DRAFT

Alaska Aviation Emission Inventory

Prepared for:

Western Governor's Association
Western Regional Air Partnership

January 13, 2004

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Introduction

Background

The Western Regional Air Partnership (WRAP) is a collaborative effort of tribal governments, state governments, and various federal agencies to implement the recommendations of the Grand Canyon Visibility Transport Commission and to develop the technical and policy tools needed by western states and tribes to comply with the U.S. Environmental Protection Agency's (EPA) regional haze rule. Other common western regional air quality issues raised by the WRAP membership may also be addressed. WRAP activities are conducted by a network of committees and forums composed of WRAP members and stakeholders who represent a wide range of viewpoints.

The EPA regional haze rule calls for visibility improvements in the national parks and wilderness areas in the country through the cooperation of state, tribal, and federal agencies. In order to identify the major sources of regional haze pollution, sources of visibility-related pollutants (mostly fine particulates) need to be analyzed and inventoried. The WRAP Emissions Forum is tasked with compiling emission inventory information for use in meeting regional haze rule requirements.

In Alaska, one potentially significant source of visibility-related pollutants is aircraft travel. Aircraft travel is commonplace in Alaska, because terrain conditions are often inhospitable to motor vehicle travel, roads and facilities are scarce, and there are large distances between communities. Consequently, there are about 600 registered airports and more than 3,000 small airstrips in the state.[11]

Emissions of carbon monoxide (CO), hydrocarbons (HC), oxides of nitrogen (NOx), oxides of sulfur (SOx), and particulates (PM) result from incomplete combustion of fuel in aircraft. Emission rates vary depending on the engine setting, which is typically constant over the different aircraft flight modes. The different aircraft operating modes include taxi and queue, take-off, climb-out, cruise, approach, and landing roll. The taxi and queue mode and the landing roll are typically considered together as the aircraft idle mode. The take-off mode is defined by the Federal Aviation Association (FAA) as the time from the start of ground roll until the aircraft reaches 1,000 feet. For ground-level emissions inventory purposes, climb-out mode is defined as the ascent from 1,000 feet up to the defined mixing height, and the approach mode includes the aircraft's descent from the mixing height to the ground. Above the mixing height, the aircraft is in cruise mode.[2] The combination of the six modes makes up a complete landing and take-off cycle (LTO) for an aircraft. Since emissions are relatively stable during each operating mode, emission factors for aircraft engines are given in terms of emissions per length of time the aircraft spends in the operating mode. The time-in-mode (TIM) varies for each aircraft category and model type, and, especially for taxi and queue time, for each airport. The different aircraft categories include the following:

- Air carriers, which are larger turbine-powered commercial aircraft with at least 60 seats or 18,000 lbs payload capacity;

[1] Superscripts denote references provided at the end of this document.

- Air taxis, which are commercial turbine or piston-powered aircraft with fewer than 60 seats or less than18,000 lbs payload capacity;
- General Aviation Aircraft, which are small piston-powered, non-commercial aircraft; and
- Military Aircraft.

Emissions of CO predominate during idle operations, and emissions of HC also increase during idle. NOx emissions predominate during take-off, climb-out, and approach. Cruising emissions have not been quantified much in the past; however, estimates made by the California Air Resources Board (CARB) during a recent study used an average of the climb-out and approach emission factors to estimate cruising emissions.[3]

In developing a complete aircraft emissions inventory for Alaska, some key issues that complicate the analysis will need to be addressed. The first concerns the identification of all airports, airbases, and airstrips for a thorough analysis. Records kept by the FAA include only airports that can qualify for Federal funding; that is, they meet certain minimum criteria for activity levels and accessibility. Because of this, the records do not include literally thousands of small private airstrips commonly found throughout Alaska. Secondly, the aircraft model-specific data necessary to use emission models developed by the FAA are limited to the air carrier category (i.e., large commercial aircraft). Activity levels for air taxi, general aviation, and military aircraft are kept for larger airports; however, the data show operations only by aircraft categories and not by airframe model, which is necessary for modeling. For smaller airports and airstrips, records for any aircraft flying in and out of the site are typically not even kept. Lastly, analysis performed on aircraft emissions in the past related only to ground-level effects. Consequently, no guidance has been developed to account for aircraft emissions beyond the mixing height (cruising emissions), and computer models developed specifically to estimate aircraft emissions consider only non-cruising emissions.

Key issues to be resolved in preparing a statewide estimate of airport emissions include:

- Most of the smaller airstrips in Alaska are "backyard airstrips" or makeshift gravel landing sites that do not require permits, certifications, and flight plans. All aircraft traffic in and out of these sites is operated under visual flight rules (VFRs), often without support from air traffic control towers. Primarily situated on private lands, these airstrips are used intermittently, and the lifespan of the land use as an airstrip can be very short. As a result, they are not registered, and no regional, state, or federal records are available to identify their locations.

- Since there are no records for smaller airstrips and there is no requirement to file flight plans for VFR flights, there are few data to characterize either the extent or the location of these flights.

- Limited seasonal activity information is available by airframe-model for the larger airports. Insight into seasonal variation is needed to address EPA's National Emission Inventory (NEI) reporting requirements.

- Operating data for flights at smaller airports are limited to general categories of aviation, not airframe-model. Since EDMS and related emission factor data require airframe-model specific activity estimates, effort will be needed to generalize the available emission factors and match them to the available activity data.

Approach

The data available to identify, locate, and estimate activity for airports and airstrips in Alaska are extremely limited, and what data are available vary in quality and quantity. The larger airports subject to the permitting, funding, and record keeping requirements of the Federal Aviation Administration (FAA) are very well documented. This information can be obtained from a number of different sources. Of these larger airports, the most data are available for those with commercial air carrier service—a total of about 114 airports—because air carriers are required to submit detailed (airframe model-specific) air traffic records to the FAA. The next tier of data availability includes the other "registered" airports required by FAA to submit federal notification for official activation as an airport, and airports undergoing construction and alterations under Federal Aviation Regulation Part 157. These registered airports comprise an additional 576, on top of the 114 airports with air carrier service, for which the data necessary for an emissions inventory analysis are readily available from Airport Master Records or Form 5010-1 submittals. The big question for this study is how the remaining airports and airstrips—over 2,000[1]—will be identified and located, and how activity for these undocumented and unregistered airports will be estimated.

The most comprehensive effort to identify and locate all of the airports and small airstrips in Alaska was a survey conducted by the Alaska Department of Transportation and Public Facilities (DOT&PF) Aviation Division in 1994 (DOT survey).[4] DOT&PF contracted a study of all available airport documentation, as well as on-site surveys, in order to develop a Statewide Aviation System Plan. Alaska DOT&PF aimed to identify and locate all the airports and airstrips in the state to assess the aviation needs and assist future aviation planning in Alaska. Their study resulted in identifying and locating a total of 1,112 airport and airbases. This provides location data for an additional 422 airports and airstrips. When this number is combined with the 690 registered airports with FAA documentation, and the sum is subtracted from an assumed total of about 3,000 airports and airstrips in the state, the result indicates approximately 1,888 airstrips that are unaccounted for in Alaska.

Although the Statewide IPP and WRAP procurement recommends a survey of the (1,888) airstrips for which there are no data, Sierra and CH2M HILL believe that this type of survey would not provide the most cost-effective means to identify these sites and estimate emissions. From conversations with local pilots in Alaska, members of the Alaskan Aviation Safety Foundation, FAA, and DOT personnel, it is clear that the following factors will hinder this type of survey effort, and result in inaccurate estimates:

[1] Assuming a total of about 3,000 airports and airstrips in the state.

- The sheer number of airstrips scattered throughout the state presents a daunting task to sample, as there are no clear geographical boundaries for survey regions or areas;

- Disorganization and lack of management at the sites and the isolation of some sites provide no clear airstrip representative to survey;

- Many of the airstrips show very random and irregular use patterns that would not be accurately represented by one-time survey observations; and

- The short lifespan of some of these airstrips, for reasons such as brush overgrowth, change in land-use by the land owner, and flooding or freezing, would yield survey results that are outdated in a few months.

Due to the data and survey limitations discussed above, a tiered approach to analyzing the airport emissions and a modified survey approach will be pursued. Information on all of the known and unknown airports will be organized into common groups or tiers (e.g., large international, hubs, military, airports with data, airports without data, etc.). Surveys will be used to fill in data gaps and verify existing information sources. Table 1 shows the data profile of the different airports in Alaska, along with descriptions of the data and sources available for each airport category. As shown in Table 1, surveys will be used to supply information for the unregistered airstrips and supplement available airframe model data. In addition, surveys will be used to verify or identify airstrip location data, and estimate seasonal activity. Where possible, a survey of local airport managers and pilots will be conducted to corroborate and estimate the following:

1. The existence and location of the small airstrips in the area,
2. The estimated airframe model distribution in the area,
3. The frequency of local general aviation flights, and
4. The seasonality of activity in the area.

CH2M HILL staff, located in Alaska, will conduct the surveys.

Organization

The remainder of this report is organized to address the methods that will be used to compute emissions from the data obtained in the surveys and the quality assurance procedures that will be employed in the development of the emission inventory estimates.

Table 1
Profile of Alaska Airports Based on Activity and Available Data Sources

Airport Category	No. of Airports	Key Data Sources			
		FAA Tower Records	DOT&PF Aviation	FAA Airport Master Record	Other
Larger Airports with Commercial Activity	~114	- Route Air Carrier Statistics by Airframe Model	- Location Latitude and Longitude	- Annual Activity by Operation Category[a]	- Airport Master Plan Activity Estimates (Available for Some) - SIP/Maintenance Plan Air Quality Analysis (Available for Some)
Medium-Sized DOT-Surveyed Airports with No Commercial Activity	576	--NA--	- Location Latitude and Longitude	- Annual Activity by Operation Category	- Aircraft Registry Provides Airframe Model Distribution - Survey to Support Aircraft Registry Model Distribution and Seasonality of Activity
DOT-Surveyed Small Airstrips (Long-Term, Mostly Private Airstrips)	422	--NA--	- Location Latitude and Longitude	--NA--	- Aircraft Registry Provides Airframe Model Distribution - Survey to Support Registry, Activity Estimate, and Seasonality of Activity
Undocumented and Unregistered Small Airstrips (Backyard Airstrips and Makeshift Gravel Runways)	~1,888	--NA--	--NA--	--NA--	- Aircraft Registry Provides Airframe Model Distribution - Survey to Support Registry, Activity Estimate, and Seasonality of Activity
TOTAL	~3,000				

Aviation Emissions Data and Methodology

Collection of Aircraft Activity Data

Sierra and CH2M HILL will compile the available airport identification and activity data from the DOT&PF Aviation Division, the FAA, and the Airport Master Records (FAA Form 5010-1). In addition, Airport Master Plans developed by each airport and the air quality analyses will be obtained, where available. A description of the data available from these sources, along with the limitations inherent in each data set, is shown in Table 2. As noted in the Introduction, a survey of local airport managers and pilots will also be conducted. A sample of possible survey questions for airport managers and pilots follows.

Table 2
Airport Identification and Activity Data Sources

Source	Data Description	Use	Limitations
FAA	Air Traffic Activity Data System (ATADS) historical monthly air traffic statistics	Provide activity estimates by season	Include only towered airports and no airframe model data for emission modeling
Airport Master Record	FAA Form 5010-1 reports of airport location (latitude and longitude) and annual operations data	Provide annual activity estimates and location data for county allocation	About 689 airports are reported and no seasonal or airframe model data are available
DOT&PF Aviation	1994 location survey of airports and airstrips in Alaska	Most extensive airport location data for county allocation (1,112 airports)	Does not report all of the small airstrips located throughout the state and does not include activity data
FAA	Airport Activity Statistics of Certified Route Carriers (Route Carrier Statistics)	Most extensive airframe-model data by airport for air carriers	Only the largest 114 airports in Alaska are included, air carrier detail only, and no seasonal activity given
Airports	Airport Master Plans	Most accurate activity records for given airport	Only a handful of Airport Master Plans are developed and not all may be readily available to the public
Air Quality Agency	SIP/Maintenance Plan Airport Air Quality Analysis	Provides model runs and inventory estimates for some pollutants	Available only for larger airports and air bases in the major urban areas

Sample Survey Questions

1. Are there small private airstrips wherein general aviation aircraft fly under visual flight rules (VFR)[1] in your city/area? If yes, how many would you estimate there are?
2. How busy would you say these airstrips are on average: 1-4 flights a month, 5-10 flights a month, 1-3 flights a week, or 4-10 flights a week? If none of these, how many flights would you estimate there are at these airstrips on average?
3. Are these airstrips busier during some seasons more than others? If yes, which seasons are busier and by how much?
4. What aircraft models/types are typically flown in those small airstrips?
5. If you are a pilot yourself, how often do you fly your aircraft?
6. If you own your own aircraft, is it registered in the same area from which you fly?

We plan to send surveys to a mixture of airport managers and pilot organizations. Resources have been allocated to contact approximately 100 separate organizations. Phone calls will be made to staff receiving the surveys to conduct phone interviews. When operational data are not available we will request information on fuel consumption and broader questions about daily operations and types of aircraft using specific facilities.

Aircraft and GSE/APU Emissions Methodology

The current FAA required method for estimating aircraft emissions at airports employs the use of the FAA's Emissions and Dispersion Modeling System (EDMS). EDMS estimates aircraft emissions of sulfur oxides (SOx), oxides of nitrogen (NOx), particulate matter (PM), carbon monoxide (CO), and hydrocarbons (HC) and has the capability to model emissions from aircraft and ground support equipment and auxiliary power units (GSE/APU) emissions. In order to perform aircraft emissions modeling, EDMS requires a separate model run for each airport, and involves explicitly entering each combination of airframe model and engine type to be considered in the modeling scenario. When airframe model data are inputted into EDMS, assignments for applicable GSEs and APUs are made, and emission estimates for both aircraft and GSE/APU are simultaneously developed by the model. Because the labor-intensive procedure of inputting individual airframe model and engine assignments cannot be automated with the current version of EDMS,[2] it is not practical to use the model to estimate emissions for all of the airports in Alaska. In addition, the aircraft model-specific activity data needed to support a complete analysis of emissions from all types of aircraft are currently not available. Specifically, activity data are inadequate for air taxis and military aircraft, where little detail is kept in FAA records, and for general aviation aircraft flights, most of which occur at non-towered facilities. EDMS does not estimate emissions of ammonia (NH_3). In order to estimate NH_3 emissions, Sierra and CH2M HILL will review available literature and apply appropriate surrogate engine data to the different aircraft engine types. Because

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[1] Airstrips with all flights conducted under VFR only (no instrumented flight rules or IFR) are not subject to federal record keeping and other regulations for airports.

[2] The EDMS model currently will not accept an input file to specify aircraft models for each airport run and the source code required to modify the model to accept input file is not available.

there are several aircraft engine types, more than one emission factor for NH_3 will be needed.

To address the concerns summarized above, we will employ an aggregate methodology for developing the aircraft emission inventory. A similar aggregate approach was used by EPA in the development of the 1996 National Toxics Inventory (NTI).[5] It was also used by Sierra in the development of an aircraft inventory for 12 WRAP states for regional haze planning, and in the development of an aircraft inventory for the Fairbanks, Alaska attainment plan.[6,7] The methodology we will use to estimate aircraft emissions is discussed in detail below. The analysis approach is different for airports with known activity and location data (largest and medium-sized airports in Table 1), than it is for airstrips where no activity data and few to no location data are officially kept.

<u>Airports with Activity Data</u> – In Table 1, these include the 114 larger airports with air carrier traffic and the 576 medium-sized airports with location and activity data. Where available, activity estimates from Airport Master Plans and emission inventories from SIP or Maintenance Plan air quality analyses are the best estimates for an airport. These plans and analyses, however, are only available for the largest airports and military air bases in Alaska. At a minimum, Airport Master Plan activity and available air quality analyses will be obtained for Anchorage International Airport (ANC), Fairbanks International Airport (FAI), Juneau International Airport (JNU), Fort Wainwright Air Force Base (FBK), and Eielson Air Force Base (EIL). Activities at these airports represent the bulk of the commercial and military air traffic in Alaska and should be accurately estimated for a statewide emissions inventory analysis. The EDMS runs used to estimate emissions for these airports need to be updated to account for revisions to PM_{10} emission factors incorporated into version 4.2 of the model.

The rest of the larger airports should have airframe-model specific activity available from FAA's Airport Activity Statistics of Certified Route Carriers. EDMS modeling is possible for all the air carrier traffic with airframe model data; however, given the time and resources available for this work, Sierra and CH2M HILL will develop a representative distribution of airframe-models for the rest of the larger airports (i.e., regional hubs) from the FAA air carrier statistics in this category. It should be noted that this representative air carrier fleet distribution will not include the activity data for the main airports, where Master Plan activity data are being collected—ANC, FAI, JNU, FBK, and EIL. Several of these airports with master plan activity data have international cargo and large air carriers that are not representative of operations at other main airports.

Using the air carrier representative model fleet in EDMS would result in air carrier fleet average emission factors for the remainder of the large airports, which could then be applied to the estimated activity at each airport. Similar to the air carrier modeling, representative airframe model distributions could be created for general aviation aircraft, air taxi, and military aircraft in the larger airports for use with EDMS. With no airframe model data available from FAA for the non-air carrier flights, the airframe model distribution could be estimated using aircraft registration records from the Alaska Aircraft Registry, supplemented by surveys of local airport managers and pilots.
Table 3 describes the method of inventory analysis that will be used for the airports with activity data. The method described will minimize the input time necessary for using

EDMS and, at the same time, provide better estimates of the emissions inventories for the largest airports, which account for the significant portion of the total aircraft inventory in Alaska.

Airstrips with No Activity Records – In Table 1, these include the 422 unregistered airstrips that have only location data from the DOT survey, and the 1,888 unregistered and undocumented airstrips. Most of these are backyard airstrips and makeshift gravel runways located on private residential land and in national parks and preserves. The most extensive effort to identify and locate the small airstrips in Alaska was the DOT survey in 1994, and this yielded location data for 422 airstrips. For the remaining airstrips in the state (roughly 1,888 airstrips, if the total is assumed to be 3,000), no data on location or activity have ever been collected, and no estimates of emissions for these sources have ever been prepared.

To estimate the activity levels at these facilities, we plan to subtract the total number of aircraft recorded in the Airport Master Records from the total in the Aircraft Registry (by category). An estimate of the activity levels for the remaining aircraft will be based on results of a Sierra and CH2M HILL survey of airport managers and local pilots. An additional source of data on local aircraft activity levels will be available from Sierra's on-going analysis of representative community emissions for the WRAP. As part of that effort, Sierra will be conducting surveys of fuel use and activity levels in 15 separate communities during summer and winter seasons. Current plans call for the collection of fuel use and LTOs by aircraft type at local airports/airstrips. The results can be extrapolated to represent activity levels at similar-sized communities within specific counties.

As with the airports with activity data, the fleet-average emission factors based on the Aircraft Registry airframe models will be used for estimating the county-specific emissions inventory. Table 4 summarizes the methodology that will be used for estimating emissions from the small airstrips in Alaska for which there are no activity data.

A check on the aggregate level of general aviation activity will be performed by obtaining statistics on the total level of aviation gasoline distributed in Alaska in recent years. Estimates of the gallons of aviation gasoline consumed can be inferred from Alaska Department of Revenue tax receipts. The survey data will be used to compute an estimate of fuel consumed for a typical general aviation flight. This value will be divided into the total annual fuel consumption to estimate the annual number of LTOs. This value will be used as an order of magnitude check on the total number of general aviation flights estimated across all of the airport categories. Since records are available for general aviation activity for the larger airports, it will provide insight into the accuracy of the estimates produced for the smaller airstrips with no activity records.

Table 3
Emissions Inventory Analysis of Airports with Activity Data

Aircraft Category	Analysis Method	Activity Data Sources	Assumptions

Table 3 **Emissions Inventory Analysis of Airports with Activity Data**			
All Categories (where available)	-----	SIP/Maintenance Plan Air Quality Analysis (some available)	Assumes data source is most accurate available for activity data
Air Carrier	EDMS fleet-average emissions factors using representative aircraft model-distribution Estimated fleet-average NH_3 emission factors from engine data review	Route Air Carrier Statistics and/or Airport Master Plan	Assumes equivalent aircraft distribution for airports in category
General Aviation and Air Taxi	EDMS fleet-average emissions factors using representative aircraft model-distribution Estimated fleet-average NH_3 emission factors from engine data review	Aircraft Registry and Survey Results for Model Distribution Airport Master Records for Activity	Assumes registry model distribution or summary results mirror activity model distribution Assumes equivalent aircraft distribution for all airports
Military	EDMS fleet-average emissions factors using representative aircraft model-distribution Estimated fleet-average PM and NH_3 emission factors from engine data review	Aircraft Registry and Survey Results for Model Distribution Airport Master Records for Activity	Assumes registry model distribution or summary results mirror activity model distribution Assumes equivalent aircraft distribution for all airports

Table 4 **Emissions Inventory Analysis of Airstrips with No Activity Data**			
Aircraft Category	Analysis Method	Activity Data Sources	Assumptions
General Aviation Air Taxi and Military (If Any)	EDMS fleet-average emissions factors using representative aircraft model-distribution Estimated fleet-average PM and NH_3 emission factors from engine data review	Aircraft Registry and Survey Results for Model Distribution and Activity	Assumes registry model distribution or summary results mirror activity model distribution Assumes equivalent aircraft distribution for all airports

<u>Allocation of Emissions by County (i.e., Borough)</u> – As mentioned above, location data for 1,112 airports and airbases in Alaska are available from DOT&PF's 1994 survey. Sierra used the coordinates from that survey to assign the location of larger and medium

sized airports in Table 1 (~114 and 576 airports listed for these categories) to each of the 27 Boroughs in the state. For the undocumented airports in Table 1 (~1,888 listed for this category), we will assign them in proportion to the distribution that results from assigning the location of the DOT-surveyed small airstrips in Table 1 (the 422 airports listed for this category).

<u>Seasonal Emissions Estimates</u> – A monthly distribution of aircraft activity in Alaska for a subset of the larger airports will be obtained using the FAA's Air Traffic Activity Data System (ATADS).[8] All airports with FAA-operated or FAA-contracted traffic control towers are included in the ATADS, about eight of which are in Alaska. These eight airports are:

1. Kodiak Airport (ADQ),
2. King Salmon Airport (AKN),
3. Anchorage International Airport (ANC),
4. Bethel Airport (BET),
5. Kenai Municipal Airport (ENA),
6. Fairbanks International Airport (FAI),
7. Juneau International Airport (JNU), and
8. Merrill Field (MRI).

The monthly activities for these airports are available by aircraft operation category and could be used to represent the seasonal differences in air traffic for each aircraft operation category in other airports. However, this assumes that aircraft within the same aircraft category are similarly operated regardless of airport size, which may or may not be a good assumption. Given that the eight airports with ATADS data are larger airports, with MRI being the only one with no air carrier service, the seasonal activity from ATADS will fit the larger and medium-sized airports better than the small airstrips. Because of this, we will use the results of the airport managers and pilots survey for estimating seasonal activity at the small airstrips.

Quality Assurance Plan

This section presents a review of the QA procedures that will be used during the development of the statewide aircraft emission inventory. It includes all of the critical elements recommended in the U.S. EPA document *Guidance for the Preparation of Quality Assurance Plans for Ozone/Carbon Monoxide State Implementation Plan Emission Inventories*,[9] as well as guidance provided through the Emission Inventory Improvement Program (EIIP).[10] It also provides written instructions for the technical and quality aspects associated with development of the new emission inventories. These procedures will ensure that the aircraft inventory is as complete, accurate, comparable, and representative as possible.

Inventory tasks and QC procedures will include data checking by the inventory development team (IDT) throughout the development of the inventory and final emission report. These procedures include, but are not limited to, the following:

- The development and implementation of written procedures for data collection, data assessment, data handling, calculation of emissions, and reporting;
- Adequate management and supervision of the work;
- Review of all calculations for technical soundness and accuracy, including verification that the appropriate emission factors were used and the impacts of controls were correctly addressed;
- Correct assignment of Source Category Codes;
- Assignment of DARS scores;
- Use of technically sound approaches when developing results based on engineering judgment;
- Documentation of the data in a manner that will allow reconstruction of all inventory development activities; and
- Maintenance of an orderly master file of all the data gathered and a copy-ready version of the final inventory submitted to the U.S. EPA.

The emission inventory developed in accordance with this plan is for SIP development and is considered Level II, based on guidance provided by the 1996 EIIP. The estimates contained in the inventories will be used to make decisions about the need for and types of control strategies required to ensure reasonable progress in meeting visibility goals for Alaska's Class I areas. As a result, they must satisfy applicable quality assurance (QA) requirements.

The first step in this process is establishing the data quality objectives (DQO) for the new inventories. Table 5 presents a summary of the procedures to be employed in meeting the DQOs. It shows that considerable effort will be focused on meeting accuracy, completeness, representativeness, and comparability objectives. Table 6 shows the data quality indicators (DQIs) that will be used to measure progress towards the DQOs. The Data Attribute Rating System (DARS)[11] will be used to verify the desired inventory accuracy.

Table 5
Data Quality Objectives

DQO	Procedure for Achieving Objective
Accuracy	For nonroad mobile sources, the data generator will check 100% of the calculations, and another equally qualified inventory development team member will check 10% of the calculations. In all cases, the data validator will develop a written summary of his or her activities, and will conduct follow-up activities to ensure that data are corrected as needed. If more than 5% of the calculations checked by the data validator need to be revised, then 100% of the calculations will be checked.
Completeness	Extensive planning will be conducted prior to data collection to identify all applicable emission sources. After identifying these sources, the goal will be to determine 100% of the emissions from the largest emitting sources from each source category and as many of the minor sources as possible within the time frame allotted for the work. Those sources identified but not included in the inventory will be identified in the data file and final report.
Representativeness	Technical personnel will review all of the primary source data AND compare them to previous emission results and similar results from comparable regions to determine the reasonableness of the emissions estimates and representativeness of the data.
Comparability	To ensure that the data are comparable, standard procedures will be followed and results will be presented in the same units that were used in previous criteria and toxic pollutant inventories.

Table 6
Data Quality Indicators

DQO	Inventory DQI Target Values
Accuracy	Achieve DARS score $<=0.5$ for nonroad mobile source inventory.
Completeness	90% of aircraft LTOs.
Representativeness	Allocation of representative airports to individual Boroughs.
Comparability	Results to be compared to recent criteria and toxic pollutant inventories.

Managerial Responsibilities

Sierra will lead the preparation of the community emission inventories. Key assignments shall include those outlined below.

Source Inventory Development Managers – responsible for planning and leading source specific inventory development activities.

QA/QC Coordinator – the person responsible for ensuring that adequate QA/QC procedures are incorporated into the inventory development process. The QA Coordinator's responsibilities and activities are as follows:

- Help develop the QAP;
- Provide QA training to inventory development and QA personnel;
- Attend inventory status meetings;
- Follow up on recommendation for corrective actions;
- Keep the Inventory Development Manager informed of actions;
- Work with the WRAP Project Manager to resolve any quality concerns that cannot be resolved at the inventory management level; and
- Maintain a file of findings and corresponding corrective actions.

The QA Coordinator reports directly to Sierra's Project Manager overseeing the development of the inventory. These reporting lines help provide an objective approach to the implementation of the QA program and reporting of quality issues.

Schedule

Data collection activities are to be completed by the end of January. Emission inventory estimates will be completed by the end of February and the draft report is to be completed by the end of March.

General QA/QC Procedures

QA/QC procedures described in this QAP were developed to help ensure data accuracy, completeness, representativeness, and comparability. These procedures have been incorporated in the technical procedures, where applicable, and will be implemented by the IDT throughout the planning, data collection, emission estimation, and reporting phases of the inventory development program.

QC procedures will be implemented by the IDT during inventory development to meet the technical objectives and DQOs. These activities will be conducted at the following steps in the inventory development process:

- Data collection;

- Data documentation;
- Calculation of emissions;
- Data checking and DARS scoring;
- Reporting; and
- Maintenance of the master file.

Data collection will be conducted according to U.S. EPA-approved procedures. The approach and supporting documents or references will be thoroughly documented and included in the emissions report.

All activities conducted by the IDT will be documented. The traditional approach is to use bound notebooks with indices to facilitate the retrieval of recorded information. An alternate approach is to record activities electronically and make this information available to team members located in different parts of the state. To enhance communication and productivity, team members will be allowed to employ either approach but will be encouraged to track information relative to the development of the inventory electronically. This daily log of activities will help another IDT member reproduce the emission results and allow an evaluation of data accuracy and completeness.

The following procedures are to be followed when documenting data in the notebooks:

- Data will recorded legibly and in black ink;

- Entries will be corrected by drawing a single line through the data and writing the correct data above or below the correction (with initials, date, and explanation of corrections to allow reconstruction of the work);

- Complete descriptions of all data sources will be included (references to be included in final inventory report);

- Units of measurements will provided for emission sources that are omitted from the final inventory (justification required in report);

- The procedures used to calculate emissions will be described and example calculations will be provided;

- The approach used to determine completeness for each source type will be described;

- Documents from which emission factors are taken will be identified and referenced; and

- The source, agency, group, or company providing information by telephone will be identified (include telephone number and date information was provided).

Worksheets and contact reports may also be used to maintain records of data sources or calculations; however, the same guidelines must be followed when recording information on them. A file will be developed specifically for these forms to ensure that they are retained and are easily located when the data are needed to calculate emissions. A contact report should include the date of contact; originator name, title, organization, and address of person contacted; and a summary. All worksheets, electronic spreadsheets, and notebooks will be reviewed periodically by the inventory development task leaders to determine whether the procedures described above are being followed. This review should be evidenced by a dated signature on the notebook pages or worksheets reviewed (i.e., reviewed by ________ on _______).

Data used in calculation emissions should be checked for data accuracy, reasonableness, and completeness. The results from data checking will be documented to further qualify the emission estimates. In addition to the DARS scores assigned, the number of data points checked assists reviewers in evaluating the accuracy of the completed emissions report. Documentation of DARS scoring and data checking should include descriptions of the rationale for scoring, the data checked, and the dated signature of the reviewer.

Data Reporting

Reporting will be accomplished by submitting written documentation and emissions summaries to the WRAP Emission Forum. All supporting documentation, project notebooks, data sheets, and calculations shall be submitted for review.

The report will include summary tables, raw listings of equipment, activity levels and emissions from individual sources, and a QA documentation section. A detailed inventory report allows comparison of baseline inventories between one area and another and the evaluation of the impact of control strategies, and also facilitates updates to the inventory and development of projection inventories.

In addition to EIIP guidance, the U.S. EPA report *Example Documentation Report for 1990 Base Year Ozone and Carbon Monoxide State Implementation Plan Emission Inventories*[12] will be followed. These documents provide guidance for presenting and documenting SIP emissions inventories, and contain examples of how to present and verify inventory development efforts. The QA documentation section of the emissions inventory will provide enough detail so that the inventory development described in the report can be compared to the information provided in this QAP. Any discrepancies will be identified and explained.

At a minimum, documentation should describe in general terms how the inventory data were collected and where they came from. The report will include the components listed below.

- A description of the geographic area included in the inventory, including documentation for any adjustments made to the original designated area.

Documentation shall reference all sources of current or projected data, and include maps of borough boundaries for excluded areas.

- The base year of the emissions inventory.
- The population of the area, and the source of the population data.
- Efforts taken as part of QA program.
- Procedures used to temporally allocate each source category (e.g., selection of the months comprising the seasons, seasonal variations in activity levels at sources, daily variation in activity levels, etc.).
- Procedures used to spatially allocate the emissions inventory. If a dispersion model will be used for control strategy demonstrations, a map of the geographic area with the modeling domain and grid squares overlaid shall be included. The grid square sizes need to be indicated on the map.

The QA documentation section of the inventory report will describe each deviation from approved procedures or findings that could compromise the successful outcome of the inventory. Documentation of each finding will include a description of the action or data reviewed that led to the quality concern, along with a recommendation for corrective action. The QA documentation section of the inventory report will then discuss how the recommended corrective actions were implemented.

References

1 . Flight tips for Pilots in Alaska, *http://www.alaska.faa.gov/flytoak/oldflttips1.htm*.

2 . "The Impact of National Airspace Systems (NAS) Modernization on Aircraft Emissions," DOT/FAA/SD-400-98/1, Department of Transportation, Federal Aviation Administration, Operations Research and Analysis, Systems Engineering and Technical Assistance, September 1998.

3 . California Air Resources Board, 1997 Southern California Ozone Study (SCOS97) Gridded 3-D Commercial Jet Emissions website, http://www.arb.ca.gov/eos/scos97/gcje.html. January 2002.

4 . Discussions with Carl Siebe of the Alaska Department of Transportation and Public Facilities (DOT&PF) Statewide Aviation Division, August 2004.

5 . "Documentation for the 1996 Base Year National Toxics Inventory for Aircraft Sources," Prepared by Eastern Research Group, Inc. for U.S. EPA, June 2000.

6 . "Final Report, Development of WRAP Mobile Source Emission Inventories," Prepared by ENVIRON International Corp., Sierra Research and E.H. Pechan & Associates for the Western Governors' Association, February 9, 2004.

7 . "Fairbanks 1995-2001 Carbon Monoxide Emission Inventory," Prepared by Sierra Research for Fairbanks North Star Borough, Report No. SR01-07-04, July 24, 2001.

8 . Air Traffic Activity Data System (ATADS), Federal Aviation Administration website, http://www.apo.data.faa.gov/faaatadsall.HTM

9 . "Guidance for the Preparation of Quality Assurance Plans for O3/CO SIP Emission Inventories," EPA-450/4-88-023, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, 1988.

10 . "Emission Inventory Improvement Program," Volumes II-VI, prepared by State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Officials (STAPPA/ALAPCO), 1996.

11 . Beck, L.L., R.L Peer, L.A. Bravo, and Y. Yan, "A Data Attribute Rating System," presented at the Air & Waste Management Association Specialty Conference on Emission Inventory Issues, Raleigh, North Carolina, November 1994.

12 . EPA-450/4-92-007, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, 1992.