Frequently Asked Questions (FAQ)
Conducting Quantitative MSAT Analysis for FHWA NEPA Documents

The Federal Highway Administration (FHWA) issued interim guidance for mobile source air toxic (MSAT) analysis in the National Environmental Policy Act (NEPA) process for highway projects ("*Interim Guidance Update on Mobile Source Air Toxics Analysis in NEPA,"* December 6, 2012).[1] However, it does not provide detailed recommendations on how to conduct a quantitative MSAT analysis as specified in the interim guidance using the U.S. Environmental Protection Agency's (EPA) MOtor Vehicle Emissions Simulator (MOVES) model. This document provides information on how FHWA recommends that project sponsors can use MOVES for NEPA MSAT analysis including: a) defining the scope of MOVES work; b) gathering input data; and c) post-processing results. These are insights based on our experience in conducting quantitative MSAT analysis and questions received. FHWA recommends reviewing the EPA MOVES user documents and tools posted at: http://www.epa.gov/otaq/models/moves/.

Q. 1) What information will I need to prepare?

A. 1) The first thing you need is a plan that scopes out the analysis. Questions to ask include:

What pollutants am I modeling?
What years and seasons am I modeling?
How do I set up the run specification (RunSpec)?
What input data do I need?
What inputs vary by year? By season? By time of day? By alternative?
What traffic and other data do I need to develop the inputs?
What version of MOVES will be used (MOVES2010b or MOVES2014[2])?

Q. 2) How do I define the affected environment?

A. 2) MSAT analyses are intended to capture the anticipated changes in emissions within an affected environment, defined as the transportation network directly affected by the project. The affected environment for MSATs may be different than the affected environment defined in the NEPA document for other environmental effects, such as noise or wetlands. Analyzing MSATs only within a geographically-defined "study area" will not capture the emissions effects of changes in traffic on roadways outside of that area, which is particularly important where the proposed project would create an alternative route or divert traffic from one roadway class to another. At the other extreme, analyzing a metropolitan area's entire roadway network will result in emissions estimates

[1] Posted at www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/aqintguidmem.pdf
[2] Posted at http://www.epa.gov/otaq/models/moves/ and additional information about MOVES2014 is posted at http://www.epa.gov/otaq/models/moves/documents/420b14008.pdf and information about the MOVES2014 grace period is posted at https://www.federalregister.gov/articles/2014/10/07/2014-23258/official-release-of-the-moves2014-motor-vehicle-emissions-model-for-sips-and-transportation

for many roadway links not affected by the project, diluting the results of the analysis.

FHWA recommends analyzing all segments associated with the project, plus those segments expecting meaningful changes in emissions as a result of the project (e.g., ± 10% or more). Define the affected network based on available project-specific information such as the environmental document traffic analysis considering changes in such metrics as:

- ± 5% or more in annual average daily traffic (AADT) on congested highway links of level of service (LOS) D or worse;
- ± 10% or more in AADT on uncongested highway links of LOS C or better;
- ± 10% or more in travel time; and
- ± 10% or more in intersection delay.

These recommendations are not a substitute for project-specific knowledge and consideration of local circumstances. For example, if traffic modeling shows that some low-volume links far removed from the project area show a meaningful change in traffic, one would have to consider whether this is a real effect, or a modeling artifact. Likewise, when analyzing a project that has no meaningful alternative routes (e.g., upgrading an isolated river crossing), it may not be necessary to evaluate traffic changes on other routes. Any such deviation from these recommendations should include documentation in the project file explaining what segments were included or excluded from the affected area and why.

Q. 3) What inputs will I need for an MSAT emissions analysis using MOVES?

A. 3) Since MOVES analysis involves a large number of individual input and output files, good organization is very important. It is helpful to start by establishing a file structure and naming conventions. FHWA recommends that you develop a master checklist of inputs needed for each run and define what each run will address, and what files will be needed for input data and outputs. The following table is one example. Some input spreadsheets may be used for all runs, some are specific to each calendar year, and some are specific to individual alternatives. These variations are discussed in more detail in the County Data Manager Template under Question 9. Also, while an input database is needed for each run, modelers have the option of defining an output database for each run (shown here), or using the same output database for multiple MOVES runs. The key is to establish a written "roadmap" of all the related files, so that they can be easily referenced to develop summary information for the NEPA document, and so that reviewers can follow how you conducted the analysis.

2015 Base Year No Action run	
Input database: 2015_NA_in; Output database: 2015_NA_out	
Input:	**Spreadsheet data file:**
Age distribution	Age_allruns.xls
Sourcetype population	Population_2015.xls
I/M	IM_2015.xls

Fuels	Fuels_2015_allmonths.xls
Vehicle-miles traveled (VMT)	VMT_2015_NA.xls
Speed distribution	Speed_2015_NA.xls
Road type distribution	Roadtype_2015_NA.xls
Ramp fraction	Ramps_allruns.xls
Month, Day VMT fractions	MonthDayfractions_allruns.xls
Hour VMT fractions	Hourfractions_2015.xls
Fuel type and technologies	Not used (defaults)

Q. 4) Where do I get the data?

A. 4) Coordinating with other local agencies to see if relevant input data has already been developed is the best way to start. Other agencies in the project area (the metropolitan planning organization (MPO), state department of transportation (DOT), and/or state air agency) may have already developed data for some of the necessary MOVES inputs. For example, the state DOT may have developed an age distribution, the MPO may have developed future source population estimates and hourly VMT distributions, and the state air agency may have developed fuel and inspection/maintenance (I/M) inputs that substitute for model defaults. Early coordination with the project team can help identify these sources of input data and avoid repeating work that some other group has already completed.

Q. 5 How do I develop and perform quality assurance (QA) on the input spreadsheets?

A.5) In FHWA's experience, most cases of incorrect or counterintuitive MOVES results are explained by input errors. Thus, it is worthwhile to QA and test a sample of MOVES input data before conducting a large number of MOVES runs that may have to be repeated if an error in the input data is found.

First, develop a set of spreadsheet inputs for one MOVES run and test them. Create the necessary RunSpec, and import the input data using the County Data Manager (it's good to label this run as a Test run to avoid later confusion). Find and resolve any error messages that appear in the County Data Manager as you're importing data. For this run, you can also obtain results by Fuel Type, Emission Process, Road Type, and Source Use Type by choosing options provided in Output Emissions Detail panel, which can help in troubleshooting problems.

Execute the RunSpec and QA the output. Are all pollutants, emission processes, road types, etc. that you requested in the RunSpec included in the output? Did you get "0" for any emissions? Do the distance outputs agree with your VMT inputs (e.g., does the annual VMT you entered along with the month and day VMT fractions give you the same daily VMT you started with)?

If everything looks OK, then develop the spreadsheet inputs for the remainder of the runs.

Additional QA checks:

- Related spreadsheets should each have the same number of rows and file size
- Check that distributions that should sum to one, do sum to one
- Reality check on spreadsheets and raw data: Does VMT really triple between No Action and Build? Is 30% of traffic really moving at 2.5 mph? Do we really have motorcycle VMT in the winter, or twice as much truck VMT as car VMT?

Q. 6) What specific elements of the analysis are recommended for MOVES RunSpecs and inputs for MSAT analysis?

A. 6) FHWA's recommendations for a MOVES RunSpec and data inputs are contained in the two tables at the end of this document. This FAQ provides some additional explanation on specific elements of the analysis. For more information on developing MOVES RunSpecs and data inputs, FHWA recommends reviewing the MOVES User Guide posted at http://www.epa.gov/otaq/models/moves/documents/420b12001b.pdf.

In July 2014, EPA released MOVES2014. Recommendations in this FAQ are applicable to both MOVES2010b and MOVES2014 unless specifically noted.

MOVES Domain/Scale and Calculation Type: County, Inventory:

FHWA recommends using MOVES at the County scale for quantitative MSAT analysis. The County scale refers to a method of operating MOVES and does not imply that an entire geographic county is being modeled. The County scale requires area-specific input data, which is conducive to developing MSAT emission inventories for the affected transportation network or affected environment of a proposed project in the NEPA context. The County Data Manager tool for importing data provides important error-checking capabilities, and can export defaults for some inputs where local data won't be used.

The National scale relies on default data that may not reflect conditions in the project area, and is not recommended for quantitative MSAT analysis. The Project scale requires link-level input data. It is possible to use MOVES at the Project scale to develop MSAT emission inventories by entering data for all links in the affected transportation network directly rather than pre-processing these data to produce the input data distributions required to operate MOVES at the County scale. However, operating MOVES at the Project scale requires more runs, requires more post-processing in spreadsheets, and is more cumbersome to troubleshoot.

FHWA recommends selecting the Inventory Calculation Type because MOVES runs faster and MOVES output can be used directly to produce reports for most MSAT pollutants to include in NEPA documentation. The MOVES Rates Calculation Type requires more post-processing in spreadsheets, takes longer to run, and is more cumbersome to troubleshoot.

Representing annual average emissions

Since FHWA guidance is based on addressing the priority MSAT from EPA's 1999 National Air Toxic Assessment of chronic health exposure, the analysis should reflect annual-average conditions, and needs to account for the changes in emissions due to different traffic conditions, meteorology, and fuels during the year. For MSAT analysis with MOVES, FHWA recommends modeling four months to represent the different seasons, averaging the resulting emissions to obtain an estimate for a typical day, and multiplying by 365 to estimate annual emissions (if desired, NEPA documents can report emissions either on a daily or annual basis).

Vehicles/equipment

MOVES internally allocates some VMT to compressed natural gas (CNG) transit buses. In addition to all gas and diesel vehicle types, CNG transit buses need to be modeled. If there are none of these buses in the area, they do not need to be selected, but inputs are needed for Alternative Vehicles, Fuels, and Technologies (AVFT) in the County Data Manager specifying no CNG bus VMT for all model years. MOVES2014 also allocates some light-duty VMT to the E85 fuel type, so E85 needs to be modeled in this version of MOVES.

Pollutants and processes

For most highway projects affecting vehicle activity on the network, FHWA recommends that quantitative MSAT emissions analyses reflect only running exhaust and crankcase running exhaust (processID = 1, 15) and if using MOVES2014, include evap permeation and evap fuel leaks (processID = 11, 13). The other emission processes from vehicles do not occur on roadways. For major intermodal freight facilities, off-network vehicle activity may need to be characterized in MOVES along with any significant number of new trips occurring on the network. For these projects, off-network emission processes, such as start, extended idle, and evap components, should also be reflected in the quantitative MSAT emissions analysis. Contact FHWA to request technical assistance, if needed.

The MSAT RunSpec Template under Question 9 indicates which pollutants to model to capture the 7 MSATs listed in FHWA’s interim guidance.

Diesel particulate matter (PM) emissions are not computed as a separate pollutant species in MOVES. They are represented by selecting Primary Exhaust PM10 – Total for diesel fuel vehicles only (not gasoline vehicles). To calculate diesel vehicle PM10 exhaust, there are two options: 1) conduct separate MOVES runs with *only* Diesel Fuel vehicles selected in the Vehicles/Equipment panel (recommended—note that the VMT inputs do not change, since MOVES will ignore VMT from other vehicles), or 2) model PM10 exhaust with the rest of the MSATs, and with “Fuel Type” selected in Output Emissions Detail. Note that this latter approach will double the size of the output for all pollutants, or triple it if CNG is modeled. Use results reported in the MOVES output for Primary Exhaust PM10 – Total (pollutantID = 100), for diesel fuel vehicles (fueltypeID = 2), and for running exhaust and crankcase running exhaust processes (processID = 1 and 15) depending on the Output Emissions Detail options selected. Be aware that MOVES

requires prerequisite pollutants to be selected to model Primary Exhaust PM10 – Total and these results will also be included in the MOVES output. If using MOVES2014, Primary Exhaust PM2.5 – Total and the Primary Exhaust PM2.5 – Species of Composite – NonECPM, Elemental Carbon, H2O (aerosol), and Sulfate Particulate (pollutantID = 110, 118, 112, 119, 115) are required. If using MOVES2010b, Primary PM10 – Organic Carbon, Primary PM10 – Elemental Carbon, and Primary PM10 – Sulfate Particulate (pollutantID = 101, 102, 105) are required.

POM (polycyclic organic matter) cannot be modeled directly as an individual "pollutant" in MOVES; to calculate emissions of this pollutant, the following individual pollutants need to be modeled:

Pollutant ID	Pollutant Name	Pollutant ID	Pollutant Name
68	Dibenzo(a,h)anthracene particle	168	Dibenzo(a,h)anthracene gas
69	Fluoranthene particle	169	Fluoranthene gas
70	Acenaphthene particle	170	Acenaphthene gas
71	Acenaphthylene particle	171	Acenaphthylene gas
72	Anthracene particle	172	Anthracene gas
73	Benz(a)anthracene particle	173	Benz(a)anthracene gas
74	Benzo(a)pyrene particle	174	Benzo(a)pyrene gas
75	Benzo(b)fluoranthene particle	175	Benzo(b)fluoranthene gas
76	Benzo(g,h,i)perylene particle	176	Benzo(g,h,i)perylene gas
77	Benzo(k)fluoranthene particle	177	Benzo(k)fluoranthene gas
78	Chrysene particle	178	Chrysene gas
81	Fluorene particle	181	Fluorene gas
82	Indeno(1,2,3,c,d)pyrene particle	182	Indeno(1,2,3,c,d)pyrene gas
83	Phenanthrene particle	183	Phenanthrene gas
84	Pyrene particle	184	Pyrene gas

MOVES2010b and MOVES2014 currently report zero emissions for some of these pollutants, but they may be quantified in future versions of MOVES. Note that the MOVES Summary Reporter does not appear to work with these pollutants; the results will need to be accessed through the MySQL output database.

Q. 7) What Post-MOVES QA is needed?

A. 7) After the MOVES runs are complete it is important to QA and interpret output:

- Check file size and number of rows in output—related runs should have the same size output.
- Check for and investigate cases where emissions = 0.
- Some QA questions may include:
    - Do the emissions trends make sense?
    - Are there any obvious outliers?
    - Can you explain why emissions between alternatives are different?

- Why are emissions higher (or lower) for the build alternatives compared to No Action?
- Do the results make sense in the context of project purpose and need?

Q. 8) Are there other tips that make this process run more smoothly?

A. 8) Yes. It is good to use naming conventions so that it's easy to tell which RunSpecs, input databases, input data spreadsheets, and output databases go together.

Use the Description panel in the RunSpec to explain what each run does.

FHWA is available to offer assistance with troubleshooting, so when sending a group of files for review, include a brief "readme" document explaining what each file is. Send every file needed to trace the process from beginning to end (the MOVES RunSpecs, input data spreadsheets, input databases, output databases, and post-processing spreadsheets used to generate the results tables for the NEPA document).

Explain any anomalies (e.g., an output database that contains more than one run when others don't, etc.).

Q. 9) Are there templates for the MOVES RunSpec and County Data Manager inputs?

A. 9) Yes they are provided below. If desired, these templates can be employed as checklists, to organize the work flow and to facilitate discussions among the project team on options for the analysis framework before MOVES analysis begins. The last column of each table is blank, and can be used to document the approach specific to each element.

FHWA MOVES MSAT RunSpec Template

MOVES GUI Panel	Recommendation	Notes	Project Selections
Description	Use this to document the purpose of each run (e.g., "base year MSATs," "2040 No-build MSATs," etc.)		
Scale	Use County scale and Inventory mode	Inventory mode easier to use, less potential for error in post-processing	
Time Spans	Use "hour" time aggregation level. Model base year, project design year, first year of operation (optional but	This approach captures seasonal variations in emissions without need to model all months. All 24	

	recommended) (separate runs needed for each year). Model 4 seasons (e.g., Jan, Apr, Jul, Oct) Model weekdays. Model all 24 hours.	hours needed to capture effects of temperature and speed.	
Geographic Bounds	County where project is located		
Vehicles/Equipment	All gas and diesel vehicle types; CNG transit bus; E85 fuel type in MOVES2014	CNG bus needed unless local AVFT inputs available with zero CNG fraction for buses. E85 needed for three vehicle types in MOVES2014.	

MOVES GUI Panel	Recommendation	Notes	Project Selections
Road type	All road types in affected transportation network; not "off-network"	"Off-network" includes only non-roadway emissions that are not included in MSAT analysis	
Pollutants/Processes	**Pollutants:** Primary Exhaust PM10-Total (as Diesel PM) Benzene 1,3-Butadiene Formaldehyde Acrolein PAH (for naphthalene and POM) **Processes:** running exhaust, crankcase running exhaust; for MOVES2014, add evap permeation and evap fuel leaks.	MOVES2010b only reports results for naphthalene gas, not naphthalene particle.	
Manage Input Data Sets	No inputs needed		
Strategies	No inputs needed		
General Output	Units of grams or		

	pounds recommended so results don't round down to zero; report distance travelled for QA checks		
Output Emissions Detail	Road type, maybe fuel type; not source type, emissions process or model year	For Diesel PM, two options: 1) choose fuel type in Output Emissions Detail, and use results only for diesel fuel vehicles, or 2) do a separate run for Diesel PM with only diesel fuel vehicles selected in vehicles/equipment panel	
Advanced Performance Features	No selections needed		

FHWA MOVES MSAT County Data Manager Template

Input	Level of Detail/notes	Possible data sources	Data source for project
Age distribution	Same for all runs	State air agency, MPO, state DOT	
Sourcetype population	Project-specific data should be used for projects that affect off-network (non-roadway) emissions; otherwise input values for the area should be reasonable.	MOVES defaults, state air agency, MPO, state DOT	
Meteorology	Same for all runs. For simplicity, recommend one input table covering all months and hours.	State air agency, MOVES defaults	
I/M, fuels	Same for all alternatives, differ by year, fuels vary by season. One I/M table needed for each year; one complete set of fuel inputs can also be used for each year (instead of separate inputs by month).	State air agency, MOVES defaults	

Fuel Type and Technologies	Optional, same for all runs; see note above [part of Fuels inputs (AVFT) in MOVES2014]		
VMT and speeds	Unique inputs needed for each run (these vary by year and by alternative). Speed inputs should be as detailed as possible to capture congestion relief impacts (at a minimum: peak and off-peak speeds)	Project traffic modeling	

Input	Level of Detail/notes	Possible data sources	Data source for project
Road type distribution and ramp fraction	Include unique input for each run if the project changes these factors (e.g., shifting VMT from arterial to freeway, or increases ramp fraction by building new ramps). Also varies by year.	Project traffic modeling, MPO, state DOT	
Day and month VMT fractions	Same for all runs	MPO, state DOT, MOVES defaults	
Hour VMT fractions	Same for all alternatives, may differ by year	MPO, state DOT, MOVES defaults	

Additional County Data Manager inputs are available for Hoteling, Retrofit, and Starts in MOVES2014 that may be applicable to certain types of projects (e.g., intermodal freight facilities).

Q. 10) What if I still have questions?

A. 10) If you have questions on how to define the scope of the analysis, set up the runs, or develop any input data, don't hesitate to ask for advice. FHWA provides assistance on MSAT analysis for projects all around the country. It's better to resolve an issue before starting an analysis than to spend time revising inputs and rerunning multiple MOVES runs later.

If you have questions, please contact Victoria Martinez at victoria.martinez@dot.gov, Jeff Houk at jeff.houk@dot.gov or Michael Claggett at michael.claggett@dot.gov.