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NR-010f

Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

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Purpose

This report describes and documents exhaust emission factors, crankcase estimates, and brake specific fuel consumption (BSFC) estimates used for spark ignition (SI) engines in EPA's final NONROAD2008a emission inventory model. It covers engines powered by gasoline, natural gas and liquefied petroleum gas. Relative to the December 2005 version of this report, this version has been updated to incorporate the standards in the 2008 final rulemaking affecting small nonroad SI engines and equipment, as well as marine SI engines and vessels. [1]

Additional EPA reports describe other issues relating to emission factors including NONROAD evaporative emission rates (NR-012d), refueling emissions (NR-013b), adjustments to emission rates due to variations in fuel and temperature (NR-001c), speciation of hydrocarbon emissions (NR-002c), and adjustments to emission rates as equipment deteriorates due to time and use (NR-011d). Emission factors for compression ignition (diesel) engines are covered in a separate report (NR-009d).

Introduction

The U.S. EPA's NONROAD model computes county-level emission inventories for nonroad engines. These calculations rely on emission factors -- estimates of the amount of pollution emitted by a particular type of equipment during a unit of use. Typically emission factors for nonroad sources are reported in grams per horsepower-hour (g/hp-hr), but they also may be reported in grams per mile (g/mile), grams per hour, grams per gallon, etc. The SI exhaust emission factors in the NONROAD model are reported in g/hp-hr, with the exception of nonroad motorcycles and all-terrain vehicles, which are reported in g/mile. The SI BSFCs are reported in lb/hp-hr, with the exception of nonroad motorcycles and all-terrain vehicles, which are reported in lb/mile.

The pollutants covered by this report include exhaust total hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NO_x), total particulate matter (PM), carbon dioxide (CO₂), and sulfur dioxide (SO₂). For nonroad engines, all PM emissions are assumed to be smaller than

10 microns (PM₁₀), and 92% of the PM from gasoline and diesel fueled engines is assumed to be smaller than 2.5 microns (PM_{2.5}). For gaseous fueled engines (LPG/CNG), 100% of the PM emissions are assumed to be smaller than PM_{2.5}. The NONROAD Reporting Utility allows the user to select the desired size range.

Zero-mile, steady-state emission factors for HC, CO, NO_x, PM, and steady-state BSFCs are discussed first, followed by adjustments (where applicable) to account for transient operation. Technology distributions by model year, to account for changes in emission factors over time, are then discussed. Derivation of CO₂ and SO₂ emission factors follows. Crankcase emissions are then discussed.

As explained in NR-006e, spark-ignition engine equipment population under 25 horsepower will be combined into one source classification code (SCC) per application to handle expected shifts in market share between 2 and 4-stroke gasoline, LPG, and CNG engines. In the model, the distinction between two- and four-stroke spark-ignition engine emission factors will be maintained using the technology groups described in this report. In this current document, the SCC distinction between 2 and 4-stroke gasoline, LPG, and CNG engines is maintained; however, in the model, we will distinguish emission factors between them by using the technology group methodology.

Background

Prior to the NONROAD model, there have been three major efforts to estimate nonroad spark ignition emission inventories. We have reviewed these efforts in our work to select emission factors for the final version of NONROAD. The three inventories/models are:

EPA's Nonroad Engine and Vehicle Emission Study ("NEVES").[2] Published in November, 1991, this study was mandated by Congress to determine whether nonroad sources made a significant contribution to urban air pollution. The study covers emissions from all nonroad engines and includes hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NO_x), total particulates (PM), sulfur dioxide (SO₂) and other pollutants. It provides inventories for 19 ozone and 16 CO nonattainment areas.

California Air Resources Board's (ARB's) nonroad model ("OFFROAD"), designed to estimate nonroad emissions for the state of California only. A draft version of this model was released August 1, 1997. [3] The model covers HC, CO, NO_x, PM, sulfur dioxide (SO₂), and carbon dioxide (CO₂) for all nonroad engines. ARB periodically revises components of the OFFROAD model. "OFFROAD2007", dated December 15, 2006, is currently available via the ARB website. [4]

EPA's "Small Engine Model"--designed as an internal tool for evaluating various control scenarios, EPA has used this model to estimate the effect of regulations on small spark-ignition (SI) engines under 19 kW (25 hp). This model has evolved over time, but the pre-control exhaust emission factors have not changed since the model was documented in 1995.[5] The model computes national-level inventories of nonroad HC, CO, and NO_x.

The emission factors used in these prior efforts have been based on a very small number of engine studies, particularly when compared to the large body of data available for highway vehicles.

Emission Factor Categories

NEVES defines emission factors by the equipment use (i.e., by "application") but does not assign different emission factors to engines of different sizes within the same application. On the other hand, OFFROAD and the Small Engine Model define emission factors by engine size (by horsepower in OFFROAD and by displacement in the Small Engine Model), but do not assign different emission factors to engines used in different applications that are of the same size. Given the structure of emission control regulations and the design similarities between engines of the same horsepower used in various applications, we define emission factors primarily by power level in final NONROAD2008a. Appendix A provides a comparison of the power categories in OFFROAD, the Small Engine Model, and NONROAD. The NONROAD model allows for the use of application-specific emission factors if there is sufficient information to justify their use. We use application-based emission factor categories only to distinguish recreational marine engines and selected recreational vehicles.

Emission Standards

In addition to estimating emissions from pre-controlled engines, the NONROAD model is designed to account for the effect of federal emissions standards. The model does not cover California emission standards and federal standards that are not yet final. Thus, NONROAD will include emission factors under the following final regulations that cover SI engines at or below 19 kilowatts (25 hp) and SI marine engines:

Emissions for New Nonroad Spark Ignition Engines at or below 19 Kilowatts. July 1995. ("Small Engine Rule, Phase 1") [6]

Phase 2: Emission Standards for New Nonroad Nonhandheld Spark-Ignition Engines At or Below 19 Kilowatts. March 1999. ("Small Engine Nonhandheld Rule, Phase 2") [7]

Phase 2: Emission Standards for New Nonroad Spark-Ignition Handheld Engines At or Below 19 Kilowatts and Minor Amendments to Emission Requirements Applicable to Small Spark-Ignition Engines and Marine Spark-Ignition Engines. April 2000. ("Small Engine Handheld Rule, Phase 2") [8]

Final Rule for New Gasoline Spark-Ignition Marine Engines; Exemptions for New Nonroad Compression-Ignition engines at or Above 37 Kilowatts and New Nonroad Spark-Ignition Engines at or Below 19 Kilowatts October 1996. ("Marine Rule") [9]

Control of Emissions From Nonroad Large Spark-Ignition Engines and Recreational Engines (Marine and Land-Based); Final Rule. November 2002. [10]

Control of Emissions From Nonroad Spark-Ignition Engines and Equipment; Final Rule. October 2008. [11]

Zero-Hour, Steady-State Emission Factors for HC, CO, NO_x, PM, and Steady-State BSFCs

This section describes the zero-hour, steady-state emission factors and steady-state BSFCs that are used in final NONROAD2008a. Pre-controlled (baseline) and controlled (where applicable) emission factors are described for each of the following regulatory equipment categories: small SI engines ≤ 25 hp, large SI engines > 25 hp, land-based recreational engines, and recreational marine engines.

Spark-Ignition (SI) Engines ≤ 25 hp

This category includes all engines ≤ 25 hp except those used for recreational applications (such as motorcycles or snowmobiles), for marine propulsion, or for toy boats and airplanes. The engines in this category are used primarily in lawn and garden equipment.

For this category, engines are segregated by the class of the engine (I - V). Each class is determined by the use of the engine, i.e., handheld or nonhandheld, and engine displacement. Classes I and II refer to nonhandheld small SI engines; classes III, IV, and V refer to handheld small SI engines. The classes have the following displacements: Class I (< 225 cc); Class II (≥ 225 cc); Class III (< 20 cc); Class IV (≥ 20 cc and < 50 cc); Class V (≥ 50 cc).

Engines in handheld applications (such as leafblowers and chainsaws) are subject to two phases of regulation (Phase 1 and Phase 2). Under the Phase 1 regulations, new engines have had to meet emission standards for HC, CO, and NO_x since 1997. More stringent Phase 2 standards phase in between 2002 and 2007.

For nonhandheld applications (such as lawn and garden tractors and lawnmowers), similar Phase 1 regulations have been in place since 1997. More stringent Phase 2 standards phase in between 2001 and 2007. Phase 3 standards are phased in beginning in 2012 for Class I engines and 2011 for Class II engines. The test procedure used for the small SI regulations is the Small SI Engine Federal Steady-State Test Procedure.

Tables 1-5 contain the baseline, Phase 1, Phase 2, and Phase 3 (where applicable) controlled emission factors for these five classes of engines. There are no LPG or CNG engines less than 25 hp in final NONROAD2008; therefore, the emission factors in these tables are used for gasoline engines in the model.

In order to account for the effect of the rulemaking and the phase-in of the new standards, engines meeting the new standards were defined by the technology types in Tables 1-5. (A complete list and description of SI technology types used in final NONROAD2008a is provided in Appendix B, Table B3.) Handheld engines (Classes III-V) tend to be primarily 2-stroke engines, with catalyst equipped engines beginning with the Phase 1 standards. Nonhandheld engines include both 2 and 4-stroke engines, but manufacturers are expected to build only 4-stroke engines with the advent of the new regulations. Nonhandheld 4-stroke engine production is split between two technical types, side-valve and overhead valve systems, which have been shown to exhibit significantly different emission characteristics.

In general, for baseline emissions, NONROAD uses emission factors based on those in the Small Engine Model. [5] Also, the PM emission factors for the entire category (both baseline and controlled) are based on values in NEVES. [2]

For nonhandheld (class I and II) engines, NONROAD uses the brake-specific fuel consumption (BSFC), HC, CO, and NO_x emission factors for Phase 1 that are contained in the final regulatory impact analysis for the March 1999 rulemaking. [7] (The baseline emission factors are also contained in this reference.) The Phase 1 emission factors were based on values obtained from the EPA 1998 Phase 1 Certification database. For Phase 2, the emission factors for Class II engines were back-calculated using 1) the Phase 2 standards, and 2) a multiplicative deterioration factor for each pollutant. For Class I engines, the Phase 2 emission factors were updated since the rulemaking based on testing performed by EPA on 16 walk-behind lawnmowers powered by engines that have been certified to the Phase 2 standards. [13]

There are also Phase 3 HC+NO_x emission standards promulgated in October 2008 that apply to the nonhandheld Class I and II engines. The Phase 3 emission factors were developed based on testing of catalyst-equipped engines both in the laboratory and in-use. [14, 15] The deterioration factors are described in more detail in NR-011d.

For handheld (class III, IV, and V) engines, NONROAD uses the BSFC, HC, CO, and NO_x emission factors for Phase 1 and 2 that are contained in the final regulatory impact analysis for the April 2000 rule. [16] (The baseline emission factors are also contained in this reference.) For Phase 1, the emission factors were back-calculated using 1) the Phase 1 standards, and 2) a multiplicative deterioration factor for each pollutant. For Phase 2, the emission factors were determined using the same methodology. There are no Phase 3 standards for handheld engines. As mentioned above, the deterioration factors are described in more detail in NR-011d.

Table 1. Emissions and BSFCs for Class III Handheld Small SI Engines (< 20cc)*

| Engine Tech Type | HC g/hp-hr | CO g/hp-hr | NO_x g/hp-hr | PM g/hp-hr | BSFC lb/hp-hr |
|--|-----------------------|-----------------------|-----------------------------------|-----------------------|--------------------------|
| G2H3 (gas 2-stroke handheld Class III, baseline) | 261.00 | 718.87 | 0.97 | 7.7 | 1.365 |
| G2H31 (Phase 1) | 219.99 | 480.31 | 0.78 | 7.7 | 1.184 |
| G2H3C1 (Phase 1 with catalyst) | 219.99 | 480.31 | 0.78 | 7.7 | 1.184 |
| G2H3C2 (Phase 2 with catalyst) | 26.87 | 141.69 | 1.49 | 7.7 | 0.822 |

* Assigned NONROAD hp range: 0-1 hp

Table 2. Emissions and BSFCs for Class IV Handheld Small SI Engines (≥20cc and <50cc)*

| Engine Tech Type | HC g/hp-hr | CO g/hp-hr | NO_x g/hp-hr | PM g/hp-hr | BSFC lb/hp-hr |
|---|-----------------------|-----------------------|-----------------------------------|-----------------------|--------------------------|
| G2H4 (gas 2-stroke handheld Class IV, baseline) | 261.00 | 718.87 | 0.94 | 7.7 | 1.365 |
| G2H41 (Phase 1) | 179.72 | 407.38 | 0.51 | 7.7 | 1.184 |
| G2H4C1 (Phase 1 with catalyst) | 179.72 | 407.38 | 0.51 | 7.7 | 1.184 |
| G4H41 (Phase 1 4-stroke) | 22.37 | 533.42 | 1.79 | 0.06 | 0.847 |
| G2H4C2 (Phase 2 with catalyst) | 26.87 | 141.69 | 1.49 | 7.7 | 0.822 |
| G4H42 (Phase 2 4-stroke) | 25.83 | 432.51 | 1.13 | 0.06 | 0.847 |

* Assigned NONROAD hp range: 1-3 hp

Table 3. Emissions and BSFCs for Class V Handheld Small SI Engines (>50cc)*

| Engine Tech Type | HC g/hp-hr | CO g/hp-hr | NO_x g/hp-hr | PM g/hp-hr | BSFC lb/hp-hr |
|--|-----------------------|-----------------------|-----------------------------------|-----------------------|--------------------------|
| G2H5 (gas 2-stroke handheld Class V, baseline) | 159.58 | 519.02 | 0.97 | 7.7 | 0.921 |
| G2H51 (Phase 1) | 120.06 | 351.02 | 1.82 | 7.7 | 0.870 |
| G2H5C1 (Phase 1 with catalyst) | 120.06 | 351.02 | 1.82 | 7.7 | 0.870 |
| G2H52 (Phase 2) | 47.98 | 283.37 | 0.91 | 7.7 | 0.608 |

* Assigned NONROAD hp range: 3-6 hp

Table 4. Emissions and BSFCs for Class I Nonhandheld Small SI Engines (< 225cc)*

| Engine Tech Type | HC g/hp-hr | CO g/hp-hr | NO _x g/hp-hr | PM g/hp-hr | BSFC lb/hp-hr |
|---|---------------|---------------|----------------------------|---------------|------------------|
| G2N1 (gas 2-stroke nonhandheld Class I, baseline) | 207.92 | 485.81 | 0.29 | 7.7 | 0.870 |
| G4N1S (side-valve, 4-stroke, baseline) | 38.99 | 430.84 | 2.00 | 0.06 | 1.365 |
| G4N1O (overhead-valve, 4-stroke, baseline) | 13.39 | 408.84 | 1.80 | 0.06 | 0.991 |
| G4N1S1 (Phase 1 side-valve, 4-stroke) | 8.40 | 353.69 | 3.60 | 0.06 | 0.921 |
| G4N1O1 (Phase 1 overhead-valve, 4-stroke) | 8.40 | 351.16 | 3.24 | 0.06 | 0.781 |
| G4N1S2 (Phase 2 side-valve, 4-stroke) | 7.68 | 288.24 | 1.92 | 0.26 | 0.921 |
| G4N1O2 (Phase 2 overhead valve, 4-stroke) | 6.51 | 293.01 | 2.45 | 0.04 | 0.781 |
| G4N1S3 (Phase 3 side-valve, 4-stroke) | 4.18 | 238.45 | 1.04 | 0.18 | 0.921 |
| G4N1O3 (Phase 3 overhead valve, 4-stroke) | 3.80 | 242.40 | 1.42 | 0.04 | 0.781 |

* Assigned NONROAD hp range: 3-6 hp

Table 5. Emissions and BSFCs for Class II Nonhandheld Small SI Engines (≥ 225cc)*

| Engine Tech Type | HC g/hp-hr | CO g/hp-hr | NO _x g/hp-hr | PM g/hp-hr | BSFC lb/hp-hr |
|--|---------------|---------------|----------------------------|---------------|------------------|
| G2N2 (gas 2-stroke nonhandheld Class II, baseline) | 207.92 | 485.81 | 0.29 | 7.7 | 0.870 |
| G4N2S (side-valve, 4-stroke, baseline) | 9.66 | 430.84 | 2.06 | 0.06 | 0.937 |
| G4N2O (overhead-valve, 4-stroke, baseline) | 5.20 | 408.84 | 3.50 | 0.06 | 0.937 |
| G4N2S1 (Phase 1 side-valve, 4-stroke) | 5.50 | 387.02 | 4.50 | 0.06 | 0.868 |
| G4N2O1 (Phase 1 overhead valve, 4-stroke) | 5.20 | 352.57 | 3.50 | 0.06 | 0.740 |
| G4N2O2 (Phase 2 overhead valve, 4-stroke) | 4.16 | 352.57 | 2.77 | 0.06 | 0.740 |
| G4N23a (Phase 3 overhead-valve, 4-stroke) | 3.17 | 321.94 | 1.01 | 0.06 | 0.735 |

* Assigned NONROAD hp range: 6-25 hp

Spark-Ignition Engines > 25 hp

Nonroad SI engines above 25 hp are generally found in industrial equipment and are used in a wide variety of applications, including forklifts, airport ground-service equipment, terminal tractors, generators, compressors, welders, aerial lifts, and ice grooming machines. These engines may operate on gasoline, LPG, or CNG. Emission standards for SI engines >25 hp have been finalized in November 2002. [10] Both uncontrolled and Phase 1 and 2 controlled emission factors are included in NONROAD2008a.

Summaries of the precontrolled, Phase 1, and Phase 2 emission factors used for this equipment category are provided in Tables 6 through 8. Emission factors for the gasoline, LPG, and CNG engines were taken from the regulatory support document for the final rule, and are based on a summary of available test data. [17]

Table 6. Steady-State Emission Factors and BSFCs for Spark-Ignition Engines > 25 HP*

| Engine Tech Type | HC g/hp-hr | CO g/hp-hr | NO _x g/hp-hr | PM g/hp-hr | BSFC lb/hp-hr |
|---|---------------|---------------|----------------------------|---------------|------------------|
| Uncontrolled | | | | | |
| G2GT25 (gas, 2-stroke, baseline) | 208 | 486 | 0.29 | 7.7 | 1.300 |
| G4GT25 (gas, 4-stroke, baseline) | 3.85 | 107.23 | 8.43 | 0.06 | 0.605 |
| LGT25 (LPG, baseline) | 1.68 | 28.23 | 11.99 | 0.05 | 0.507 |
| NGT25 (CNG, baseline) | 24.64 | 28.23 | 11.99 | 0.05 | 0.507 |
| Phase 1 | | | | | |
| G4GT251 (gas, 4-stroke, used for 2-stroke SCCs) | 0.85 | 24.49 | 1.51 | 7.7 | 0.484 |
| G4GT251 (gas, 4-stroke, used for 4-stroke SCCs) | 0.59 | 29.86 | 1.51 | 0.06 | 0.484 |
| LGT251 (LPG) | 0.25 | 24.49 | 2.10 | 0.05 | 0.406 |
| NGT251 (CNG) | 3.69 | 24.49 | 2.10 | 0.05 | 0.406 |
| Phase 2 | | | | | |
| G4GT252 (gas, 4-stroke, used for 2-stroke SCCs) | 0.28 | 13.24 | 0.69 | 7.7 | 0.484 |
| G4GT252 (gas, 4-stroke, used for 4-stroke SCCs) | 0.27 | 11.94 | 0.69 | 0.06 | 0.484 |
| LGT252 (LPG) | 0.10 | 3.92 | 0.85 | 0.05 | 0.406 |
| NGT252 (CNG) | 1.57 | 3.92 | 0.89 | 0.05 | 0.406 |

* There are very few uncontrolled 2-stroke engines >25 hp; these can be found in 2-stroke specialty vehicle cart and pump equipment. For these 2-stroke source classification codes (SCCs), 4-stroke engines are assumed to meet the Phase 1 and Phase 2 standards, with different Phase 1 and Phase 2 emission factors in some cases than the 4-stroke SCCs.

Motorcycles, All-Terrain Vehicles (ATVs), and Snowmobiles

These engines differ significantly from other SI engines in their basic design, operating characteristics, and emission rates. Emission standards have been finalized for these engines. [10]

A summary of the emission factors for these engines is provided in Table 7. The HC, CO, and NO_x emission data for ATVs and motorcycles were provided by a manufacturer and represent various makes, models, model years, and engine sizes. The emission factors for ATVs and motorcycles are expressed as gram/mile (lb/mile for BSFC). The HC, CO, and NO_x test data used for snowmobiles came from the International Snowmobile Manufacturers Association (ISMA) and Southwest Research Institute (SwRI). The emission factors for snowmobiles are expressed as gram/hp-hr (lb/hp-hr for BSFC). The emission factors are documented in regulatory support documents for the final rule. [17, 18]

Table 7. Emission Factors and BSFCs for Offroad Motorcycles, ATVs, and Snowmobiles

| Equipment/Tech Type | HC g/mile | CO g/mile | NO _x g/mile | PM g/mile | BSFC lb/mile |
|----------------------------------|--------------|--------------|---------------------------|--------------|-----------------|
| Offroad Motorcycles | | | | | |
| RM2 (Precontrol 2-stroke) | 53.90 | 54.10 | 0.150 | 2.10 | 0.268 0.201* |
| RM4 (Precontrol 4-stroke) | 2.40 | 48.50 | 0.410 | 0.06 | 0.158 |
| RM40 (Closed crankcase 4-stroke) | 2.40 | 48.50 | 0.410 | 0.06 | 0.158 |
| RM41 (Phase 1 4-stroke) | 2.10 | 30.60 | 0.340 | 0.06 | 0.158 |
| All Terrain Vehicles | | | | | |
| RA2 (Precontrol 2-stroke) | 53.90 | 54.10 | 0.150 | 2.10 | 0.213 0.160* |
| RA4 (Precontrol 4-stroke) | 2.40 | 48.50 | 0.410 | 0.06 | 0.167 |
| RA40 (Closed crankcase 4-stroke) | 2.40 | 48.50 | 0.410 | 0.06 | 0.167 |
| RA41 (Phase 1 4-stroke) | 1.60 | 42.90 | 0.260 | 0.06 | 0.167 |
| Snowmobiles | | | | | |
| RS2 (Precontrol 2-stroke) | 111.0 | 296.0 | 0.86 | 2.70 | 1.660 |
| RS21 (Modified 2-stroke) | 53.70 | 146.9 | 0.86 | 2.70 | 1.660 |
| RS22 (Direct injection 2-stroke) | 21.80 | 90.0 | 2.80 | 0.57 | 1.245 |
| RS40 (Closed crankcase 4-stroke) | 7.80 | 123.0 | 9.20 | 0.15 | 1.245 |

* The standards for off-road motorcycle and ATV recreational engines allow the engine manufacturers to meet the controlled 4-stroke engine standard with a 2-stroke engine. If a manufacturer succeeds in meeting the 4-stroke controlled standard with a two-stroke engine, this is the estimate of what the BSFC for the controlled 2-stroke engine would be.

Recreational SI Marine Engines

Recreational SI marine engines are divided into three categories: outboard, personal watercraft (PWC), and sterndrive/inboard (SD/I) engines. For outboard and PWC, HC+NO_x emission standards have been in place since 1998. NONROAD2005 contained updated emission factors developed using certification data from eight model years (1998-2005). In addition, updated fuel consumption estimates were developed based on test data. [19] NONROAD2008a additionally accounts for more stringent HC+NO_x and CO standards starting with the 2010 model year. [15]

Pre-controlled emission factors (HC, CO, and NO_x) for SD/I engines were taken from work accomplished in support of the 1996 marine rulemaking, as well as newer information and analysis related to SD/I engines. [20, 21] BSFCs and PM emission factors were derived from NEVES. [1] First-time HC+NO_x and CO standards for SD/I engines apply starting with the 2010 model year. For SD/I engines above 373 kW (600 hp) with high-performance characteristics (generally referred to as “SD/I high-performance engines”), a different set of HC+NO_x and CO standards apply, also starting in 2010. These new standards have been accounted for in NONROAD2008a. [15]

Table 8 shows how the power level ranges used in the 1996 rulemaking analysis were matched to the power levels used in NONROAD.

Table 8. Mapping of Recreational Marine Engine Power Ranges

| Category | EPA-RIA | NONROAD Model |
|-----------------|---------------|---------------|
| Outboard | <3.9 hp | 0 - 3 hp |
| | 3.9 - 9.9 | 3 - 11 |
| | 9.9 - 29.9 | 11 - 25 |
| | 29.9 - 49.9 | 25 - 50 |
| | 49.9 - 74.9 | ----- |
| | 74.9 - 99.9 | 50 - 100 |
| | 99.9 - 149.9 | ----- |
| | 149.9 - 199.9 | 100 - 175 |
| PWC | 30 - 50 hp | 0 - 50 hp |
| | 50 - 75 | 50 - 175 |
| Inboard | 100 - 150 hp | 0 - 100 hp |
| | 150 - 200 | 100 - 175 |
| | >200 | >175 |

To determine the effect of the Federal rulemaking for these types of engines, technical types were defined to reflect new technologies that would be employed to meet the emission levels required. These new technologies would be employed to various degrees to reflect the phase-in of the new emission standards. Technical types were defined to incorporate the emission reductions expected and the phase-in of the standards. For NONROAD2005, the list of technology classes was changed using information in the certification database to better reflect actual production. For NONROAD2008a, additional technology types were added to reflect the 2010 standards. Table 9 presents a comparison of the NONROAD2004, NONROAD2005, and NONROAD2008a technology designations for recreational SI marine engines.

Generally, the updated designations are comprised of 4-5 characters. The first character is “M” for marine. The second character is either “O”, “P” or “S” for outboard, personal watercraft, or sterndrive/inboard. The third character refers to the cycle (2 or 4-stroke), and the fourth character refers to the fuel system (“C” for carbureted, “I” for indirect injection, and “D” for direct injection). The final character denotes aftertreatment with an “A.” For two-stroke engines, “indirect injection” refers to any fuel injection that is not directly injected into the cylinder (such as throttle body fuel injection). For four-stroke engines, “direct injection” includes port fuel injection. A new technology type ending in “C1” was added in NONROAD2008a to account for the 2010 standards for outboard, PWC, and SD/I engines ≤600 hp. The new technology type “MS4X” designates the 2010 standard for the SD/I high performance engines.

Table 9. Marine Engine Technology Class and Designations

| Technology Class Differentiation | | | | Class Designation | | |
|----------------------------------|-----------------------|--------------------------|-----------------|-------------------|-----------------|------------------|
| Type | Cycle | Fuel System | Aftertreatment | NONROAD 2004 | NONROAD 2005 | NONROAD 2008a |
| Outboard | 2-Stroke | Carbureted | none | M1 | MO2C | MO2C |
| | | Carburetor Modifications | none | M5 | -- | -- |
| | | Carbureted | 3- Way Catalyst | M6 | -- | -- |
| | | Indirect Injection | none | M8 | MO2I | MO2I |
| | | Direct Injection | none | M9 | MO2D | MO2D |
| | 4-Stroke | Carbureted | none | M4 | MO4C | MO4C |
| | | Indirect Injection | none | -- | MO4I | MO4I |
| | | Direct Injection | none | -- | MO4D | MO4D |
| | Meets 2010+ standards | | | -- | -- | MOC1 |
| | PWC | 2-Stroke | Carbureted | none | M2 | MP2C |
| Carburetor Modifications | | | none | M14 | -- | -- |
| Carbureted | | | 2- Way Catalyst | -- | MP2CA | MP2CA |
| Indirect Injection | | | none | -- | MP2I | MP2I |
| Direct Injection | | | none | -- | MP2D | MP2D |
| 4-Stroke | | Carbureted | none | M13 | MP4C | MP4C |
| | | Indirect Injection | none | -- | MP4I | MP4I |
| | | Direct Injection | none | -- | MP4D | MP4D |
| Meets 2010+ standards | | | -- | -- | MPC1 | |
| SD/I ≤600 hp | | 4-stroke | Carbureted | none | M3 | MS4C |
| | Direct Injection | | none | M10 | MS4D | MS4D |
| | Meets 2010+ standards | | | -- | -- | MSC1 |
| SD/I >600 hp | 4-stroke | Carbureted | none | M3 | MS4C | MS4C |
| | | Direct Injection | none | M10 | MS4D | MS4D |
| | Meets 2010+ standards | | | -- | -- | MS4X |

Tables 10 and 11 show the HC, NO_x, CO, and PM emission rates by power range and technology type for outboard and PWC engines, respectively. Table 12 provides the fuel consumption estimates by power range and technology type for outboard and PWC engines.

Table 10. Outboard Emission Factors [g/bhp-hr]

| Pollutant | HP Bin | Technology Type | | | | | | |
|-----------|---------|-----------------|--------|--------|--------|--------|--------|--------|
| | | MO2C | MO2I | MO2D | MO4C | MO4I | MO4D | MOC1 |
| HC | 0-3 | 271.92 | 230.39 | 38.74 | 25.60 | 31.77 | 19.27 | 15.57 |
| | 3-6 | 236.73 | 200.58 | 33.73 | 19.09 | 23.69 | 14.37 | 16.49 |
| | 6-11 | 201.55 | 170.77 | 28.72 | 12.61 | 15.65 | 9.49 | 11.59 |
| | 11-16 | 166.37 | 140.96 | 23.70 | 8.89 | 11.03 | 6.69 | 8.67 |
| | 16-25 | 131.18 | 111.15 | 18.69 | 6.17 | 7.66 | 4.65 | 9.32 |
| | 25-40 | 126.53 | 107.21 | 18.03 | 5.31 | 6.59 | 4.00 | 7.63 |
| | 40-50 | 120.97 | 102.50 | 15.55 | 4.81 | 5.97 | 3.62 | 6.96 |
| | 50-100 | 109.11 | 92.45 | 15.55 | 4.69 | 5.82 | 3.53 | 6.88 |
| | 100-175 | 109.11 | 92.45 | 15.55 | 4.69 | 5.82 | 3.53 | 6.83 |
| 175+ | 109.11 | 92.45 | 15.55 | 4.69 | 5.82 | 3.53 | 7.62 | |
| NOx | 0-3 | 1.34 | 1.96 | 4.32 | 5.18 | 5.44 | 5.82 | 3.60 |
| | 3-6 | 1.34 | 1.96 | 4.32 | 5.18 | 5.44 | 5.82 | 2.69 |
| | 6-11 | 1.34 | 1.96 | 4.32 | 5.18 | 5.44 | 5.82 | 4.18 |
| | 11-16 | 1.34 | 1.96 | 4.32 | 5.18 | 5.44 | 5.82 | 5.04 |
| | 16-25 | 1.34 | 1.96 | 4.32 | 5.18 | 5.44 | 5.82 | 3.21 |
| | 25-40 | 1.34 | 1.96 | 4.32 | 5.18 | 5.44 | 5.82 | 4.24 |
| | 40-50 | 1.34 | 1.96 | 4.32 | 5.18 | 5.44 | 5.82 | 4.41 |
| | 50-100 | 1.34 | 1.96 | 4.32 | 5.18 | 5.44 | 5.82 | 4.03 |
| | 100-175 | 1.34 | 1.96 | 4.32 | 5.18 | 5.44 | 5.82 | 3.73 |
| 175+ | 1.34 | 1.96 | 4.32 | 5.18 | 5.44 | 5.82 | 2.74 | |
| CO | 0-3 | 522.44 | 443.81 | 168.07 | 404.36 | 442.11 | 417.79 | 404.36 |
| | 3-6 | 357.31 | 303.53 | 114.95 | 265.94 | 303.68 | 279.37 | 265.94 |
| | 6-11 | 316.77 | 269.10 | 101.91 | 217.89 | 255.64 | 231.32 | 217.89 |
| | 11-16 | 276.23 | 234.66 | 88.87 | 184.91 | 222.65 | 198.34 | 184.91 |
| | 16-25 | 240.34 | 204.16 | 77.32 | 153.03 | 190.78 | 166.46 | 153.03 |
| | 25-40 | 240.34 | 204.16 | 77.32 | 121.16 | 158.91 | 134.59 | 141.29 |
| | 40-50 | 240.34 | 204.16 | 77.32 | 114.51 | 152.25 | 127.94 | 124.74 |
| | 50-100 | 240.34 | 204.16 | 77.32 | 114.51 | 152.25 | 127.94 | 125.94 |
| | 100-175 | 240.34 | 204.16 | 77.32 | 114.51 | 136.58 | 120.62 | 128.93 |
| 175+ | 240.34 | 204.16 | 77.32 | 114.51 | 140.71 | 120.31 | 102.09 | |
| PM | 0-3 | 5.7 | 4.7 | 0.33 | 0.06 | 0.06 | 0.06 | 0.06 |
| | 3-6 | 4.8 | 4.1 | 0.33 | 0.06 | 0.06 | 0.06 | 0.06 |
| | 6-11 | 4.1 | 3.5 | 0.33 | 0.06 | 0.06 | 0.06 | 0.06 |
| | 11-16 | 3.4 | 2.9 | 0.30 | 0.06 | 0.06 | 0.06 | 0.06 |
| | 16-25 | 2.7 | 2.3 | 0.26 | 0.06 | 0.06 | 0.06 | 0.06 |
| | 25-40 | 2.6 | 2.2 | 0.26 | 0.06 | 0.06 | 0.06 | 0.06 |
| | 40-50 | 2.5 | 2.1 | 0.22 | 0.06 | 0.06 | 0.06 | 0.06 |
| | 50-100 | 2.2 | 1.9 | 0.22 | 0.06 | 0.06 | 0.06 | 0.06 |
| | 100-175 | 2.2 | 1.9 | 0.22 | 0.06 | 0.06 | 0.06 | 0.06 |
| 175+ | 2.2 | 1.9 | 0.22 | 0.06 | 0.06 | 0.06 | 0.06 | |

Table 11. Personal Watercraft Emission Factors [g/bhp-hr]

| Pollutant | HP Bin | Technology Type | | | | | | | |
|-----------|---------|-----------------|--------|--------|--------|--------|--------|--------|--------|
| | | MP2C | MP2I | MP2D | MP2CA | MP4C | MP4I | MP4D | MPC1 |
| HC | 0-3 | 271.92 | 205.35 | 60.78 | 106.70 | 25.84 | 31.75 | 30.09 | 15.57 |
| | 3-6 | 230.19 | 173.84 | 51.46 | 90.32 | 15.13 | 21.04 | 19.38 | 16.49 |
| | 6-11 | 188.47 | 142.33 | 42.13 | 73.95 | 4.43 | 10.33 | 8.67 | 11.59 |
| | 11-16 | 146.74 | 110.82 | 32.80 | 57.58 | 4.43 | 10.33 | 8.67 | 8.67 |
| | 16-25 | 105.02 | 79.31 | 23.48 | 41.21 | 4.43 | 10.33 | 8.67 | 9.32 |
| | 25-40 | 105.02 | 79.31 | 23.48 | 41.21 | 3.73 | 9.63 | 7.97 | 7.63 |
| | 40-50 | 105.02 | 79.31 | 23.48 | 41.21 | 3.73 | 9.63 | 7.97 | 6.96 |
| | 50-100 | 105.02 | 79.31 | 24.74 | 41.21 | 3.63 | 9.54 | 7.88 | 6.88 |
| | 100-175 | 105.02 | 79.31 | 24.37 | 41.21 | 3.63 | 9.54 | 7.88 | 6.83 |
| | 175+ | 105.02 | 79.31 | 15.76 | 41.21 | 3.63 | 9.54 | 7.88 | 7.62 |
| NOx | 0-3 | 1.08 | 1.31 | 3.78 | 0.27 | 1.47 | 4.90 | 3.55 | 3.60 |
| | 3-6 | 1.08 | 1.31 | 3.78 | 0.27 | 1.07 | 4.90 | 3.55 | 2.69 |
| | 6-11 | 1.08 | 1.31 | 3.78 | 0.27 | 5.98 | 4.90 | 3.55 | 4.18 |
| | 11-16 | 1.08 | 1.31 | 3.78 | 0.27 | 5.98 | 4.90 | 3.55 | 5.04 |
| | 16-25 | 1.08 | 1.31 | 3.78 | 0.27 | 5.98 | 4.90 | 3.55 | 3.21 |
| | 25-40 | 1.08 | 1.31 | 3.78 | 0.27 | 5.98 | 4.90 | 3.55 | 4.24 |
| | 40-50 | 1.08 | 1.31 | 3.78 | 0.27 | 5.98 | 4.90 | 3.55 | 4.41 |
| | 50-100 | 1.08 | 1.31 | 3.78 | 0.27 | 5.98 | 4.90 | 3.55 | 4.03 |
| | 100-175 | 1.08 | 1.31 | 3.78 | 0.27 | 5.98 | 4.90 | 3.55 | 3.73 |
| | 175+ | 1.08 | 1.31 | 3.78 | 0.27 | 5.98 | 4.90 | 3.55 | 2.74 |
| CO | 0-3 | 522.44 | 477.03 | 231.18 | 547.75 | 476.96 | 476.96 | 476.96 | 476.96 |
| | 3-6 | 444.63 | 405.98 | 196.75 | 469.94 | 401.31 | 401.31 | 401.31 | 401.31 |
| | 6-11 | 366.82 | 334.94 | 162.32 | 392.13 | 181.13 | 181.13 | 181.13 | 181.13 |
| | 11-16 | 289.01 | 263.89 | 127.89 | 314.32 | 171.94 | 171.94 | 171.94 | 171.94 |
| | 16-25 | 211.20 | 192.84 | 93.46 | 236.51 | 162.74 | 162.74 | 162.74 | 162.74 |
| | 25-40 | 211.20 | 192.84 | 93.46 | 236.51 | 153.54 | 153.54 | 153.54 | 153.54 |
| | 40-50 | 211.20 | 192.84 | 93.46 | 236.51 | 153.54 | 153.54 | 153.54 | 93.46 |
| | 50-100 | 211.20 | 193.65 | 100.82 | 236.51 | 153.54 | 153.54 | 153.54 | 153.54 |
| | 100-175 | 211.20 | 193.65 | 94.68 | 236.51 | 153.54 | 153.54 | 153.54 | 150.44 |
| | 175+ | 211.20 | 193.65 | 85.06 | 236.51 | 153.54 | 153.54 | 153.54 | 85.06 |
| PM | 0-3 | 5.5 | 4.7 | 0.33 | 2.16 | 0.06 | 0.06 | 0.06 | 0.06 |
| | 3-6 | 4.8 | 4.1 | 0.33 | 1.88 | 0.06 | 0.06 | 0.06 | 0.06 |
| | 6-11 | 4.1 | 3.5 | 0.33 | 1.61 | 0.06 | 0.06 | 0.06 | 0.06 |
| | 11-16 | 3.4 | 2.9 | 0.30 | 1.33 | 0.06 | 0.06 | 0.06 | 0.06 |
| | 16-25 | 2.7 | 2.3 | 0.26 | 1.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| | 25-40 | 2.6 | 2.2 | 0.26 | 1.02 | 0.06 | 0.06 | 0.06 | 0.06 |
| | 40-50 | 2.5 | 2.1 | 0.22 | 0.98 | 0.06 | 0.06 | 0.06 | 0.06 |
| | 50-100 | 2.2 | 1.9 | 0.22 | 0.86 | 0.06 | 0.06 | 0.06 | 0.06 |
| | 100-175 | 2.2 | 1.9 | 0.22 | 0.86 | 0.06 | 0.06 | 0.06 | 0.06 |
| | 175+ | 2.2 | 1.9 | 0.22 | 0.86 | 0.06 | 0.06 | 0.06 | 0.06 |

Table 12. Fuel Consumption Factors for Outboards and PWC [lbs/bhp-hr]

| HP Bin | Technology Type | | | | | | |
|---------|---------------------|--------------|--------------|--------------|--------------------------|-------|-------|
| | MO2C MP2C, MP2CA | MO2I MP2I | MO2D MP2D | MO4C MP4C | MO4I, MO4D MP4I, MP4D | MOC1 | MPC1 |
| 0-3 | 1.803 | 1.623 | 1.443 | 0.925 | 0.832 | 0.925 | 0.925 |
| 3-6 | 1.618 | 1.456 | 1.295 | 0.920 | 0.828 | 0.920 | 0.920 |
| 6-11 | 1.479 | 1.332 | 1.184 | 0.911 | 0.820 | 0.911 | 0.911 |
| 11-16 | 1.387 | 1.248 | 1.110 | 0.906 | 0.816 | 0.906 | 0.906 |
| 16-25 | 1.341 | 1.207 | 1.073 | 0.892 | 0.803 | 0.892 | 0.892 |
| 25-40 | 1.156 | 1.040 | 0.925 | 0.867 | 0.780 | 0.867 | 0.867 |
| 40-50 | 1.110 | 0.999 | 0.888 | 0.832 | 0.749 | 0.832 | 0.832 |
| 50-100 | 1.063 | 0.957 | 0.851 | 0.798 | 0.718 | 0.773 | 0.798 |
| 100-175 | 0.925 | 0.832 | 0.740 | 0.694 | 0.624 | 0.682 | 0.647 |
| 175+ | 0.832 | 0.749 | 0.666 | 0.624 | 0.562 | 0.635 | 0.624 |

In NONROAD, the pre-controlled technology types for SD/I engines are MS4C for carbureted engines and MS4D for direct injection engines. The technology types for the 2010 controls are MS4X for the high performance engines and MSC1 for the other engines. Table 13 presents the emission factors and fuel consumption estimates for SD/I engines.

Table 13. Emissions and Fuel Consumption for Inboard Engines (g/bhp-hr)

| HP Bin | Tech Type | HC g/hp-hr | CO g/hp-hr | NO _x g/hp-hr | PM g/hp-hr | BSFC lb/hp-hr |
|---------|-----------|---------------|---------------|----------------------------|---------------|------------------|
| ≤600 hp | MS4C | 5.88 | 153.7 | 5.35 | 0.06 | 0.657 |
| | MS4D | 3.02 | 71.8 | 8.48 | 0.06 | 0.567 |
| | MSC1 | 1.34 | 41.0 | 1.19 | 0.06 | 0.567 |
| >600 hp | MS4C | 10.31 | 188.7 | 6.26 | 0.06 | 0.657 |
| | MS4D | 10.31 | 154.6 | 5.07 | 0.06 | 0.595 |
| | MS4X | 6.39 | 154.6 | 5.07 | 0.06 | 0.595 |

Accounting for In-Use Operation

Many nonroad engines operate under transient loads, but the engines are typically tested with steady-state tests. For small SI engines (≤25 hp), three studies have compared transient and steady-state emissions in SI engines, but they have not found consistent results and, in most cases, transient and steady-state have produced equivalent emission factors. [22, 23, 24] At present, EPA believes there is not sufficient information to justify an in-use transient adjustment factor (TAF) for small SI engines, so the NONROAD model will use emission factors based on

unadjusted steady-state test results. Similarly, TAFs are not applied to the zero hour, steady-state emission factors for recreational equipment and SI marine engines.

For large SI engines >25 hp, based on emission measurements from highway engines comparable to uncontrolled large SI engines, transient emission levels are 30 percent higher for HC and 45 percent higher for CO relative to steady-state measurements. [17, 25] The NONROAD model therefore multiplies steady-state emission factors for SI engines >25 hp by a TAF of 1.3 for HC and 1.45 for CO to estimate emission levels during normal, transient operation. Test data do not support adjusting NO_x emission levels for transient operation and so a TAF of 1.0 is used for NO_x emissions. Also, the model applies no TAFs for generators, pumps, or compressors, since engines in these applications are less likely to experience transient operation. A summary of the TAFs used for large SI engines >25 hp is provided in Table 14.

Table 14. Transient Adjustment Factors (TAFs) for Spark-Ignition Engines >25 hp

| Tech Types | HC g/hp-hr | CO g/hp-hr | NO _x g/hp-hr | PM g/hp-hr | BSFC lb/hp-hr |
|-----------------------------|---------------|---------------|----------------------------|---------------|------------------|
| Pre-control TAFs | | | | | |
| Gasoline | 1.3 | 1.45 | 1.0 | 1.0 | 1.0 |
| LPG | 1.3 | 1.45 | 1.0 | 1.0 | 1.0 |
| CNG | 1.3 | 1.45 | 1.0 | 1.0 | 1.0 |
| Phase 1 Control TAFs | | | | | |
| Gasoline | 1.7 | 1.7 | 1.4 | 1.0 | 1.0 |
| LPG | 2.9 | 1.45 | 1.5 | 1.0 | 1.0 |
| CNG | 2.9 | 1.45 | 1.5 | 1.0 | 1.0 |
| Phase 2 Control TAFs | | | | | |
| Gasoline | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| LPG | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| CNG | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |

TAFs are applied to gasoline 2-stroke (G2GT25), gasoline 4-stroke (G4GT25), LPG (LGT25), and CNG (NGT25) engines. TAFs are not applied to generator sets, pumps, or air compressors, as these are less likely to experience transient operation.

Technology Distributions

NONROAD accounts for changes in sales fractions and emissions from the advent of emission standards or other changes by assigning technology groups to each Source Classification Code (SCC). Each technology group has its own emission factors as described

above, and the fraction of the population assigned to each group can change over time. The exhaust technology fractions by year are contained in an input file in NONROAD called tech-exh.dat.

The regulations previously discussed for the SI engine categories are expected to influence the sales fraction of various technology types and the emission rates of those technologies. These anticipated changes are described in the regulatory support documents for the rulemakings and were used directly in NONROAD2008a.

The technology fractions by SCC in tech-exh.dat are provided in Appendix B.

Carbon Dioxide Emission Factors

Emission factors for CO₂ are rarely measured; instead, they typically are calculated based on brake-specific fuel consumption (BSFC). The NONROAD model uses BSFC to compute CO₂ emissions directly, as shown in the equation below. The carbon that goes to exhaust HC emissions is subtracted. This does not require a CO₂ emission factors input file.

$$CO_2 = (BSFC * 453.6 * - HC) * 0.87 * (44/12)$$

where

CO₂ is in g/hp-hr

BSFC is the fuel consumption in lb/hp-hr

453.6 is the conversion factor from pounds to grams

HC is the in-use adjusted hydrocarbon emissions in g/hp-hr

0.87 is the carbon mass fraction of diesel

44/12 is the ratio of CO₂ mass to carbon mass

Sulfur Dioxide Emission Factors

Sulfur dioxide emissions are rarely measured. Instead, they typically are calculated from fuel consumption and fuel sulfur content. We have retained this approach for the NONROAD model. Sulfur dioxide emission factors for gasoline engines are calculated using the following equation:

$$SO_2 = (BSFC * 453.6 * (1 - soxcnv) - HC) * 0.01 * soxbas * 2$$

where

SO₂ is in g/hp-hr

BSFC is the fuel consumption in lb/hp-hr

453.6 is the conversion factor from pounds to grams

soxcnv is the fraction of fuel sulfur converted to direct PM (soxcnv = 0.03 for gasoline engines)

HC is the in-use adjusted hydrocarbon emissions in g/hp-hr

0.01 is the conversion factor from weight percent to weight fraction

soxbas is the episodic weight percent of sulfur in the fuel (default value for gasoline is 0.0339)

2 is the grams of SO₂ formed from a gram of sulfur

The calculation for CNG/LPG engines is similar, with an average default fuel sulfur weight percent (soxbas) of 0.008 and the same sulfur conversion rate (soxcnv = 0.03).

The SO₂ emission factors are calculated based on the default fuel sulfur contents listed here. NONROAD users may use the model interface to adjust the fuel sulfur content without changing the input files.

Crankcase Emissions

Crankcase emissions are those emissions that escape from the combustion chamber past the piston rings into the crankcase of four-stroke spark-ignition engines. Crankcase emissions from 2-stroke engines do not exist due to the free flow of gases from the crankcase to the combustion chamber in these engines. EPA Phase I regulations require closed crankcases for all 1997 and later spark-ignition engines under 19 kilowatts (25 hp), so these are assumed to have zero crankcase emissions.[26] Also, all 4-stroke engines used in marine vessels are assumed to have closed crankcases, including inboard, sterndrive, and 4-stroke outboards. In addition, 4-stroke engines in recreational equipment meeting Phase 1 or later controls have zero crankcase emissions. There are also some pre-control 4-stroke engines with closed crankcases used in recreational equipment (identified in NONROAD as technology types with the extension “40”). All other gasoline 4-stroke equipment are assumed to have open crankcases, except lawn and garden equipment produced prior to 1997. NONROAD uses the estimate that 21 percent of pre-1997 lawn and garden equipment have open crankcases. In addition, the model assumes that all compression ignition diesel engines have crankcase emissions.

It should be noted that the final Nonroad Diesel Engine Tier 4 Rule assumes zero crankcase emissions for Tier 4 nonroad engines, and this is reflected in all the model versions starting with draft NONROAD2004.

Crankcase Emissions: Sources of Values Used in NONROAD

Due to lack of any other sources of crankcase emission data, the final NONROAD2008a model uses the crankcase emission factors from NEVES for all engines produced without closed crankcases. NEVES uses data from on-highway engines to estimate nonroad crankcase emission rates. Using the NEVES data, NONROAD assumes the crankcase HC emission factor is equal to 33% of the exhaust HC emission factor for 4-stroke engines with open crankcases. For diesel engines with open crankcases, NONROAD assumes the HC emission factor is equal to 2.0% of the exhaust HC emission factor. These percentages are applied to the final calculated exhaust emission factors, so the resulting crankcase emission factors include the same percentage deterioration as used for exhaust HC.

Although NEVES also provides diesel crankcase emission factors for CO (0.2% of exhaust CO) and NO_x (0.05% of exhaust NO_x), there is no provision within NONROAD for modeling these since they are so small. Comments are welcome regarding the need for inclusion of CO and NO_x crankcase emissions either within the model or as a manual addition to the exhaust estimates produced by the model.

References

- [1] “Control of Emissions From Nonroad Spark-Ignition Engines and Equipment; Final Rule,” 73 FR 59034, October 8, 2008.
- [2] “Nonroad Engine and Vehicle Emission Study” (NEVES), U.S. EPA, Office of Air and Radiation, 21A-2001, November, 1991.
- [3] “Documentation of Input Factors for the New Off-Road Mobile Source Emissions Inventory Model,” (“Inputs...”) Energy and Environmental Analysis, Inc. for California Air Resources Board, February, 1997.
- [4] OFFROAD2007 Model and Supporting Documentation. Available online at <http://www.arb.ca.gov/msei/offroad/offroad.htm>.
- [5] “Documentation of the OMS Small Gasoline Engine Spreadsheet System, Final Technical Memorandum,” Dan Bowman, TRC Environmental Corporation, August 1995.
- [6] “Emissions for New Nonroad Spark-Ignition Engines At or Below 19 Kilowatts; Final Rule,” 60 FR 34581, July 3, 1995.
- [7] “Phase 2: Emission Standards for New Nonroad Nonhandheld Spark Ignition Engines At or Below 19 Kilowatts,” Amendments to 40 CFR Part 90, March 1999.
- [8] “Phase 2: Emission Standards for New Nonroad Spark-Ignition Handheld Engines At or Below 19 Kilowatts and Minor Amendments to Emission Requirements Applicable to Small Spark-Ignition Engines and Marine Spark-Ignition Engines; Final Rule,” 65 FR 24268, April 25, 2000.
- [9] “Final Rule for New Gasoline Spark-Ignition Marine Engines; Exemptions for New Nonroad Compression-Ignition Engines at or Above 37 Kilowatts and New Nonroad Spark-Ignition Engines at or Below 19 Kilowatts,” 61 FR 52088, October 4, 1996.
- [10] “Control of Emissions From Nonroad Large Spark-Ignition Engines and Recreational Engines (Marine and Land-Based); Final Rule,” 67 FR 68241, November 8, 2002.
- [11] “Control of Emissions From Nonroad Spark-Ignition Engines and Equipment; Final Rule,” 73 FR 59034, October 8, 2008.
- [12] “Final Regulatory Impact Analysis, Phase 2: Emission Standards for New Nonroad Nonhandheld Spark-Ignition Engines At or Below 19 Kilowatts,” U.S. EPA, EPA420-R-99-003, March 1999.
- [13] “Updates to Phase 2 Technology Mix, Emission Factors, and Deterioration Rates for Spark-Ignition Nonroad Nonhandheld Engines at or below 19 Kilowatts for the NONROAD Emissions

Inventory Model,” Memo from Phil Carlson to Docket EPA-HQ-OAR-2004-0008, March 6, 2007. Docket Document EPA-HQ-OAR-2004-0008-0543.

[14] “Phase 3 Technology Mix, Emission Factors, and Deterioration Rates for Spark-Ignition Nonroad Nonhandheld Engines at or below 19 Kilowatts for the NONROAD Emissions Inventory Model for the Final Rule,” Memo from Phil Carlson to Docket EPA-HQ-OAR-2004-0008, May 21, 2008. Docket Document EPA-HQ-OAR-2004-0008-0842.

[15] “Final Regulatory Impact Analysis, Phase 2 Final Rule: Emission Standards for New Nonroad Handheld Spark-Ignition Engines At or Below 19 Kilowatts,” U.S. EPA, EPA420-R-00-004, March 2000.

[16] “Final Regulatory Impact Analysis, Control of Emissions from Marine SI and Small SI Engines, Vessels, and Equipment,” U.S. EPA, EPA420-R-08-014, September 2008.

[17] “Final Regulatory Support Document: Control of Emissions from Unregulated Nonroad Engines,” U.S. EPA, EPA420-R-02-022, September 2002.

[18] “Emission Modeling for Recreational Vehicles,” EPA Memorandum from Linc Wehrly to Docket A-98-01, EPA420-F-00-051, November 13, 2000.

[19] “Updates to Technology Mix, Emissions Factors, Deterioration Rates, Power Distribution, and Fuel Consumption Estimates for SI Marine Engines in the NONROAD Emissions Inventory Model,” Memo from Mike Samulski to Docket OAR-2004-0008, November 30, 2005.

[20] “Regulatory Impact Analysis: Control of Air Pollution Emission Standards for New Spark-Ignition Marine Engines,” U.S. EPA, October, 1996.

[21] “Revisions to the June 2000 Release of NONROAD to Reflect New Information and Analysis on Marine and Industrial Engines,” EPA Memorandum from Mike Samulski to Docket A-98-01, Docket Item IV-8-1, November 2, 2000.

[22] “Emissions Analysis of Small Utility Engines.” Sun, X., et al. SAE paper 952080. 1995.

[23] “Emissions from 4-Cycle Walk-Behind-Mower Engines: Test Cycle Effects.” Gabele, Peter. SAE Paper 972793. 1997

[24] “Transient versus steady-state test procedure evaluation of 4-cycle utility engines,” Carpenter, T., Buszkiewicz, T., Trimble, T. EPA regulation negotiation test procedure task group, November, 1994. EPA Air Docket A-93-29, Docket Item II-M-27 and “Final Report - Handheld Subgroup of the Test Procedure Task Group”, EPA Air Docket A-93-29, Docket Item II-M-40.

[25] "Regulatory Analysis and Environmental Impact of Final Emission Regulations for 1984 and Later Model Year Heavy Duty Engines," p. 189, U.S. EPA, Docket A-2000-01, December 1979.

[26] Federal Register: July 3, 1995 (Volume 60, Number 127), Page 34581-34657, "Control of Air Pollution; Emission Standards for New Nonroad Spark-ignition Engines At or Below 19 Kilowatts," and Code of Federal Regulations 40 CFR 90.109 "Requirement of certification--closed crankcase."

Appendix A
Cross-Inventory Comparison of SI Emission Factors

Comparing emission factors between inventory models (NEVES, OFFROAD, EPA’s Small Engine Model) is not straightforward because the different models and inventories use different units and different categories in distinguishing emission factors. To compare the factors, all factors were converted to list emission factors in g/hp-hr by engine type, application and horsepower. This conversion required mapping both the ARB horsepower groups and the Small Engine Model’s displacement classes to the horsepower groups used by the NONROAD model (see Tables A1 and A2). It was also necessary to combine the Small Engine Model’s overhead-valve and side-valve categories into a single category by using a sales-weighted average, using the sales mix listed in Table A3.

Table A1. Mapping of small engine groupings used in the Small Engine Model and ARB’s OFFROAD model to the small engine groupings used in the NONROAD model

| Small Engine Model Class/Displacement | ARB Power Range | NONROAD Power Range | NONROAD source classification |
|---------------------------------------|---------------------|---------------------|--|
| Non-Handheld, I <225 cc | 2-5 hp | 3-6 hp | All engines except 2-stroke trimmers/edgers/cutters, chainsaws, leafblowers, and snowblowers |
| Non-Handheld, II >225 cc | 5-15 hp 15-25 hp | 6-16 hp 16-25 hp | All engines except 2-stroke trimmers/edgers/cutters, chainsaws, leafblowers, and snowblowers |
| Handheld, III 0-20 cc | ≤ 2 hp | 0-1 hp | All engines |
| Handheld, IV 20-50 cc | ≤ 2 hp | 1-3 hp | All engines |
| Handheld, V >50 cc | 2-15 hp | 3-6 hp | All 2-stroke trimmers/edgers/cutters, chainsaws, leafblowers, and snowblowers |

Table A2. Mapping of large engine groupings used in ARB’s OFFROAD model to the large engine groupings used in the NONROAD model.

| ARB hp range | NONROAD hp Range |
|--------------|------------------|
| 5-15 | 6-11 & 11-16 |
| 15-25 | 16-25 |
| 25-50 | 25-50 |
| 50-120 | 50-100 |
| 120-175 | 100-175 |
| 175-250 | 175-250 |
| 250-500 | 250-500 |
| 500-750 | 500-750 |
| 750-9999 | 750-3000+ |

Table A3. Sales Mix for Small Engine Model, Pre-control [1]

| Application | Sales Mix | | | | | | | | |
|------------------------------|-------------------|---------|---------|-----------------------|---------|---|------------|-------------|------------|
| | 2-stroke handheld | | | 2-stroke non-handheld | | 4-stroke non-handheld, overhead- and side-valve | | | |
| | Class 3 | Class 4 | Class 5 | Class 1 | Class 2 | Class 1 OHV | Class 1 SV | Class 2 OHV | Class 2 SV |
| Lawn Mowers | | | | 0.1 | | 0.065 | 0.835 | | 0.0014 |
| Trimmers/ Edgers/ Cutters | 0.0501 | 0.9173 | 0.0077 | | | 0.0016 | 0.0231 | | 0.0002 |
| Chain Saws | 0.0035 | 0.6426 | 0.3539 | | | | | | |
| Leaf Blowers/ Vacuums | 0.0528 | 0.6299 | 0.2086 | | | 0.0007 | 0.0721 | 0.0001 | 0.0359 |
| Generator Sets | | | | 0.0017 | | 0.0057 | 0.2853 | 0.0551 | 0.6522 |
| Tillers | | 0.0101 | 0 | | | | 0.7938 | 0.0001 | 0.196 |
| Snowblowers | | | 0.3205 | | | | 0.3732 | | 0.3063 |
| Commercial Turf Equipment | | | | 0.0099 | | 0.04 | 0.0647 | 0.3658 | 0.5196 |
| Rear Engine Riding Mowers | | | | | | | 0.0499 | 0.1563 | 0.7939 |
| Lawn & Garden Tractors | | | | | | 0.0222 | 0.804 | 0.0013 | 0.1725 |
| Pumps | | | | | | | 0.0049 | 0.1421 | 0.8531 |
| All Other Equipment | | | | 0.0974 | 0.0024 | 0.0375 | 0.4064 | 0.0081 | 0.4482 |

[1]”Documentation of the OMS Small Gasoline Engine Spreadsheet System, Final Technical Memorandum” TRC Environmental Corporation for U.S. EPA Air and Energy Research Laboratory. August 1995.

Appendix B Technology Groups and Distributions by Year

NONROAD accounts for changes in sales fractions and emissions from the advent of emission standards or other changes by assigning technology groups to each Source Classification Code (SCC). (SCC descriptions are given in NR-006e.) Each technology group has its own emission factor and the fraction of the population assigned to each group can change over time. The exhaust “technology fractions” are contained in an input file in NONROAD called *tech-exh.dat*. A sample record for 4-stroke lawnmowers might show a shift in engine sales from side-valve engines (Tech Group 1) to overhead valve engines (Tech Group 2) as illustrated in Table B1, which shows side-valve engines declining from 90% of sales in 1991 to 50% of sales in 1997.

Table B1. Sample Technology Fractions

| SCC/Year | Horsepower Range | Tech group/fraction | Tech group/fraction |
|------------|------------------|---------------------|---------------------|
| 2260004010 | 3-6 hp | 1 | 2 |
| 1990 | | 0.90 | 0.10 |
| 1997 | | 0.50 | 0.50 |

Each technology group has an associated emission factor given in the emission factor input file for that pollutant. This emission factor can change with time. For example, CO emissions from Technology Group 1 (side-valve engines) might decrease from 819 g/hp-hr for model year engines 1990 through 1996 to 387 g/hp-hr for model years 1997 and later as shown in Table B2. The year listed in the emission factor input file is the first year in which the new emission factor applies.

Table B2. Sample Emission Factors

| SCC/Year | Horsepower Range | Technology group/emissions | Units | Pollutant |
|------------|------------------|----------------------------|---------|-----------|
| 2265004010 | 3-6 hp | 1 | g/hp-hr | CO |
| 1990 | | 819 | | |
| 2265004010 | 3-6 hp | 1 | g/hp-hr | CO |
| 1997 | | 387 | | |

For pre-controlled engines, the only technology groups currently identified are those used to combine SCCs for spark-ignition engines <25 hp as described in NR-006e. Technology groups primarily will be used for engines subject to emissions regulations. The regulations discussed in the main body of this report (for small SI engines ≤ 25 hp and SI recreational marine engines) are expected to influence the sales fraction of various technology types and the emission rates of those technologies. The technology types meeting the new standards (with appropriately lower emission factors) then gain market share during the appropriate model years which represent the start year of the regulations. These anticipated changes are described in EPA's rulemakings.

Table B3 provides a list and description of the SI technology groups used in final NONROAD2008a. Table B4 contains the technology fractions in tech-exh.dat.

If new emission factors are developed for other parts of the inventory (e.g., larger SI engines) to reflect distinctions between different engine technologies with different emission levels, then appropriate technology groups, technology fractions, and emission factors will be added to the model. Similarly, appropriate emission factors will be added to the model if new emission standards are implemented.

Table B3. Spark-Ignition Technologies in the Final NONROAD2008a Model

| Engine Tech Type Code | SI Engine Category | Description |
|------------------------------|---------------------------|---|
| G2GT25 | Large SI > 25hp | Gasoline, 2-stroke, Baseline |
| G4GT25 | Large SI > 25hp | Gasoline, 4-stroke, Baseline |
| G4GT251 | Large SI > 25hp | Gasoline, 4-stroke, Phase 1 |
| G4GT252 | Large SI > 25hp | Gasoline, 4-stroke, Phase 2 |
| LGT25 | Large SI > 25hp | Liquid Petroleum Gas, Baseline |
| LGT251 | Large SI > 25hp | Liquid Petroleum Gas, Phase 1 |
| LGT252 | Large SI > 25hp | Liquid Petroleum Gas, Phase 2 |
| NGT25 | Large SI > 25hp | Compressed Natural Gas, Baseline |
| NGT251 | Large SI > 25hp | Compressed Natural Gas, Phase 1 |
| NGT252 | Large SI > 25hp | Compressed Natural Gas, Phase 2 |
| G2H3 | Small SI ≤ 25 hp | Gasoline, 2-stroke, handheld Class III (<20cc), Baseline |
| G2H31 | Small SI ≤ 25 hp | Gasoline, 2-stroke, handheld Class III (<20cc), Phase 1 |
| G2H3C1 | Small SI ≤ 25 hp | Gasoline, 2-stroke, handheld Class III (<20cc), Phase 1 with catalyst |

Table B3. Spark-Ignition Technologies in the Final NONROAD2008a Model

| Engine Tech Type Code | SI Engine Category | Description |
|------------------------------|---------------------------|--|
| G4H31 | Small SI \leq 25hp | Not used |
| G2H32 | Small SI \leq 25hp | Not used |
| G2H3C2 | Small SI \leq 25hp | Gasoline, 2-stroke, handheld Class III ($<20\text{cc}$), Phase 2 with catalyst |
| G4H32 | Small SI \leq 25hp | Not used |
| G2H4 | Small SI \leq 25hp | Gasoline, 2-stroke, handheld Class IV ($\geq 20\text{cc}$ and $<50\text{cc}$), Baseline |
| G2H4C | Small SI \leq 25hp | Not used |
| G4H4 | Small SI \leq 25hp | Not used |
| G2H41 | Small SI \leq 25hp | Gasoline, 2-stroke, handheld Class IV ($\geq 20\text{cc}$ and $<50\text{cc}$), Phase 1 |
| G2H4C1 | Small SI \leq 25hp | Gasoline, 2-stroke, handheld Class IV ($\geq 20\text{cc}$ and $<50\text{cc}$), Phase 1 with catalyst |
| G4H41 | Small SI \leq 25hp | Gasoline, 4-stroke, handheld Class IV ($\geq 20\text{cc}$ and $<50\text{cc}$), Phase 1 |
| G2H42 | Small SI \leq 25hp | Not used |
| G2H4C2 | Small SI \leq 25hp | Gasoline, 2-stroke, handheld Class IV ($\geq 20\text{cc}$ and $<50\text{cc}$), Phase 2 with catalyst |
| G4H42 | Small SI \leq 25hp | Gasoline, 4-stroke, handheld Class IV ($\geq 20\text{cc}$ and $<50\text{cc}$), Phase 2 |
| G2H5 | Small SI \leq 25hp | Gasoline, 2-stroke, handheld Class V ($\geq 50\text{cc}$), Baseline |
| G2H5C | Small SI \leq 25hp | Not used |
| G2H51 | Small SI \leq 25hp | Gasoline, 2-stroke, handheld Class V ($\geq 50\text{cc}$), Phase 1 |
| G2H5C1 | Small SI \leq 25hp | Gasoline, 2-stroke, handheld Class V ($\geq 50\text{cc}$), Phase 1 with catalyst |
| G2H52 | Small SI \leq 25hp | Gasoline, 2-stroke, handheld Class V ($\geq 50\text{cc}$), Phase 2 |
| G2H5C2 | Small SI \leq 25hp | Not used |
| G2N1 | Small SI \leq 25hp | Gasoline, 2-stroke, nonhandheld Class I ($<225\text{cc}$), Baseline |
| G4N1O | Small SI \leq 25hp | Gasoline, 4-stroke, overhead-valve, nonhandheld Class I ($<225\text{cc}$), Baseline |
| G4N1S | Small SI \leq 25hp | Gasoline, 4-stroke, side-valve, nonhandheld Class I ($<225\text{cc}$), Baseline |
| G4N1O1 | Small SI \leq 25hp | Gasoline, 4-stroke, overhead-valve, nonhandheld Class I ($<225\text{cc}$), Phase 1 |

Table B3. Spark-Ignition Technologies in the Final NONROAD2008a Model

| Engine Tech Type Code | SI Engine Category | Description |
|------------------------------|---------------------------|--|
| G4N1S1 | Small SI \leq 25hp | Gasoline, 4-stroke, side-valve, nonhandheld Class I (<225cc), Phase 1 |
| G4N1O2 | Small SI \leq 25hp | Gasoline, 4-stroke, overhead-valve, nonhandheld Class I (<225cc), Phase 2 |
| G4N1S2 | Small SI \leq 25hp | Gasoline, 4-stroke, side-valve, nonhandheld Class I (<225cc), Phase 2 |
| G4N1O3 | Small SI \leq 25hp | Gasoline, 4-stroke, overhead-valve, nonhandheld Class I (<225cc), Phase 3 |
| G4N1S3 | Small SI \leq 25hp | Gasoline, 4-stroke, side-valve, nonhandheld Class I (<225cc), Phase 3 |
| G2N2 | Small SI \leq 25hp | Gasoline, 2-stroke, nonhandheld Class II (\geq 225cc), Baseline |
| G4N2O | Small SI \leq 25hp | Gasoline, 4-stroke, overhead-valve, nonhandheld Class II (\geq 225cc), Baseline |
| G4N2S | Small SI \leq 25hp | Gasoline, 4-stroke, side-valve, nonhandheld Class II (\geq 225cc), Baseline |
| G4N2O1 | Small SI \leq 25hp | Gasoline, 4-stroke, overhead-valve, nonhandheld Class II (\geq 225cc), Phase 1 |
| G4N2S1 | Small SI \leq 25hp | Gasoline, 4-stroke, side-valve, nonhandheld Class II (\geq 225cc), Phase 1 |
| G4N2O2 | Small SI \leq 25hp | Gasoline, 4-stroke, overhead-valve, nonhandheld Class II (\geq 225cc), Phase 2 |
| G4N2S2 | Small SI \leq 25hp | Not used (all Class II Phase 2 engines are overhead-valve) |
| G4N23a | Small SI \leq 25hp | Gasoline, 4-stroke, side-valve, nonhandheld Class II (\geq 225cc), Phase 3 |
| G4N23b | Small SI \leq 25hp | Not used |
| MO2C | Recreational Marine | Outboard, 2-stroke, carbureted, no aftertreatment |
| MO2I | Recreational Marine | Outboard, 2-stroke, indirect injection, no aftertreatment |
| MO2D | Recreational Marine | Outboard, 2-stroke, direct injection, no aftertreatment |
| MO4C | Recreational Marine | Outboard, 4-stroke, carbureted, no aftertreatment |
| MO4I | Recreational Marine | Outboard, 4-stroke, indirect injection, no aftertreatment |
| MO4D | Recreational Marine | Outboard, 4-stroke, direct injection, no aftertreatment |
| MOC1 | Recreational Marine | Outboard, 2010+ standards |

Table B3. Spark-Ignition Technologies in the Final NONROAD2008a Model

| Engine Tech Type Code | SI Engine Category | Description |
|------------------------------|---------------------------|---|
| MP2C | Recreational Marine | Personal Watercraft, 2-stroke, carbureted, no aftertreatment |
| MP2I | Recreational Marine | Personal Watercraft, 2-stroke, indirect injection, no aftertreatment |
| MP2D | Recreational Marine | Personal Watercraft, 2-stroke, direct injection, no aftertreatment |
| MP2CA | Recreational Marine | Personal Watercraft, 2-stroke, carbureted, 2-way catalyst |
| MP4C | Recreational Marine | Personal Watercraft, 4-stroke, carbureted, no aftertreatment |
| MP4I | Recreational Marine | Personal Watercraft, 4-stroke, indirect injection, no aftertreatment |
| MP4D | Recreational Marine | Personal Watercraft, 4-stroke, direct injection, no aftertreatment |
| MPC1 | Recreational Marine | Personal Watercraft, 2010+ standards |
| MS4C | Recreational Marine | Sterndrive/Inboard, 4-stroke, carbureted, no aftertreatment |
| MS4D | Recreational Marine | Sterndrive/Inboard, 4-stroke, direct injection, no aftertreatment |
| MSC1 | Recreational Marine | Sterndrive/Inboard, 4-stroke, 2010+ standards |
| MS4X | Recreational Marine | Sterndrive/Inboard, ≥ 600 hp, 4-stroke, 2010+ standards |
| RM2 | Recreational Equipment | Offroad Motorcycles, 2-stroke, Baseline |
| RM4 | Recreational Equipment | Offroad Motorcycles, 4-stroke, Baseline |
| RM40 | Recreational Equipment | Offroad Motorcycles, 4-stroke, closed crankcase, Baseline |
| RM41 | Recreational Equipment | Offroad Motorcycles, 4-stroke, Phase 1 |
| RS2 | Recreational Equipment | Snowmobiles, 2-stroke, Baseline |
| RS4 | Recreational Equipment | Snowmobiles, 4-stroke, Baseline (associated only with 4-stroke SCC which has zero population) |
| RS40 | Recreational Equipment | Snowmobiles, 4-stroke, closed crankcase, Baseline |
| RS21 | Recreational Equipment | Snowmobiles, 2-stroke, Phase 1 |
| RS41 | Recreational Equipment | Snowmobiles, 4-stroke, Phase 1 (associated only with 4-stroke SCC which has zero population) |
| RS22 | Recreational Equipment | Snowmobiles, 2-stroke, Phase 2 |
| RS42 | Recreational Equipment | Snowmobiles, 4-stroke, Phase 2 (associated only with 4-stroke SCC which has zero population) |
| RA2 | Recreational Equipment | All-Terrain Vehicles, 2-stroke, Baseline |
| RA4 | Recreational Equipment | All-Terrain Vehicles, 4-stroke, Baseline |
| | | |

Table B3. Spark-Ignition Technologies in the Final NONROAD2008a Model

| Engine Tech Type Code | SI Engine Category | Description |
|------------------------------|---------------------------|--|
| RA40 | Recreational Equipment | All-Terrain Vehicles, 4-stroke, closed crankcase, Baseline |
| RA41 | Recreational Equipment | All-Terrain Vehicles, 4-stroke, Phase 1 |
| RA42 | Recreational Equipment | Not used |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|----------------|----------------|---------------|---------------|---------------|--------------|---------------|--------------|
| | 2260000000 | 25 | 9999 | G2GT25 | G4GT251 | G4GT252 | | | | | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | | | | | | |
| 2004 | | | | 0.000 | 1.000 | 0.000 | | | | | | |
| 2007 | | | | 0.000 | 0.000 | 1.000 | | | | | | |
| | 2265000000 | 25 | 9999 | G4GT25 | G4GT251 | G4GT252 | | | | | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | | | | | | |
| 2004 | | | | 0.000 | 1.000 | 0.000 | | | | | | |
| 2007 | | | | 0.000 | 0.000 | 1.000 | | | | | | |
| | 2260000000 | 0 | 1 | G2H3 | G2H31 | G2H3C1 | G2H32 | G4H31 | G2H3C2 | G4H32 | | |
| 1900 | | | | 1.000 | 0.0000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 1996 | | | | 0.500 | 0.4950 | 0.0050 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 1997 | | | | 0.000 | 0.9900 | 0.0100 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 2002 | | | | 0.000 | 0.7425 | 0.0075 | 0.000 | 0.000 | 0.250 | 0.000 | | |
| 2003 | | | | 0.000 | 0.4950 | 0.0050 | 0.000 | 0.000 | 0.500 | 0.000 | | |
| 2004 | | | | 0.000 | 0.2475 | 0.0025 | 0.000 | 0.000 | 0.750 | 0.000 | | |
| 2005 | | | | 0.000 | 0.0000 | 0.0000 | 0.000 | 0.000 | 1.000 | 0.000 | | |
| 2006 | | | | 0.000 | 0.0000 | 0.0000 | 0.000 | 0.000 | 1.000 | 0.000 | | |
| | 2260000000 | 1 | 3 | G2H4 | G2H4C | G4H4 | G2H41 | G2H4C1 | G4H41 | G2H42 | G2H4C2 | G4H42 |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.500 | 0.000 | 0.000 | 0.495 | 0.005 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.990 | 0.010 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.675 | 0.075 | 0.000 | 0.000 | 0.200 | 0.050 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.450 | 0.050 | 0.000 | 0.000 | 0.400 | 0.100 |
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.225 | 0.025 | 0.000 | 0.000 | 0.600 | 0.150 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.800 | 0.200 |
| 2006 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.800 | 0.200 |
| | 2260000000 | 3 | 6 | G2H5 | G2H5C | G2H51 | G2H5C1 | G2H52 | G2H5C2 | | | |
| 1900 | | | | 1.000 | 0.000 | 0.0000 | 0.0000 | 0.000 | 0.000 | | | |
| 1996 | | | | 0.500 | 0.000 | 0.4950 | 0.0050 | 0.000 | 0.000 | | | |
| 1997 | | | | 0.000 | 0.000 | 0.9900 | 0.0100 | 0.000 | 0.000 | | | |
| 2002 | | | | 0.000 | 0.000 | 0.9900 | 0.0100 | 0.000 | 0.000 | | | |
| 2003 | | | | 0.000 | 0.000 | 0.9900 | 0.0100 | 0.000 | 0.000 | | | |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|--------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 2004 | | | | 0.000 | 0.000 | 0.7425 | 0.0075 | 0.250 | 0.000 | | | |
| 2005 | | | | 0.000 | 0.000 | 0.4950 | 0.0050 | 0.500 | 0.000 | | | |
| 2006 | | | | 0.000 | 0.000 | 0.2475 | 0.0025 | 0.750 | 0.000 | | | |
| 2007 | | | | 0.000 | 0.000 | 0.0000 | 0.0000 | 1.000 | 0.000 | | | |
| 2008 | | | | 0.000 | 0.000 | 0.0000 | 0.0000 | 1.000 | 0.000 | | | |
| | 2260000000 | 6 | 25 | G2N2 | G4N2O | G4N2S | G4N2O1 | G4N2S1 | G4N2O2 | G4N2S2 | G4N23a | G4N23b |
| 1900 | | | | 0.005 | 0.018 | 0.977 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.003 | 0.009 | 0.488 | 0.000 | 0.500 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.017 | 0.983 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2001 | | | | 0.000 | 0.000 | 0.000 | 0.008 | 0.492 | 0.500 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.006 | 0.369 | 0.625 | 0.000 | 0.000 | 0.000 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.004 | 0.246 | 0.750 | 0.000 | 0.000 | 0.000 |
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.002 | 0.123 | 0.875 | 0.000 | 0.000 | 0.000 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| 2011 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.170 | 0.000 | 0.830 | 0.000 |
| 2013 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.070 | 0.000 | 0.930 | 0.000 |
| 2015 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| | 2265000000 | 0 | 6 | G2N1 | G4N1O | G4N1S | G4N1O1 | G4N1S1 | G4N1O2 | G4N1S2 | G4N1O3 | G4N1S3 |
| 1900 | | | | 0.180 | 0.069 | 0.751 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.090 | 0.035 | 0.375 | 0.083 | 0.417 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.167 | 0.833 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | | | | 0.000 | 0.000 | 0.000 | 0.097 | 0.486 | 0.167 | 0.250 | 0.000 | 0.000 |
| 2008 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 | 0.000 | 0.000 |
| 2012 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.020 | 0.030 | 0.380 | 0.570 |
| 2014 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 |
| | 2265000000 | 6 | 25 | G2N2 | G4N2O | G4N2S | G4N2O1 | G4N2S1 | G4N2O2 | G4N2S2 | G4N23a | G4N23b |
| 1900 | | | | 0.005 | 0.018 | 0.977 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.003 | 0.009 | 0.488 | 0.000 | 0.500 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.017 | 0.983 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2001 | | | | 0.000 | 0.000 | 0.000 | 0.008 | 0.492 | 0.500 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.006 | 0.369 | 0.625 | 0.000 | 0.000 | 0.000 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.004 | 0.246 | 0.750 | 0.000 | 0.000 | 0.000 |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|-------------|-------------|-------------|-------|-------|-------|-------|-------|
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.002 | 0.123 | 0.875 | 0.000 | 0.000 | 0.000 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| 2011 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.170 | 0.000 | 0.830 | 0.000 |
| 2013 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.070 | 0.000 | 0.930 | 0.000 |
| 2015 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| | 2260001010 | 0 | 9999 | RM2 | RM41 | | | | | | | |
| 1900 | | | | 1.000 | 0.000 | | | | | | | |
| 2006 | | | | 0.760 | 0.240 | | | | | | | |
| 2007 | | | | 0.530 | 0.470 | | | | | | | |
| 2008 | | | | 0.490 | 0.510 | | | | | | | |
| 2009 | | | | 0.460 | 0.540 | | | | | | | |
| | 2265001010 | 0 | 9999 | RM4 | RM40 | RM41 | | | | | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | | | | | | |
| 1999 | | | | 0.667 | 0.333 | 0.000 | | | | | | |
| 2001 | | | | 0.333 | 0.667 | 0.000 | | | | | | |
| 2003 | | | | 0.000 | 1.000 | 0.000 | | | | | | |
| 2006 | | | | 0.000 | 0.560 | 0.440 | | | | | | |
| 2007 | | | | 0.000 | 0.120 | 0.880 | | | | | | |
| 2008 | | | | 0.000 | 0.060 | 0.940 | | | | | | |
| 2009 | | | | 0.000 | 0.000 | 1.000 | | | | | | |
| | 2260001020 | 0 | 9999 | RS2 | RS21 | RS22 | RS40 | | | | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | | | | | |
| 2005 | | | | 0.860 | 0.000 | 0.070 | 0.070 | | | | | |
| 2006 | | | | 0.530 | 0.300 | 0.085 | 0.085 | | | | | |
| 2007 | | | | 0.200 | 0.600 | 0.100 | 0.100 | | | | | |
| 2010 | | | | 0.200 | 0.300 | 0.350 | 0.150 | | | | | |
| 2012 | | | | 0.100 | 0.200 | 0.500 | 0.200 | | | | | |
| | 2265001020 | 0 | 9999 | RS4 | RS40 | RS41 | RS42 | | | | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | | | | | |
| 1999 | | | | 0.667 | 0.333 | 0.000 | 0.000 | | | | | |
| 2001 | | | | 0.333 | 0.667 | 0.000 | 0.000 | | | | | |
| 2003 | | | | 0.000 | 1.000 | 0.000 | 0.000 | | | | | |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|--------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 2006 | | | | 0.000 | 0.000 | 1.000 | 0.000 | | | | | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 1.000 | | | | | |
| | 2260001030 | 0 | 9999 | RA2 | RA41 | RA42 | | | | | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | | | | | | |
| 2006 | | | | 0.650 | 0.350 | 0.000 | | | | | | |
| 2007 | | | | 0.300 | 0.700 | 0.000 | | | | | | |
| 2008 | | | | 0.150 | 0.850 | 0.000 | | | | | | |
| 2009 | | | | 0.000 | 1.000 | 0.000 | | | | | | |
| | 2265001030 | 0 | 9999 | RA4 | RA40 | RA41 | RA42 | | | | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | | | | | |
| 1999 | | | | 0.667 | 0.333 | 0.000 | 0.000 | | | | | |
| 2001 | | | | 0.333 | 0.667 | 0.000 | 0.000 | | | | | |
| 2003 | | | | 0.000 | 1.000 | 0.000 | 0.000 | | | | | |
| 2006 | | | | 0.000 | 0.500 | 0.500 | 0.000 | | | | | |
| 2007 | | | | 0.000 | 0.000 | 1.000 | 0.000 | | | | | |
| | 2265004010 | 0 | 6 | G2N1 | G4N1O | G4N1S | G4N1O1 | G4N1S1 | G4N1O2 | G4N1S2 | G4N1O3 | G4N1S3 |
| 1900 | | | | 0.050 | 0.070 | 0.880 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.025 | 0.035 | 0.440 | 0.052 | 0.448 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.104 | 0.896 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | | | | 0.000 | 0.000 | 0.000 | 0.097 | 0.486 | 0.167 | 0.250 | 0.000 | 0.000 |
| 2008 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 | 0.000 | 0.000 |
| 2012 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.020 | 0.030 | 0.380 | 0.570 |
| 2014 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 |
| | 2265004011 | 0 | 6 | G2N1 | G4N1O | G4N1S | G4N1O1 | G4N1S1 | G4N1O2 | G4N1S2 | G4N1O3 | G4N1S3 |
| 1900 | | | | 0.150 | 0.060 | 0.790 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.075 | 0.030 | 0.395 | 0.072 | 0.429 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.143 | 0.857 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | | | | 0.000 | 0.000 | 0.000 | 0.097 | 0.486 | 0.167 | 0.250 | 0.000 | 0.000 |
| 2008 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 | 0.000 | 0.000 |
| 2012 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.020 | 0.030 | 0.380 | 0.570 |
| 2014 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|--------------|---------------|---------------|--------------|---------------|--------------|--------|--------|
| | | | | G2N1 | G4N1O | G4N1S | G4N1O1 | G4N1S1 | G4N1O2 | G4N1S2 | G4N1O3 | G4N1S3 |
| | 2265004015 | 0 | 6 | | | | | | | | | |
| 1900 | | | | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.000 | 0.500 | 0.005 | 0.495 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.010 | 0.990 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | | | | 0.000 | 0.000 | 0.000 | 0.097 | 0.486 | 0.167 | 0.250 | 0.000 | 0.000 |
| 2008 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 | 0.000 | 0.000 |
| 2012 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.020 | 0.030 | 0.380 | 0.570 |
| 2014 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 |
| | 2260004020 | 6 | 9999 | G2H5 | G2H5C | G2H51 | G2H5C1 | G2H52 | G2H5C2 | | | |
| 1900 | | | | 1.000 | 0.000 | 0.0000 | 0.0000 | 0.000 | 0.000 | | | |
| 1996 | | | | 0.500 | 0.000 | 0.4950 | 0.0050 | 0.000 | 0.000 | | | |
| 1997 | | | | 0.000 | 0.000 | 0.9900 | 0.0100 | 0.000 | 0.000 | | | |
| 2002 | | | | 0.000 | 0.000 | 0.9900 | 0.0100 | 0.000 | 0.000 | | | |
| 2003 | | | | 0.000 | 0.000 | 0.9900 | 0.0100 | 0.000 | 0.000 | | | |
| 2004 | | | | 0.000 | 0.000 | 0.7425 | 0.0075 | 0.250 | 0.000 | | | |
| 2005 | | | | 0.000 | 0.000 | 0.4950 | 0.0050 | 0.500 | 0.000 | | | |
| 2006 | | | | 0.000 | 0.000 | 0.2475 | 0.0025 | 0.750 | 0.000 | | | |
| 2007 | | | | 0.000 | 0.000 | 0.0000 | 0.0000 | 1.000 | 0.000 | | | |
| 2008 | | | | 0.000 | 0.000 | 0.0000 | 0.0000 | 1.000 | 0.000 | | | |
| | 2260004021 | 6 | 9999 | G2H5 | G2H5C | G2H51 | G2H5C1 | G2H52 | G2H5C2 | | | |
| 1900 | | | | 1.000 | 0.000 | 0.0000 | 0.0000 | 0.000 | 0.000 | | | |
| 1996 | | | | 0.500 | 0.000 | 0.4950 | 0.0050 | 0.000 | 0.000 | | | |
| 1997 | | | | 0.000 | 0.000 | 0.9900 | 0.0100 | 0.000 | 0.000 | | | |
| 2002 | | | | 0.000 | 0.000 | 0.9900 | 0.0100 | 0.000 | 0.000 | | | |
| 2003 | | | | 0.000 | 0.000 | 0.9900 | 0.0100 | 0.000 | 0.000 | | | |
| 2004 | | | | 0.000 | 0.000 | 0.7425 | 0.0075 | 0.250 | 0.000 | | | |
| 2005 | | | | 0.000 | 0.000 | 0.4950 | 0.0050 | 0.500 | 0.000 | | | |
| 2006 | | | | 0.000 | 0.000 | 0.2475 | 0.0025 | 0.750 | 0.000 | | | |
| 2007 | | | | 0.000 | 0.000 | 0.0000 | 0.0000 | 1.000 | 0.000 | | | |
| 2008 | | | | 0.000 | 0.000 | 0.0000 | 0.0000 | 1.000 | 0.000 | | | |
| | 2260004025 | 0 | 1 | G2H3 | G2H31 | G2H3C1 | G2H32 | G4H31 | G2H3C2 | G4H32 | | |
| 1900 | | | | 1.000 | 0.0000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | | |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|--------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 1996 | | | | 0.500 | 0.4950 | 0.0050 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 1997 | | | | 0.000 | 0.9900 | 0.0100 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 2002 | | | | 0.000 | 0.7425 | 0.0075 | 0.000 | 0.000 | 0.250 | 0.000 | | |
| 2003 | | | | 0.000 | 0.4950 | 0.0050 | 0.000 | 0.000 | 0.500 | 0.000 | | |
| 2004 | | | | 0.000 | 0.2475 | 0.0025 | 0.000 | 0.000 | 0.750 | 0.000 | | |
| 2005 | | | | 0.000 | 0.0000 | 0.0000 | 0.000 | 0.000 | 1.000 | 0.000 | | |
| 2006 | | | | 0.000 | 0.0000 | 0.0000 | 0.000 | 0.000 | 1.000 | 0.000 | | |
| | 2260004025 | 1 | 3 | G2H4 | G2H4C | G4H4 | G2H41 | G2H4C1 | G4H41 | G2H42 | G2H4C2 | G4H42 |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.500 | 0.000 | 0.000 | 0.490 | 0.005 | 0.005 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.980 | 0.010 | 0.010 | 0.000 | 0.000 | 0.000 |
| 1998 | | | | 0.000 | 0.000 | 0.000 | 0.972 | 0.010 | 0.018 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.675 | 0.075 | 0.000 | 0.000 | 0.200 | 0.050 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.450 | 0.050 | 0.000 | 0.000 | 0.400 | 0.100 |
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.225 | 0.025 | 0.000 | 0.000 | 0.600 | 0.150 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.800 | 0.200 |
| 2006 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.800 | 0.200 |
| | 2265004025 | 3 | 6 | G2N1 | G4N1O | G4N1S | G4N1O1 | G4N1S1 | G4N1O2 | G4N1S2 | G4N1O3 | G4N1S3 |
| 1900 | | | | 0.000 | 0.063 | 0.936 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.032 | 0.468 | 0.037 | 0.463 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.073 | 0.927 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | | | | 0.000 | 0.000 | 0.000 | 0.097 | 0.486 | 0.167 | 0.250 | 0.000 | 0.000 |
| 2008 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 | 0.000 | 0.000 |
| 2012 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.020 | 0.030 | 0.380 | 0.570 |
| 2014 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 |
| | 2265004025 | 6 | 25 | G2N2 | G4N2O | G4N2S | G4N2O1 | G4N2S1 | G4N2O2 | G4N2S2 | G4N23a | G4N23b |
| 1900 | | | | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.000 | 0.500 | 0.000 | 0.500 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2001 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.500 | 0.500 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.375 | 0.625 | 0.000 | 0.000 | 0.000 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.250 | 0.750 | 0.000 | 0.000 | 0.000 |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|--------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.125 | 0.875 | 0.000 | 0.000 | 0.000 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| 2011 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.170 | 0.000 | 0.830 | 0.000 |
| 2013 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.070 | 0.000 | 0.930 | 0.000 |
| 2015 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| | 2260004026 | 0 | 1 | G2H3 | G2H31 | G2H3C1 | G2H32 | G4H31 | G2H3C2 | G4H32 | | |
| 1900 | | | | 1.000 | 0.0000 | 0.0000 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 1996 | | | | 0.500 | 0.4950 | 0.0050 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 1997 | | | | 0.000 | 0.9900 | 0.0100 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 2002 | | | | 0.000 | 0.7425 | 0.0075 | 0.000 | 0.000 | 0.250 | 0.000 | | |
| 2003 | | | | 0.000 | 0.4950 | 0.0050 | 0.000 | 0.000 | 0.500 | 0.000 | | |
| 2004 | | | | 0.000 | 0.2475 | 0.0025 | 0.000 | 0.000 | 0.750 | 0.000 | | |
| 2005 | | | | 0.000 | 0.0000 | 0.0000 | 0.000 | 0.000 | 1.000 | 0.000 | | |
| 2006 | | | | 0.000 | 0.0000 | 0.0000 | 0.000 | 0.000 | 1.000 | 0.000 | | |
| | 2260004026 | 1 | 3 | G2H4 | G2H4C | G4H4 | G2H41 | G2H4C1 | G4H41 | G2H42 | G2H4C2 | G4H42 |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.500 | 0.000 | 0.000 | 0.490 | 0.005 | 0.005 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.980 | 0.010 | 0.010 | 0.000 | 0.000 | 0.000 |
| 1998 | | | | 0.000 | 0.000 | 0.000 | 0.972 | 0.010 | 0.018 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.675 | 0.075 | 0.000 | 0.000 | 0.200 | 0.050 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.450 | 0.050 | 0.000 | 0.000 | 0.400 | 0.100 |
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.225 | 0.025 | 0.000 | 0.000 | 0.600 | 0.150 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.800 | 0.200 |
| 2006 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.800 | 0.200 |
| | 2265004026 | 3 | 6 | G2N1 | G4N1O | G4N1S | G4N1O1 | G4N1S1 | G4N1O2 | G4N1S2 | G4N1O3 | G4N1S3 |
| 1900 | | | | 0.000 | 0.063 | 0.936 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.032 | 0.468 | 0.037 | 0.463 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.073 | 0.927 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | | | | 0.000 | 0.000 | 0.000 | 0.097 | 0.486 | 0.167 | 0.250 | 0.000 | 0.000 |
| 2008 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 | 0.000 | 0.000 |
| 2012 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.020 | 0.030 | 0.380 | 0.570 |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|--------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 2014 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 |
| | 2265004026 | 6 | 25 | G2N2 | G4N2O | G4N2S | G4N2O1 | G4N2S1 | G4N2O2 | G4N2S2 | G4N23a | G4N23b |
| 1900 | | | | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.000 | 0.500 | 0.000 | 0.500 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2001 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.500 | 0.500 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.375 | 0.625 | 0.000 | 0.000 | 0.000 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.250 | 0.750 | 0.000 | 0.000 | 0.000 |
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.125 | 0.875 | 0.000 | 0.000 | 0.000 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| 2011 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.170 | 0.000 | 0.830 | 0.000 |
| 2013 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.070 | 0.000 | 0.930 | 0.000 |
| 2015 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| | 2265004030 | 0 | 6 | G2N1 | G4N1O | G4N1S | G4N1O1 | G4N1S1 | G4N1O2 | G4N1S2 | G4N1O3 | G4N1S3 |
| 1900 | | | | 0.000 | 0.010 | 0.990 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.005 | 0.495 | 0.010 | 0.490 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.019 | 0.981 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | | | | 0.000 | 0.000 | 0.000 | 0.097 | 0.486 | 0.167 | 0.250 | 0.000 | 0.000 |
| 2008 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 | 0.000 | 0.000 |
| 2012 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.020 | 0.030 | 0.380 | 0.570 |
| 2014 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 |
| | 2265004030 | 6 | 25 | G2N2 | G4N2O | G4N2S | G4N2O1 | G4N2S1 | G4N2O2 | G4N2S2 | G4N23a | G4N23b |
| 1900 | | | | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.000 | 0.500 | 0.000 | 0.500 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.002 | 0.998 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2001 | | | | 0.000 | 0.000 | 0.000 | 0.001 | 0.499 | 0.500 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.375 | 0.625 | 0.000 | 0.000 | 0.000 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.250 | 0.750 | 0.000 | 0.000 | 0.000 |
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.125 | 0.875 | 0.000 | 0.000 | 0.000 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| 2011 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.170 | 0.000 | 0.830 | 0.000 |
| 2013 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.070 | 0.000 | 0.930 | 0.000 |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|--------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 2015 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| | 2265004031 | 0 | 6 | G2N1 | G4N1O | G4N1S | G4N1O1 | G4N1S1 | G4N1O2 | G4N1S2 | G4N1O3 | G4N1S3 |
| 1900 | | | | 0.000 | 0.010 | 0.990 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.005 | 0.495 | 0.010 | 0.490 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.019 | 0.981 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | | | | 0.000 | 0.000 | 0.000 | 0.097 | 0.486 | 0.167 | 0.250 | 0.000 | 0.000 |
| 2008 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 | 0.000 | 0.000 |
| 2012 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.020 | 0.030 | 0.380 | 0.570 |
| 2014 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 |
| | 2265004031 | 6 | 25 | G2N2 | G4N2O | G4N2S | G4N2O1 | G4N2S1 | G4N2O2 | G4N2S2 | G4N23a | G4N23b |
| 1900 | | | | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.000 | 0.500 | 0.000 | 0.500 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.002 | 0.998 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2001 | | | | 0.000 | 0.000 | 0.000 | 0.001 | 0.499 | 0.500 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.375 | 0.625 | 0.000 | 0.000 | 0.000 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.250 | 0.750 | 0.000 | 0.000 | 0.000 |
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.125 | 0.875 | 0.000 | 0.000 | 0.000 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| 2011 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.170 | 0.000 | 0.830 | 0.000 |
| 2013 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.070 | 0.000 | 0.930 | 0.000 |
| 2015 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| | 2260004035 | 0 | 6 | G2N1 | G4N1O | G4N1S | | | | | | |
| 1900 | | | | 0.600 | 0.080 | 0.320 | | | | | | |
| | 2260004035 | 6 | 25 | G2N2 | G4N2O | G4N2S | | | | | | |
| 1900 | | | | 0.000 | 0.200 | 0.800 | | | | | | |
| | 2260004036 | 0 | 6 | G2N1 | G4N1O | G4N1S | | | | | | |
| 1900 | | | | 0.600 | 0.080 | 0.320 | | | | | | |
| | 2260004036 | 6 | 25 | G2N2 | G4N2O | G4N2S | | | | | | |
| 1900 | | | | 0.000 | 0.200 | 0.800 | | | | | | |
| | 2265004035 | 0 | 6 | G2N1 | G4N1O | G4N1S | | | | | | |
| 1900 | | | | 0.600 | 0.080 | 0.320 | | | | | | |
| | 2265004035 | 6 | 25 | G2N2 | G4N2O | G4N2S | | | | | | |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|--------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 1900 | | | | 0.000 | 0.200 | 0.800 | | | | | | |
| | 2265004036 | 0 | 6 | G2N1 | G4N1O | G4N1S | | | | | | |
| 1900 | | | | 0.600 | 0.080 | 0.320 | | | | | | |
| | 2265004036 | 6 | 25 | G2N2 | G4N2O | G4N2S | | | | | | |
| 1900 | | | | 0.000 | 0.200 | 0.800 | | | | | | |
| | 2265004040 | 0 | 6 | G2N1 | G4N1O | G4N1S | G4N1O1 | G4N1S1 | G4N1O2 | G4N1S2 | G4N1O3 | G4N1S3 |
| 1900 | | | | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.000 | 0.500 | 0.005 | 0.495 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.010 | 0.990 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | | | | 0.000 | 0.000 | 0.000 | 0.097 | 0.486 | 0.167 | 0.250 | 0.000 | 0.000 |
| 2008 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 | 0.000 | 0.000 |
| 2012 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.020 | 0.030 | 0.380 | 0.570 |
| 2014 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 |
| | 2265004040 | 6 | 25 | G2N2 | G4N2O | G4N2S | G4N2O1 | G4N2S1 | G4N2O2 | G4N2S2 | G4N23a | G4N23b |
| 1900 | | | | 0.000 | 0.164 | 0.836 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.082 | 0.418 | 0.082 | 0.418 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.164 | 0.836 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2001 | | | | 0.000 | 0.000 | 0.000 | 0.082 | 0.418 | 0.500 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.062 | 0.313 | 0.625 | 0.000 | 0.000 | 0.000 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.041 | 0.209 | 0.750 | 0.000 | 0.000 | 0.000 |
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.020 | 0.105 | 0.875 | 0.000 | 0.000 | 0.000 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| 2011 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.170 | 0.000 | 0.830 | 0.000 |
| 2013 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.070 | 0.000 | 0.930 | 0.000 |
| 2015 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| | 2265004041 | 0 | 6 | G2N1 | G4N1O | G4N1S | G4N1O1 | G4N1S1 | G4N1O2 | G4N1S2 | G4N1O3 | G4N1S3 |
| 1900 | | | | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.000 | 0.500 | 0.005 | 0.495 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.010 | 0.990 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | | | | 0.000 | 0.000 | 0.000 | 0.097 | 0.486 | 0.167 | 0.250 | 0.000 | 0.000 |
| 2008 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 | 0.000 | 0.000 |
| 2012 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.020 | 0.030 | 0.380 | 0.570 |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|--------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 2014 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 |
| | 2265004041 | 6 | 25 | G2N2 | G4N2O | G4N2S | G4N2O1 | G4N2S1 | G4N2O2 | G4N2S2 | G4N23a | G4N23b |
| 1900 | | | | 0.000 | 0.164 | 0.836 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.082 | 0.418 | 0.082 | 0.418 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.164 | 0.836 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2001 | | | | 0.000 | 0.000 | 0.000 | 0.082 | 0.418 | 0.500 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.062 | 0.313 | 0.625 | 0.000 | 0.000 | 0.000 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.041 | 0.209 | 0.750 | 0.000 | 0.000 | 0.000 |
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.020 | 0.105 | 0.875 | 0.000 | 0.000 | 0.000 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| 2011 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.170 | 0.000 | 0.830 | 0.000 |
| 2013 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.070 | 0.000 | 0.930 | 0.000 |
| 2015 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| | 2265004055 | 0 | 6 | G2N1 | G4N1O | G4N1S | G4N1O1 | G4N1S1 | G4N1O2 | G4N1S2 | G4N1O3 | G4N1S3 |
| 1900 | | | | 0.000 | 0.027 | 0.973 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.013 | 0.487 | 0.018 | 0.481 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.037 | 0.963 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | | | | 0.000 | 0.000 | 0.000 | 0.097 | 0.486 | 0.167 | 0.250 | 0.000 | 0.000 |
| 2008 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 | 0.000 | 0.000 |
| 2012 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.020 | 0.030 | 0.380 | 0.570 |
| 2014 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 |
| | 2265004055 | 6 | 25 | G2N2 | G4N2O | G4N2S | G4N2O1 | G4N2S1 | G4N2O2 | G4N2S2 | G4N23a | G4N23b |
| 1900 | | | | 0.000 | 0.007 | 0.993 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.003 | 0.497 | 0.003 | 0.497 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.007 | 0.993 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2001 | | | | 0.000 | 0.000 | 0.000 | 0.003 | 0.497 | 0.500 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.002 | 0.373 | 0.625 | 0.000 | 0.000 | 0.000 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.001 | 0.249 | 0.750 | 0.000 | 0.000 | 0.000 |
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.125 | 0.875 | 0.000 | 0.000 | 0.000 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| 2011 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.170 | 0.000 | 0.830 | 0.000 |
| 2013 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.070 | 0.000 | 0.930 | 0.000 |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|--------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 2015 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| | 2265004056 | 0 | 6 | G2N1 | G4N1O | G4N1S | G4N1O1 | G4N1S1 | G4N1O2 | G4N1S2 | G4N1O3 | G4N1S3 |
| 1900 | | | | 0.000 | 0.027 | 0.973 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.013 | 0.487 | 0.018 | 0.481 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.037 | 0.963 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | | | | 0.000 | 0.000 | 0.000 | 0.097 | 0.486 | 0.167 | 0.250 | 0.000 | 0.000 |
| 2008 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 | 0.000 | 0.000 |
| 2012 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.020 | 0.030 | 0.380 | 0.570 |
| 2014 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 |
| | 2265004056 | 6 | 25 | G2N2 | G4N2O | G4N2S | G4N2O1 | G4N2S1 | G4N2O2 | G4N2S2 | G4N23a | G4N23b |
| 1900 | | | | 0.000 | 0.007 | 0.993 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.003 | 0.497 | 0.003 | 0.497 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.007 | 0.993 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2001 | | | | 0.000 | 0.000 | 0.000 | 0.003 | 0.497 | 0.500 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.002 | 0.373 | 0.625 | 0.000 | 0.000 | 0.000 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.001 | 0.249 | 0.750 | 0.000 | 0.000 | 0.000 |
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.125 | 0.875 | 0.000 | 0.000 | 0.000 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| 2011 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.170 | 0.000 | 0.830 | 0.000 |
| 2013 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.070 | 0.000 | 0.930 | 0.000 |
| 2015 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| | 2265004071 | 0 | 6 | G2N1 | G4N1O | G4N1S | G4N1O1 | G4N1S1 | G4N1O2 | G4N1S2 | G4N1O3 | G4N1S3 |
| 1900 | | | | 0.086 | 0.349 | 0.565 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.043 | 0.175 | 0.282 | 0.199 | 0.301 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.398 | 0.602 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | | | | 0.000 | 0.000 | 0.000 | 0.097 | 0.486 | 0.167 | 0.250 | 0.000 | 0.000 |
| 2008 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 | 0.000 | 0.000 |
| 2012 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.020 | 0.030 | 0.380 | 0.570 |
| 2014 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 |
| | 2265004071 | 6 | 25 | G2N2 | G4N2O | G4N2S | G4N2O1 | G4N2S1 | G4N2O2 | G4N2S2 | G4N23a | G4N23b |
| 1900 | | | | 0.000 | 0.413 | 0.587 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.207 | 0.293 | 0.000 | 0.500 | 0.000 | 0.000 | 0.000 | 0.000 |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|--------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.413 | 0.587 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2001 | | | | 0.000 | 0.000 | 0.000 | 0.206 | 0.294 | 0.500 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.155 | 0.220 | 0.625 | 0.000 | 0.000 | 0.000 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.104 | 0.146 | 0.750 | 0.000 | 0.000 | 0.000 |
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.052 | 0.073 | 0.875 | 0.000 | 0.000 | 0.000 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| 2011 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.170 | 0.000 | 0.830 | 0.000 |
| 2013 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.070 | 0.000 | 0.930 | 0.000 |
| 2015 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| | 2265005040 | 6 | 25 | G2N2 | G4N2O | G4N2S | G4N2O1 | G4N2S1 | G4N2O2 | G4N2S2 | G4N23a | G4N23b |
| 1900 | | | | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.000 | 0.500 | 0.000 | 0.500 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2001 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.500 | 0.500 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.375 | 0.625 | 0.000 | 0.000 | 0.000 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.250 | 0.750 | 0.000 | 0.000 | 0.000 |
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.125 | 0.875 | 0.000 | 0.000 | 0.000 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| 2011 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.170 | 0.000 | 0.830 | 0.000 |
| 2013 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.070 | 0.000 | 0.930 | 0.000 |
| 2015 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| | 2265006005 | 0 | 6 | G2N1 | G4N1O | G4N1S | G4N1O1 | G4N1S1 | G4N1O2 | G4N1S2 | G4N1O3 | G4N1S3 |
| 1900 | | | | 0.006 | 0.020 | 0.974 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.003 | 0.010 | 0.487 | 0.016 | 0.484 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.032 | 0.968 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | | | | 0.000 | 0.000 | 0.000 | 0.097 | 0.486 | 0.167 | 0.250 | 0.000 | 0.000 |
| 2008 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 | 0.000 | 0.000 |
| 2012 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.020 | 0.030 | 0.380 | 0.570 |
| 2014 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 |
| | 2265006005 | 6 | 25 | G2N2 | G4N2O | G4N2S | G4N2O1 | G4N2S1 | G4N2O2 | G4N2S2 | G4N23a | G4N23b |
| 1900 | | | | 0.000 | 0.078 | 0.922 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.039 | 0.461 | 0.039 | 0.461 | 0.000 | 0.000 | 0.000 | 0.000 |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|--------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.078 | 0.922 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2001 | | | | 0.000 | 0.000 | 0.000 | 0.039 | 0.461 | 0.500 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.030 | 0.345 | 0.625 | 0.000 | 0.000 | 0.000 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.020 | 0.230 | 0.750 | 0.000 | 0.000 | 0.000 |
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.010 | 0.115 | 0.875 | 0.000 | 0.000 | 0.000 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| 2011 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.170 | 0.000 | 0.830 | 0.000 |
| 2013 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.070 | 0.000 | 0.930 | 0.000 |
| 2015 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| | 2265006010 | 0 | 6 | G2N1 | G4N1O | G4N1S | G4N1O1 | G4N1S1 | G4N1O2 | G4N1S2 | G4N1O3 | G4N1S3 |
| 1900 | | | | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.000 | 0.500 | 0.005 | 0.495 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.010 | 0.990 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | | | | 0.000 | 0.000 | 0.000 | 0.097 | 0.486 | 0.167 | 0.250 | 0.000 | 0.000 |
| 2008 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 | 0.000 | 0.000 |
| 2012 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.020 | 0.030 | 0.380 | 0.570 |
| 2014 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 |
| | 2265006010 | 6 | 25 | G2N2 | G4N2O | G4N2S | G4N2O1 | G4N2S1 | G4N2O2 | G4N2S2 | G4N23a | G4N23b |
| 1900 | | | | 0.000 | 0.143 | 0.857 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.000 | 0.072 | 0.428 | 0.072 | 0.428 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.143 | 0.857 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2001 | | | | 0.000 | 0.000 | 0.000 | 0.071 | 0.429 | 0.500 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.053 | 0.322 | 0.625 | 0.000 | 0.000 | 0.000 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.035 | 0.215 | 0.750 | 0.000 | 0.000 | 0.000 |
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.017 | 0.108 | 0.875 | 0.000 | 0.000 | 0.000 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| 2011 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.170 | 0.000 | 0.830 | 0.000 |
| 2013 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.070 | 0.000 | 0.930 | 0.000 |
| 2015 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| | 2260007005 | 6 | 9999 | G2H5 | G2H5C | G2H5I | G2H5C1 | G2H5I | G2H5C2 | | | |
| 1900 | | | | 1.000 | 0.000 | 0.0000 | 0.0000 | 0.000 | 0.000 | | | |
| 1996 | | | | 0.500 | 0.000 | 0.4950 | 0.0050 | 0.000 | 0.000 | | | |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 1997 | | | | 0.000 | 0.000 | 0.9900 | 0.0100 | 0.000 | 0.000 | | | |
| 2002 | | | | 0.000 | 0.000 | 0.9900 | 0.0100 | 0.000 | 0.000 | | | |
| 2003 | | | | 0.000 | 0.000 | 0.9900 | 0.0100 | 0.000 | 0.000 | | | |
| 2004 | | | | 0.000 | 0.000 | 0.7425 | 0.0075 | 0.250 | 0.000 | | | |
| 2005 | | | | 0.000 | 0.000 | 0.4950 | 0.0050 | 0.500 | 0.000 | | | |
| 2006 | | | | 0.000 | 0.000 | 0.2475 | 0.0025 | 0.750 | 0.000 | | | |
| 2007 | | | | 0.000 | 0.000 | 0.0000 | 0.0000 | 1.000 | 0.000 | | | |
| 2008 | | | | 0.000 | 0.000 | 0.0000 | 0.0000 | 1.000 | 0.000 | | | |
| | 2265010010 | 0 | 6 | G2N1 | G4N1O | G4N1S | G4N1O1 | G4N1S1 | G4N1O2 | G4N1S2 | G4N1O3 | G4N1S3 |
| 1900 | | | | 0.180 | 0.069 | 0.751 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.090 | 0.035 | 0.375 | 0.083 | 0.417 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.167 | 0.833 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | | | | 0.000 | 0.000 | 0.000 | 0.097 | 0.486 | 0.167 | 0.250 | 0.000 | 0.000 |
| 2008 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 | 0.000 | 0.000 |
| 2012 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.020 | 0.030 | 0.380 | 0.570 |
| 2014 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 |
| | 2267000000 | 25 | 9999 | LGT25 | LGT251 | LGT252 | | | | | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | | | | | | |
| 2004 | | | | 0.000 | 1.000 | 0.000 | | | | | | |
| 2007 | | | | 0.000 | 0.000 | 1.000 | | | | | | |
| | 2268000000 | 25 | 9999 | NGT25 | NGT251 | NGT252 | | | | | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | | | | | | |
| 2004 | | | | 0.000 | 1.000 | 0.000 | | | | | | |
| 2007 | | | | 0.000 | 0.000 | 1.000 | | | | | | |
| | 2282005010 | 0 | 3 | MO2C | MO2I | MO2D | MO4C | MO4I | MO4D | MOC1 | | |
| 1900 | | | | 0.900 | 0.000 | 0.000 | 0.100 | 0.000 | 0.000 | 0.000 | | |
| 1998 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 1999 | | | | 0.620 | 0.000 | 0.000 | 0.380 | 0.000 | 0.000 | 0.000 | | |
| 2000 | | | | 0.673 | 0.000 | 0.000 | 0.327 | 0.000 | 0.000 | 0.000 | | |
| 2001 | | | | 0.601 | 0.000 | 0.000 | 0.399 | 0.000 | 0.000 | 0.000 | | |
| 2002 | | | | 0.350 | 0.000 | 0.000 | 0.650 | 0.000 | 0.000 | 0.000 | | |
| 2003 | | | | 0.104 | 0.000 | 0.000 | 0.896 | 0.000 | 0.000 | 0.000 | | |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|-------------|-------------|-------------|-------------|-------------|-------------|--|--|
| 2004 | | | | 0.088 | 0.000 | 0.000 | 0.912 | 0.000 | 0.000 | 0.000 | | |
| 2005 | | | | 0.104 | 0.000 | 0.000 | 0.896 | 0.000 | 0.000 | 0.000 | | |
| 2006 | | | | 0.100 | 0.000 | 0.000 | 0.900 | 0.000 | 0.000 | 0.000 | | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | | |
| | 2282005010 | 3 | 6 | MO2C | MO2I | MO2D | MO4C | MO4I | MO4D | MOC1 | | |
| 1900 | | | | 0.957 | 0.000 | 0.000 | 0.043 | 0.000 | 0.000 | 0.000 | | |
| 1997 | | | | 0.870 | 0.000 | 0.000 | 0.130 | 0.000 | 0.000 | 0.000 | | |
| 1998 | | | | 0.707 | 0.000 | 0.000 | 0.293 | 0.000 | 0.000 | 0.000 | | |
| 1999 | | | | 0.730 | 0.000 | 0.000 | 0.270 | 0.000 | 0.000 | 0.000 | | |
| 2000 | | | | 0.596 | 0.000 | 0.000 | 0.404 | 0.000 | 0.000 | 0.000 | | |
| 2001 | | | | 0.547 | 0.000 | 0.000 | 0.453 | 0.000 | 0.000 | 0.000 | | |
| 2002 | | | | 0.463 | 0.000 | 0.000 | 0.537 | 0.000 | 0.000 | 0.000 | | |
| 2003 | | | | 0.443 | 0.000 | 0.000 | 0.557 | 0.000 | 0.000 | 0.000 | | |
| 2004 | | | | 0.554 | 0.000 | 0.000 | 0.446 | 0.000 | 0.000 | 0.000 | | |
| 2005 | | | | 0.386 | 0.000 | 0.000 | 0.614 | 0.000 | 0.000 | 0.000 | | |
| 2006 | | | | 0.400 | 0.000 | 0.000 | 0.600 | 0.000 | 0.000 | 0.000 | | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | | |
| | 2282005010 | 6 | 11 | MO2C | MO2I | MO2D | MO4C | MO4I | MO4D | MOC1 | | |
| 1900 | | | | 0.957 | 0.000 | 0.000 | 0.043 | 0.000 | 0.000 | 0.000 | | |
| 1997 | | | | 0.870 | 0.000 | 0.000 | 0.130 | 0.000 | 0.000 | 0.000 | | |
| 1998 | | | | 0.710 | 0.000 | 0.000 | 0.290 | 0.000 | 0.000 | 0.000 | | |
| 1999 | | | | 0.672 | 0.000 | 0.000 | 0.328 | 0.000 | 0.000 | 0.000 | | |
| 2000 | | | | 0.523 | 0.000 | 0.000 | 0.477 | 0.000 | 0.000 | 0.000 | | |
| 2001 | | | | 0.169 | 0.000 | 0.000 | 0.831 | 0.000 | 0.000 | 0.000 | | |
| 2002 | | | | 0.269 | 0.000 | 0.000 | 0.731 | 0.000 | 0.000 | 0.000 | | |
| 2003 | | | | 0.222 | 0.000 | 0.000 | 0.778 | 0.000 | 0.000 | 0.000 | | |
| 2004 | | | | 0.185 | 0.000 | 0.000 | 0.815 | 0.000 | 0.000 | 0.000 | | |
| 2005 | | | | 0.157 | 0.000 | 0.000 | 0.843 | 0.000 | 0.000 | 0.000 | | |
| 2006 | | | | 0.150 | 0.000 | 0.000 | 0.850 | 0.000 | 0.000 | 0.000 | | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | | |
| | 2282005010 | 11 | 16 | MO2C | MO2I | MO2D | MO4C | MO4I | MO4D | MOC1 | | |
| 1900 | | | | 0.989 | 0.000 | 0.000 | 0.011 | 0.000 | 0.000 | 0.000 | | |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|-------------|-------------|-------------|-------------|-------------|-------------|--|--|
| 1998 | | | | 0.732 | 0.000 | 0.000 | 0.268 | 0.000 | 0.000 | 0.000 | | |
| 1999 | | | | 0.802 | 0.000 | 0.000 | 0.198 | 0.000 | 0.000 | 0.000 | | |
| 2000 | | | | 0.546 | 0.000 | 0.000 | 0.454 | 0.000 | 0.000 | 0.000 | | |
| 2001 | | | | 0.124 | 0.000 | 0.000 | 0.876 | 0.000 | 0.000 | 0.000 | | |
| 2002 | | | | 0.203 | 0.000 | 0.000 | 0.797 | 0.000 | 0.000 | 0.000 | | |
| 2003 | | | | 0.282 | 0.000 | 0.000 | 0.718 | 0.000 | 0.000 | 0.000 | | |
| 2004 | | | | 0.240 | 0.000 | 0.000 | 0.760 | 0.000 | 0.000 | 0.000 | | |
| 2005 | | | | 0.132 | 0.000 | 0.000 | 0.868 | 0.000 | 0.000 | 0.000 | | |
| 2006 | | | | 0.150 | 0.000 | 0.000 | 0.850 | 0.000 | 0.000 | 0.000 | | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | | |
| | 2282005010 | 16 | 25 | MO2C | MO2I | MO2D | MO4C | MO4I | MO4D | MOC1 | | |
| 1900 | | | | 0.989 | 0.000 | 0.000 | 0.011 | 0.000 | 0.000 | 0.000 | | |
| 1998 | | | | 0.928 | 0.000 | 0.000 | 0.072 | 0.000 | 0.000 | 0.000 | | |
| 1999 | | | | 0.866 | 0.000 | 0.000 | 0.134 | 0.000 | 0.000 | 0.000 | | |
| 2000 | | | | 0.720 | 0.000 | 0.000 | 0.280 | 0.000 | 0.000 | 0.000 | | |
| 2001 | | | | 0.748 | 0.000 | 0.000 | 0.252 | 0.000 | 0.000 | 0.000 | | |
| 2002 | | | | 0.678 | 0.000 | 0.000 | 0.322 | 0.000 | 0.000 | 0.000 | | |
| 2003 | | | | 0.535 | 0.000 | 0.000 | 0.465 | 0.000 | 0.000 | 0.000 | | |
| 2004 | | | | 0.295 | 0.000 | 0.000 | 0.705 | 0.000 | 0.000 | 0.000 | | |
| 2005 | | | | 0.406 | 0.000 | 0.000 | 0.594 | 0.000 | 0.000 | 0.000 | | |
| 2006 | | | | 0.300 | 0.000 | 0.000 | 0.700 | 0.000 | 0.000 | 0.000 | | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | | |
| | 2282005010 | 25 | 40 | MO2C | MO2I | MO2D | MO4C | MO4I | MO4D | MOC1 | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 1998 | | | | 0.688 | 0.000 | 0.000 | 0.312 | 0.000 | 0.000 | 0.000 | | |
| 1999 | | | | 0.794 | 0.000 | 0.000 | 0.206 | 0.000 | 0.000 | 0.000 | | |
| 2000 | | | | 0.569 | 0.000 | 0.000 | 0.431 | 0.000 | 0.000 | 0.000 | | |
| 2001 | | | | 0.421 | 0.000 | 0.000 | 0.579 | 0.000 | 0.000 | 0.000 | | |
| 2002 | | | | 0.385 | 0.000 | 0.000 | 0.566 | 0.049 | 0.000 | 0.000 | | |
| 2003 | | | | 0.515 | 0.000 | 0.000 | 0.396 | 0.089 | 0.000 | 0.000 | | |
| 2004 | | | | 0.390 | 0.000 | 0.000 | 0.368 | 0.242 | 0.000 | 0.000 | | |
| 2005 | | | | 0.267 | 0.000 | 0.000 | 0.532 | 0.201 | 0.000 | 0.000 | | |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|-------------|-------------|-------------|-------------|-------------|-------------|--|--|
| 2006 | | | | 0.250 | 0.000 | 0.000 | 0.500 | 0.250 | 0.000 | 0.000 | | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | | |
| | 2282005010 | 40 | 50 | MO2C | MO2I | MO2D | MO4C | MO4I | MO4D | MOC1 | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 1998 | | | | 0.945 | 0.000 | 0.000 | 0.055 | 0.000 | 0.000 | 0.000 | | |
| 1999 | | | | 0.758 | 0.000 | 0.000 | 0.242 | 0.000 | 0.000 | 0.000 | | |
| 2000 | | | | 0.460 | 0.000 | 0.001 | 0.249 | 0.000 | 0.290 | 0.000 | | |
| 2001 | | | | 0.689 | 0.000 | 0.019 | 0.155 | 0.000 | 0.137 | 0.000 | | |
| 2002 | | | | 0.615 | 0.000 | 0.051 | 0.181 | 0.000 | 0.153 | 0.000 | | |
| 2003 | | | | 0.566 | 0.000 | 0.029 | 0.299 | 0.000 | 0.106 | 0.000 | | |
| 2004 | | | | 0.645 | 0.000 | 0.000 | 0.125 | 0.000 | 0.230 | 0.000 | | |
| 2005 | | | | 0.412 | 0.000 | 0.026 | 0.127 | 0.000 | 0.435 | 0.000 | | |
| 2006 | | | | 0.400 | 0.000 | 0.050 | 0.150 | 0.000 | 0.400 | 0.000 | | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | | |
| | 2282005010 | 50 | 75 | MO2C | MO2I | MO2D | MO4C | MO4I | MO4D | MOC1 | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 1998 | | | | 0.791 | 0.000 | 0.000 | 0.156 | 0.000 | 0.054 | 0.000 | | |
| 1999 | | | | 0.785 | 0.000 | 0.000 | 0.067 | 0.000 | 0.148 | 0.000 | | |
| 2000 | | | | 0.639 | 0.000 | 0.000 | 0.145 | 0.000 | 0.216 | 0.000 | | |
| 2001 | | | | 0.460 | 0.000 | 0.000 | 0.456 | 0.000 | 0.084 | 0.000 | | |
| 2002 | | | | 0.362 | 0.000 | 0.000 | 0.423 | 0.179 | 0.037 | 0.000 | | |
| 2003 | | | | 0.384 | 0.000 | 0.000 | 0.439 | 0.127 | 0.051 | 0.000 | | |
| 2004 | | | | 0.197 | 0.000 | 0.000 | 0.287 | 0.428 | 0.088 | 0.000 | | |
| 2005 | | | | 0.193 | 0.000 | 0.000 | 0.148 | 0.405 | 0.254 | 0.000 | | |
| 2006 | | | | 0.200 | 0.000 | 0.100 | 0.000 | 0.300 | 0.400 | 0.000 | | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | | |
| | 2282005010 | 75 | 100 | MO2C | MO2I | MO2D | MO4C | MO4I | MO4D | MOC1 | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 1998 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 1999 | | | | 0.837 | 0.000 | 0.000 | 0.163 | 0.000 | 0.000 | 0.000 | | |
| 2000 | | | | 0.519 | 0.000 | 0.120 | 0.362 | 0.000 | 0.000 | 0.000 | | |
| 2001 | | | | 0.472 | 0.000 | 0.085 | 0.421 | 0.000 | 0.022 | 0.000 | | |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|-------------|-------------|-------------|-------------|-------------|-------------|--|--|
| 2002 | | | | 0.476 | 0.000 | 0.069 | 0.300 | 0.000 | 0.155 | 0.000 | | |
| 2003 | | | | 0.470 | 0.000 | 0.007 | 0.237 | 0.000 | 0.286 | 0.000 | | |
| 2004 | | | | 0.275 | 0.000 | 0.170 | 0.207 | 0.000 | 0.348 | 0.000 | | |
| 2005 | | | | 0.310 | 0.000 | 0.114 | 0.001 | 0.000 | 0.575 | 0.000 | | |
| 2006 | | | | 0.200 | 0.000 | 0.100 | 0.000 | 0.300 | 0.400 | 0.000 | | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | | |
| | 2282005010 | 100 | 175 | MO2C | MO2I | MO2D | MO4C | MO4I | MO4D | MOC1 | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 1997 | | | | 0.988 | 0.012 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 1998 | | | | 0.914 | 0.000 | 0.086 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 1999 | | | | 0.702 | 0.029 | 0.227 | 0.000 | 0.000 | 0.042 | 0.000 | | |
| 2000 | | | | 0.622 | 0.068 | 0.178 | 0.000 | 0.059 | 0.073 | 0.000 | | |
| 2001 | | | | 0.559 | 0.028 | 0.202 | 0.000 | 0.127 | 0.084 | 0.000 | | |
| 2002 | | | | 0.487 | 0.050 | 0.253 | 0.000 | 0.102 | 0.108 | 0.000 | | |
| 2003 | | | | 0.390 | 0.041 | 0.261 | 0.000 | 0.105 | 0.202 | 0.000 | | |
| 2004 | | | | 0.382 | 0.026 | 0.055 | 0.000 | 0.378 | 0.159 | 0.000 | | |
| 2005 | | | | 0.167 | 0.004 | 0.301 | 0.000 | 0.037 | 0.491 | 0.000 | | |
| 2006 | | | | 0.150 | 0.050 | 0.300 | 0.000 | 0.050 | 0.450 | 0.000 | | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | | |
| | 2282005010 | 175 | 9999 | MO2C | MO2I | MO2D | MO4C | MO4I | MO4D | MOC1 | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 1997 | | | | 0.967 | 0.033 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 1998 | | | | 0.740 | 0.072 | 0.188 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 1999 | | | | 0.250 | 0.424 | 0.326 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 2000 | | | | 0.338 | 0.204 | 0.459 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 2001 | | | | 0.222 | 0.150 | 0.628 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| 2002 | | | | 0.039 | 0.378 | 0.449 | 0.000 | 0.072 | 0.062 | 0.000 | | |
| 2003 | | | | 0.005 | 0.308 | 0.487 | 0.000 | 0.200 | 0.000 | 0.000 | | |
| 2004 | | | | 0.026 | 0.106 | 0.583 | 0.000 | 0.243 | 0.042 | 0.000 | | |
| 2005 | | | | 0.004 | 0.259 | 0.595 | 0.000 | 0.142 | 0.000 | 0.000 | | |
| 2006 | | | | 0.000 | 0.250 | 0.600 | 0.000 | 0.150 | 0.000 | 0.000 | | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | | |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|-------------|-------------|--------------|-------------|-------------|-------------|-------------|--|
| | 2282005015 | 0 | 3 | MP2C | MP2I | MP2D | MP2CA | MP4C | MP4I | MP4D | MPC1 | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2001 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | |
| | 2282005015 | 3 | 6 | MP2C | MP2I | MP2D | MP2CA | MP4C | MP4I | MP4D | MPC1 | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | |
| | 2282005015 | 6 | 11 | MP2C | MP2I | MP2D | MP2CA | MP4C | MP4I | MP4D | MPC1 | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | |
| | 2282005015 | 11 | 16 | MP2C | MP2I | MP2D | MP2CA | MP4C | MP4I | MP4D | MPC1 | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2005 | | | | 0.800 | 0.000 | 0.000 | 0.000 | 0.200 | 0.000 | 0.000 | 0.000 | |
| 2006 | | | | 0.600 | 0.000 | 0.000 | 0.000 | 0.400 | 0.000 | 0.000 | 0.000 | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | |
| | 2282005015 | 16 | 25 | MP2C | MP2I | MP2D | MP2CA | MP4C | MP4I | MP4D | MPC1 | |
| 1900 | | | | 0.218 | 0.000 | 0.000 | 0.000 | 0.782 | 0.000 | 0.000 | 0.000 | |
| 2005 | | | | 0.200 | 0.000 | 0.000 | 0.000 | 0.800 | 0.000 | 0.000 | 0.000 | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | |
| | 2282005015 | 25 | 40 | MP2C | MP2I | MP2D | MP2CA | MP4C | MP4I | MP4D | MPC1 | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 1999 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | |
| 2000 | | | | 0.640 | 0.000 | 0.000 | 0.000 | 0.360 | 0.000 | 0.000 | 0.000 | |
| 2001 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | |
| 2002 | | | | 0.017 | 0.000 | 0.000 | 0.000 | 0.983 | 0.000 | 0.000 | 0.000 | |
| 2003 | | | | 0.019 | 0.000 | 0.000 | 0.000 | 0.981 | 0.000 | 0.000 | 0.000 | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | |
| | 2282005015 | 40 | 50 | MP2C | MP2I | MP2D | MP2CA | MP4C | MP4I | MP4D | MPC1 | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2005 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|-------------|-------------|--------------|-------------|-------------|-------------|-------------|--|
| 2006 | | | | 0.700 | 0.000 | 0.300 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | |
| | 2282005015 | 50 | 75 | MP2C | MP2I | MP2D | MP2CA | MP4C | MP4I | MP4D | MPC1 | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 1999 | | | | 0.991 | 0.000 | 0.000 | 0.000 | 0.009 | 0.000 | 0.000 | 0.000 | |
| 2000 | | | | 0.932 | 0.000 | 0.000 | 0.000 | 0.068 | 0.000 | 0.000 | 0.000 | |
| 2001 | | | | 0.928 | 0.000 | 0.000 | 0.000 | 0.072 | 0.000 | 0.000 | 0.000 | |
| 2002 | | | | 0.976 | 0.000 | 0.000 | 0.000 | 0.024 | 0.000 | 0.000 | 0.000 | |
| 2003 | | | | 0.906 | 0.000 | 0.000 | 0.000 | 0.094 | 0.000 | 0.000 | 0.000 | |
| 2004 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2005 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2006 | | | | 0.900 | 0.000 | 0.000 | 0.000 | 0.100 | 0.000 | 0.000 | 0.000 | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | |
| | 2282005015 | 75 | 100 | MP2C | MP2I | MP2D | MP2CA | MP4C | MP4I | MP4D | MPC1 | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 1999 | | | | 0.394 | 0.606 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2000 | | | | 0.803 | 0.197 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2001 | | | | 0.770 | 0.230 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2002 | | | | 0.700 | 0.150 | 0.150 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2003 | | | | 0.720 | 0.219 | 0.061 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2004 | | | | 0.541 | 0.459 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2005 | | | | 0.340 | 0.660 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2006 | | | | 0.300 | 0.600 | 0.100 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | |
| | 2282005015 | 100 | 175 | MP2C | MP2I | MP2D | MP2CA | MP4C | MP4I | MP4D | MPC1 | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 1999 | | | | 0.957 | 0.000 | 0.043 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2000 | | | | 0.655 | 0.000 | 0.229 | 0.116 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2001 | | | | 0.496 | 0.000 | 0.242 | 0.262 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2002 | | | | 0.343 | 0.000 | 0.245 | 0.149 | 0.000 | 0.072 | 0.191 | 0.000 | |
| 2003 | | | | 0.137 | 0.000 | 0.336 | 0.037 | 0.000 | 0.192 | 0.299 | 0.000 | |
| 2004 | | | | 0.174 | 0.000 | 0.055 | 0.000 | 0.000 | 0.455 | 0.316 | 0.000 | |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|-------------|-------------|--------------|-------------|-------------|-------------|-------------|--|
| 2005 | | | | 0.059 | 0.000 | 0.036 | 0.000 | 0.000 | 0.068 | 0.837 | 0.000 | |
| 2006 | | | | 0.050 | 0.000 | 0.050 | 0.000 | 0.000 | 0.050 | 0.850 | 0.000 | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | |
| | 2282005015 | 175 | 9999 | MP2C | MP2I | MP2D | MP2CA | MP4C | MP4I | MP4D | MPC1 | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2000 | | | | 0.480 | 0.520 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2001 | | | | 0.588 | 0.300 | 0.112 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2002 | | | | 0.000 | 0.686 | 0.314 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2003 | | | | 0.000 | 0.500 | 0.500 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2004 | | | | 0.000 | 0.863 | 0.137 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2005 | | | | 0.000 | 0.690 | 0.310 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2006 | | | | 0.000 | 0.700 | 0.300 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| 2010 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | |
| | 2282010005 | 0 | 50 | MS4C | MS4D | MSC1 | | | | | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | | | | | | |
| 2010 | | | | 0.100 | 0.000 | 0.900 | | | | | | |
| 2011 | | | | 0.000 | 0.000 | 1.000 | | | | | | |
| | 2282010005 | 50 | 100 | MS4C | MS4D | MSC1 | | | | | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | | | | | | |
| 2004 | | | | 0.917 | 0.083 | 0.000 | | | | | | |
| 2005 | | | | 0.833 | 0.167 | 0.000 | | | | | | |
| 2006 | | | | 0.750 | 0.250 | 0.000 | | | | | | |
| 2007 | | | | 0.667 | 0.333 | 0.000 | | | | | | |
| 2008 | | | | 0.583 | 0.417 | 0.000 | | | | | | |
| 2010 | | | | 0.050 | 0.050 | 0.900 | | | | | | |
| 2011 | | | | 0.000 | 0.000 | 1.000 | | | | | | |
| | 2282010005 | 100 | 175 | MS4C | MS4D | MSC1 | | | | | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | | | | | | |
| 2004 | | | | 0.917 | 0.083 | 0.000 | | | | | | |
| 2005 | | | | 0.833 | 0.167 | 0.000 | | | | | | |
| 2006 | | | | 0.750 | 0.250 | 0.000 | | | | | | |
| 2007 | | | | 0.667 | 0.333 | 0.000 | | | | | | |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|-------------|-------------|--|--|--|--|--|--|
| 2008 | | | | 0.583 | 0.417 | 0.000 | | | | | | |
| 2010 | | | | 0.300 | 0.300 | 0.400 | | | | | | |
| 2011 | | | | 0.000 | 0.000 | 1.000 | | | | | | |
| | 2282010005 | 175 | 300 | MS4C | MS4D | MSC1 | | | | | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | | | | | | |
| 1996 | | | | 0.900 | 0.100 | 0.000 | | | | | | |
| 1997 | | | | 0.800 | 0.200 | 0.000 | | | | | | |
| 1998 | | | | 0.700 | 0.300 | 0.000 | | | | | | |
| 1999 | | | | 0.600 | 0.400 | 0.000 | | | | | | |
| 2000 | | | | 0.562 | 0.439 | 0.000 | | | | | | |
| 2001 | | | | 0.523 | 0.477 | 0.000 | | | | | | |
| 2002 | | | | 0.485 | 0.516 | 0.000 | | | | | | |
| 2003 | | | | 0.446 | 0.554 | 0.000 | | | | | | |
| 2004 | | | | 0.388 | 0.612 | 0.000 | | | | | | |
| 2005 | | | | 0.331 | 0.669 | 0.000 | | | | | | |
| 2006 | | | | 0.273 | 0.727 | 0.000 | | | | | | |
| 2007 | | | | 0.215 | 0.785 | 0.000 | | | | | | |
| 2008 | | | | 0.158 | 0.842 | 0.000 | | | | | | |
| 2010 | | | | 0.010 | 0.090 | 0.900 | | | | | | |
| 2011 | | | | 0.000 | 0.000 | 1.000 | | | | | | |
| | 2282010005 | 300 | 600 | MS4C | MS4D | MSC1 | | | | | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | | | | | | |
| 1995 | | | | 0.900 | 0.100 | 0.000 | | | | | | |
| 1996 | | | | 0.800 | 0.200 | 0.000 | | | | | | |
| 1997 | | | | 0.700 | 0.300 | 0.000 | | | | | | |
| 1998 | | | | 0.600 | 0.400 | 0.000 | | | | | | |
| 1999 | | | | 0.500 | 0.500 | 0.000 | | | | | | |
| 2000 | | | | 0.375 | 0.625 | 0.000 | | | | | | |
| 2001 | | | | 0.250 | 0.750 | 0.000 | | | | | | |
| 2002 | | | | 0.125 | 0.875 | 0.000 | | | | | | |
| 2003 | | | | 0.000 | 1.000 | 0.000 | | | | | | |
| 2010 | | | | 0.000 | 0.250 | 0.750 | | | | | | |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | |
|------|------------|-------|-------|--|----------------|----------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 2011 | | | | 0.000 | 0.000 | 1.000 | | | | | | |
| | 2282010005 | 600 | 9999 | MS4C | MS4D | MS4X | | | | | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | | | | | | |
| 1995 | | | | 0.900 | 0.100 | 0.000 | | | | | | |
| 1996 | | | | 0.800 | 0.200 | 0.000 | | | | | | |
| 1997 | | | | 0.700 | 0.300 | 0.000 | | | | | | |
| 1998 | | | | 0.600 | 0.400 | 0.000 | | | | | | |
| 1999 | | | | 0.500 | 0.500 | 0.000 | | | | | | |
| 2010 | | | | 0.150 | 0.580 | 0.270 | | | | | | |
| 2011 | | | | 0.150 | 0.150 | 0.700 | | | | | | |
| 2013 | | | | 0.000 | 0.000 | 1.000 | | | | | | |
| | 2285004015 | 0 | 6 | G2N1 | G4N1O | G4N1S | G4N1O1 | G4N1S1 | G4N1O2 | G4N1S2 | G4N1O3 | G4N1S3 |
| 1900 | | | | 0.180 | 0.069 | 0.751 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.090 | 0.035 | 0.375 | 0.083 | 0.417 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.167 | 0.833 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | | | | 0.000 | 0.000 | 0.000 | 0.097 | 0.486 | 0.167 | 0.250 | 0.000 | 0.000 |
| 2008 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 | 0.000 | 0.000 |
| 2012 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.020 | 0.030 | 0.380 | 0.570 |
| 2014 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 | 0.600 |
| | 2285004015 | 6 | 25 | G2N2 | G4N2O | G4N2S | G4N2O1 | G4N2S1 | G4N2O2 | G4N2S2 | G4N23a | G4N23b |
| 1900 | | | | 0.005 | 0.018 | 0.977 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | | | | 0.003 | 0.009 | 0.488 | 0.000 | 0.500 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | | | | 0.000 | 0.000 | 0.000 | 0.017 | 0.983 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2001 | | | | 0.000 | 0.000 | 0.000 | 0.008 | 0.492 | 0.500 | 0.000 | 0.000 | 0.000 |
| 2002 | | | | 0.000 | 0.000 | 0.000 | 0.006 | 0.369 | 0.625 | 0.000 | 0.000 | 0.000 |
| 2003 | | | | 0.000 | 0.000 | 0.000 | 0.004 | 0.246 | 0.750 | 0.000 | 0.000 | 0.000 |
| 2004 | | | | 0.000 | 0.000 | 0.000 | 0.002 | 0.123 | 0.875 | 0.000 | 0.000 | 0.000 |
| 2005 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| 2011 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.170 | 0.000 | 0.830 | 0.000 |
| 2013 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.070 | 0.000 | 0.930 | 0.000 |
| 2015 | | | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| | 2285004015 | 25 | 9999 | G4GT25 | G4GT251 | G4GT252 | | | | | | |

Table B4. Nonroad SI Technology Distributions by SCC and HP Category*

| Year | SCC | HPMin | HPMax | Fraction of Population in Each Technology Type | | | | | | | | | |
|------|------------|-------|-------|--|---------------|---------------|--|--|--|--|--|--|--|
| 1900 | | | | 1.000 | 0.000 | 0.000 | | | | | | | |
| 2004 | | | | 0.000 | 1.000 | 0.000 | | | | | | | |
| 2007 | | | | 0.000 | 0.000 | 1.000 | | | | | | | |
| | 2285006015 | 25 | 9999 | LGT25 | LGT251 | LGT252 | | | | | | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | | | | | | | |
| 2004 | | | | 0.000 | 1.000 | 0.000 | | | | | | | |
| 2007 | | | | 0.000 | 0.000 | 1.000 | | | | | | | |
| | 2285008015 | 25 | 9999 | NGT25 | NGT251 | NGT252 | | | | | | | |
| 1900 | | | | 1.000 | 0.000 | 0.000 | | | | | | | |
| 2004 | | | | 0.000 | 1.000 | 0.000 | | | | | | | |
| 2007 | | | | 0.000 | 0.000 | 1.000 | | | | | | | |

* Taken from tech-exh.dat input file.