I/M Lookup Table Update

United States
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I/M Lookup Table Update

Transportation and Regional Programs Division
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DISCLAIMER NO. 1

The accuracy of the information contained in this database has not been verified by some of the manufacturers of the vehicles. Inaccuracies regarding drivetrain configuration (e.g., two-wheel versus four-wheel drive) and other parameters could affect the safety of dynamometer testing. In addition, the failure to properly identify vehicles with "traction control" systems could lead to excessive stress on vehicle components during dynamometer testing. To minimize the risks associated with such inaccuracies, it is recommended that vehicles be adequately restrained during dynamometer testing until the validity of the information in the database has been confirmed. To minimize the risk of damage to vehicles, it is recommended that drivers be trained to detect the drive configuration of all vehicles and to recognize when a traction control system is present.

DISCLAIMER NO. 2

Although the information described in this report has been funded wholly or in part by the United States Environmental Protection Agency under Contract No. 68-C7-0051, it has not been subjected to the Agency's peer and administrative review and is being released for information purposes only. It therefore may not necessarily reflect the views of the Agency and no official endorsement should be inferred.

I/M LOOKUP TABLE UPDATE

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1. INTRODUCTION

A number of states have implemented enhanced vehicle emissions inspection and maintenance (I/M) programs. Vehicles subject to enhanced I/M have exhaust emissions measured while undergoing "loaded mode" testing, i.e., in which the vehicle is driven on a standard driving cycle on a chassis dynamometer. One or a combination of the possible driving cycles listed below are currently being used in the enhanced I/M programs.

1. A 240-second, stop-and-go driving (transient) test called the "IM240."

2. Shorter transient test cycles such as the IM93, IM147 (which are both subsets of the IM240), or BAR31 tests.

3. A shorter, steady-state test called the "Acceleration Simulation Mode" (ASM) 2525, designed to simulate acceleration during in-use vehicle operation. Although ASM tests are run at a steady speed, the dynamometer is set to load the vehicle more than if the vehicle were cruising at a steady speed. "ASM2525" is run at 25% of the load required to accelerate at 3.3 mph/sec (the maximum acceleration rate on the FTP) at a speed of 25 mph.

4. A second ASM test mode called the "ASM5015." "ASM5015" is run at 50% of the load required to accelerate at 3.3 mph/sec (the maximum acceleration rate on the FTP) at a speed of 15 mph.

To efficiently use one or more of the above tests, an I/M test facility must be able to quickly and easily adjust the chassis dynamometer power absorption and (in the case of the IM240 or another transient test cycle) inertia weight settings for each vehicle, so that the vehicle engine is properly loaded during testing. Under enhanced I/M test guidance issued by EPA,[*] the dynamometer settings are to be automatically selected for each vehicle, based on vehicle parameters entered into the test record by the I/M lane inspector.

According to the enhanced test guidance, EPA is responsible for supplying an electronic lookup table that can be used to automatically select the proper dynamometer settings for

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[*] "IM240 & Evap Technical Guidance," U.S. Environmental Protection Agency, EPA420-R-00-007, April 2000, and "Acceleration Simulation Mode Test Procedures, Emission Standards, Quality Control Requirements, and Equipment Specifications," U.S. Environmental Protection Agency, EPA-AA-RPSD-IM-96-2, July 1996.

each particular vehicle. Under contract to EPA, Sierra Research developed and released in September 1994 an initial version of the Lookup Table that contained both dynamometer settings and purge/pressure testability data. Subsequent versions have also been prepared and released by Sierra for EPA. This report addresses Sierra's latest release (Version 1.8.4) of the Lookup Table. Changes incorporated into Version 1.8.4 of the table include the addition of 1999 model-year vehicles, deletion of data on alternative test pressures for conducting the fuel inlet vehicle evaporative control system integrity (pressure) test, deletion of heavy-duty vehicle data records, correction/addition of test parameters based on a detailed comparison with I/M test data provided by the state of Virginia and other independent sources of data, and other miscellaneous updates.

Section 2 of this report provides background on the sources of data used to construct and update the electronic Lookup Table. Section 3 describes the format of the database and Section 4 contains the computational methodologies used to construct it. Section 5 provides additional details on the changes incorporated into Version 1.8.4 of the table.

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2. SOURCES OF DATA

Several sources were accessed to obtain necessary vehicle parameter data. Each of these sources is discussed below, along with a description of the data obtained from each source.

EPA Certification Database

The primary source of information used to initially develop the Lookup Table was certification data obtained from EPA's certification databases located on the Wayne State University mainframe computer in Detroit, Michigan. Pertinent data from this source are described in Table 1. The listed data were provided by EPA for 1981 and later model year vehicles (data on curb weight, rather than equivalent test weight, were provided for some models). In addition, incomplete data for model years 1978–1980 were also provided. For example, vehicle coastdown times were not provided for most of the 1978–1980 models.

Determination of Model Names - The EPA certification data described above contain certain model names that are listed in a very cryptic fashion. Cryptic model codes for GM, Toyota, and New United Motor Manufacturers Inc. (NUMMI) models are used extensively in the database. Manufacturers of other models identified by coded name include Chrysler, Ford, Fuji, Isuzu, and Suzuki (Ford and Fuji used cryptic names before 1983 only). Because I/M inspectors will use publicly known model names to identify vehicles brought in for testing, a method was needed to convert the model codes contained in the certification database into the proper model names. Accordingly, additional certification data (for 1979 and later models) containing a "carline code" field and another database containing a carline code decoder were obtained from EPA. This information was used to decode most of the model codes.

A SAS program was created to read in the additional certification data and the carline code decoder database. The two data sets were merged by model year and carline code to create one data set (for model years 1979–1993) containing the following vehicle parameters: model year, manufacturer, engine family, model name, equivalent test weight, axle ratio, test vehicle type, and transmission configuration.

The program then read in all the certification data initially provided by EPA, and kept only the vehicles associated with the manufacturers using the carline codes. It also determined whether each model's transmission type was manual, automatic, or either.

Table 1

EPA Certification Data

- Model year (MDYR)
- Manufacturer (MFR)
- Model (MODL)
- Vehicle type (VTYP)
- Sales class (SACL)
- Altitude code (ALTC)
- Engine type (ETYP)
- Fuel type (FTYP)
- Engine family (ENFM)
- Evaporative family (EVFM)
- Coastdown time (VCDT)
- Displacement (DISP)
- Number of cylinders (#CYL)
- Drive axle weight/full (VAXF)
- Drive axle weight/empty (VAXE)
- Evaporative system type (EVSY)
- Main fuel tank capacity (MTNK)
- Auxiliary fuel tank capacity (ATNK)
- Model code (MDCD)
- Drive type (DRCD)
- Axle ratio (AXLR)
- Transmission configuration (VTRN)
- EPA test type (TTYP)
- Equivalent test weight (ETW)

The combined carline/certification data set and the additional certification data set were merged by model year, manufacturer engine family, and equivalent test weight. This process gave an excellent match between the certification data set and the model names, with only 21 engine family/model records not able to be identified. A subsequent attempt was made to match these outstanding records with engine family/model combinations identified in additional certification data (described below) published annually in the Federal Register.

The outstanding records were matched to possible model names. Because a single data record in the Federal Register data set can represent several different models, multiple records were generated in the engine-family-specific vehicle parameter database for most of the outstanding certification records, with a separate record corresponding to each possible model.

Review of model names in the two certification data sets revealed a significant number of errors and inconsistencies in model naming convention. Accordingly, a list of common "publicly known" model names was created and merged with the two data sets to eliminate inconsistent entries. The resulting model names were used in the Lookup Table to replace corresponding model names and/or codes.

Manufacturer Identification

A separate list of manufacturers was provided by EPA for use in the database. This list, which includes both the full name and a two-character "EPA Manufacturer Subcode" for each listed manufacturer, is contained in the Society of Automotive Engineers' (SAE's) J2008 recommended organization of vehicle service information. These names and subcodes were merged with the four-character manufacturer abbreviation included in the EPA certification data to convert the abbreviations to the full names and subcodes contained in SAE J2008. The resulting subcodes and full names are included in fields 2 and 3, respectively, of the Lookup Table.

For some manufacturers, no match was found between the certification database codes and entries on the SAE J2008 list. This was particularly true for manufacturers of older models, some of whom may not be in business at present. For such vehicles, the full name of the manufacturer (if it could be determined) or (at a minimum) the manufacturer abbreviation included in the EPA certification database was included in field 3 of the Lookup Table. Field 2 has been left blank for these vehicles.

Federal Register Data

EPA certification data for each model year are also published annually in the Federal Register. Based on discussions with EPA's Freedom of Information Officer at Ann Arbor, it was learned that these data were available in electronic format for model years 1979–1993.[*] These data included the following applicable vehicle parameters:

- Model year;
- Manufacturer;
- Model description;
- Engine family;
- Engine displacement;
- Transmission type;

[*] At the time the first version of the Lookup Table was developed, the 1993 model year was the most recent for which Federal Register data were available. Subsequent updates to the table have been based on electronic copies of the vehicle certification and fuel economy data provided directly to Sierra by EPA technical staff.

- Inertia weight class;[*] and
- Actual dynamometer horsepower.[**]

A program was developed to convert these data into standard ASCII text files. (As provided by EPA, they were formatted in tabular fashion identically to how they appear in the Federal Register.) This approach is summarized below.

Federal Register Data Retrieval - A FORTRAN program was written to read Federal Register data files and print out the year, manufacturer, vehicle type, model name, engine family, emission control system entries, engine displacement, fuel delivery system, transmission type, equivalent test weight (ETW), and "actual" dynamometer horsepower. The program results in a listing that includes each model associated with an engine family, along with the ETWs listed for each certification vehicle used for a particular group of models.[***] If an engine family has two possible displacements, there would also be separate records created for each displacement. For example, 30 separate data records would be created for an engine family with 5 possible models, 3 different ETWs, and 2 displacements, each with a different combination of model, ETW, and displacement. If both a manual and automatic transmission were listed for a certain engine family test, the transmission-type entry would be listed in the record as "E" (for either). Otherwise, the transmission type would be labeled as either "M" for manual or "A" for automatic.

The resulting Federal Register data were merged into the vehicle parameter database. In addition, Federal Register certification data for the 1973–1978 model years, which were not available electronically, were entered manually and merged into the vehicle parameter database as well. Records from the two certification data sources (EPA and the Federal Register) were compared on the basis of model year, manufacturer, model name, and engine family. Federal Register records that had identical entries to EPA records in these four fields were deleted from the database, since the ETW data contained in the EPA database are more accurate than those contained in the Federal Register data. (The ETWs contained in the EPA data are specific to the vehicle-engine family combination identified in each record, whereas ETWs in the Federal Register data are based on the certification vehicles considered to be representative of a group of vehicle-engine family combinations.)

This methodology resulted in the use of Federal Register certification data for those vehicle-engine family combinations (i.e., 1973–1978 models plus some later model vehicles) for which no records were available in the EPA certification database.

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[*] Equivalent test weight, rather than inertia weight class, was recorded for 1980 and later models.

[**] This value was recorded only for 1983 and later models.

[***] The Federal Register data are a compilation of the results of certification tests submitted by the vehicle manufacturers. Test results may be submitted for one or more "certification" vehicles considered representative of a group of models containing the same engine family.

Vehicle Manufacturers

In addition to the certification data obtained above, additional data related to vehicle testability were obtained directly from the manufacturers listed in Table 2. These manufacturers were asked to provide the following information related to the testability of their models:

- Traction control present;
- Manual traction control disablement possible;
- Anti-lock braking (ABS) present;
- Anti-lock braking disablement possible;
- Four-wheel-drive present;
- Full-time four-wheel-drive; and
- Relevant evaporative control system design information.

Table 2

Manufacturers Contacted Regarding Vehicle Testability

- BMW
- Chrysler
- Ford
- General Motors
- Honda
- Hyundai
- Isuzu
- Mazda
- Mitsubishi
- Nissan
- Saab
- Subaru
- Toyota
- Volkswagen
- Volvo

Vehicle testability data received from the manufacturers were incorporated into the vehicle parameter database and the consolidated Lookup Table.* Possible entries are "Y", "N", "M", and "U", for yes, no, maybe, and unknown, respectively. "U" was entered for those models for which no data were received. "M" entries were entered into the vehicle testability fields for those models that may or may not be equipped with the various systems described above.

The "M" category is particularly applicable to the Lookup Table, since the aggregated vehicle records included in that database may contain a combination of vehicles, some of which are equipped with these systems and some of which are not. An "M" would also be entered for those models on which one of the above systems (e.g., ABS) was offered as an option by the manufacturer. As noted during the September 13, 1994 meeting of the IM240 Test Parameter Subcommittee meeting, ABS and/or traction control systems may be offered as options on a wide range of models and model years, depending on the manufacturer. For such vehicles, a determination will need to be made at the time of inspection as to whether a particular vehicle is equipped with traction control.

Manufacturer Review of Lookup Table - Several manufacturers have reviewed the various releases of the Lookup Table, and provided corrections and additions to the data. This includes the three domestic manufacturers (i.e., General Motors, Ford, and Chrysler) as well as some of the foreign manufacturers. These modifications are included in subsequent versions of the table.

Small-Volume Manufacturers

Data from small-volume manufacturers (those producing fewer than 5,000 vehicles per year) are not included in the certification database provided by EPA. They are, however, included in the Federal Register data set. Available Federal Register data for 1973-1993 models produced by small-volume manufacturers were therefore included in the initial version of the Lookup Table. Since subsequent updates to the table have been based primarily on certification data provided directly to Sierra by EPA, 1994 and later models produced by small-volume manufacturers are not included.

1968–1972 Model Year Data

No certification data, from either the EPA databases or the Federal Register data, were available for 1968–1972 model year vehicles. Because of the extremely limited nature of available data from other sources (e.g., annual Automotive News Marketing Data Books

* The approach used to consolidate the full vehicle parameter data set into the Lookup Table data set is described in Section 3.

and a listing[*] of 1972 models compiled and provided to Sierra by Automotive Testing Laboratories [ATL]), these data are not included in the Lookup Table.

Default Parameters

Default dynamometer parameters, which can be used in cases where model identification is impossible, were also developed. For Version 1.1 of the Lookup Table, track road-load horsepower (TRLHP) and inertia weight default values contained in Section 85.2221(c)(5) of an earlier version of EPA's high-tech guidance were used. (TRLHP settings for inertia weights of 5500 and 6000 lbs were linearly extrapolated from the data contained in Section 85.2221(c)(5), which include inertia weights only up to 5000 lbs.) For Versions 1.2 through 1.5.1, the IM240 default values were modified based on a revised list of defaults[**] provided by EPA. In addition, ASM default values developed by EPA[***] were incorporated. The revised default values included TRLHP and generic tire/roll losses (GTRL) on both 8.625" and 20.0" diameter dynamometer rolls. These values were disaggregated according to both vehicle body style and either number of cylinders or vehicle test weight.

As part of the development of Version 1.6.1 of the Lookup Table, EPA directed Sierra to review and determine if the defaults contained in the table should be updated. An analysis was therefore conducted of the existing default values. Existing Lookup Table entries were sorted according to body shape, number of cylinders, and model year grouping. Five model year groups were selected: 1973–80, 1981–84, 1985–89, 1990–94, and 1995–97. These groups were chosen on a relatively arbitrary basis to determine the degree of variance and trends in TRLHP and ETW values among model years.

Assuming the observations were normally distributed within each analysis category (i.e., body shape/#cylinders/model year group combination), lower-limit confidence intervals were then calculated for TRLHP and ETW in each category using a Student's-*t* test as follows. Using lower-limit intervals of 5% and 20% recommended by EPA (meaning that 95% and 80%, respectively, of all observations occur <u>above</u> the interval), appropriate *t*-values were looked up from a standard statistical table as a function of sample size *n* (e.g., $t_{5\%}$ for large *n* is 1.645). The lower limit values for TRLHP and ETW were then calculated using the following equation:

$$Lower\,Limit \quad = \quad \mu - \frac{t \times \sigma}{\sqrt{n}}$$

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[*] "Vehicle Manual: 1972-1978," Automotive Testing Laboratories, Inc., undated.

[**] "Default IM240 Dynamometer Loading, Test Weights, and Tire Losses," U.S. EPA, June 7, 1995.

[***] "ASM2 Procedures and Equipment Specifications, Ver 1.5," U.S. Environmental Protection Agency, July 6, 1995.

where μ and σ are the sample mean and standard deviation, respectively, and t and n are defined as above.

TRLHP and ETW values resulting from these lower-limit metrics are thus considered conservative, since they represent underloading of most vehicles in each range.

Several observations were drawn from the results of the above analysis:

- Some shape/cylinder categories exhibited a significant spread in TRLHP and ETW values across the model year ranges, while others did not.

- There did not appear to be any predominant trend in TRLHP values over time (i.e., they do not all decline or increase with increasing model year).

- With few exceptions, ETW values appeared to generally increase with model year (i.e., newer models are heavier on average for a given shape and number of cylinders).

- There were significant differences in the existing defaults contained in the Lookup Table, and the 5% and 20% lower-limit intervals.

- A limited number of other year/shape/cylinder categories contained no applicable data records.

- In almost all cases, there was little difference in the 5% and 20% lower-limit intervals for either TRLHP or ETW.

It was also noted that no defaults currently exist in the Lookup Table for rotary engines. TRLHP values associated with rotary engine-equipped vehicles appear roughly comparable to those of four-cylinder vehicles. However, ETW values for the rotary vehicles are heavier than the four-cylinder vehicles.

Based on the above results, a decision was made to develop and incorporate updated default values into Version 1.6.1 of the Lookup Table. The approach chosen to create the updated defaults included the following elements:

1. New TRLHP and ETW defaults would be developed based on the 20% lower-limit intervals. Revised ETW defaults would be rounded to the nearest 250 pounds.

2. Model-year-specific defaults would be developed to replace the previous single set of defaults contained at the beginning of the first (1973–1978 model year) Lookup Table file. Defaults for year/shape/cylinder containing no data records would be developed from neighboring model years. Model-year-specific defaults would not be included for year/shape/cylinder combinations not manufactured in those years.

3. Default values for rotary engines would be added to the Lookup Table.

Model-year-specific defaults are now included at the beginning of each model year grouping in the table. To avoid confusion with the previous default values, new Lookup Table vehicle identification codes (or "index numbers") have been developed for all defaults. The convention used for the index numbers contained in the default records is MY99XX. For example, the first default value for the 1973 model year would have an index number of 739901, the second 739902, and so on.

Manufacturer Fuel Economy Data

As noted in Sierra's 1997 report* to EPA on the Lookup Table, a comparison of EPA certification data with other sources of vehicle model and test weight information shows that use of the certification data as the principal source of information has introduced some errors into the table. This finding is also supported by comments received from some of the manufacturers. It is primarily because the certification data do not include a full listing of all models actually sold by the manufacturers in a particular model year. In addition, it is apparent that some models that were certified were never actually sold.

As a result of this finding, Sierra recommended to EPA in 1997 that future efforts to update the Lookup Table be based on fuel economy data that the manufacturers must submit to EPA. Unlike the certification data, the fuel economy data contain a complete listing of dynamometer parameters for all models sold by each manufacturer.

At roughly that same time (i.e., circa 1997), EPA also transferred its certification and fuel economy data from the Wayne State databases mentioned previously to an in-house inter-relational database system called the Certification and Fuel Economy Information System (CFEIS). This contractor-developed Oracle-based system is maintained by EPA staff.

While EPA technical staff concurred with Sierra's 1997 recommendation to use manufacturer fuel economy data as the primary basis for future updates to the Lookup Table, the switch to the CFEIS system has complicated this transition. According to EPA database staff, the inter-relational nature of the CFEIS system makes it somewhat difficult to determine the exact source (i.e., certification or fuel economy submittals) of data elements extracted from the system. EPA is continuing to investigate this issue, with the intent being to migrate as soon as possible to using fuel economy data as the primary source of data for new model year vehicles in future releases of the Lookup Table.

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*"VIN-Based Lookup Table," prepared for U.S. Environmental Protection Agency, Sierra Research, Inc., Report No. SR97-10-01, October 13, 1997.

Miscellaneous Additional Sources

Additional ABS and traction control data were also obtained from Tier One, a market research firm specializing in automotive electronics. The Tier One data, which included detailed information disaggregated by make, model, model year, and vehicle platform, were input to the Lookup Table[*] for those manufacturers that did not supply data directly to Sierra. In addition, data contained in an all-wheel-drive/traction control guide[**] produced by the Colorado Department of Public Health and Environment were reviewed and incorporated, where appropriate, into the Lookup Table.

Data on pressure testability status and canister location, obtained from the Louisville I/M program, selected vehicle manufacturers (e.g., Chrysler), and All Data on-line automotive service manuals, were also incorporated into Version 1.1 of the Lookup Table. Additional purge and pressure testability data (e.g., the appropriate level of pressurization to be used) obtained from the vehicle manufacturers were included in subsequent releases.[***] In addition, gas cap adapter data (i.e., which adapters to use with which vehicles) provided by Stant Manufacturing were incorporated into Version 1.4 and subsequent releases of the table.

Several independent sources of information regarding vehicle models and test weights were also accessed during development of Version 1.4 and subsequent releases of the Lookup Table. These sources include the Kelly Blue Book, the Automotive News Market Data Book, the Standard Catalog of Imported Cars, and the Standard Catalog of American Light-Duty Trucks.

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[*] Tier One data for 1988-1995 models produced by domestic manufacturers were included in Version 1.1 of the Lookup Table. These data were expanded in Version 1.2 to include imported vehicles and the older domestic models.

[**] "All Wheel Drive/Traction Control Guide," Colorado Department of Public Health and Environment, June 1995.

[***] As discussed in more detail in Section 5, these data have been deleted from Version 1.8.4 and subsequent versions of the Lookup Table.

3. DATABASE FORMAT

A comprehensive vehicle parameter database, disaggregated to the engine family level, was initially developed from the sources listed in Section 2. This data set was then collapsed into a more aggregated data set, for distribution to I/M programs as an electronic Lookup Table. The Lookup Table database is described below, followed by detailed format specifications for the table.

Lookup Table

The Lookup Table contains fields for data specified by EPA staff, as well as additional data suggested by the I/M contractors (e.g., canister location). In some cases, data are not currently available for certain vehicle parameters. Fields for these parameters are included for future use, but have been left blank in the current version.

The first nine fields in each database record contain vehicle identification entries. These fields are as follows:

1. Model year;
2. Manufacturer code;[*]
3. Manufacturer name;
4. Manufacturer division;
5. Public model name;
6. Body style (e.g., sedan, wagon, etc.);
7. Number of cylinders;
8. Engine displacement; and
9. Transmission type.

Following the above entries, each record contains a unique vehicle identification code, which can be used to cross-reference the record with entries for the same vehicle listing in other versions of the Lookup Table.[**]

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[*] The second and third fields both reference the vehicle manufacturer, with the second field being a two-character code and the third the full name of the manufacturer.

[**] Vehicle identification codes were changed between Versions 1.1 and 1.2 of the Lookup Table. Versions 1.2 and later releases have consistent vehicle IDs.

Fields are then provided for the type of fuel burned by the vehicle (only gasoline-powered and a relatively few alternatively fueled vehicles are currently included in the Lookup Table), evaporative control system, and the number and location of evaporative canisters. A simple locational coding system for canister location has been developed, based on the quadrant codes listed below.

1 = left front
2 = right front
3 = right rear
4 = left rear
M = multiple locations

While much more elaborate (e.g., x/y coordinate systems) locational systems could be adopted, it is believed that a system that simply identifies general canister locations is much more likely to be used by I/M inspectors.

A field for the sales class of the vehicle* is then provided. This is followed by fields for all required IM240 dynamometer settings, e.g., ETW, TRLHP, and 8.625" and 20.0" GTRL. Because the Lookup Table is disaggregated only to the level described above, a methodology for aggregating multiple ETW values into the database records contained in the table has been developed and is explained below. Reasons for excluding certain vehicle parameters from the Lookup Table are also discussed.

Methodology for Developing Test Parameters by Vehicle Category - In developing this methodology, a review was conducted of the approach previously employed by EPA to construct the Lookup Table used by ATL for IM240 testing in Hammond, Indiana, and Phoenix, Arizona. Under that approach, ETW and TRLHP values were averaged to obtain a value for each vehicle category. In cases of significant variation within a single vehicle category, EPA used a somewhat subjective approach that attempted to select ETW and TRLHP values between the minimum and maximum values for the category so that (1) the values increased as engine size increased, and (2) there were no "unreasonable" jumps in values from model year to model year.

An alternative approach to that previously used by EPA has been employed to develop ETW values for each vehicle category. This methodology follows guidance provided by EPA to use a conservative approach to compute the test parameters for each vehicle category. EPA's guidance indicated that (1) an engine should be underloaded, rather than overloaded, in developing test parameters for the aggregated vehicle categories; and (2) ETW is more important than TRLHP in setting the dynamometer test parameters. In accordance with this guidance, the lowest ETW value in each vehicle category was used for that category. (In cases where a vehicle category contained both EPA and Federal Register certification data records, the lowest ETW from the EPA certification records was used.) Vehicle coast down time (VCDT) and drive axle weights (VAXF and VAXE)

*Sales class entries have been simplified in Version 1.4 and subsequent releases of the Lookup Table to simply identify whether a vehicle was certified as a passenger vehicle or truck.

corresponding to the selected ETW were then used to compute TRLHP and GTRL, respectively.* In cases where a corresponding VCDT value was not included in the certification database for a minimum ETW within a specific vehicle category, the VCDT corresponding to the ETW value closest to the minimum was used. (A similar methodology was used in the case of missing drive axle weight data.)

Following the IM240 dynamometer settings, similar dynamometer settings for the two most common ASM test modes (ASM5015 and ASM2525) have been incorporated into the Lookup Table, using formulas supplied by EPA.** Fields are then provided for average drive axle weight, wheelbase, and drive layout code (e.g., front, rear, etc.). Following that are fields for fuel tank size (to aid in pressure testing) and dynamometer testability (e.g., four-wheel-drive, traction control, and ABS status).

In keeping with the conservative approach to aggregating test parameters discussed above, the minimum fuel tank size for a specific vehicle within each vehicle category has been assumed for that category as well. In cases of yes/no answers that vary across engine families contained within a single vehicle category, an "M" (for maybe) entry has been used to indicate the possibility of a particular option. For example, if a single vehicle category includes both full-time and selectable four-wheel-drive vehicles, an "M" would be entered in the full-time four-wheel-drive field.

Fields are also included for location codes of the four-wheel-drive selector and manual traction disablement switch. Version 1.7.2 of the Lookup Table was the first release to include information provided by the manufacturers (i.e., Volkswagen) on the location of the traction control disablement switch. It was therefore necessary to develop a standard nomenclature for mapping the location of the switch. In consultation with Volkswagen, it was decided to use the same mapping scheme as recently proposed for mapping the location of the OBDII diagnostic link connector (DLC). This standardization of a single mapping approach for identifying both items will help avoid inspector confusion in finding the disablement switch and DLC on individual vehicles.

A field is provided for entry of an upper fuel economy limit, for use as a quality control check on the testing results. Following that are fields for the testability status of the vehicle for the EPA and inlet pressure tests, and the EPA and tracer purge tests.*** Comment fields are also provided for each pressure and purge test, to allow entry of the reason (if applicable) for a vehicle being untestable on that test. In addition, fields are provided for minimum and maximum test pressures for the two pressure tests. As discussed in more detail in Section 5, however, all alternative test pressures have been deleted from the Lookup Table beginning with Version 1.8.2.

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* Computational methodologies are described in Section 4.

** "ASM Horsepower Equations," U.S. Environmental Protection Agency, July 1995.

***No acceptable tracer purge test has been approved by EPA at present.

The next-to-the-last field contains the date of the record. There was some confusion in the past regarding the convention used in modifying the date of each individual Lookup Table record. Some users believed this date should change with each new version of the Lookup Table and be consistent for all records contained in that version. Other users felt the record date should only be changed for those records modified in that version of the table (i.e., there would be no change of date if the record were not modified). They also pointed out that each version of the Lookup Table has its own revision date and it makes little sense to put the same date in all the individual records as well.

After considering this issue, Sierra recommended and EPA agreed that the date of record will remain the same in succeeding versions of the table, unless a change is made to the record. Any record in Version 1.8.4 that contains an updated date is therefore either new or has been modified in some manner.

The final field is the gas cap adapter that should be used in testing the vehicle using the Stant testing apparatus.

Database Format

Table 3 provides a detailed format listing for the Lookup Table. The data set is formatted as a series of comma-separated, variable length ASCII text files. To keep the data set at a manageable size, it has been divided into files of no more than 1 Mb in length. This has resulted in five data files, covering the following model year ranges:

1. 1973–1978;
2. 1979–1984;
3. 1985–1990;
4. 1991–1996; and
5. 1997–1999.

To aid in proper field identification, comma-separated headings for each field have been added as the first line in the five data files. The abbreviations used for each field heading are included in Table 3.

Beginning with Version 1.6.1 of the Lookup Table, actual data values have been deleted from certain of the Lookup Table fields. These include Fields 21, 23-25, 27-29, and 54. These fields are now marked as “reserved” in Table 3.

Fields 19 and 20 have been redefined respectively as VINPLC and VINCHAR beginning with Version 1.7.2 of the table. VINPLC indicates the location of the VIN digit that identifies the GVWR range of certain makes of light-duty trucks (LDTs) that include models both under and over 6000 lbs GVWR. VINCHAR includes all VIN characters that represent LDTs with GVWRs of less than or equal to 6000 pounds. Additional details on the contents of these fields are provided in Section 4.

Table 3

Format of EPA I/M Lookup Table

Field	Maximum Length*	Name	Abbrev.	Description
1	2	Model Year	MDYR	alphanumeric (last 2 digits, DF=default records)
2	2	Manufacturer Code	MFRC	alphanumeric (2-digit SAE J2008 abbreviation)
3	40	Manufacturer Name	MFRN	alphanumeric (full name)
4	17	Manufacturer Division	DIV	alpha (full name)
5	23	Public Model Name	PNAME	alpha (commonly known name of model)
6	1	Body Style	SHAPE	numeric (1=sedan, 2=station wagon, 3=pickup, 4=sport/utility, 5=minivan, 6=full-size van)
7	2	No. of Cylinders	NCYL	alphanumeric (R = rotary)
8	3	Engine Displacement	DISPLR	numeric (liters, includes decimal, n.n)
9	1	Transmission Type	TRANY	alpha (M=manual, A=automatic, E=either)
10	8	Vehicle Category ID	VCID	numeric, unique code for vehicles with identical entries in first 8 fields
11	1	Fuel Type	FULTYPE	numeric (1=gasoline, 2=natural gas, others=reserved)
12	2	Evaporative System	EVSYS	numeric (0=not recorded, 1=crankcase, 2=canister, 3=tank, 4=none, 5=canister+charcoal air cleaner, 98=various types, 99=other)
13	1	No. of Evap Canisters	NCAN	alphanumeric (V=varies)
14	2	Location of Canisters	LOCAN	alphanumeric (1-4 = vehicle quadrant locations, FT=on fuel tank, M=multiple locations)
15	2	Sales Class	SACL	alphanumeric (V=vehicle, T=truck, E=either)
16	4	Equivalent Test Weight	ETW	numeric (lbs, nnnnn)
17	4	Inertia Weight Class	IWC	numeric (lbs, nnnnn)

* All fields are comma separated, variable length.

Table 3 (continued)

Format of EPA I/M Lookup Table

Field	Maximum Length*	Name	Abbrev.	Description
18	4	Track Road-Load Horsepower (50 mph)	TRLHP	numeric (hp, includes decimal, nn.n)
19	2	VIN Digit	VINPLC	numeric (nn)
20	8	VIN Character	VINCHAR	alphanumeric
21	1	(Reserved)		
22	4	Tire/Roll Interface Losses on 8.625" Roll at 50 mph	GTRL8	numeric (hp, includes decimal, nn.n)
23	1	(Reserved)		
24	1	(Reserved)		
25	1	(Reserved)		
26	4	Tire/Roll Interface Losses on 20.0" Roll at 50 mph	GTRL20	numeric (hp, includes decimal, nn.n)
27	1	(Reserved)		
28	1	(Reserved)		
29	1	(Reserved)		
30	4	Total ASM5015 Horsepower	THP5015	numeric (hp, includes decimal, nn.n)
31	4	Total ASM2525 Horsepower	THP2525	numeric (hp, includes decimal, nn.n)
32	4	ASM5015 Horsepower for 8.625" Roll	HP50158	numeric (hp, includes decimal, nn.n)

* All fields are comma separated, variable length.

Table 3 (continued)

Format of EPA I/M Lookup Table

Field	Maximum Length*	Name	Abbrev.	Description
33	4	ASM2525 Horsepower for 8.625" Roll	HP25258	numeric (hp, includes decimal, nn.n)
34	4	ASM5015 Horsepower for 20.0" Roll	HP501520	numeric (hp, includes decimal, nn.n)
35	4	ASM2525 Horsepower for 20.0" Roll	HP252520	numeric (hp, includes decimal, nn.n)
36	4	ASM5015 Tire/Roll Interface Losses on 8.625" Roll	GTRL1508	numeric (hp, includes decimal, nn.n)
37	4	ASM2525 Tire/Roll Interface Losses on 8.625" Roll	GTRL2508	numeric (hp, includes decimal, nn.n)
38	4	ASM5015 Tire/Roll Interface Losses on 20.0" Roll	GTRL1520	numeric (hp, includes decimal, nn.n)
39	4	ASM2525 Tire/Roll Interface Losses on 20.0" Roll	GTRL2520	numeric (hp, includes decimal, nn.n)
40	4	Average Drive Axle Wt.	DAXWT	numeric (lbs, nnnn)
41	5	Wheelbase	WHLBS	numeric (inches, includes decimal, nnn.n)
42	1	Drive Layout Code	DRLCD	numeric (1=front drive, 2=rear drive, 3=selectable 4-wheel-drive, 4=full-time 4-wheel drive, 5=varies)
43	1	Full-time 4-Wheel?	FWDS	alpha (Y,N,M,U)

* All fields are comma separated, variable length.

Table 3 (continued)

Format of EPA I/M Lookup Table

Field	Maximum Length*	Name	Abbrev.	Description
44	1	Location of Four-Wheel Selector	LFWD	alphanumeric (1-8 = vehicle location)
45	4	Main Fuel Tank Size	MTNK	numeric (gallons, nn.n)
46	1	Auxiliary Fuel Tank?	ATNKQ	alpha (Y=yes,N=no,M=maybe,U=unknown)
47	4	Auxiliary Tank Size	ATNK	numeric (gallons, nn.n)
48	1	Traction Control?	TC	alpha (Y,N,M,U)
49	1	Traction Control Disablement?	TCS	alpha (Y,N,M,U)
50	1	Disablement Switch Location	LTC	alphanumeric (1-8 = vehicle location)
51	1	Anti-lock Braking?	ABS	alpha (Y,N,M,U)
52	1	ABS Disablement Possible?	ABSS	alpha (Y,N,M,U)
53	1	2-Wheel-Drive Dyno Testing Possible?	DYNTST2	alpha (N,M)
54	1	(Reserved)		
55	1	(Reserved)		
56	3	EPA Pressure Test Status	PRSTAT	alpha (NOT, LOW, MED, HIG, ALT, C_A, UNK)
57	3	EPA PT Comments	PRSTCOM	alpha (VLV, CLM, INA, PRT, UNK)
58	4	EPA PT Min. Pressure	EPAMIN	numeric (nn.n in of H20, includes decimal)
59	4	EPA PT Max. Pressure	EPAMAX	numeric (nn.n in of H20, includes decimal)
60	3	Inlet Pressure Test Status	PRSTAT1	alpha (NOT, LOW, MED, HIG, UNK)
61	3	Inlet PT Comments	PRST1COM	alpha (NYL, INA, B_P, UNK)

* All fields are comma separated, variable length.

Table 3 (continued)

Format of EPA I/M Lookup Table

Field	Maximum Length*	Name	Abbrev.	Description
62	4	Inlet PT Min. Pressure	INLPRMIN	numeric (nn.n in of H20, includes decimal)
63	4	Inlet PT Max. Pressure	INLPRMAX	numeric (nn.n in of H20, includes decimal)
64	3	EPA Purge Test Status	PUSTAT	alpha (NOT, LOW, MED, HIG, UNK)
65	3	EPA Purge Test Comments	PUSTCOM	alpha (as needed)
66	3	Tracer Purge Test Status	PUSTAT1	alpha (NOT, LOW, MED, HIG, UNK)
67	3	Tracer Purge Test Comments	PUST1COM	alpha (BRP, UNK)
68	4	Tracer Purge Test Minimum Pressure	TRCPUMIN	numeric (nn.n in of H20, includes decimal)
69	4	Tracer Purge Test Maximum Pressure	TRCPUMAX	numeric (nn.n in of H20, includes decimal)
70	9	Date of Record	RDATE	alphanumeric (dd/MMM/yy)
71	1	Gas Cap Configuration	GASCAP	alphanumeric (A,B,C,E,F,G,H,L,O,Z,U,N)
Total	271	(not including commas)		

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* All fields are comma separated, variable length.

4. COMPUTATIONAL METHODOLOGIES

The majority of the vehicle parameter data contained in the I/M Lookup Table were either imported directly from one of the EPA certification data sets or provided by the manufacturers. However, it was necessary to compute or otherwise develop the values of some vehicle parameters. Data sources are summarized in Table 4. More complete descriptions of a selected number of the vehicle parameters, including the methods and formulas used for the required computations, are presented below. For ease of reference, each parameter is referenced by its respective field number in the vehicle parameter database. The discussion is divided into two separate model-year categories (1979 and newer, and 1973–1978), due to differences in the type of data available for each category.[*] Unless otherwise noted, the information presented for 1979 and newer models also applies to the older models as well.

1979 and Newer Vehicles

The sources of data for these vehicles are the EPA certification and fuel economy databases that, prior to 1998, were located on the Wayne State computer system. These data are now being maintained by EPA on its in-house Oracle database, CFEIS.

Transmission Type (field #9) - The various transmission types contained in the certification database were aggregated into three categories: manual, automatic, or either.

Vehicle Category Identification Number (field #10) - A unique code was developed and assigned to each vehicle grouping that had identical entries in fields 1–9. This code begins with the last two digits of the model year of vehicles included in each category, followed by additional numbers assigned by Sierra.

Fuel Type (field #11) - Almost all records contained in the Lookup Table are for gasoline-powered vehicles (fuel type =1). Beginning with the 1997 model year, a limited number of alternatively fueled vehicle records are included, as follows:

[*] Data for vehicles produced by small-volume manufacturers are not contained in the EPA certification database, but are included in the certification data published annually in the Federal Register. As a result, the information presented below for model years 1973–1978 also applies to all 1973–1993 models produced by small-volume manufacturers. As noted previously, no 1994 and newer models produced by small-volume manufacturers are included in the Lookup Table.

Table 4

Data Sources for EPA I/M Lookup Table

Field	Name	Source of Data
1	Model Year	Cert database (MDYR)
2	Manufacturer Code	Code in SAE J2008, based on Cert database (MFR)
3	Manufacturer Name	Name in SAE J2008, based on Cert database (MFR)
4	Manufacturer Division	Developed by Sierra, based on Cert database
5	Public Model Name	Developed by Sierra, based on Cert database (MODL)
6	Body Style	Unique code developed by Sierra
7	No. of Cylinders	Cert database (#CYL), manufacturers
8	Engine Displacement	Cert database (DISP), manufacturers
9	Transmission Type	Cert database (developed from VTRN)
10	Vehicle Category ID	Unique code developed by Sierra
11	Fuel Type	Cert database (developed from FTYP), manufacturers
12	Evaporative System Type	Cert database (EVSY), manufacturers
13	No. of Evap Canisters	All-Data on-line database, manufacturers
14	Location of Canisters	All-Data on-line database, manufacturers
15	Sales Class	Cert database (SACL)
16	Equivalent Test Weight	Cert database (ETW), manufacturers, other independent sources
17	Inertia Weight Class	Computed from ETW
18	Track Road-Load hp at 50 mph (TRLHP)	Computed from ETW and VCDT, manufacturers
19	VIN Digit	VIN decoding handbooks
20	VIN Characters	VIN decoding handbooks
21	(Reserved)	
22	Tire/Roll Interface Losses on 8.625” Roll at 50 mph ($GTRL_8$)	Computed from DAXWT
23	(Reserved)	
24	(Reserved)	
25	(Reserved)	
26	Tire/Roll Interface Losses on 20.0” Roll at 50 mph ($GTRL_{20}$)	Computed from DAXWT

Table 4 (continued)

Data Sources for EPA I/M Lookup Table

Field	Name	Source of Data
27	(Reserved)	
28	(Reserved)	
29	(Reserved)	
30	Total ASM5015 Horsepower	EPA ASM horsepower equations
31	Total ASM2525 Horsepower	EPA ASM horsepower equations
32	ASM5015 Horsepower for 8.625” Roll	EPA ASM horsepower equations
33	ASM2525 Horsepower for 8.625” Roll	EPA ASM horsepower equations
34	ASM5015 Horsepower for 20.0” Roll	EPA ASM horsepower equations
35	ASM2525 Horsepower for 20.0” Roll	EPA ASM horsepower equations
36	ASM5015 Tire/Roll Interface Losses on 8.625” Roll	EPA ASM horsepower equations
37	ASM2525 Tire/Roll Interface Losses on 8.625” Roll	EPA ASM horsepower equations
38	ASM5015 Tire/Roll Interface Losses on 20.0” Roll	EPA ASM horsepower equations
39	ASM2525 Tire/Roll Interface Losses on 20.0” Roll	EPA ASM horsepower equations
40	Average Drive Axle Wt. (DAXWT)	Average of VAXF and VAXE in Cert database
41	Wheelbase	Manufacturers (limited data)
42	Drive Layout Code	Cert database (developed from DRCD), manufacturers
43	Full-time Four-Wheel-Drive?	Manufacturers, Colorado DPHE
44	Location of Four-Wheel Selector	Not currently entered
45	Main Fuel Tank Size	Cert database (MTNK), manufacturers
46	Auxiliary Fuel Tank?	Assumed=Y, if Cert database contains value for ATNK
47	Auxiliary Fuel Tank Size	Cert database (ATNK)
48	Traction Control?	Manufacturers, Tier One, Colorado DPHE
49	Manual Traction Control Disablement Possible?	Manufacturers, Colorado DPHE

Table 4 (continued)

Data Sources for EPA I/M Lookup Table

Field	Name	Source of Data
50	Location of Disablement Switch	Manufacturers (limited data)
51	Anti-lock Braking?	Manufacturers, Tier One
52	Anti-lock Braking Disablement Possible?	Manufacturers
53	2-Wheel-Drive Dyno Testing	Sierra, from 4-wheel-drive and traction control data
54	(Reserved)	
55	(Reserved)	
56	EPA Pressure Test Status	Louisville I/M program
57	EPA PT Comments	Manufacturers
58	EPA PT Min. Pressure	No longer populated
59	EPA PT Max. Pressure	No longer populated
60	Inlet Pressure Test Status	Louisville I/M program
61	Inlet PT Comments	Manufacturers
62	Inlet PT Min. Pressure	No longer populated
63	Inlet PT Max. Pressure	No longer populated
64	EPA Purge Test Status	Not currently entered
65	EPA Purge Test Comments	Not currently entered
66	Tracer Purge Test Status	Not currently entered
67	Tracer Purge Test Comments	Manufacturers
68	Tracer Purge Test Min. Pressure	Manufacturers
69	Tracer Purge Test Max. Pressure	Manufacturers
70	Date of Record	Sierra
71	Gas Cap Configuration	Stant Manufacturing

- Flexible-fuel vehicles (FFVs), with fuel type = 1; and
- Dedicated natural gas vehicles, with fuel type = 2.

Equivalent Test Weight (field #16) - For 1994–1996 models, 300 lbs was added to the curb weight data provided by EPA, and the resulting value rounded to the nearest 125-lb increment, to compute equivalent test weight (ETW). In some cases, data provided directly to Sierra by the manufacturers were used in place of the certification data.

Beginning with the 1997 model year records contained in the Lookup Table, the ETW data incorporate changes in certification test weights specified in the Code of Federal Regulations (CFR) for heavy light-duty trucks (LDTs). The issue of light-duty truck definitions is relatively complicated, and confused by the fact that the definitions contained in the CFR are not the same as those used in previous versions of EPA's high-tech test guidance. Table 5 is provided below to illustrate the differences between these definitions.

Table 5
Light-Duty Truck Definitions

Ref.	Category	Weight Range
CFR	Light LDT:	0–6,000 lbs GVWR
	LDT1	Light LDT under 3,751 lbs LVW[a]
	LDT2	Light LDT of 3,751–5,750 lbs LVW
	Heavy LDT:	6,001–8,500 lbs GVWR
	LDT3	heavy LDT of 3,751–5,750 TW[b]
	LDT4	heavy LDT greater than 5,750 TW
High-Tech Guidance (June 1996)	LDT1	0–6,000 lbs GVWR
	LDT2	6,000–8,500 lbs GVWR
High-Tech Guidance (April 2000)	LDT (0–6,000 lbs GVWR)	
	LDT (6,001–8,500 lbs GVWR)	

[a]LVW = curb weight + 300 lbs, which is equivalent to the equivalent test weight (ETW) values contained in the EPA I/M Lookup Table for most vehicles. The ETW values are basically rounded versions of the test weight basis (see next footnote) for each vehicle.

[b]TW = total weight. TW is equivalent to LVW for all vehicles except MY1994 and later Tier 1 heavy LDTs (e.g., those certified to the Tier 1 standards). For MY1994 and later Tier 1 heavy LDTs, ALVW is to be used for TW. ALVW is defined as (curb weight + GVWR) / 2.

The definitions noted in the table for the June 1996 version of EPA's high-tech guidance are consistent with those contained in EPA's MOBILE models, but clearly conflict with the CFR definitions. The August 1998 and later versions of the guidance address this issue somewhat by eliminating the 1 and 2 after the LDT titles in the standards tables.

According to CFR §86.129-94, test weights for model year 1994 and later heavy LDTs certified to Tier 1 standards are to be based on adjusted loaded vehicle weight (ALVW). ALVW is defined as the average of curb weight plus gross vehicle weight rating (i.e., [curb weight + GVWR] / 2) in CFR section 86.094-2. EPA also inserted ALVW in place of LVW for the 5,750 lb breakpoint in the standards in the August 1998 guidance and indicated this breakpoint is to be used for 1996 and newer vehicles. (The June 1996 version indicated it should be used for 1994+ Tier 1 LDTs.) This is because Tier 1 vehicles were phased in beginning with the 1994 model year, with 1996 being the first model year with all vehicles certified to Tier 1 standards. EPA's revision to include the 1996 model year as the first year for the 5,750 lb breakpoint eliminates the need for inspectors to determine whether a 1994–1995 vehicle was certified to the Tier 1 standards, in order to set the appropriate IM240 cutpoints.

The effect of the above requirement is that the proper IM240 test weight for 1996 and newer heavy LDTs is the average of curb weight plus GVWR. However, it appears that the 1996 model year certification data provided to Sierra for inclusion in the Lookup Table did not include ALVW values. A review of ETW values for the 1996 LDTs included in the table shows few in the 5,500 lbs or greater range. The reason for this oversight is unclear, but may be related to the transition to the CFEIS system that occurred at about this same time period. Conversely, a review of 1997 model year and later data contained in the Lookup Table shows a number of LDTs with heavier ETWs (up to as much as 8,000 lbs), which clearly reflect the correct use of ALVW.

The significance of this issue is that to properly test all of the 1997 models included in the table, IM240 programs will either need to have dynamometers that have the capability of handling inertia weight settings of up to as much as 8,500 lbs, or simply underload the vehicles relative to how they were initially certified.

Inertia Weight Class (field #17) - These data are computed from the ETW values contained in the certification database or provided by the manufacturers, using the approach incorporated into the conversion table contained in CFR §86.129-94. Under this method, all ETW values are rounded down to the nearest inertia weight class. Thus, for example, vehicles with ETWs of 3000 and 3250 lbs would both be considered to have the same inertia weight class of 3000 lbs. For the lighter vehicles (i.e., those with ETWs less than 3000 lbs), the CFR table includes inertia weight classes in increments of 250 lbs. For ETWs of greater than 3000 lbs, the CFR inertia weight classes are based on increments of 500 lbs. The same approach is used to compute the inertia weight classes in the Lookup Table, with all ETWs above 3000 lbs being rounded down to the nearest 500-lb inertia weight class, and all ETWs below 3000 lbs rounded down to the nearest 250-lb inertia weight class.

Track Road-Load Horsepower (field #18) - These data are computed from the ETW and VCDT values contained in the certification database, using the formula contained in §85.2226(a)(2)(iv) of the high-tech I/M test procedures.* This formula is as follows:

$$TRLHP = \frac{(0.5*ETW/32.2) * (V_1^2 - V_2^2)}{(550*ET)}$$

where: ET = vehicle coastdown time (VCDT) from 55 to 45 mph
ETW = equivalent test weight (lbs)
V_1 = initial velocity in ft/sec equivalent to 55 mph
V_2 = final velocity in ft/sec equivalent to 45 mph

As discussed previously, VCDT data were not available for a large portion of the 1979-1980 models contained in the Wayne State databases. For these models, an alternate method of computing TRLHP values must be used. TRLHP settings for these models, based on vehicle type and either inertia weight class or number of cylinders, are selected using the revised IM240 and ASM default values (dated June 7, 1995, and July 6, 1995, respectively) provided by EPA. For vehicles with inertia weights heavier than shown in the revised default table, TRLHP values corresponding to the heaviest test weight for the appropriate vehicle category were used.

In some cases, data provided directly to Sierra by the manufacturers were used in place of the certification data or default values.

VIN Digit and VIN Characters (fields #19 and 20) - The respective EPA guidance documents for IM240 and ASM testing contain separate sets of recommended cutpoints for light trucks with a gross vehicle weight rating (GVWR) of (1) 0–6000 pounds; and (2) 6001–8500 pounds. As a result, GVWR information is needed for these vehicles in order to determine the correct emissions standards to which they should be tested. Version 1.7.2 and subsequent versions of the Lookup Table have therefore been modified to aid I/M programs in determining the GVWR for a particular vehicle.

To accomplish this, Fields 19 and 20 have been defined as VINPLC and VINCHAR. (These fields were reserved in the previous version of the Lookup Table.) These fields are populated for 1981 and later makes of light-duty trucks (LDTs) that include models both under and over 6000 lbs GVWR. Certain pre-1981 records are also populated, if available VIN decoding information indicates that 1981+ VIN standardization rules also apply to these vehicles. Data included in the two fields are as follows:

1. VINPLC indicates the location of the VIN digit that identifies the GVWR range of the vehicle; and

*Unless otherwise noted, all references to the high-tech test procedures contained in this section refer to the June 1996 version of the guidance.

2. VINCHAR includes all VIN characters that represent LDTs with GVWRs of less than or equal to 6000 pounds.

As an example of the available information, GVWR range is indicated by the fourth VIN digit on 1994–95 Ford LDTs, based on the following codes:

- A = Under 3000 lbs
- B = 3001–4000 lbs
- C = 4001–5000 lbs
- D = 5001–6000 lbs
- E = 6001–7000 lbs
- F = 7001–8000 lbs
- G = 8001–8500 lbs
- H = 8501–9000 lbs
- J = 9001–10000 lbs
- 3 = 10001–14000 lbs
- 4 = 14001–16000 lbs

In this example, VINPLC would be populated with a "4" and VINCHAR would contain the following entry: "ABCD." The combination of these entries indicates that a 1994–95 Ford LDT that has an A, B, C, or D in the fourth VIN digit will have a GVWR of less than or equal to 6000 pounds. Users can thus use this information and the VIN entry to determine whether a particular 1994–95 Ford LDT should be subject to 0–6000 or 6001–8500 pound tailpipe standards.

Generic Tire/Roll Interface Losses on 8.625" Roll (field #22) - These data are computed from the full and empty drive axle weights (VAXF and VAXE) contained in the Cert database, using the formula contained in §85.2226(a)(2)(xv) of the high-tech I/M test procedures and assuming that average drive axle weight (DAXWT) equals (VAXF+VAXE)/2. The formula is as follows:

$$GTRL_{@\ 50\ mph\text{-}8} = (-0.378193) + [(0.0033207) * (DAXWT)]$$

Generic Tire/Roll Interface Losses on 20.0" Roll (field #26) - These data are computed from the full and empty drive axle weights (VAXF and VAXE) contained in the certification database, using the formula contained in §85.2226(a)(2)(xvi) of the high-tech I/M test procedures and assuming that average drive axle weight (DAXWT) equals (VAXF+VAXE)/2. The formula is as follows:

$$GTRL_{@\ 50\ mph\text{-}20} = (0.241645) + [(0.0020844) * (DAXWT)]$$

Total ASM5015 Horsepower (field #30) - These data are computed from the following ASM horsepower equations provided by EPA and the At_8, Bt_8 and Ct_8 default values provided in §85.2226(a)(2)(xiii):

$$THP5015 = HP5015_8 + GTRL_{@\ 15\ mph\text{-}8}$$

$HP5015_8 = ETW/250^*$

$GTRL_{@\ 15\ mph\text{-}8} = \{[At_8*(15\ mph)] + [Bt_8*(15\ mph)^2] + [Ct_8*(15\ mph)^3]\} * GTRL_{@\ 50\ mph\text{-}8}$

where: $At_8 = 0.76 / 50$
$Bt_8 = 0.33 / 2{,}500$
$Ct_8 = - 0.09 / 125{,}000$

Total ASM2525 Horsepower (field #31) - These data are computed from the following ASM horsepower equations provided by EPA and the At_8, Bt_8, and Ct_8 default values provided above:

$THP2525 = HP2525_8 + GTRL_{@\ 25\ mph\text{-}8}$

$HP2525_8 = ETW/300^*$

$GTRL_{@\ 25\ mph\text{-}8} = \{[At_8*(25\ mph)] + [Bt_8*(25\ mph)^2] + [Ct_8*(25\ mph)^3]\} * GTRL_{@\ 50\ mph\text{-}8}$

ASM5015 Horsepower for 8.625" Roll (field #32) - These data are based on the following equation, which is presented in SAE Paper No. 891120:

$HP5015_8 = ETW/250$

ASM2525 Horsepower for 8.625" Roll (field #33) - These data are based on the following equation, which is presented in SAE Paper No. 891120:

$HP2525_8 = ETW/300$

ASM5015 Horsepower for 20.0" Roll (field #34) - These data are computed from the following ASM horsepower equations provided by EPA and the At_{20}, Bt_{20}, and Ct_{20} default values provided in §85.2226(a)(2)(xiii):

$HP5015_{20} = THP5015 - GTRL_{@\ 15\ mph\text{-}20}$

$GTRL_{@\ 15\ mph\text{-}20} = \{[At_{20}*(15\ mph)] + [Bt_{20}*(15\ mph)^2] + [Ct_{20}*(15\ mph)^3]\} * GTRL_{@\ 50\ mph\text{-}20}$

where: $At_{20} = 0.65 / 50$
$Bt_{20} = 0.48 / 2{,}500$

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* This equation is contained in SAE Paper No. 891120.

$$Ct_{20} = - 0.13 / 125{,}000$$

ASM2525 Horsepower for 20.0" Roll (field #35) - These data are computed from the following ASM horsepower equations provided by EPA and the At_{20}, Bt_{20}, and Ct_{20} default values provided above:

$$HP2525_{20} = THP2525 - GTRL_{@\ 25\ mph\text{-}20}$$

$$GTRL_{@\ 25\ mph\text{-}20} = \{[At_{20}*(25\ mph)] + [Bt_{20}*(25\ mph)^2] + [Ct_{20}*(25\ mph)^3]\} * GTRL_{@\ 50\ mph\text{-}20}$$

ASM5015 Tire/Roll Interface Losses on 8.625" Roll (field #36) - These data are computed from the following ASM horsepower equation provided by EPA and the At_8, Bt_8, and Ct_8 default values provided above:

$$GTRL_{@\ 15\ mph\text{-}8} = \{[At_8*(15\ mph)] + [Bt_8*(15\ mph)^2] + [Ct_8*(15\ mph)^3]\} * GTRL_{@\ 50\ mph\text{-}8}$$

ASM2525 Tire/Roll Interface Losses on 8.625" Roll (field #37) - These data are computed from the following ASM horsepower equation provided by EPA and the At_8, Bt_8, and Ct_8 default values provided above:

$$GTRL_{@\ 25\ mph\text{-}8} = \{[At_8*(25\ mph)] + [Bt_8*(25\ mph)^2] + [Ct_8*(25\ mph)^3]\} * GTRL_{@\ 50\ mph\text{-}8}$$

ASM5015 Tire/Roll Interface Losses on 20.0" Roll (field #38) - These data are computed from the following ASM horsepower equation provided by EPA and the At_{20}, Bt_{20}, and Ct_{20} default values provided above:

$$GTRL_{@\ 15\ mph\text{-}20} = \{[At_{20}*(15\ mph)] + [Bt_{20}*(15\ mph)^2] + [Ct_{20}*(15\ mph)^3]\} * GTRL_{@\ 50\ mph\text{-}20}$$

ASM2525 Tire/Roll Interface Losses on 20.0" Roll (field #39) - These data are computed from the following ASM horsepower equation provided by EPA and the At_{20}, Bt_{20}, and Ct_{20} default values provided in above:

$$GTRL_{@\ 25\ mph\text{-}20} = \{[At_{20}*(25\ mph)] + [Bt_{20}*(25\ mph)^2] + [Ct_{20}*(25\ mph)^3]\} * GTRL_{@\ 50\ mph\text{-}20}$$

Average Drive Axle Weight (field #40) - These data are computed from the full and empty drive axle weights (VAXF and VAXE) contained in the certification database,

assuming that DAXWT = (VAXF+VAXE)/2. In some cases, when no value of VAXE is provided in the Certification database, the DAXWT is calculated as 60% of ETW for front-wheel-drive sedans and station wagons, and 50% of ETW for all other vehicle types.

Wheelbase (field #41) - These data are available in non-electronic form in the annual Automotive News Market Data Books for each model year. In addition, the All Wheel/Traction Control Guide compiled by the Colorado Department of Public Health and Environment (CDPHE) also contains wheelbase data. Only limited wheelbase data provided by the manufacturers (e.g., Ford) have been input to the I/M Lookup Table.

Drive Layout Code (field #42) - The various drive code types contained in the certification database have been aggregated into three categories: front, rear, or four-wheel. It is impossible to tell from the certification data whether a vehicle has selectable or full-time four-wheel-drive. Because of this, the manufacturers were asked to identify which vehicles had full-time four-wheel drive. These data were used to disaggregate vehicles equipped with four-wheel-drive into selectable or full-time four-wheel-drive categories.

Full-Time Four-Wheel-Drive (field #43) - As discussed above, data from the manufacturers were used to identify which vehicles had full-time four-wheel-drive. Data from the CDPHE All Wheel/Traction Control Guide were also input, where appropriate, in cases of missing manufacturer data.

Location of Four-Wheel Selector (field #44) - Due to time and resource constraints, these data have not been input to the Lookup Table.

Auxiliary Fuel Tank (Yes/No) (field #46) - A “yes” answer is assumed for this entry if the certification database contains a value for the auxiliary fuel tank size; otherwise, this entry is assumed to be “no.”

Location of Traction Control Disablement Switch (field #50) - Only limited data provided by the manufacturers (e.g., Volkswagen) have been input to the Lookup Table. As described in more detail in Section 5, the location codes used in this field are identical to those proposed for use in mapping the location of OBDII diagnostic link connectors.

EPA Pressure Test Status and Comments (fields #56-57) - These data are based on pressure testability data obtained from the Louisville I/M program and reasons for untestability received from selected manufacturers.

Minimum and Maximum Pressures for EPA Pressure Test (fields #58-59) - These fields have been left blank starting with Version 1.8.2 of the Lookup Table.

Inlet Pressure Test Status and Comments (fields #60-61) - These data are based on pressure testability data obtained from the Louisville I/M program and reasons for untestability received from selected manufacturers.

Minimum and Maximum Pressures for Inlet Pressure Test (fields #62-63) - These fields have been left blank starting with Version 1.8.2 of the Lookup Table.

Tracer Purge Comments (field #67) - These data are based on reasons for untestability received from selected manufacturers.

Minimum and Maximum Pressures for Tracer Purge Test (fields #68-69) - These data are based on data received from selected manufacturers.

Gas Cap Configuration (field #71) - To facilitate gas cap pressure testing, this field identifies the gas cap adapter type that should be used for testing the vehicle, based on data received from Stant Manufacturing. A description of the field is provided below.

Field Entry	Stant Adapter Descriptor
A	Blue
B	Yellow
C	Red
E	Green
F	Black*
G	Gray
H	Threaded
L	Light Blue (new)
O	Orange (new)
Z	Varies
U	Untestable
N	Unknown or no adapter required

Pre-1979 Model Year Vehicles

The database descriptions, data sources, and computational methodologies presented above primarily apply to those model years contained in the EPA certification and fuel economy data provided directly to Sierra by EPA, i.e., for model year 1979 and later. In addition to those data, Sierra also obtained certification data for the 1979–1993 model years that were published annually in the Federal Register. These data were similar, but not identical, to the certification data provided by EPA. (The Federal Register data included some models that were not included in the EPA databases.) Federal Register data for model years 1973–1978 were also entered manually. As described previously, fewer data are available for these earlier model years. Accordingly, the following

*According to Stant, an upgraded black adapter has been developed to address problems that users have experienced in attempting to test certain Honda models because the fuel fillpipes on these vehicles are slightly different from SAE specifications. The upgraded adapter can be visually distinguished from the previous unit based on the presence of a white "gripping ring." Stant intends to continue to use the color black to describe the upgraded version of this adapter. Since this is how it is coded in the I/M Lookup Table, no change will be made to the table entries in response to the upgrade.

methodologies were used to develop the necessary vehicle test parameters (dynamometer settings) for those models for which only Federal Register certification data are available (i.e., 1972–1978 models plus some later model vehicles).

Number of Cylinders (field #5) - These values are not included in the Federal Register database; therefore, this field has been left blank for pre-1979 vehicles for which no data have been provided by the manufacturers or obtained from other sources.

Equivalent Test Weight (field #18) - These values are included in the Federal Register database only for 1980 and later models; therefore, this field has been left blank for pre-1980 vehicles for which no data have been obtained from independent sources (e.g., the Automotive News Market Data Book) or provided by the manufacturers.

Inertia Weight Class (field #19) - Inertia weight class (IWC) data were included in the Federal Register data set for 1979 and earlier models. These values, rounded down to the nearest 500-lb weight class for IWC values above 3000 lbs and down to the nearest 250-lb weight class for IWC values below 3000 lbs, were used unless better data (e.g., from the manufacturers) were available. For 1980 and later models, inertia weight classes were computed by rounding ETW values in the same manner.

Track Road-Load Horsepower (field #20) - TRLHP settings for IM240 testing were based on the model-year-specific default values developed by Sierra using the approach described in Section 2. In some cases, data provided directly to Sierra by the manufacturers were used in place of the default values.

Average Drive Axle Weight (field #32) - As described above, DAXWT data are needed to compute GTRL values. Because these data were not published in the Federal Register, the GTRL values in EPA's revised default table were assumed. The DAXWT values for pre-1979 vehicles were calculated as 60% of ETW for front-wheel-drive sedans and station wagons, and 50% of ETW for all remaining vehicle types.

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5. LOOKUP TABLE UPDATES

Additional modifications, based on comments received on the previous version of the Lookup Table, were incorporated into Version 1.8.4 of the table. These changes are listed below.

1999 Models

1999 model year vehicles, based on manufacturer fuel economy and vehicle certification data, data submitted by the vehicle manufacturers, and other sources, have been added to the table. A limited number of models (particularly those manufactured by small-volume manufacturers) may be missing. Users are encouraged to contact Sierra or EPA directly if they identify missing models.

Data Parameters - For the 1999 models included in the table, complete dynamometer loadings and testability parameters have been included. Stant gas cap adapter information was also added based on a review of the listings contained in the Stant manual.

Default Values - 1999 model-year-specific default values have been included at the beginning of the records for this model year.

Evaporative Fuel Inlet Pressure Test Data

Data regarding alternative test pressures for use in conducting the fuel inlet vehicle evaporative control system integrity (pressure) test that were provided in previous versions of the table have been deleted due to (1) concerns that some of the test pressures were sufficiently high to create the potential for damaging evap systems; (2) the infeasibility of identifying suitable test pressures for 1996-1999 model year vehicles due to the phase-in of vehicles equipped with enhanced evaporative emission control systems into the in-use fleet; and (3) the fact that no programs have been using the alternative test pressures. It is recommended that anyone wishing to conduct vehicle pressure testing follow EPA guidance and use the standard test pressure specified contained therein.

Other Modifications

Miscellaneous Changes - Information provided by the Virginia Department of Environmental Quality was used to investigate differences between test data recorded in its I/M program and information contained in the table. Based on the results of this review, miscellaneous changes were made related to transmission type, engine displacement, and division and model names.

Updated information provided by Honda, Mitsubishi, Subaru, Isuzu, and Land Rover regarding previously existing records was incorporated.

An extensive review was performed of existing records in the table. This resulted in corrections to (1) TRLHP settings for a few 1994-1995 models; (2) drive layout code entries for a number of 1978-1998 models (most related to four-wheel-drive options); and (3) gas cap entries for some 1990-1991 Hondas. In addition, it was noted that a number of 1997-1998 models included in the table had exceptionally high test weights and TRLHP. These models appear to be heavy-duty vehicles and should not be included in the table (which is supposed to contain information on only passenger cars and light-duty trucks). They were therefore deleted.

Record Date - The date on each record that was either added or modified as a result of the above changes reflects the release date of Version 1.8.4 of the Lookup Table.

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