant concentration of zero; no removal of pollutants by settling and deposition on the ground (i.e. total reflection of the plume at the earth's surface); and no removal of pollutants by chemical transformation to other species. The combination of these assumptions allows a calculation of steady-state concentration at any specified receptor downwind of the source. The assumption of zero upwind concentration of each pollutant allows the modeling of only those emissions resulting from the sources being modeled. When performing an NAAQS assessment, however, it is necessary to add those dispersion model results to ambient or background pollutant levels measured for the area to determine whether or not the source will produce enough additional pollution to cause a violation of the NAAQS.

In modeling a complex emission system, such as an airport, a dispersion model is likely to represent sources as point, line, and area emissions, based on the type of sources identified in the emissions inventory. Point sources include stationary emission points such as sand piles, boiler stacks, and painting operations. Modeling of these sources is straightforward, using the Gaussian point source approximation given above. In some cases, mobile sources may also be modeled as point sources. For example, the takeoff roll and climb of an aircraft are most easily modeled as a series of "puffs," each of which is treated as a single Gaussian point source with a duration of a few seconds.

Roadways may be modeled as line sources or a series of point sources. The line source approximation involves the solving of an integral along the specified line, which results in a greater computational requirement than the approximation as a series of point sources. Both calculations are based on the Gaussian model, with similar results expected in most cases. A dispersion model may include adjustments for factors associated with roadways that affect turbulence, such as surface roughness. Surface roughness of the area near the roadway has an effect on dispersion because the source of emissions is very close to the ground, and may be required as input to some dispersion models.

Parking lots may be modeled as area sources, a series of line sources, or as a series of point sources. Because each type of model relies upon the same Gaussian approximation, results should be independent of the type of model used as long as the receptor is located far enough away from the parking lot. The key factors in choosing one source model over another are the difference in computational demand and whether EPA has "approved" the model for use on the particular type of application.

Dispersion models using a Gaussian approximation of pollutants have been applied for many years to emissions from stacks at industrial and utility sites. For those cases, the important issues in dispersion modeling have been incorporating estimates of plume rise and downwash of the plume at the stack tip and nearby buildings. At airports, stack emissions make up a very small component of the total emissions, with the majority arising instead from mobile sources such as aircraft, passenger vehicles, and ground support equipment. However, the Gaussian approximation is a general-purpose dispersion equation that has been modified for use on mobile source emissions as well as stack emissions.

I2 DATA INPUTS

This section outlines various data inputs required for a dispersion modeling run. These include characteristics of each emission source, meteorological parameters such as wind speed and direction, local topography, and receptor locations.

I2.1 Emission Sources

Dispersion models require several pieces of information about each emission source being included in the model, including:

- Source type.
- Emissions of each pollutant for each time period being investigated.

Depending on the source type, some additional information about the sources is likely to be required to model dispersion of pollutant emissions. These additional information requirements include:

- Source layout, including location and height.
- For stack emissions, parameters including stack gas temperature, exit velocity, and inside stack diameter.
- For mobile sources, surface roughness length of surrounding area.

The data requirements and likely sources of information are listed below.

I2.1.1 Source Type

Dispersion models for complex sites such as airports provide categories for each of the source types likely to be found on the site. These categories are necessary because of the differences in the way that the sources are represented in the dispersion model. For example, stacks are modeled as stationary point sources with a rising plume whereas roadways may be modeled as a line source with no plume rise but with consideration of the effect of surface roughness on dispersion. Therefore, specification of the source category type tells the computer how to model a given source and which additional pieces of information are required.

I2.1.2 Emissions of Each Pollutant

The main goal of the source inventory is to estimate the emissions of pollutants from each source. The pollutants of concern at airports are generally CO, NO_x, SO_2, PM-10, and HC. For some sources, such as aircraft engines, emission factors are available for all of these. Other sources emit only one pollutant. For example, particulate matter is the only air pollution problem associated with sand or salt piles. The emissions inventory typically provides an average rate of emissions of each pollutant for each source.

I2.1.3 Location and Height of Emission Sources

The physical layout of the emission sources is required by a dispersion model because the goal is to provide a pollutant concentration in air that varies with location. To this end, all sources should be located on a master grid that is used for the dispersion model. The height of the emission point is also required for each source, as it is used in the Gaussian equation to calculate ground-level concentrations downwind. Estimates of source location and height should be readily available from the airport operator or base operations section.

I2.1.4 Stack Characteristics

Stack emissions, which make up a very small percentage of the overall emissions at airports, require an estimate of plume rise before the Gaussian approximation may be applied. Plume rise is a result of thermal buoyancy of the stack gas and the vertical momentum of the gas as it leaves the stack. Three parameters are required to calculate plume rise that are not otherwise collected in the emissions inventory: stack gas temperature, vertical velocity of the gas exiting the stack, and the inside diameter of the stack. These may be obtained by direct sampling of the stack.

I2.1.5 Surface Roughness Length

The surface roughness length of the area surrounding the roadway is often a required input parameter in the dispersion modeling of emissions from mobile source. The surface roughness length, in meters or centimeters, is a measure of the near-surface wind resistance. Table I-1 provides typical surface roughness lengths for a variety of land uses.

Surface Type	Surface Roughness Length (cm)
Smooth desert	0.03
Grass (4 cm)	0.14
Grass (5-6 cm)	0.75
Alfalfa (15.2 cm)	2.72
Grass (60-70 cm)	11.40
Wheat (60 cm)	22.00
Corn (220 cm)	74.00
Citrus Orchard	198.00
Fir Forest	283.00
City Land Use:	
- Apartment residential	370.00
- Central business district	321.00
- Office	175.00
- Park	127.00
- Single family residential	108.00

Table I-1: Surface Roughness Lengths for Various Land Uses[1]

I2.2 Meteorology

Dispersion of pollutants in the atmosphere is largely dependent upon meteorological conditions, especially the following:

- Wind speed and direction,
- Atmospheric stability,
- Mixing depth.

[1] Source: EPA Office of Air Quality Planning and Standards, *User's Guide to CAL3QHC Version 2.0*, EPA-454/R-92-006, September 1995, p. 30.

A wide range of meteorological data is collected hourly at most airports. This information is available from the National Climatic Data Center in a digital format ready for use by most dispersion models. One year to several years' data is required by regulatory agencies for a modeling run to be considered valid.

I2.2.1 Wind Speed and Direction

Wind speed and direction are important parameters in modeling the dispersion of pollutants in the atmosphere. The Gaussian approximation assumes that wind speed is constant from one direction for a given time period being modeled, usually one hour. Wind speeds are usually measured by an anemometer at a height of 20 feet or sometimes 10 m. These measurements may or may not be corrected by the dispersion model to account for increasing wind speed with height.

For those time periods in which the wind speed is given as zero or "calm", a model will generally assign a minimum wind speed. If a wind speed of zero were specified, the Gaussian equation would compute an infinite concentration of the pollutant at the source, with no dispersion. In reality, diffusion of pollutants into the surrounding atmosphere would take place in calm conditions.

I2.2.2 Atmospheric Stability

Atmospheric stability and the presence of atmospheric turbulence are predominant factors that determine the rate at which airborne pollutants are diffused. A region of the atmosphere with strong vertical motion enhances dispersion by scattering pollutants through a larger volume of air. Atmospheric stability determines the extent to which vertical mixing will occur and, consequently, the degree to which airborne pollutants are mixed within a parcel of air. Stability is influenced strongly by vertical temperature distribution. Horizontal mixing of the atmosphere also influences the pathway of airborne pollutants through wind speed and related turbulence. In general, atmospheric stability is a function of the temperature distribution with height, solar radiation, cloud cover, and wind speed.

The stability is expressed in terms of the Pasquill-Gifford (P-G) stability classification system, which identifies six classes ranging from A (very unstable) to F (very stable). In unstable atmospheric conditions, the high turbulence and associated vertical mixing produce a peak ground-level pollutant concentration near the emission source, with low concentrations at distances far from the source. The most unstable conditions occur during daylight hours, with low wind speeds and high solar radiation contributing to higher instability. In stable atmospheric conditions, the low level of vertical mixing results in a low ground-level steady-state concentration near the source, with comparatively higher concentrations at long distances from the source. The most stable atmospheric conditions occur at night, during times of low wind speeds and clear skies. Dispersion models convert wind speed data, cloud cover data, and solar radiation to the corresponding stability category, according to Table I-2. Some models require the direct input of stability categories along with other meteorological data.

Once the proper P-G stability category has been identified, the Gaussian standard deviation factors σ_y and σ_z may be calculated. Dispersion models perform this calculation internally, with no additional input required from the user. A methodology for calculating these values is given in Turner's "Workbook of Atmospheric Dispersion Estimates," in EPA's *APTI Course 423: Dispersion of Air Pollution — Theory and Model Application, Selected Readings Packet*, p. 1-6 (Reference 40).

Surface Wind Speed (at 10m) (m/s)	Day			Night	
	Incoming Solar Radiation			Cloudy	Clear[2]
	Strong	Moderate	Slight[3]		
<2	A	A-B	B	E	F
2-3	A-B	B	C	E	F
3-5	B	B-C	C	D	E
5-6	C	C-D	D	D	D
>6	C	D	D	D	D

Table I-2: Key To P-G Stability Categories[4]

I2.2.3 Mixing Layer Height

In some models, the dispersion calculation is modified to consider the effects of the mixing layer height on pollutant concentration. The mixing layer height (also known as the mixing depth or inversion layer height) is the elevation of the boundary between the vertically mixed layer of air closest to the earth's surface and the relatively stable layer of air above. Vertical diffusion of pollutants occurs readily within the mixing layer but does not occur to any significant degree within the stable layer. The height of the mixing layer generally ranges between 1,000 ft and 4,000 ft depending upon weather conditions and time of day. The boundary between the two layers is evidenced by the bottom of cumulus clouds.

The presence of a stable layer above the mixing layer has the effect of restricting vertical diffusion of pollutants. This "lidding" effect requires a modification of the simple Gaussian approximation for it to remain accurate at distances greater than several kilometers downwind of the emission source. For applications such as airports, however, where the major pollutant of concern (CO) is not likely to be transported at high concentration very far from the source, mixing depth effects on downwind pollutant concentrations may be ignored without too much loss of accuracy.

I2.3 Topography

Many dispersion models require topographic information for the area being modeled. Digitized topographic information for all sites in the U.S. is available from the United States Geological Survey and other sources, but this data must be properly formatted and aligned with the grid used to determine the layout of the site.

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[2] Meteorologists divide the sky into eight sections to determine the degree of cloud cover. If three or fewer sections contain clouds, the sky is considered clear: if four or more section have clouds, the sky is considered cloudy.

[3] Category D should be used for overcast conditions during day or night.

[4] Source: Turner's "Workbook of Atmospheric Dispersion Estimates," in EPA's *APTI Course 423: Dispersion of Air Pollution — Theory and Model Application, Selected Readings Packet,* p. 1-6.

The simple Gaussian approximation given above is not reliable in areas of complex terrain (i.e., areas in which the terrain rises above the effective emission height), and may not be valid in intermediate terrain (i.e., areas in which the terrain rises above the stack height but not the effective emission height). Models have been developed for use in complex and intermediate terrain, but the focus of these models is stationary point source emissions rather than mobile sources, which are the greatest emission sources at airports and air bases.

Terrain in the vicinity of airports is usually quite flat because of the requirement for a level runway, approach, and climb-out area. Dispersion models can take advantage of this property of airport locations to make the simplifying assumption that the terrain is flat. This assumption allows the model to use the Gaussian approximation with no modifications that would increase the computational requirement.

I2.4 Receptors

Receptors are defined by the user as those areas in which pollutant concentrations in air are to be calculated. If an overall view of pollutant concentration on and off the site is desired, then a grid of receptors should be defined. For many applications, however, only those locations defined as "sensitive" (i.e., where the public is likely to come into contact with emissions) may be modeled in order to reduce the computational requirement. For a complex emissions scenario such as an airport, reducing the number of receptors may be necessary because each receptor defined may add hours to the computation time.

Appendix J: State Indirect Source Review Regulations

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J1. OVERVIEW

Several states have Indirect Source Review (ISR) regulations. ISR regulations establish threshold levels above which an air quality review is required. ISR thresholds vary by state, and in a few states, may only apply to a small localized area. For those ISR regulations applicable to airports and air bases, the thresholds usually are based on parking lot capacity, highway (annual daily or hourly) traffic volume, and/or airport annual passengers or aircraft operations. Airports and air bases below the threshold levels would be exempt from the review.

Table J-1 lists ISR thresholds for states that have ISR regulations at the time of this writing. Individual states should be contacted regarding the specifics of their ISR regulations.

Table J-1: State Threshold Criteria for Indirect Source Review[1]

State	Parking Lots	Highways[2]	Airports
California (North Coast Air Basin[3])	1,000 new spaces or increase of 1,000 new spaces	20,000 ADT	50,000 annual aircraft operations by regularly scheduled air carriers or 1,600,000 total annual passengers
Connecticut		new highway on a new location, new expressway interchange service, or new lane greater than a mile in length and connecting either signalized intersections or expressway interchanges	
Minnesota	2,000 new spaces, increase of 1,000 new spaces, or increase to 2,000 total spaces	20,000 ADT (within a metropolitan area) or increase of 10,000 ADT	1,000,000 new or total annual passengers on regularly scheduled air carriers and commercial charter flights
New York[4]	state or federally owned parking facility, including a lot or garage	20,000 ADT or increase of 10,000 ADT	
North Carolina	Lot(s): 1,500 new spaces[5] or increase to 1,500 total spaces[5]; 500 spaces beyond the last permitted number of spaces of an existing lot(s) with at least 1,500 spaces Deck/Garage: 750 new spaces[6] or increase to 750 total spaces[6]; 250 spaces beyond the last permitted number of spaces of an existing deck/ garage with at least 750 spaces Lot(s)/Deck/Garage Combination: 1,000 new spaces[7] or increase to 1,000 total spaces[7]; 500 spaces beyond the last permitted number of spaces of an existing combination with at least 1,000 spaces		100,000 annual aircraft operations or 45 peak-hour aircraft operations
Oregon	250 new spaces or increase to 250 total spaces, except for Portland with 150 spaces[8] 500 new spaces or increase to 500 total spaces[9] 1,000 new spaces or increase to 1,000 total spaces	20,000 ADT, increase to 20,000 ADT, or increase of 10,000 ADT[10] 50,000 ADT, increase to 50,000 ADT, or increase of 25,000 ADT	50,000 annual aircraft operations or increase of 25,000 annual aircraft operations
Utah	600 new spaces or increase of 350 spaces		
Vermont	CO Attainment:[11] 1,000 new spaces or increase of 500 spaces CO Nonattainment:[12] 500 new spaces or increase of 250	CO Attainment:[11] 20,000 new ADT or increase of 10,000 ADT CO Nonattainment:[12] 10,000 new ADT or increase of 5,000 ADT	

	spaces		
Wisconsin	Metropolitan County:[13] 1,000 new spaces or increase of 1,000 spaces Non-Metropolitan County:[14] 1,500 new spaces or increase of 1,500 spaces	Metropolitan County:[13] 1,200 peak-hour vehicle volume (including a intersection leg) or increase of 1,200 peak-hour vehicle volume Non-Metropolitan County:[14] 4 new lanes of traffic, new intersection with 4 lanes of traffic for each leg, or 2 additional lanes of traffic (including intersections); or, 1,800 peak-hour vehicle volume (including a intersection leg) or increase of 1,800 peak-hour volume	

1 Refers to construction permits/approval

2 ADT is an abbreviation for average daily trips. For New York and Wisconsin, threshold criteria also applies to roads.

3 Comprise of the counties of Del Norte, Trinity, Mendocino, and part of Sonoma County.

4 Applies only in the County of New York south of 60th Street.

5 1,500 spaces or 450,000 square feet (i.e., 1,500 spaces at 300 square feet per stall).

6 750 spaces or 225,000 square feet (i.e., 750 spaces at 300 feet per stall).

7 1,000 spaces or 300,000 square feet (i.e., 1,000 spaces at 300 feet per stall).

8 Applies only to sources in or within five miles of the municipal boundaries of a municipality with a population of 50,000 or more including, but not limited to, Portland, Salem, and Eugene; or, sources within the State Implementation Plan Medford Carbon Monoxide nonattainment area boundary.

9 Applies only to sources within Clackamas, Lane, Marion, Multnomah, or Washington Counties and the municipal boundary of Medford.

10 Applies only to sources in or within five miles of the municipal boundaries of a municipality with a population of 50,000 or more including, but not limited to, Portland, Salem, and Eugene; or, sources within Clackamas, Jackson, Lane, Marion, Multnomah, or Washington Counties.

11 Applies to sources in municipalities that have been designated as attainment areas for carbon monoxide.

12 Applies to sources in municipalities that have been designated as nonattainment areas for carbon monoxide or in which the applicable ambient air quality standard for carbon monoxide is being exceeded as shown by modeling or acceptable monitoring data.

13 Applies to sources within a metropolitan county.

14 Applies to sources outside metropolitan counties.