Performance Standard Modeling for New and Existing Vehicle Inspection and Maintenance (I/M) Programs Using the MOVES Mobile Source Emissions Model

EPA United States Environmental Protection Agency

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Transportation and Climate Division
Office of Transportation and Air Quality
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1.0 Does this guidance create any new requirements?

This guidance does not create any new requirements, but was instead developed by the U.S. Environmental Protection Agency's (US EPA) Office of Transportation and Air Quality (OTAQ) for use by EPA's Regional Offices, state and local air agencies, and other stakeholders in the vehicle inspection and maintenance (I/M) community interested in modeling the impacts of I/M program design on the mobile source inventory for the development of I/M State Implementation Plans (SIPs) and/or other purposes. The legally binding requirements for vehicle I/M programs can be found in Clean Air Act (CAA) sections 182 (a-c), 184(b), and 187 (a-b) and in the I/M rule (40 CFR Part 51, subpart S). This policy document does not substitute for those provisions or regulations, nor is it a regulation itself. Thus, it does not impose binding, enforceable requirements on any party, and may not be applicable in all situations. EPA and State decision makers retain the discretion to adopt approaches for approval of State Implementation Plan (SIP) measures like I/M that differ from this guidance where appropriate and consistent with applicable law and regulations. Any final decisions by EPA regarding a particular SIP measure will only be made based on the statute and regulations in the context of EPA notice and comment rulemaking on a submitted SIP revision. This guidance may be revised periodically without public notice.

2.0 A Brief History Of The I/M Performance Standards

Since the early 1980's, vehicle I/M programs have been used as an air quality control strategy in certain areas[1] of the United States found to be violating the National Ambient Air Quality Standards (NAAQS) for either ozone, carbon monoxide (CO), or both. I/M programs help improve air quality by identifying high emitting vehicles in the in-use fleet and causing them to be repaired. A high emitting vehicle is one which is emitting at some increment above the standard to which it was certified, either 2-3 times the standard for vehicles being tailpipe tested, or 1.5 times the standard for vehicles equipped with onboard diagnostic (OBD) systems and subject to the OBD test.

Early I/M programs varied widely based upon the tests performed, the design of the testing network, the level of enforcement against motorists and test stations, and overall program effectiveness. As a result, in 1990, the CAA was amended to – among other things – formalize the minimum program requirements for mandatory I/M programs. As part of this effort, the 1990 CAA established two types of I/M programs: basic I/M for certain moderate ozone and/or CO nonattainment areas and enhanced I/M for certain serious or worse nonattainment areas, as well as certain areas located within the North East Ozone Transport Region (OTR) regardless of attainment status. Among its I/M provisions, the CAA required the US EPA to establish

[1] See Appendix E of this guidance document for a complete discussion of the criteria for determining whether a given area is required to adopt an I/M program.

performance standards that mandatory I/M programs had to either meet or exceed in terms of the emission reductions they achieved.

EPA first promulgated performance standards for basic and enhanced I/M programs in November 1992 as part of the original I/M rule. The I/M performance standards have been revised several times since to provide areas greater flexibility to design I/M programs that meet local needs and also to address the change from the original 1-hour ozone standard to an 8-hour ozone standard. The last time the I/M performance standards were revised was in April 2006 to address I/M programs newly required under the original and subsequent 8-hour ozone standards.

Until recently, I/M performance standard modeling was performed using the MOBILE series of emission factor models. With the exception of California (which uses the EMFAC model developed specifically for that state), all other I/M programs currently in operation in the United States were developed using one of the versions of the MOBILE model to determine whether they met the applicable performance standard as part of developing their I/M SIPs.

To meet its own regulatory needs and the needs of states for greater analytical capability in SIP and transportation planning development, in December 2009, EPA released its next generation of mobile source emission factor model – known as the MOtor Vehicle Emission Simulator or MOVES model – to replace the MOBILE model. Any new or existing I/M program needing to do I/M performance standard modeling or needing to assess the SIP impacts of revisions to an I/M program now or in the foreseeable future will be required to use a version of the MOVES model, with the possible exception of California for the reason stated above. Readers interested in more information on the history, uses, and development of the MOVES model can find it online at the following web address:

http://www.epa.gov/otaq/models/moves/index.htm

3.0 How Were the I/M Performance Standards Established?

States new to I/M must demonstrate their program's ability to meet the relevant performance standard when the program is first proposed as part of the I/M SIP. Existing I/M program areas which have not been redesignated to attainment must also do performance standard modeling whenever they revise their I/M SIP in a way that is likely to change the level of emission reductions achieved by the program.

Historically, EPA's approach to establishing minimum performance standards for basic and enhanced I/M has involved publishing a list of program parameters for each performance standard in the *Federal Register* as part of the larger I/M rule. These program parameters tend to be those that impact the amount of reductions a program is projected to achieve and include: test frequency, test type, test standards, vehicle model year and vehicle type coverage, compliance rate, waiver rate, etc. To determine whether a state's proposed program is projected to meet or exceed the relevant performance standard, the state needs to perform three modeling scenarios: a no-I/M case, the proposed program, and the applicable I/M performance standard. These modeling scenarios are to be performed using the most recently required mobile source emission

factor model along with other locally variable parameters, such as the age distribution of the local in-use fleet, average ambient temperature, the distribution of vehicle miles travelled (VMT), average speed, etc. The proposed program and performance standard scenarios are compared to the no-I/M case to determine the percent reduction produced by the proposed program and the applicable performance standard, respectively. If the proposed program is projected to achieve the same or greater percent reductions in hydrocarbons (HC), oxides of nitrogen (NOx), and/or carbon monoxide (CO) as would be achieved by the performance standard, then the proposed program is considered to have met the performance standard and is one step closer to being deemed approvable.

4.0 Can an I/M Program be Changed Without Doing Performance Standard Modeling?

States can change their I/M programs without doing performance standard modeling if the I/M program area in question has been redesignated to attainment for the pollutant(s) that originally triggered the I/M requirement and the I/M program is being continued as part of the area's maintenance plan. In this case, the state must simply demonstrate that the revisions to the I/M program will not interfere with the area's ability to attain or maintain any NAAQS, or with any other applicable CAA requirement. One means of making this demonstration is by quantifying the difference in emission reductions between the original program and the proposed program and offsetting any shortfall through new, previously unclaimed and contemporaneous emission reductions. The shortfall can be quantified in much the same way that the program demonstrates that it meets the performance standard: by modeling the original and proposed programs using the most recently approved mobile source emission factor model, which is currently the MOVES model[2].

It should be noted that areas seeking to drop tailpipe testing in favor of OBD-only testing without strengthening the program in some other way (for example, by changing the test frequency from biennial to annual, or covering more of the newer model years) will necessarily create a shortfall that will either have to be filled with reductions from non-I/M control measures for the SIP to remain whole, or the program will need to make a demonstration (for example, by using photochemical grid modeling) showing that the shortfall does not prevent the area from maintaining the NAAQS for which the program was required. The program will also need to demonstrate that the shortfall will not interfere with the area's ability to meet any other relevant NAAQS.

5.0 Why is EPA Issuing this Guidance Now?

As noted above, in December 2009, EPA released its next generation of mobile source emission factor model, MOVES, to replace the MOBILE model. Like MOBILE, MOVES is intended to be used for several different purposes, from the development of federal regulations

[2] In addition to using the most recently approved mobile source emission model, areas seeking approval for I/M program revisions also need to update program inputs that may have changed since the last time the program was modeled, including replacing projected rates for compliance, waivers, etc., with numbers based upon actual operating program data.

related to mobile sources to the development by states of their individual mobile source SIPs. Although the two models were originally designed with similar purposes in mind, nevertheless there are significant differences between the two. This is especially true when it comes to how various elements of the I/M performance standards are addressed. Because of these differences – and because the use of the MOBILE model is no longer accepted for performance standard modeling – EPA believes this guidance is needed, especially by users familiar with the previous MOBILE model who may be confused by the change in approach to performance standard modeling taken by MOVES versus MOBILE.

While all areas required to implement an I/M program under the CAA are currently doing so, this guidance is nevertheless timely for at least two reasons:

1) As the majority of the in-use fleet turns over to vehicles equipped with onboard diagnostic (OBD) technology, many existing I/M program areas may seek to revise their programs to achieve greater efficiencies at lower costs; and
2) As the current ozone standard is revised (as it was in 2008) areas previously exempt from the I/M requirement may be required to adopt such programs for the first time.

In either of the above events, the I/M areas – whether new or existing – will be required to demonstrate that their new or revised programs will meet the applicable CAA requirements. This demonstration will require modeling to demonstrate the program meets the relevant I/M performance standard or to quantify how proposed program changes will impact the emission reductions achieved by the existing program. This guidance will discuss how I/M programs are to be modeled using MOVES, including how to perform the relevant performance standard modeling. The guidance will also address which type of modeling demonstration is required under various scenarios.

6.0 The Fundamentals of Performance Standard Modeling

When modeling any of the I/M performance standards, it is necessary to perform a minimum of three modeling runs. These include:

1) A no-I/M run which includes all the required local area parameters and control measures with the exception of an I/M program;
2) The proposed program run which includes all the local area parameters and control measures as well as the sequence of inputs required to define the proposed program; and
3) The performance standard run which includes all the local area parameters and control measures and an I/M program including all the program elements of the required I/M performance standard.

By comparing both the proposed program results and the performance standard results to the no I/M case, the state can estimate the emission reductions projected to be achieved by the two different cases as a percent reduction relative to no I/M. For a basic I/M program, if the

proposed program achieves the same or greater emission reductions as does the performance standard program, then the proposed program is considered to have "met" the performance standard and that portion of the state's I/M SIP is therefore approvable[3]. In the case of an enhanced I/M program, if the proposed program's net reductions are within 0.02 grams-per-mile (gpm) of the reductions achieved by the relevant performance standard for hydrocarbons (HC) and/or oxides of nitrogen (NOx), it is considered to have met the applicable performance standard[4].

7.0 Which Performance Standard Should be Used?

As stated above, outside of maintenance areas, all new I/M programs and existing I/M programs undergoing revision must include I/M performance standard modeling as part of their I/M SIP or I/M SIP revision. Sections 51.351 and 51.352 of the I/M rule include numerous iterations of the I/M performance standards for basic and enhanced I/M programs. The reason for this variety is twofold: 1) to provide I/M program areas greater flexibility in designing their I/M programs as warranted by the relative severity of the air quality issue being addressed; and 2) to address revisions to the ozone NAAQS. The modeling requirements vary depending on whether the non-attainment area in question has an existing I/M program or, if it does not, whether it meets the other triggering requirements for a mandatory I/M program, such as being classified as moderate or worse nonattainment for ozone, or being located within the Ozone Transport Region (OTR), regardless of attainment status[5]. Below, we discuss the I/M modeling requirements for new and existing non-attainment areas.

7.1 I/M Modeling Requirements for New Non-attainment Areas

Certain areas of the country that do not currently have an I/M program may be required to adopt such a program in the future if the area is found to meet certain criteria. The first of these is that the area must be designated non-attainment for the most recent 8-hour ozone standard, and must also be classified as moderate non-attainment or worse. If the area is classified as moderate non-attainment for the 8-hour standard (and is not part of a multi-state non-attainment area) then the area must also have an urbanized population of at least 200,000 or more based upon the 1990 U.S. Census. If the new ozone non-attainment area is classified as serious or worse non-attainment for the 8-hour ozone standard (and is not part of a multi-state non-attainment area)

[3] Meeting the relevant performance standard is not the only hurdle to be cleared when revising an existing I/M program. Areas will also need to consider the section 110(l) anti-backsliding provisions of the Clean Air Act although any shortfall resulting from revising the I/M program does not need to be made up by the program. Such shortfalls can be made up by new, previously uncredited emission reductions from other control measures.

[4] The 0.02 gpm enhanced performance standard buffer applies to pollutants separately, not cumulatively. Therefore, a program that came within 0.02 gpm for HC and 0.02 gpm for NOx would be considered to meet the performance standard while one which met or exceeded the performance standard reductions for HC while falling short of the NOx reductions by 0.03 gpm or more would not.

[5] Classification as moderate non-attainment for ozone and/or an area's location within the OTR do not, in and of themselves, automatically trigger the I/M requirement. Such areas also need to meet minimum population thresholds before I/M is required. These population levels vary, depending upon whether the area in question is subject to basic, enhanced, or OTR enhanced I/M, as discussed elsewhere in this guidance.

then the area must also have an urbanized population of at least 200,000 or more based upon the 1980 U.S. Census[6].

As part of designing an approvable I/M program, the State must demonstrate that the proposed program will meet or exceed the applicable I/M performance standard.

For areas classified as moderate non-attainment for an 8-hour ozone standard, the applicable I/M performance standard consists of the following elements under 40 CFR 51.352(e):

(1) *Network type.* Centralized testing.

(2) *Start date.* 4 years after the effective date of designation and classification under the 8-hour ozone standard.

(3) *Test frequency.* Annual testing.

(4) *Model year coverage.* Testing of model year 1968 and newer vehicles.

(5) *Vehicle type coverage.* Light duty vehicles.

(6) *Emission test type.* Idle testing for model year 1968–2000 vehicles; onboard diagnostic checks on model year 2001 and newer vehicles.

(7) *Emission standards.* Those specified in 40 CFR part 85, subpart W.

(8) *Emission control device inspections.* None.

(9) *Evaporative system function checks.* None, with the exception of those performed by the OBD system on vehicles so-equipped and only for model year 2001 and newer vehicles.

(10) *Stringency.* A 20% emission test failure rate among pre-1981 model year vehicles.

(11) *Waiver rate.* A 0% waiver rate, as a percentage of failed vehicles.

(12) *Compliance rate.* A 100% compliance rate.

(13) *Evaluation date.* Newly required basic I/M programs shall be shown to obtain the same or lower emission levels as the model program described above by an evaluation

[6] The CAA also includes I/M requirements for metropolitan statistical areas (MSAs) within the OTR with populations of 100,000 or more, regardless of attainment status for ozone. It is not likely that any area in the OTR would be newly required to adopt an I/M program based upon classification under a new or subsequent ozone standard because the enhanced I/M requirement for the OTR is tied to population threshold only, and not to attainment status. It is possible, however, that an existing OTR I/M program might need to be upgraded if its status changed from attainment to serious or worse nonattainment for ozone.

date set 6 years after the effective date of designation and classification under the 8-hour ozone standard for the applicable ozone precursor(s).

For 8-hour non-attainment areas classified as serious or above, the applicable performance standard consists of the following elements under 40 CFR 51.351(i):

(1) *Network type.* Centralized testing.

(2) *Start date.* 4 years after the effective date of designation and classification under the 8-hour ozone standard.

(3) *Test frequency.* Annual testing.

(4) *Model year coverage.* Testing of model year 1968 and newer vehicles.

(5) *Vehicle type coverage.* Light duty vehicles, and light duty trucks, rated up to 8,500 pounds GVWR.

(6) *Emission test type.* Idle testing for model year 1968–2000 vehicles; onboard diagnostic checks on model year 2001 and newer vehicles.

(7) *Emission standards.* Those specified in 40 CFR part 85, subpart W.

(8) *Emission control device inspections.* Visual inspection of the positive crankcase ventilation valve on all 1968 through 1971 model year vehicles, inclusive, and of the exhaust gas recirculation valve on all 1972 and newer model year vehicles.

(9) *Evaporative system function checks.* None, with the exception of those performed by the OBD system on vehicles so-equipped and only for model year 2001 and newer vehicles.

(10) *Stringency.* A 20% emission test failure rate among pre-1981 model year vehicles.

(11) *Waiver rate.* A 3% waiver rate, as a percentage of failed vehicles.

(12) *Compliance rate.* A 96% compliance rate.

(13) *Evaluation date.* Newly required enhanced I/M programs shall be shown to obtain the same or lower emission levels for HC and NO_X as the model program described above assuming an evaluation date set 6 years after the effective date of designation and classification under the 8-hour ozone standard to within 0.020 grams-per-mile (gpm) of the performance standard expressed as a gpm benefit relative to no I/M. Subject programs shall demonstrate through modeling the ability to maintain this percent level of emission reduction (or better) through their applicable attainment date for the 8-hour ozone standard.

7.2 I/M Modeling Requirements for Existing Non-attainment Areas

All existing I/M program areas are either: 1) located in the OTR, regardless of attainment status; 2) maintenance for carbon monoxide and/or ozone; or 3) they are non-attainment for one or more 8-hour ozone standards. As discussed previously, I/M programs in maintenance areas do not need to perform performance standard modeling as part of revising their I/M SIP. Instead, the program must demonstrate that any potential shortfall created by the change does not adversely affect an area's ability to attain or maintain any applicable NAAQS or to meet any other relevant CAA requirement. To revise an existing I/M program in a current nonattainment area, the program must make the same non-interference demonstration as required of an I/M program in a maintenance area undergoing similar changes, but must also demonstrate that the revised program will continue to meet the applicable 8-hour ozone I/M performance standard(s). For areas classified as moderate non-attainment for an 8-hour ozone standard, the I/M performance standard consists of the program elements identified under 40 CFR 51.352(e) (see section 6.1 above for the complete list). For 8-hour non-attainment areas classified as serious or above, the applicable performance standard consists of the program elements identified under 40 CFR 51.351(i), which are also listed above, in section 7.1.

8.0 How do the I/M Input Parameters for MOVES Compare to Those for MOBILE?

While the performance standards for existing and newly required I/M programs have not changed since areas were designated and classified under the 1997 8-hour ozone standard, the model used for performing those performance standard demonstrations has changed significantly. In particular, the way that I/M programs are modeled has been simplified with the elimination of some and the consolidation of other program parameters previously used with earlier versions of EPA's mobile source emission factor model. State modelers familiar with the MOBILE series of emission factor models as well as first-time modelers trying to follow the text of the performance standards described above may notice that some modeling parameters called for in the performance standards are no longer needed to model an I/M program or its associated performance standard. These input parameters have been eliminated as part of EPA's effort to streamline and simplify the I/M modeling process and the reasons for doing so are discussed in detail below.

In addition to streamlining the input parameters required to model an I/M program, another difference between the MOBILE model and MOVES that modelers may notice is the way in which the model's outputs are expressed. While the MOBILE model's outputs were generally expressed as an average gram-per-mile emission factor, MOVES has the option of producing outputs as either the total mass of emissions over a particular time period (known in MOVES as the "inventory "calculation type) or as an emission rate in grams per mile for running emissions, but in grams *per vehicle* for start and evaporative emissions (known in MOVES as the "emission rates" calculation type). Neither of these output options is exactly equivalent to the gram-per-mile emission factors produced by MOBILE.

While this difference between the two models doesn't matter when it comes to comparing a program to the basic performance standard it is an issue when it comes to comparing a

proposed program to the enhanced performance standard. This is because the enhanced performance standard includes an optional buffer, so that an area that comes within 0.020 grams-per-mile of the performance standard is considered to have met that standard. Areas that fall slightly short of meeting the enhanced I/M performance standard under MOVES may still take advantage of this buffer by converting MOVES' mass-over-time inventory output to the equivalent in grams per mile by using the script EPA has provided with MOVES that automatically converts MOVES inventory output to the equivalent in grams per mile[7]. The script needed to do this is called "EmissionRates.sql" and can be run using the "Run MySQL Script on Output Database" option in the Post Processing menu in MOVES. Once the outputs for the no I/M case, the performance standard, and the proposed program have been converted to gram-per-mile emission factors, the gram-per-mile reduction from the I/M runs can be derived by subtracting the I/M emission factor from the no-I/M emission factor. After that, the 0.020 gpm buffer can be applied as was done under the MOBILE model.

To aid potential new and existing I/M program areas in developing their I/M performance standard runs, EPA is providing default templates for both the basic and enhanced I/M performance standards for use by the states with the MOVES emission factor model. These templates can be found as tables in Appendix A, and are also available as Excel spreadsheets, which are included with the electronic version of this guidance and are also available online at: http://www.epa.gov/otaq/epg/techguid.htm.

In the sections that follow, we will discuss the current status of each I/M performance standard input parameter, including whether or not it is still required to model I/M under the MOVES model, and if not, why.

8.1 Network Type

Network type is no longer part of modeling an I/M program because the difference between centralized and decentralized programs has become insignificant. This is because centralized test information databases allow programs to monitor all test stations at once – effectively centralizing program oversight. Also, the introduction of onboard diagnostic (OBD) testing technology – which is currently replacing traditional tailpipe testing in many areas – has allowed for several sophisticated enforcement methods that have helped investigators to identify and protect against vulnerabilities that previously distinguished centralized versus decentralized programs.

8.2 Start Date

Given that the attainment dates for all I/M programs assume that programs will be fully implemented at least one full inspection cycle prior to the attainment date, the need for inputting the start date is effectively moot. As a result, the input parameter for start date previously

[7] MOVES emission rates output cannot be used for this purpose because there is no simple way to convert grams-per-vehicle output for starts and evaporative emissions to grams per mile.

available in the MOBILE model was removed as part of the general effort to streamline the number of required I/M inputs needed to run MOVES.

8.3 Test Frequency

MOVES allows users to enter either annual (1) or biennial (2) test frequency under the template column named "inspectFreq," which is short for "inspection frequency."

8.4 Model Year Coverage

The MOVES I/M performance standard templates address model year coverage with columns for the first and last model years covered relative to the evaluation year. MOVES uses these two columns (i.e., "begModelYearID" and "endModelYearID") to specify the beginning and ending model years affected by a particular portion of the I/M program.

8.5 Compliance Rates, Waiver Rates, and Vehicle Types

MOVES uses the compliance factor input ("complianceFactor") to account for I/M program compliance rates, waiver rates, and adjustments needed to account for the fraction of vehicles within a source type that are covered by the I/M program. The last will be referred to here as the "regulatory class coverage adjustment." The compliance factor is entered as a number from 0 to 100 and represents the percentage of vehicles within a source type that actually receive the benefits of the program. Since all three components of the compliance factor are calculated as multiplicative factors, the total compliance factor entered in MOVES2010 is calculated as:

Compliance Factor = percent compliance rate x (100 - percent waiver rate) x regulatory class coverage adjustment

Appendix C provides a sample adjustment calculation using compliance rate, waiver rate, and regulatory class coverage to arrive at a single percent compliance factor (see template column heading, "complianceFactor"). The terms "compliance rate," "waiver rate," and "vehicle type adjustment" are discussed in more detail below.

8.5.1 Compliance Rate

The compliance rate is the percentage of vehicles in the fleet covered by the I/M program that complete the I/M program and receive either a certificate of compliance or a waiver. Historical compliance should be determined by sticker surveys, license plate surveys, or a comparison of the number of final tests to the number of vehicles subject to the I/M requirement. Planners should not assume a compliance rate of 100%. An area planning to implement an I/M program using a registration denial system that automatically generates compliance documents

that uniquely identify the complying vehicle and that are serially numbered, accounted for, and subject to centralized processing by government clerks with management oversight may assume a 96% compliance rate for modeling purposes prior to program implementation. Once the program begins implementation, however, the compliance rate should be based on operating program data.

8.5.2 Waiver Rate

The waiver rate is the percentage of vehicles that fail an initial I/M test and do not pass a retest, but instead receive a certificate of compliance via a waiver. Actual historical waiver rates should be used as the basis for estimating future waiver rates. Because the Compliance Factor in MOVES is a measure of the percentage of vehicles registered in the modeling domain that actually receive an I/M benefit, the percentage of vehicles that are not waived (i.e., 100 - percent waiver rate) is used as one input when calculating the compliance factor.

8.5.3 Vehicle Type Adjustment

I/M programs entered in MOVES can only be applied to across entire source types. It should be noted, however, that MOVES's source types are composed of several vehicle weight classes, some of which may be subject to I/M in a given area while others are exempt. Therefore applying I/M benefits to the entire MOVES source type may not always be appropriate. To account for this, a table of adjustment factors has been included in Appendix B which can be used to adjust the compliance factor to account for the portion of a given source type that is subject to I/M. The adjustments in Appendix B are percentages of Vehicle Miles Traveled (VMT) by the various regulatory weight classes within the various source types. After reviewing the table, users should sum the adjustments for weight classes within a source type that are covered by an I/M program. This sum provides users with a multiplicative factor that can be applied along with the compliance rate and waiver rate discussed above. Users who believe regional regulatory class coverage adjustments are more appropriate than the defaults provided in Appendix B should provide documentation in the SIP or regional conformity analysis of the local data and methods used to derive those adjustments.

8.6 Emission Test Type and Emission Standards

In the MOBILE model, the need to input a series of emission standards or cutpoints for the various I/M test types was gradually reduced until only the IM240 required a separate input for emissions standards. For the other test types, like the idle or the Acceleration Simulation Mode (ASM) tests, the cutpoints were essentially hardwired into the model. With MOVES, this process of phasing out the cutpoint input has been completed. Users need only select the appropriate test type and the model will automatically apply the relevant standard.

MOVES allows users to choose among 13 exhaust emissions tests and 7 evaporative emissions tests. The MOVES inputs for these tests can be found in Appendix D. In the I/M

performance standard template, emission test type is entered under the column headed "testStandardsID." These test types include the MOBILE I/M input parameter for evaporative system functional checks but do not include emission control device inspections, which are discussed below.

8.7 Emission Control Device Inspections

While the last version of the MOBILE model included a modest amount of credit for some of the eight potential emission control device inspections (also known as anti-tampering or ATP checks) that programs have used historically, most such checks received little if any credit. As a general matter, the trend over the course of the MOBILE model's existence was for tampering checks to get progressively less credit, either because the checks were too difficult to perform correctly in the field or because the kind of tampering gradually became irrelevant. For example, testing for misfueling is no longer necessary as a result of the phase-out of leaded fuel. Tampering checks were finally removed from MOVES as a logical progression of the downgrading of tampering credits that had been going on in the MOBILE model through MOBILE6.2. Also, as a practical matter, tampering inspections are becoming increasingly redundant as OBD-equipped vehicles come to dominate the in-use fleet. This is because the most common forms of tampering – like catalyst removal – are easily detected by the OBD system, which will cause the "Check Engine" light to illuminate, which in turn will result in the vehicle in question failing its I/M test.

8.8 I/M Stringency

The "I/M stringency" input parameter was used to allow users of earlier iterations of the MOBILE model to input the failure rate among pre-1981 model year vehicles. As the model evolved (and fleets turned over to the point where pre-1981 model year vehicles became an insignificant fraction of the in-use fleet) this input was retained as a place keeper to avoid having to redesign the structure of existing input files. As a place keeper, the number that was input did not affect the results, but was required for the model to run properly. As long as users input a number within the acceptable range, the model would run, but the choice of number did not impact the results of a given run. Because MOVES was programmed as a brand new kind of mobile source emission factor model from the ground up, it was no longer necessary to retain I/M stringency for the model to run properly. Therefore, it was removed as part of a larger effort to streamline and simplify the I/M modeling process.

8.9 Evaluation Date

The date for which the I/M program is being evaluated – also known as the evaluation date – is entered as a four-digit year under the template column headed "yearID."

9.0 Modeling Non-Performance Standard Vehicle Exemptions

In addition to the I/M-related inputs required to model an I/M performance standard, the MOBILE model also allowed users to model exemptions of the newest and/or oldest model years. In MOBILE, for new vehicles, this allowance was known as a "grace period," and for older vehicles, this allowance was called an "exemption age." These last two program parameters can be modeled in MOVES by adjusting the first and last covered model years relative to the evaluation year. MOVES uses these two columns (i.e., "begModelYearID" and "endModelYearID") to specify the beginning and ending model years affected by a particular part of the I/M program. For I/M programs without a grace period for new vehicles or an exemption period for older vehicles, this is simply the first and last model year affected by the program.

For I/M programs with a grace period for new vehicles or an exemption period for older vehicles, this entry should reflect the actual model years covered by the program in the calendar year of evaluation. As a result, the beginning and ending model years for an I/M program may vary depending on the calendar year of analysis. For example, a typical OBD I/M program might apply to all model years beginning with 1996. However, if that program also includes a grace period during which newer vehicles are exempt from the program, the ending model year of the program should reflect the most recent model year included in the program based on the calendar year of analysis. For example, if in calendar year 2005, the most recent model year being tested in a program with a three-year grace period is the 2002 model year, a MOVES run for calendar year 2005 would have an ending model year of 2002. An analysis of the same program for calendar year 2010 would have an ending model year of 2007.

Similar adjustments to the beginning model year should be made to account for exemptions of older model years. In that case, the beginning model year of the program should reflect the oldest model year still being tested. For example, if a program stops testing vehicles after they reach 20 years old, then in 2005, the oldest model year still being tested in a program would be the 1985 model year. Therefore, a MOVES run for calendar year 2005 for such a program would have a beginning model year of 1985. An analysis of the same program for calendar year 2010 would have a beginning model year of 1990.

Note that because of this treatment of beginning and end years, a unique set of I/M inputs would be needed for each calendar year modeled. This is different than what was possible under MOBILE, where one set of I/M inputs could be used for any calendar year.

10.0 Other I/M-Related MOVES Input Parameters

In addition to the MOVES inputs described above there are other inputs that are unique to the MOVES model and are required for the model to run properly. These include the state, county and year IDs as well as pollutant process ID, source type ID, fuel type ID, and I/M program ID. These program descriptors are explained in greater detail below.

10.1 Pollutant process ID (polProcessID)

MOVES estimates emission reductions from I/M programs for hydrocarbons, NOx, and CO. For exhaust emissions, I/M programs can affect both running and start emissions. For evaporative emissions, I/M programs affect hydrocarbon emissions from fuel vapor venting and fuel leaks.

10.2 Source Type ID (sourceTypeID) and Fuel Type ID (fuelTypeID)

These entries are used to describe the source (vehicle) types and fuel types included in the I/M program. Users should check to make sure that the vehicle and fuel types match the I/M program parameters for the vehicles included in the local program. MOVES currently calculates I/M program benefits only for gasoline vehicles.

I/M programs have historically applied to vehicles by regulatory weight class; however, MOVES applies I/M benefits by source type. This can lead to discrepancies between the number of vehicles covered in the actual I/M program and the number of vehicles that MOVES assumes are covered. For example, an I/M program that targets trucks less than 8,501 pounds Gross Vehicle Weight Rating (GVWR) (i.e. regulatory classes LDT1, LDT2, LDT3, and LDT4) would include parts of two MOVES source types: passenger trucks (sourcetypeID 31) and light commercial trucks (32). However, these source types also include vehicles with GVWR greater than 8,501 lbs. When an I/M program is applied to source types 31 and 32 in MOVES, all of the vehicles in these source types get I/M benefits. Users can adjust the compliance factor to account for the fraction of vehicles within a source type that are actually covered by the I/M program. How this calculation is performed is illustrated in Appendix C.

10.3 I/M Program ID (IMProgramID)

In MOVES, I/M programs that have both exhaust and evaporative inspection components, including OBD programs, are modeled as two separate, simultaneous programs identified using different I/M program ID numbers in the I/M program ID column. Users should be careful to include both the exhaust and evaporative components to ensure proper credit for the program. Likewise, an I/M program that applies different tests to different vehicles (e.g., an IM240 program that applies to older model years and an OBD program that applies to newer model years) is also modeled as two separate, simultaneous programs identified using different I/M program ID numbers in the I/M program ID column and using the beginning and ending model year columns to differentiate what model years are covered by each program.

10.4 Use I/M? (useIMyn)

Lastly, the MOVES I/M input parameters include a column labeled “useIMyn” which allows the user to turn off (“N”) or on (“Y”) the portion of the I/M program described in that row of the table.

11.0 Local Input Parameters

Depending upon the modeling exercise being done, users may need to include local data for locally variable input parameters such as vehicle type and age distribution, average speed, temperature, and vehicle-miles-travelled (VMT). For areas needing to demonstrate whether a proposed I/M program meets the performance standard only (i.e., without quantifying the actual mass emission reductions of the program for a shortfall calculation or other SIP purposes, such as an attainment demonstration), such areas will have the option of using MOVES' national defaults for these local variables in place of locally derived data. If an area has reason to believe that using national defaults may reduce the flexibility it has in designing its I/M program (by, for example, requiring that more model years be included than might otherwise be the case), such areas may be better served by using the same locally-derived inputs it previously used for developing emissions inventories for a SIP. State and local agencies should consult EPA's Technical Guidance on the use of MOVES for SIPs and transportation conformity guidance (available at www.epa.gov/otaq/models/moves/420b10023.pdf) for more details on choosing MOVES RunSpec parameters and appropriate local inputs when developing emission inventories for a SIP. For areas that are modeling a proposed I/M program or program revision for other purposes, such as for a shortfall calculation or attainment demonstration, the local inputs used should be consistent with those used to develop the emissions inventory.

12.0 Additional Questions?

The guidance in this document should cover the majority of day-to-day I/M modeling questions that may arise when running the most recent version of the MOVES mobile source emission factor model. Should users run into issues not addressed in this guidance, please contact your Regional I/M contact with a detail description of the issue. OTAQ will work with its Regional partners to resolve any issues that may arise on a case-by-case basis. Any unique interpretation or supplemental guidance that results from these individual consultations will be made available through updates to this guidance, or through separate communication to the States and Regions, as circumstances warrant.

APPENDIX A: I/M Performance Standard Templates for MOVES2010

The table below contains the inputs a user needs to enter into the MOVES County Data Manager to model the basic I/M performance standard with the following exceptions: the user needs to supply a county ID in the third column and may need to change the year ID in the fourth column, depending upon the evaluation year desired. If the year ID is changed, please note that the End Model Year ID in column 11 will also need to be adjusted, relative to the evaluation year selected. For more information on how to enter inputs into the County Data Manager, please refer to the MOVES Technical Guidance released with the latest version of MOVES.

Basic I/M Performance Standard Default MOVES2010 Input

polProcessID	stateID	countyID	yearID	sourceTypeID	fuelTypeID	IMProgramID	inspectFreq	testStandardsID	begModelYearID	endModelYearID	useIMyn	complianceFactor
101			2019	21	1	111	1	11	1968	2000	y	100
102			2019	21	1	111	1	11	1968	2000	y	100
301			2019	21	1	111	1	11	1968	2000	y	100
302			2019	21	1	111	1	11	1968	2000	y	100
101			2019	21	1	151	1	51	2001	2018	y	100
102			2019	21	1	151	1	51	2001	2018	y	100
301			2019	21	1	151	1	51	2001	2018	y	100
302			2019	21	1	151	1	51	2001	2018	y	100
112			2019	21	1	143	1	43	2001	2018	y	100

Enhanced I/M Performance Standard Default MOVES2010 Input

The table below contains the inputs a user needs to enter into the MOVES County Data Manager to model the basic I/M performance standard with the following exceptions: the user needs to supply a county ID in the third column and may need to change the year ID in the fourth column, depending upon the evaluation year desired. If the year ID is changed, please note that the End Model Year ID in column 11 will also need to be adjusted, relative to the evaluation year selected. For more information on how to enter inputs into the County Data Manager, please refer to the MOVES Technical Guidance released with the latest version of MOVES.

polProcessID	stateID	countyID	yearID	sourceTypeID	fuelTypeID	IMProgramID	inspectFreq	testStandardsID	begModelYearID	endModelYearID	useIMyn	complianceFactor
101			2019	21	1	111	1	11	1968	2000	y	93.12
101			2019	31	1	111	1	11	1968	2000	y	87.53
101			2019	32	1	111	1	11	1968	2000	y	81.95
102			2019	21	1	111	1	11	1968	2000	y	93.12
102			2019	31	1	111	1	11	1968	2000	y	87.53
102			2019	32	1	111	1	11	1968	2000	y	81.95
301			2019	21	1	111	1	11	1968	2000	y	93.12
301			2019	31	1	111	1	11	1968	2000	y	87.53
301			2019	32	1	111	1	11	1968	2000	y	81.95
302			2019	21	1	111	1	11	1968	2000	y	93.12
302			2019	31	1	111	1	11	1968	2000	y	87.53
302			2019	32	1	111	1	11	1968	2000	y	81.95
101			2019	21	1	151	1	51	2001	2018	y	93.12
101			2019	31	1	151	1	51	2001	2018	y	87.53
101			2019	32	1	151	1	51	2001	2018	y	81.95
102			2019	21	1	151	1	51	2001	2018	y	93.12
102			2019	31	1	151	1	51	2001	2018	y	87.53
102			2019	32	1	151	1	51	2001	2018	y	81.95
301			2019	21	1	151	1	51	2001	2018	y	93.12
301			2019	31	1	151	1	51	2001	2018	y	87.53
301			2019	32	1	151	1	51	2001	2018	y	81.95
302			2019	21	1	151	1	51	2001	2018	y	93.12
302			2019	31	1	151	1	51	2001	2018	y	87.53
302			2019	32	1	151	1	51	2001	2018	y	81.95
112			2019	21	1	143	1	43	2001	2018	y	93.12
112			2019	31	1	143	1	43	2001	2018	y	87.53
112			2019	32	1	143	1	43	2001	2018	y	81.95

APPENDIX B: Gasoline I/M Regulatory Coverage Adjustments

Source Type Description	SourceTypeID	MOBILE6 Vehicle Class Description	M6VClassID	Regulatory Class Coverage Adjustment (%)
Motorcycle	11	Motorcycles (Gasoline)	24	100%
Passenger Car	21	LD Gas Vehicles (Passenger Cars)	1	100%
Passenger Truck	31	LD Gas Trucks 1 (0 - 6,000 lbs. GVWR, 0 - 3,750 lbs. LVW)	2	31%
		LD Gas Trucks 2 (0 - 6,000 lbs. GVWR, 3,751 - 5,750 lbs. LVW)	3	31%
		LD Gas Trucks 3 (6,001 - 8,500 lbs. GVWR, 0 - 5,750 lbs. ALVW)	4	16%
		LD Gas Trucks 4 (6,001 - 8,500 lbs. GVWR, > 5,751 lbs. ALVW)	5	16%
		Class 2b HD Gas Vehicles (8,501 - 10,000 lbs. GVWR)	6	3%
		Class 3 HD Gas Vehicles (10,001 - 14,000 lbs. GVWR)	7	3%
Light Commercial Truck	32	LD Gas Trucks 1 (0 - 6,000 lbs. GVWR, 0 - 3,750 lbs. LVW)	2	29%
		LD Gas Trucks 2 (0 - 6,000 lbs. GVWR, 3,751 - 5,750 lbs. LVW)	3	29%
		LD Gas Trucks 3 (6,001 - 8,500 lbs. GVWR, 0 - 5,750 lbs. ALVW)	4	15%
		LD Gas Trucks 4 (6,001 - 8,500 lbs. GVWR, > 5,751 lbs. ALVW)	5	15%
		Class 2b HD Gas Vehicles (8,501 - 10,000 lbs. GVWR)	6	5%
		Class 3 HD Gas Vehicles (10,001 - 14,000 lbs. GVWR)	7	5%
		Class 4 HD Gas Vehicles (14,001 - 16,000 lbs. GVWR)	8	1%
		Class 5 HD Gas Vehicles (16,001 - 19,500 lbs. GVWR)	9	1%

Gasoline I/M Regulatory Coverage Adjustments (cont.)

Source Type Description	SourceTypeID	MOBILE6 Vehicle Class Description	M6VClassID	Regulatory Class Coverage Adjustment (%)
Transit Bus	42	Class 6 HD Gas Vehicles (19,501 - 26,000 lbs. GVWR)	10	50%
		Class 7 HD Gas Vehicles (26,001 - 33,000 lbs. GVWR)	11	50%
School Bus	43	Class 6 HD Gas Vehicles (19,501 - 26,000 lbs. GVWR)	10	50%
		Class 7 HD Gas Vehicles (26,001 - 33,000 lbs. GVWR)	11	50%
Refuse Truck	51	Class 6 HD Gas Vehicles (19,501 - 26,000 lbs. GVWR)	10	50%
		Class 7 HD Gas Vehicles (26,001 - 33,000 lbs. GVWR)	11	50%
Single Unit Short-haul Truck	52	Class 6 HD Gas Vehicles (19,501 - 26,000 lbs. GVWR)	10	49%
		Class 7 HD Gas Vehicles (26,001 - 33,000 lbs. GVWR)	11	49%
		Class 8a HD Gas Vehicles (33,001 - 60,000 lbs. GVWR)	12	1%
		Class 8b HD Gas Vehicles (> 60,000 lbs. GVWR)	13	1%
Single Unit Long-haul Truck	53	Class 6 HD Gas Vehicles (19,501 - 26,000 lbs. GVWR)	10	48%
		Class 7 HD Gas Vehicles (26,001 - 33,000 lbs. GVWR)	11	48%
		Class 8a HD Gas Vehicles (33,001 - 60,000 lbs. GVWR)	12	2%
		Class 8b HD Gas Vehicles (> 60,000 lbs. GVWR)	13	2%
Motor Home	54	Class 6 HD Gas Vehicles (19,501 - 26,000 lbs. GVWR)	10	50%
		Class 7 HD Gas Vehicles (26,001 - 33,000 lbs. GVWR)	11	50%
Combination Short-haul Truck	61	Class 6 HD Gas Vehicles (19,501 - 26,000 lbs. GVWR)	10	48%
		Class 7 HD Gas Vehicles (26,001 - 33,000 lbs. GVWR)	11	48%
		Class 8a HD Gas Vehicles (33,001 - 60,000 lbs. GVWR)	12	2%
		Class 8b HD Gas Vehicles (> 60,000 lbs. GVWR)	13	2%

APPENDIX C: Sample Adjustment using Compliance Rate, Waiver Rate, and Regulatory Class Coverage

Using an I/M program that targets trucks less than 8501 lbs. Gross Vehicle Weight Rating (GVWR) (regulatory classes LDT1, LDT2, LDT3, and LDT4) would include parts of two MOVES2010 source types: passenger trucks (sourcetypeID 31) and light commercial trucks (32). Users should first determine the compliance rate and waiver rate for the trucks covered by that program. For this example, we will assume that the compliance rate is 96% and the waiver rate is 8%.

The user would then determine the regulatory class coverage adjustment by summing the percentages of those regulatory classes less than 8501 lbs. GVRW separately for source types 31 and 32 using the information in Table A in this Appendix. For source type 31, the regulatory class coverage adjustment is 94% (31% + 31% + 16% + 16%). For source type 32, the regulatory class coverage adjustment is 88% (29% + 29% + 15% + 15%).

Using these results, the compliance factor for source type 31 is:

Compliance factor = compliance rate x (100 - waiver rate) x regulatory class coverage

83% = 96% x (100-8)% x 94%

The compliance factor for source type 32 is:

Compliance factor = compliance rate x (100 - waiver rate) x regulatory class coverage

78% = 96% x (100-8)% x 88%

These values would be entered as compliance factors of 83 for source type 31 and 78 for source type 32.

APPENDIX D: MOVES2010 I/M Emission Test Types

Test Standards ID	Test Standards Description	Description
11	Unloaded Idle Test	Test performed while vehicle idles in Park or Neutral
12	Two-mode, 2500 RPM/Idle Test	Test performed while vehicle idles and at 2500 rpm
13	Loaded / Idle Test	Test performed while vehicle operates on a chassis dynamometer at constant load
21	ASM 2525 Phase-in Cutpoints	Test performed on a dynamometer, under load, through a defined "steady state" driving cycle at 25 mph and 25% load, at phase-in cutpoints.
22	ASM 5015 Phase-in Cutpoints	Test performed on a dynamometer, under load, through two defined "steady state" driving cycles at 25 mph and 25% load, and 15 mph and 50% load, at phase-in cutpoints.
23	ASM 2525/5015 Phase-in Cutpoints	Test performed on a dynamometer, under load, through two defined "steady state" driving cycles at 25 mph and 25% load, and 15 mph and 50% load, at phase-in cutpoints.
24	ASM 2525 Final Cutpoints	Test performed on a dynamometer, under load, through a defined "steady state" driving cycle at 25 mph and 25% load, at final cutpoints.
25	ASM 5015 Final Cutpoints	Test performed on a dynamometer, under load, through a defined "steady state" driving cycle at 15 mph and 50% load, at final cutpoints.
26	ASM 2525/5015 Final Cutpoints	Test performed on an inertia-weighted dynamometer through two defined "steady state" driving cycles at 25 mph and 25% load, and 15 mph and 50% load, at final cutpoints.
31	IM240 Phase-in Cutpoints	Test performed on a dynamometer, under load, through a pre-defined "transient" driving cycle of up to 240 seconds at phase-in cutpoints.
33	IM240 Final Cutpoints	Test performed on a dynamometer, under load, through a pre-defined "transient" driving cycle of up to 240 seconds.
41	Evaporative Gas Cap Check	A test conducted by pressurizing the gas cap for the purpose of identifying leaks in the gas cap.
42	Evaporative System Pressure Check	A test conducted by pressuring the evaporative system by way of the fuel tank's fill neck and sometimes referred to as the fill neck pressure (FP) test.
43	Evaporative System OBD Check	Test of the evaporative emission related systems and components performed by visual check of the MIL and scan of the OBD computer system for readiness, MIL status, and stored trouble codes, on 1996 and newer, OBD-equipped vehicles.
44	Evaporative Gas Cap and Pressure Check	A pair of tests to identify leaks in the gas cap (GC) and the rest of the vehicle's evaporative system. The latter test is conducted by pressuring the evaporative system by way of the fuel tank's fill neck and is referred to as the fill neck pressure (FP) test.
45	Evaporative Gas Cap and OBD Check	The evaporative OBD test performed in conjunction with a separate check of the gas cap (GC) for the purpose of identifying leaks in the gas cap not otherwise identified by the evaporative OBD check. This combination of tests can only be conducted on 1996 and newer, OBD-equipped vehicles.
46	Evaporative Pressure and OBD Check	The evaporative OBD test performed in conjunction with a separate fill neck pressure test.
47	Evaporative Gas Cap, Pressure and OBD Check	The evaporative OBD test performed in conjunction with a separate fill neck pressure test and gas cap test.
51	Exhaust OBD Check	Test of exhaust-related systems and components performed by visual check of Malfunction Indicator Light (MIL) and scan of on-board (OBD) computer for system readiness, MIL status and stored trouble codes, on 1996 and newer OBD-equipped vehicles only

APPENDIX E: Determining Whether an Area is Required to Do I/M Under the Ozone Standard

Under the Clean Air Act there are several factors to consider when determining whether an area is required to implement an I/M program under the ozone standard.

- The first of these is the area's classification for the ozone standard:
    - If the area is classified as **marginal** and is not already running an I/M program due to some other standard or requirement, then I/M is not required.
    - If the area is classified as **moderate** and is not already running an I/M program due to some other standard or requirement, then a basic I/M program may be required depending on whether the area meets certain other criteria related to population. [CAA §182(b)(4)]
    - If the area is classified as **serious or worse** and is not already running an I/M program due to some other standard or requirement, then an enhanced I/M program may be required depending on whether the area meets certain other criteria related to population. [CAA §182(c)(3)]
- Once an area's classification has been set, the next factor to consider is whether the area is contained completely within the boundaries of a single state, or is part of a multi-state nonattainment area.
- If the nonattainment area is wholly contained within a single state, then the next thing to consider is the area's population:
    - If the area is **moderate** and had a 1990[8] Census-defined urbanized area with a population of 200,000 or more, it must implement a basic I/M program in the 1990 Census-defined urbanized area. [40 CFR 51.350(a)(4)]
    - If the area is **serious or worse** and had a 1980 Bureau of Census-defined urbanized area population of 200,000 or more, then it must implement an enhanced I/M program in the 1990 Census-defined urbanized area. [CAA §182(c)(3); 40 CFR 51.350(a)(2)]
- If the nonattainment area covers a multi-state area, then the next thing to consider is how much of the nonattainment area's urbanized population is contained within the state in question:

[8] The use of these older census figures is driven by the fact that the 1990 Clean Air Act was explicit with regard to the census that was to be used to determine the applicability of enhanced I/M. The Act specifies both the 200,000 urbanized population threshold and use of the 1980 Census. EPA has taken the position that since we cannot change these statutory requirements for enhanced I/M, it does not make sense to change the regulatory population requirements for basic I/M.

- If the overall nonattainment area had a total urbanized area population of 200,000 or more based upon the applicable census (1990 for moderate areas; 1980 for serious and above), and the state in question included a 1990 Census-defined urbanized population of at least 50,000, then the state in question must implement either a basic or enhanced I/M program in the 1990 Census-defined urbanized area, depending upon the nonattainment area's classification.

- Lastly, we need to determine how current Census Bureau metropolitan area boundaries compare to the Census Bureau definitions and boundaries in place at the time the Clean Air Act was enacted in 1990. The boundaries in place in 1990 are the key to determining whether such an area will be required to implement an I/M program.

- The reason for doing this is because in many cases areas currently being grouped together were not so grouped under the boundaries and definitions being used in 1990, when the Act was enacted.

    - For example, the current combined statistical area (CBSA) known as Beaumont-Port Arthur, Texas (which consists of Jefferson, Orange, and Hardin counties) was not treated as a single area back in 1990.

    - Instead, the counties were treated separately.

    - Individually, the counties' urbanized populations fell well below the minimum 200,000 threshold for triggering either the basic or enhanced I/M requirement.

    - As a result, the areas of Beaumont and Port Arthur – which were treated as separate urbanized areas back in 1990 – are not subject to either the basic or enhanced I/M requirement, regardless of their designation and/or classification under the current ozone standard.