Alaska Department of Environmental Conservation

Amendments to:
State Air Quality Control Plan

Vol. III: Appendix III.C.3.
Base Year Emission Inventory Comparison

{Appendices to:
Volume II, Section III.C Fairbanks Transportation Control Program}.

Adopted

March 12, 2015

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Larry Hartig, Commissioner

(This page serves as a placeholder for two-sided copying)

November 20, 2012

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Memo to: Cindy Heil, ADEC

From: Tom Carlson and Bob Dulla

Subject: Summary of Inventory Revisions to the 2008 Fairbanks CO Maintenance Plan

Since the development of the 2008 Fairbanks CO Maintenance Plan (MP), several methodological revisions have been applied and updated activity data were obtained that supersede elements of the CO inventory reflected in that earlier plan. These are summarized briefly in this memorandum.

The revisions/updates to the CO inventory in the 2008 Plan are listed below and grouped by inventory sector: on-road mobile, non-road mobile, area, and point.

On-Road Mobile

Vehicle emissions were estimated for the Fairbanks modeling area using EPA's MOVES (Motor Vehicle Emission Simulator). The analysis was based on the MOVES2010b version released in June 2012. MOVES is the successor to EPA's MOBILE series of on-road vehicle emissions models. It can be used to estimate exhaust and evaporative emissions as well as brake and tire wear emissions from all types of on-road vehicles. Compared to MOBILE6.2, MOVES incorporates substantial new emissions test data and accounts for changes in vehicle technology and regulations as well as an improved understanding of in-use emission levels and the factors that influence them.

Modeling Approach – The basic approach in applying MOVES to calculate vehicle emissions for the nonattainment area was based on MOVES technical modeling guidance developed by EPA[1] for use in SIP and regional conformity analyses. In accordance with that guidance, MOVES was executed for the four-month (November through February) winter CO season that corresponds to the period in which violations of the ambient standard may occur in Fairbanks. Per EPA's guidance, MOVES was also executed on an hourly time-scale to more accurately reflect diurnal variations in travel and ambient conditions that can affect vehicle emissions.

[1] "Technical Guidance on the Use of MOVES2010 for Emission Inventory Preparation in State Implementation Plans and Transportation Conformity," U.S. Environmental Protection Agency, Office of Transportation and Air Quality, EPA-420-B-10-023, April 2010.

For SIP and conformity analysis, MOVES must be executed using the County Domain/Scale option. (MOVES can also be executed in National Scale and Project Scale modes.) For regional conformity analyses using MOVES County Scale option, EPA's guidance essentially directs users to input a detailed series of data that replace nationwide-based default values with vehicle fleet, travel activity, and other parameters that represent the county or region being modeled.

MOVES was executed for the Fairbanks, Alaska geographic area to produce estimates of CO emissions. Discussions of the development of the detailed MOVES inputs in accordance with EPA's MOVES SIP development guidance are presented below.

Vehicle Populations (Source Type Population & Age Distribution) − Vehicle registrations from the Alaska Division of Motor Vehicles (DMV) and recent Alaska Parking Lot Survey data conducted by ADEC provided the basis for the vehicle fleet populations and age distributions used to model the Fairbanks vehicle fleet with MOVES. The DMV data were obtained through ADEC from a "dump" of the statewide registration database as of May 2010. The DMV database includes vehicle make, model, model year, Vehicle Identification Number (VIN), vehicle class code, body style, registration status, and expiration date.

Using a VIN decoding tool licensed by ADEC, supplemental information such as vehicle class, gross vehicle weight, vehicle type, body type, and fuel type (e.g., gasoline vs. diesel) were also determined in order to help classify each vehicle into one of the 13 MOVES Source Types. Key vehicle attribute fields from the DMV database and VIN decoder outputs were used to categorize each vehicle record into one of the 13 usage-based "Source Type" categories as defined in MOVES to characterize the vehicle fleet.

Gasoline vs. Diesel-Fueled Vehicle Fractions (AVFT Strategies) – MOVES provides users the ability to override its default nationwide-based travel splits between different fuels and technologies. These Alternative Vehicle Fuel and Technology (AVFT) inputs are supplied to MOVES2010b through the County Data Manager.

In order to account for differences in splits between gasoline- and diesel-fuel vehicles in the Fairbanks fleet compared to the U.S. as a whole, fuel fraction tables by source type and model year were also constructed using the DMV VIN decoded data described earlier. Not surprisingly, the MOVES default splits between gasoline and diesel vehicles were not representative of the Fairbanks fleet. Generally speaking, gasoline fractions were found to be lower in Fairbanks than the nationwide-based MOVES defaults (and diesel fractions were commensurately higher).

Travel Activity (Vehicle Type VMT) – Estimates of VMT over the expanded transportation modeling network (covering the entire CO nonattainment area) from the TransCAD travel model link output files were processed and input to MOVES through the "Vehicle Type VMT" input within the County Data Manager. The Vehicle Type VMT input must be in units of VMT per year, not VMT per day. The annual VMT must also be supplied by "HPMS Vehicle Type," which is essentially an aggregated version of the 13-category MOVES Source Type scheme. Since states are required to provide periodic travel (i.e., VMT) estimates to FHWA via the Highway Performance Monitoring System (HPMS), EPA has designed MOVES to accept VMT input by these HPMS

Vehicle Type categories. Link-level TransCAD model output files from the transportation modeling performed by FMATS for a 2010 base year and a 2035 forecast were processed to prepare these MOVES inputs for each analysis year. The 2010 TransCAD outputs were used directly to represent VMT for the 2010 analysis year. For analysis years 2011 through 2015, VMT was linearly interpolated from the 2010 and 2035 TransCAD outputs (which exhibited an annual VMT growth rate of roughly 1.0%). For analysis years 2005 through 2009, total VMT was back-casted from the 2010 TransCAD outputs based on historically developed regional VMT estimates supplied by ADOT&PF.

The TransCAD outputs encompasses a modeling domain that extends beyond the CO nonattainment area. Spatial processing performed during the development of the TransCAD outputs was used to identify whether each link was within or outside the smaller CO nonattainment area. The VMT estimates for this analysis were based on the subset of links within the CO nonattainment Area.

Annual mileage per vehicle estimates by HPMS Vehicle Type were extracted from MOVES2010b nationwide default model runs and were used in conjunction with travel model VMT splits between Passenger and Truck VMT to apportion total VMT output by TransCAD into the six HPMS Vehicle Type categories required by MOVES.

Other MOVES Inputs – The remaining MOVES modeling inputs representing the Fairbanks CO nonattainment area included seasonal, daily, and diurnal travel fractions; travel activity by speed range (or bin) and roadway type; freeway ramp fractions; ambient temperature profiles; I/M program inputs; and fuel specifications. Each of these inputs was supplied to MOVES to represent Fairbanks-specific conditions through the model's County Data Manager Importer and is discussed separately below.

Monthly, Day-of-Week, and Hourly VMT Fractions – In conjunction with annual VMT by HPMS Vehicle Type, MOVES also requires inputs of monthly, weekday/weekend, and hourly travel fractions. Based on data assembled by ADOT&PF from 2009 seasonal traffic counts, traffic within the CO nonattainment area portion of the FMATS modeling area exhibits a seasonal variation such that roughly 93% of annual average daily travel occurs on average winter days (with 107% occurring on average summer days). These seasonal variations were incorporated into the MonthVMTFraction input table.

Day-of-week fractions were set to assume that travel levels are the same on weekends as weekdays. In the absence of a weekend or seven-day travel model, this is a reasonable assumption.

Hourly VMT fractions were defined based on diurnal trip percentages used to support the travel model development and validation that are listed in Appendix C.

Travel by Speed Bin and Roadway Type (Average Speed Distribution & Road Type Distribution) – The link-level TransCAD model output files described earlier were processed to develop average speed and road type distribution inputs, respectively.

The roadway type classification scheme employed in MOVES consists of the following five categories:

1. Off-Network;
2. Rural, Restricted Access;
3. Rural, Unrestricted Access;
4. Urban, Restricted Access; and
5. Urban, Unrestricted Access.

The "Off-Network" category is used by MOVES to represent engine-off evaporative or starting emissions that occur off of the travel network. For SIP and regional conformity analysis, EPA's MOVES guidance indicated that the user must supply Average Speed Distribution and Road Type Distribution inputs for the remaining on-network road types (2 through 5), but direct MOVES to calculate emissions over all five road types. In this manner, starting and evaporative emissions are properly calculated and output.

The first of the two sets of inputs, Average Speed Distributions, consists of time-based[2] (not distance-based) tabulations of the fractions of travel within each of MOVES' 16 speed bins (at 5 mph-wide intervals) by road type and hour of the day. These inputs were calculated from the TransCAD link outputs by time of day. The TransCAD outputs consisted of travel times, average speeds, and vehicle volumes for each link in the expanded modeling network for each of three daily periods:

1. AM Peak (7-9 AM);
2. PM Peak (3-6 PM); and
3. Off-Peak (9 AM-3 PM, plus 6 PM-7 AM).

Spreadsheet calculations were performed on the TransCAD link outputs to calculate time-based travel (multiplying link travel time by vehicle volume to get vehicle hours traveled or VHT) across all links. The link VHT was then allocated by MOVES road type and average speed bin. (The link classification scheme employed in the TransCAD modeling could easily be translated to the MOVES Rural/Urban and Limited/Unlimited Access road types.) Normalized speed distributions (across all 16 bins) were then calculated for each road type and time of day period and formatted for input into MOVES.

These distributions were very similar for the 2010 and 2035 TransCAD outputs. Distributions for each analysis year (2005-2015) were developed by straight-line interpolation/extrapolation of the nominal trends in the 2010 and 2035 TransCAD-based distributions.

MOVES allows the Average Speed Distribution inputs to be specified separately by Source Type (i.e., vehicle category). Thus, individual distributions were developed from Passenger VHT and Truck VHT tabulations of the TransCAD outputs. The Passenger VHT was available for each of the three modeling periods. Truck VMT was only available on a single daily basis.

[2] MOVES requires Average Speed Distribution inputs on a time-weighted basis and Road Type Distribution inputs on a distance-weighted basis.

Freeway Ramp Fractions (Ramp Fraction) – MOVES uses default values of 8% (or 0.08) to represent the fraction of time-based limited access roadway travel (Road Types 2 and 4) that occurs on freeway ramps. Fairbanks-specific ramp fraction values were tabulated from the TransCAD link level outputs and were supplied to MOVES in the Ramp Fraction input section of the County Data Manager to override the nationwide-based defaults. The Fairbanks ramp fractions in urbanized areas are higher than the default values in MOVES, reflecting the fact that shorter freeway lengths (with resulting higher ramp fractions) are driven in Fairbanks compared to the nationwide-based defaults.

Ambient Temperature Profiles (Meteorology Data) – Monthly average diurnal (i.e., hour-by-hour) ambient temperature and humidity profiles compiled by EPA for each county in the U.S. and contained in MOVES' default database were used for the emission modeling runs. According to EPA guidance, these ambient meteorology data profiles were compiled from 30 years (1971-2000) of daily temperature and humidity data. The profiles for Fairbanks (ZoneID=20900) are based on the station at the Fairbanks International Airport. The ambient temperatures range from +11.7°F in November (Hour 16) down to -16.1°F in January (Hour 5). Relative humidity ranged from 48% to 82%.

Profiles for each of the winter months modeled were exported from the MOVES database and input via the County Data Manager.

I/M Program Data (I/M Programs) – Since the Fairbanks I/M program was terminated at the end of 2009, the "Use I/M Program" input element to MOVES for the 2010-2015 analysis years was set from "Yes" to "No" to account for the elimination of the program. A compliance rate of 96% was modeled based on the latest parking lot survey data.

Fuel Specifications (Fuel Supply) – EPA has developed detailed fuel specifications (e.g., RVP, oxygen content, sulfur content, etc.) for different gasoline and diesel fuel blends used in each county of the U.S. and has loaded these specifications into the *FuelFormulation* and *FuelSupply* tables in the MOVES default database. (The first of these tables identifies the detailed properties of a specific fuel blend; the second table identifies the state and county of the U.S. and the calendar year to which it applies.) Semi-annual fuel survey data collected by the Alliance of Automobile Manufacturers (AAM) were reviewed to confirm whether the default fuel properties for Fairbanks defined in MOVES were correct. Retail gasoline data for the 2008 winter for Fairbanks from the AAM surveys indicated that sulfur and oxygen contents in MOVES reasonably matched measured levels.

However, Fairbanks diesel blends are not included in the AAM surveys. MOVES assumed diesel fuel sulfur content of 43 ppm in 2008 through 2011 and 11 ppm in 2012 and later years. These sulfur levels are believed to be reasonably representative of those required under Alaska's Ultra Low-Sulfur Diesel (ULSD) regulation.

Thus, MOVES default gasoline and diesel fuel specifications for Fairbanks were used in the analysis.

Non-Road Mobile

The non-road inventory was based on updated modeling with EPA's NONROAD model for recently developed "Big 3" criteria pollutant inventories that were generated for Anchorage, Fairbanks, and Juneau. Key revisions included a substantial increase in snowmobile emissions based on locally collected snowmobile population estimates, rather than NONROAD model defaults. Base year estimates from that effort were combined with updated aircraft inventory estimates and railroad emission estimates developed in support of the Fairbanks $PM_{2.5}$ SIP.

Area

Area source estimates were also updated based on emissions compiled for the Fairbanks $PM_{2.5}$ SIP. Key revisions were focused within the space heating sector (primarily wood-burning emissions) based on locally collected activity data and heating device emission testing data supporting the $PM_{2.5}$ SIP development. Historical and forecasted population trends from that effort were also used to develop the updated area source CO estimates.

Point

Point source estimates were updated on a facility-specific basis where data were available from the $PM_{2.5}$ SIP development. Similar population-based trends applied to the area sources were also used to project base year 2008 point source emissions obtained for the $PM_{2.5}$ SIP.

Summary

Table 1 summarizes the emission changes described above, comparing each of the source categories in 2005, 2010, and 2015. Adjustments for additional control measures included in each MP are also incorporated so that the final inventory values can be contrasted. The table shows that emission estimates for all of the source categories changed between the two inventories. As described above, the changes are the result of new insights from surveys, updated activity forecasts, and model revisions. The most significant of these are as follows:

- Use of MOVES2010b (which has higher per-vehicle emission rates than MOBILE6 at cold temperatures);

- Higher residential wood burning emissions in the area source sector based on emission testing and updated activity data collected in support of the Fairbanks $PM_{2.5}$ SIP; and

- Higher nonroad emissions based on an upwardly adjusted snowmobile population reflected in Alaska's latest criteria pollutant inventories for Fairbanks (the earlier estimates had been based on default populations estimated for Fairbanks in an earlier version of EPA's NONROAD model).

Table 1
Comparison of Source Category Emissions
Between 2008 and Current CO Maintenance Plans
(Tons/Day)

Source Category	2008 Maintenance Plan			Current Maintenance Plan		
	2005	2010	2015	2005	2010	2015
On-Road	24.98	21.25	19.15	45.48	43.48	45.19
Nonroad	3.04	3.40	3.62	14.80	15.97	16.79
Area	0.58	0.62	0.65	19.69	21.28	22.38
Point	3.08	3.29	3.44	3.09	3.34	3.51
Total	**31.69**	**28.56**	**26.87**	**83.06**	**84.08**	**87.87**

If you have any questions about the information presented above, please do not hesitate to contact us.