Expanded Emission Factors for Agricultural and Mining Equipment in GREET® Full Life-Cycle Model

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1. INTRODUCTION

Sponsored by the U.S. Department of Energy (DOE), Argonne has developed the Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET®) model (Argonne National Laboratory 2016) to estimate life cycle energy consumption and air emissions from vehicle-fuel pathways, including greenhouse gas emissions. Until recently, the model has treated air emissions from nonroad equipment used in farming and mining at a high aggregated level. To improve the ability of the model to estimate criteria air pollutant emissions including volatile organic compounds (VOCs), nitrogen oxides (NO_x), sulfur oxides (SO_x), particulate matter less than 10 micrometers (PM_{10}), particulate matter less than 2.5 micrometer ($PM_{2.5}$), carbon monoxide (CO), and methane (CH_4) from nonroad equipment, we have incorporated nonroad equipment air pollutant emissions outputs from U.S. Environmental Protection Agency's (EPA) Motor Vehicle Emission Simulator (MOVES) model into the GREET model. MOVES groups nonroad engines into 10 categories, and it estimates emission inventories for nonroad sources for criteria air pollutants, greenhouse gases, and air toxics in a given area over a specific period (US EPA 2015). The expanded emission factors will allow users to better characterize nonroad equipment air pollutant emissions in GREET pathways including agriculture and mining, as well as metals production.

This memo documents our efforts to (1) compile information regarding emissions, fuel consumption, and equipment types for nonroad sources; (2) add the capability to evaluate nonroad equipment air emissions to the GREET model.

2. METHODOLOGY

US EPA (2015) describes the data and methodology behind the MOVES model and how to use it. In this memo, we described how we used the model to generate air pollutant emissions factors (EFs) from nonroad equipment for incorporation into GREET, both Excel and GREET.net versions. A detailed discussion of MOVES overall processing flow, run specification file, and our processing of MOVES output data was included in Appendix A. Air pollution EFs from nonroad sources are a function of many factors including the size and age of engines, load factor, and fuel types. Model year EFs for a given category of nonroad equipment reflect engines certified to a single model year. For this reason, the model year EFs differ from calendar year

EFs that reflect emissions from the same category of equipment certified to all available model years that are operating in a single calendar year. Calendar year EFs reflect population growth and scrappage of that type of equipment in that calendar year per U.S. EPA's nonroad engine inventory. We have opted to use calendar year EFs so that users, when selecting the target year for simulation, can calculate results that reflect EFs from the fleet of equipment operating in that year rather than results that reflect a fleet with a single model year. It is important to note that when running GREET to estimate emissions from a given technology, for example gasoline vehicles, the target year for simulation reflects emissions associated with vehicles certified to the same model year. This approach aims to evaluate the impact of vehicle technological advances over time on vehicle air pollutant emissions. For nonroad equipment, we include emission factors (EF) for calendar years 2000, 2005, 2010, 2015, 2020, 2025, and 2030 in GREET.

For each calendar year, MOVES reports total emission inventories by equipment type. However, GREET requires EFs for each type of equipment in units of mass pollutant emitted per energy consumed (g/mmBtu). The required EFs of CH_4, CO, CO_2, NO_x, PM_{10}, $PM_{2.5}$, SO_2, and VOC for a given equipment type of a set horsepower consuming one type of fuel (e.g. diesel, natural gas, gasoline) in a given calendar year is calculated as follows:

$$EF(g/mmBtu) = \frac{M(g)}{F(kg) * E(mmBtu/kg)} \qquad (1)$$

Where

EF is the calculated emission factor for a specific pollutant;

M is the total emissions of that pollutant from the type of equipment under consideration in the calendar year;

F is the total amount of the specified fuel consumed by that type of equipment in the calendar year;

E is the energy content, in lower heating value, of the specific fuel.

The MOVES model (version: MOVES2014a-20151201) does not generate nitrous oxide (N_2O), organic carbon (OC) and black carbon (BC) emission inventories for nonroad equipment, so N_2O EFs were calculated based on EPA inventory data (US EPA 2016). Nitrous oxide (N_2O) EFs of equipment fueled by natural gas (NG) were assumed to be equivalent to EFs of the same equipment type fueled by gasoline. Tier 4 nonroad engines equipped with selective catalytic reduction (SCR) unit for NO_x control might have different N_2O emissions from pre-Tier 4 nonroad engines. We did not differentiate between N_2O EFs for pre-Tier 4 and Tier 4 engines due to data limitations. These limitations will be addressed should new data be available from EPA. The EFs of BC and OC were calculated based on the ratios of OC/BC and BC/$PM_{2.5}$ in EPA's Report to Congress (US EPA 2012) and calculated $PM_{2.5}$ EFs. The OC and EC EFs from equipment fueled by NG were assumed to be equivalent to EFs of the same equipment type fueled by gasoline. For Tier 4 nonroad diesel engines that may be equipped with diesel particulate filters for PM emission control, the BC and OC fractions of the PM emissions may be very different from those for pre-Tier 4 diesel engines. Again, this data limitation will be addressed should new data be available from EPA.

To incorporate nonroad equipment EFs into GREET pathways, the shares of each type of equipment consuming a given type of fuel were specified for a given pathway. For example, if a total of 20 mmBtu of diesel fuel are consumed per ton of metal in a mining process, the user can specify that a 200 hp bulldozer consumed 40% of this fuel, while off-highway trucks consume the remaining 60%. Aggregated EFs for given GREET pathways are calculated based on the shares and EFs:

$$EF_{agg,i}\left[\frac{g_i}{mmBtu}\right] = \sum_{j=1}^{n}\left(EF_{i,j} \times S_j\right) \qquad (2)$$

Where

Subscripts *i*, *j*, and *n* denote pollutant type, equipment type, and the total number of equipment types, respectively;

$EF_{agg,i}$ is the aggregated emission factor for pollutant *i* per unit of fuel consumed;

$EF_{i,j}$ is the calculated emission factor for pollutant *i* and equipment type *j* under a specific calendar year, horsepower, and fuel type;

S_j is the energy-based share of fuel that equipment type *j* consumes of the total fuel consumption of a given type.

Table 1 illustrates the aggregated EF calculation for bauxite mining, which has an assumed constant equipment share and varied EFs from calendar years 2000 to 2030. The calculated aggregated CO EFs are 580, 220, 74, and 21 g/mmBtu in calendar years of 2000, 2010, 2020 and 2030, respectively. In GREET, shares by pathway and emission factors for nonroad equipment are contained on the Agr_Mining_EF_TS tab, sections 1 and 2, respectively.

Table 1. An example of aggregated CO EF calculation for bauxite mining

	Operation year	Dozer, diesel, HP 300	Crushing equip, diesel, HP 600	Excavator, diesel, HP 1000	Off-highway trucks, diesel, HP 2000	Loader, diesel, HP 1000
S_j		21%	1%	12%	61%	5%
$EF_{CO,j}$ (g CO/mmBtu)	2000	510	440	610	594	600.
	2010	250	220	240	190	330
	2020	73	74	96	65	130
	2030	23	21	23	19	36
$EF_{CO,j} \times S_j$	2000	107	4.4	73	360	30
	2010	53	2.2	28	116	17
	2020	15	0.7	11	40	6.7
	2030	4.9	0.2	2.8	12	1.8
$EF_{agg, CO}$	2000	580				
	2010	220				
	2020	74				
	2030	21				

3. RESULTS AND DISCUSSION

3.1 Emission Factors (EFs) of CH_4, CO, CO_2, NO_x, PM_{10} and SO_2

The nonroad equipment that were included in GREET are listed in Table 2. These pieces of equipment were a subset of the equipment in the MOVES database. A total of 22 pieces of equipment were included, which were necessary to model GREET pathways and are reflective of typical equipment horsepower. Fuel types used by this equipment included compressed natural gas (CNG), gasoline, and diesel. Machine horsepower ranged from 50 to 3000 HP. Tables B1-B22 (Appendix B) list all EFs for 22 pieces of equipment with different HP from calendar years 2000 to 2030. Figure 1 shows an example of EF trends of the 300 HP agricultural tractor in calendar years 2000- 2030, including CH_4, CO, CO_2, NO_x, PM_{10} and SO_2. As shown in Figure 1, the CO_2 EFs increased with time, which indicated that more carbon in fuel was emitted in the form of CO_2. The EFs of CO, NO_x and PM decreased with time significantly, which might be due to advanced emission control technologies, including diesel oxidation catalysts, catalyzed diesel particulate filters and selective catalytic reduction systems. Before EPA began to limit diesel's sulfur content, nonroad diesel fuel contained as much as 5,000 ppm sulfur. EPA began to phase in ultra-low sulfur diesel (15 ppm) in 2006. Since 2014, all nonroad diesel fuel is ultra-low sulfur diesel. As shown in Figure 1, cutting diesel fuel sulfur levels reduced SO_2 EFs significantly from above 100 g/mmBtu in 2005 to below 1.0 g/mmBtu in 2015.

Table 2 Selected nonroad equipment in GREET[a] from MOVES[b]

	Agriculture			Commercial			Mining	
No.	Fuel & Equipment	HP	No.	Fuel & Equipment	HP	No.	Fuel & Equipment	HP
1	CNG & Irrigation Sets	40 100 175 300 600	1	CNG & Gas compressors	50 100 300 600	1	Diesel & Bore drill rigs	50 100 300 600 750
2	Diesel & Tractors	50 100 300 600	2	Gasoline & Pumps	50 175	2	Diesel & Crawler tractor dozers	100 300 600 1000 2000
3	Diesel & Balers	50 75 100 175 300	3	Gasoline & Hydro-power	50 175	3	Diesel & Crushing processing equip	50 100 300 600 1000
4	Diesel & Combines	100 175 300 600	4	Diesel & Air compressors	50 100 300 600	4	Diesel & Excavator	100 600 1000 2000 3000
5	Diesel & Sprayers	50 100 300 600	5	Diesel & Generator sets	50 100 300 600	5	Diesel & Off-highway tractors	300 600 1000 2000 3000
6	Diesel & Swathers	75 100 175 300				6	Diesel & Off-highway trucks	300 600 1000 2000 3000
7	Diesel & Tillers	300 600				7	Diesel & Rubber tire loaders	300 600 1000 2000 3000
8	Diesel & Other Agricultural Equip	50 100 300 600				8	Diesel & Tractors loader Backhoes	50 100 300

		9	Diesel & Other underground mining equip	50 100 300 600

[a]GREET - Greenhouse gases, Regulated Emissions, and Energy use in Transportation model;

[b]MOVES- Motor Vehicle Emission Simulator

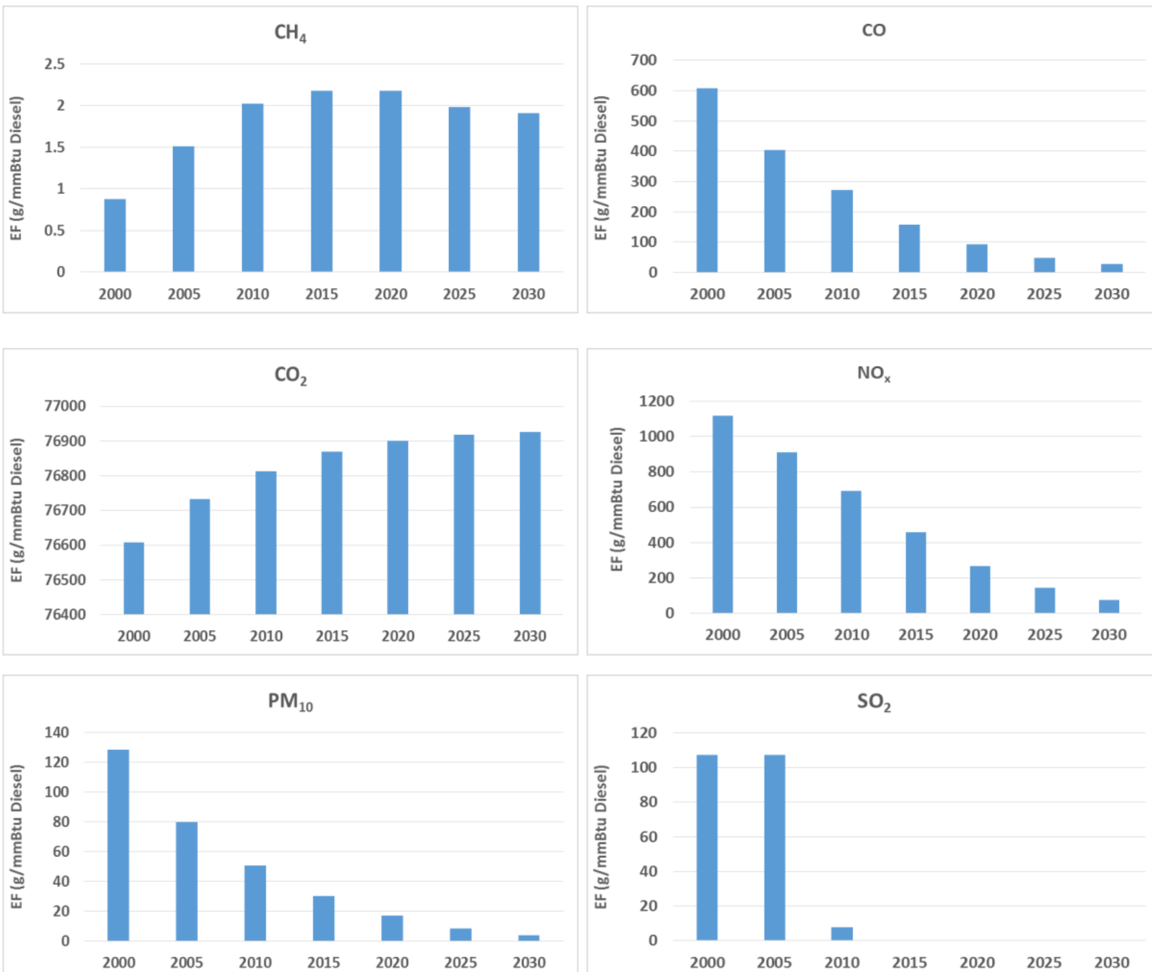

Figure 1. Agricultural tractor (HP=300 and fuel=diesel) EFs of CH_4, CO, CO_2, NO_x, PM_{10} and SO_2 in calendar years 2000-2030.

3.2 Emission Factors (EFs) of N_2O, OC and EC

Table 3 shows the N_2O EFs for nonroad equipment calculated based on the EPA greenhouse gas inventory guidance (US EPA 2016). They ranged from 1.96 to 2.11 g/mmBtu, which were similar to the results reported by Helmer, Cook et al. (2004) (Appendix B). Tables

B1-B22 (Appendix B) list N_2O EFs from calendar years 2000 to 2030. The BC and OC fractions of $PM_{2.5}$ emissions for nonroad diesel and gasoline were included in Table 4. Calculated BC and OC EFs for different equipment were listed in Tables B1-B22, which were determined by the ratios of OC/BC, and BC/$PM_{2.5}$ and calculated $PM_{2.5}$ EFs.

Table 3. N_2O emission factors for nonroad equipment

Equipment type	Fuel	g N_2O/gal fuel[a]	Btu/gal fuel[b]	g N_2O/mmBtu
Agricultural	Gasoline	0.22	112,194	1.96
	Diesel	0.26	128,450	2.02
Construction/mining	Gasoline	0.22	112,194	1.96
	Diesel	0.26	128,450	2.02
Other Nonroad	Gasoline	0.22	112,194	1.96
	Diesel	0.26	128,450	2.02
	Biodiesel	0.26	123,542	2.11

[a] US EPA (2016), [b]Argonne National Laboratory (2016)

Table 4. BC[a] and OC[b] fractions of $PM_{2.5}$ emissions for nonroad equipment[a] (US EPA 2012)

Category	OC/BC	BC/$PM_{2.5}$	OC/$PM_{2.5}$
Nonroad diesel	0.27	0.77	0.21
Nonroad gasoline	8.58	0.10	0.84

[a]BC=black carbon and [b]OC=Organic carbon.

3.3 Fuel Consumption

Tables B1-B22 (Appendix B) list fuel consumption (lb/hp-hr) for 22 pieces of equipment with different HP from calendar years 2000 to 2030. They are different from BSFC values of MOVES database (US EPA 2010, US EPA 2010, US EPA 2015). The differences were due to transient adjustment factors, load factors, and deterioration factors in the inventory calculation. These factors are functions of model year, horsepower category, and technology type (US EPA 2010, US EPA 2010, US EPA 2015). The calculated fuel consumption under a specific calendar year was a weighted average for a specific equipment type and horsepower. These fuel consumption results are not included in GREET, but GREET users may find them useful for future analysis when only available data are expressed in hours of equipment operation, instead of mmBtu of fuel consumption directly.

3.4 Updated Pathways in GREET

A total of 40 GREET agricultural and mining activity pathways have been updated to include revised and refined nonroad EFs (Table 5). The equipment share, EFs in calendar years 2000-2030, and aggregated EFs for different pathways were organized in the worksheet of "Agr_Mining_EF_TS" in GREET1_2016. Section 1 defines the equipment share percentages. Section 2 contains EFs that were calculated from the MOVES model. If MOVES is updated, emission factors in GREET will be updated. Lastly, section 3 in this tab contains aggregated EFs for each pathway, which were calculated based on the equipment share and EF data in sections 1 and 2.

Table 5. Updated pathways in GREET1 and GREET2

No	Pathways	Location (file and tab)
1	Iron ore extraction and processing	GREET2, Steel
2	Bauxite mining	GREET2, W.Al and C.Al
3	Lead ore mining	GREET2, Lead
4	Nickel ore mining	GREET2, Nickel
5	Cobalt ore mining	GREET2, Cobalt
6	Copper ore mining	GREET2, Copper
7	Zinc ore mining	GREET2, Zinc
8	Magnesium ore mining	GREET2, Magnesium
9	Dolomite mining	GREET2, Glass
10	South Africa mining	GREET2, Platinum
11	North America platinum mining	GREET2, Platinum
12	Vanadium ore mining	GREET2, Vanadium
13	Zirconium ore mining	GREET2, Zirconium
14	Primary mining and beneficiation	GREET2, Molybdenum
15	Manganese ore mining	GREET2, Manganese
16	Oil recovery	GREET1, Petroleum
17	Coal mining	GREET1, Coal
18	Uranium mining	GREET1, Uranium
19	Corn farming	GREET1, EtOH
20	Wilow farming	GREET1, EtOH
21	Poplar farming	GREET1, EtOH
22	Switchgrass farming	GREET1, EtOH
23	Miscanthus farming	GREET1, EtOH
24	Corn stover collection	GREET1, EtOH
25	Forest residue collection	GREET1, EtOH
26	Sugarcane farming	GREET1, EtOH
27	Grain sorghum farming	GREET1, EtOH
28	Sweet sorghum farming	GREET1, EtOH
29	Forage sorghum farming	GREET1, EtOH
30	Soybean farming	GREET1, BioOil
31	Palm FFB farming	GREET1, BioOil
32	Canola farming	GREET1, BioOil
33	Jatropha farming	GREET1, BioOil

34	Camelina farming	GREET1, BioOil
35	Landing preprocessing/sorting	GREET1, IDL
36	Storage	GREET1, IDL
37	Handling	GREET1, IDL
38	Limestone mining	GREET1, Ag_Inputs
39	Limestone mining in Chile	GREET1, Ag_Inputs
40	Limestone mining	GREET1, Ag_Inputs

3.5 Emission Factors (EFs) in GREET.net

The GREET.net database also contains the newly-developed nonroad EFs. GREET.net users can add the newly-added nonroad equipment to their pathways, accessing them under the Technologies menu (Figure 2).

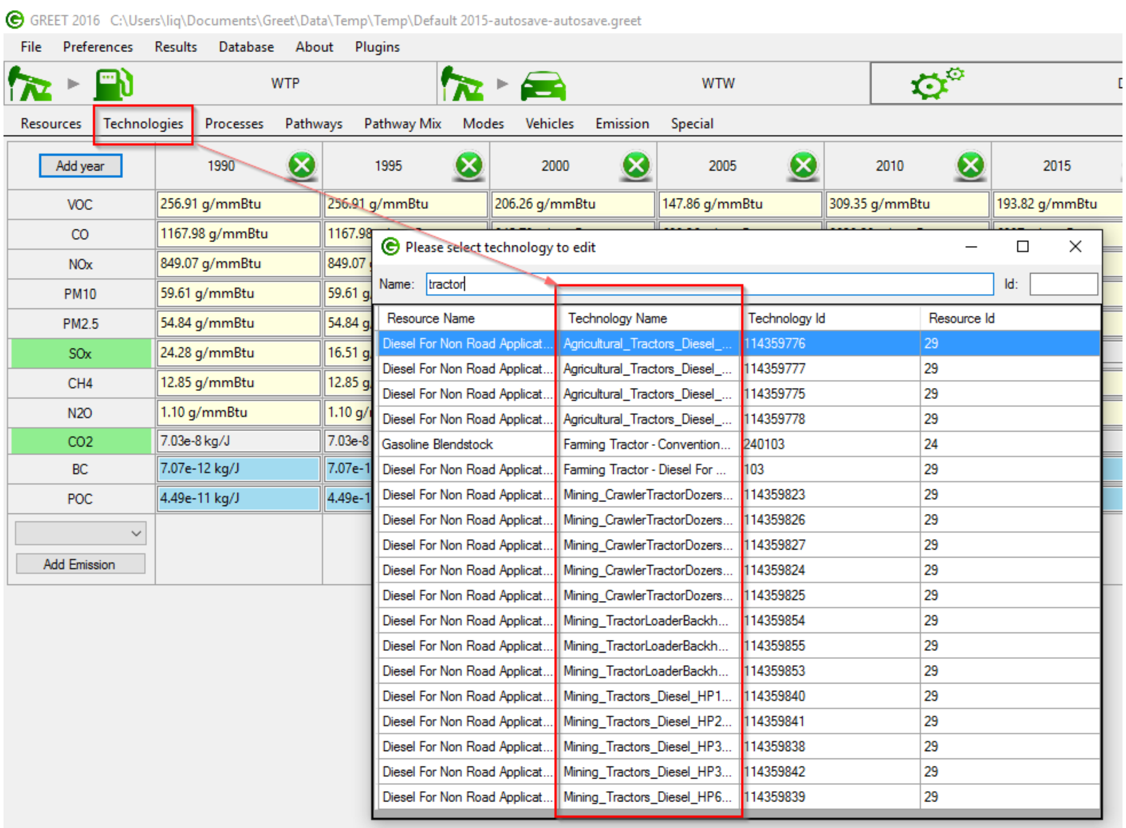

Figure 2. Nonroad equipment and machines EFs in GREET.net

4. CONCLUSIONS

By bringing together information on time series EFs and equipment shares, more than 400 EFs for equipment with different horsepower and fuel have been calculated and included in GREET1_2016, GREET2_2016, and GREET.net. Furthermore, 40 GREET pathways have been revised with aggregated nonroad EFs to improve nonroad equipment emission estimates for those pathways. These more robust and varied EFs in GREET could offer a significantly enhanced capability to model air pollutant emissions from agricultural and mining equipment.

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Appendix A: MOVES Overall Flow of Processing, Run Specification File, and Data Processing

Figure A - 1 illustrates the overall flow of processing in the MOVES model (US EPA 2015). First, a run specification file ("RunSpec") is created by using the MOVES Graphical User Interface (GUI). Then a MOVES execution database is produced by combining user inputs ("RunSpec") with the MOVES default database. After that, the MOVES produce files containing the completed work. Finally, the master loop retrieves there completed work files and processes them into output database.

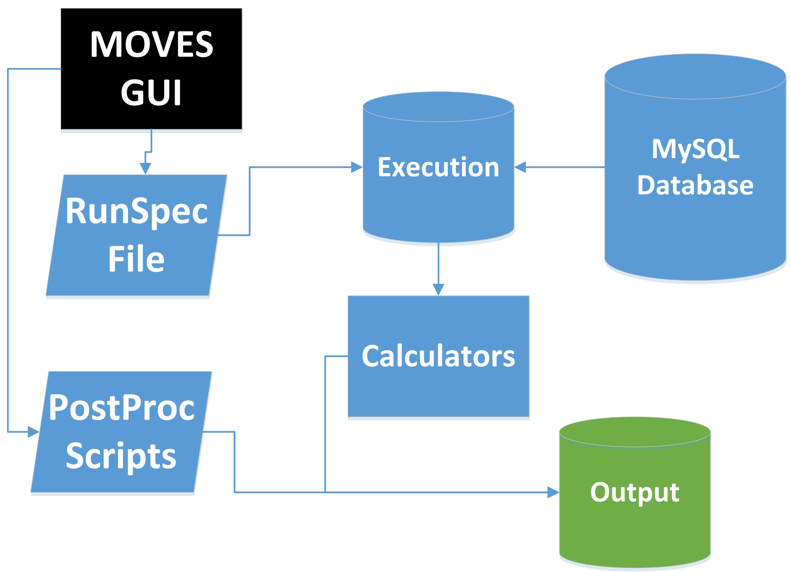

Figure A - 1. The overall flow of processing in MOVES. Cylinders represent databases, slanted rectangles represent files, square boxes represent modules or processes, and line arrows represent data flow.

A run specification file ("RunSpec") included all user's inputs, which must be defined before any simulation. Table A - 1 lists all parameters for nonroad simulation, which includes scale, time spans, geographic bounds, nonroad vehicle equipment, pollutants and processes, and outputs. The geographic bounds defined as "nation", so national aggregated inventory data were calculated. For vehicles/equipment, five fuels types, 12 sectors and their combination were defined in nonroad vehicle equipment. The output panel has two sub-panels, the general output allows the analyst to create an output database and select units. The output emissions detail is used to specify the level of detail desired in the output data tables. The 24-hour and nation is selected, no model year, emission process and fuel subtype detail was included in the output tables.

Table A - 1 Run specification file for nonroad engines

Items	Parameters
Scale	• Model: "Nonroad" • Domain/Scale: "National" • Calculation Type: "Inventory"
Time Spans	• Select year: "2000, 2005, …,2030" • Days: "Weekend" and "Weekdays" • Months: "January, February, …,December"
Geographic Bounds	• Region: "Nation"
Vehicle/Equipment: NonRoad Vehicle Equipment	• Fuels: "Compressed nature gas (CNG), Gasoline, Liquefied petroleum gas, marine diesel fuel, Nonroad Diesel Fuel" • Sectors: "Agriculture, airport support, commercial, construction, industrial, lawn/garden, logging, oil field, pleasure craft, railroad, recreational, underground mining"
Road Type	n/a
Pollutants and processes	• Pollutants: Total gaseous hydrocarbons, non-methane hydrocarbons, non-methane organic gases, total organic gases, volatile organic compounds, CH4, CO, NOx, NH3, PM2.5, PM10, SO2, Brake specific fuel consumption (BSFC), CO2 • Processes: Running exhaust, crankcase running exhaust, refueling displacement vapor loss, refueling spillage loss, evap tank permeation, evap hose permeation, diurnal fuel vapor venting, Hotsoak fuel venting
Manage input data sets	n/a
Strategies	n/a

Output	• General output:
	  o Database=nonroad_year2000To2030
	  o Units: mass units= kg, energy units=Joules, Distance units=km
	• Output emissions detail:
	  o Always: Time=24-hour day, location=Nation, Pollutant
	  o On and off road: SCC
	  o For all vehicle/equipment categories: Fuel type
	  o Off Road: Sector

Advanced performance feature	n/a

The MOVES master program generates an output database in the MySQL, which consist of several tables. Table A - 2 lists several important output tables from MOVES run output database.

Table A - 2 MOVES output tables and short description

Tables	Description
MOVESRun	Contains information that pertains to the model run as a whole: run ID, output time period, engineering units, runspec file name, default database used, master version date
MOVESError	Contains error message generated during runs.

Activitytype	Define activity type
BaseRateUnits	Define output units (mass , energy, and distance units)
MOVESActivityOutput	Report activity-related information
MOVESOutput	Contains the pollutant emission results and energy consumption

Figure A - 2 shows the database processing and output results to GREET2015 and GREET.NET. The raw MOVES output table (V1) contained very detail information, such as year ID, month ID, day ID, pollutant ID, fuel type ID, source classification code (SCC), sector ID, hp ID and emission quant mean. With Excel 2013, the row limit you can edit the raw data is 1,048,576 (x 15,384 columns). So data processing steps 1- 8 were conducted in MySQL (Structured query language). Emission factors (EF) were calculated based on pollutant and fuel consumption inventory data for different operation year and equipment model year. Emission factors (EF) were aggregated to operation year based on calculation of age distribution for nonroad model growth and scrappage. The finals MOVES output tables (V5 and V6) were exported to GREET2016 and GREET.net.

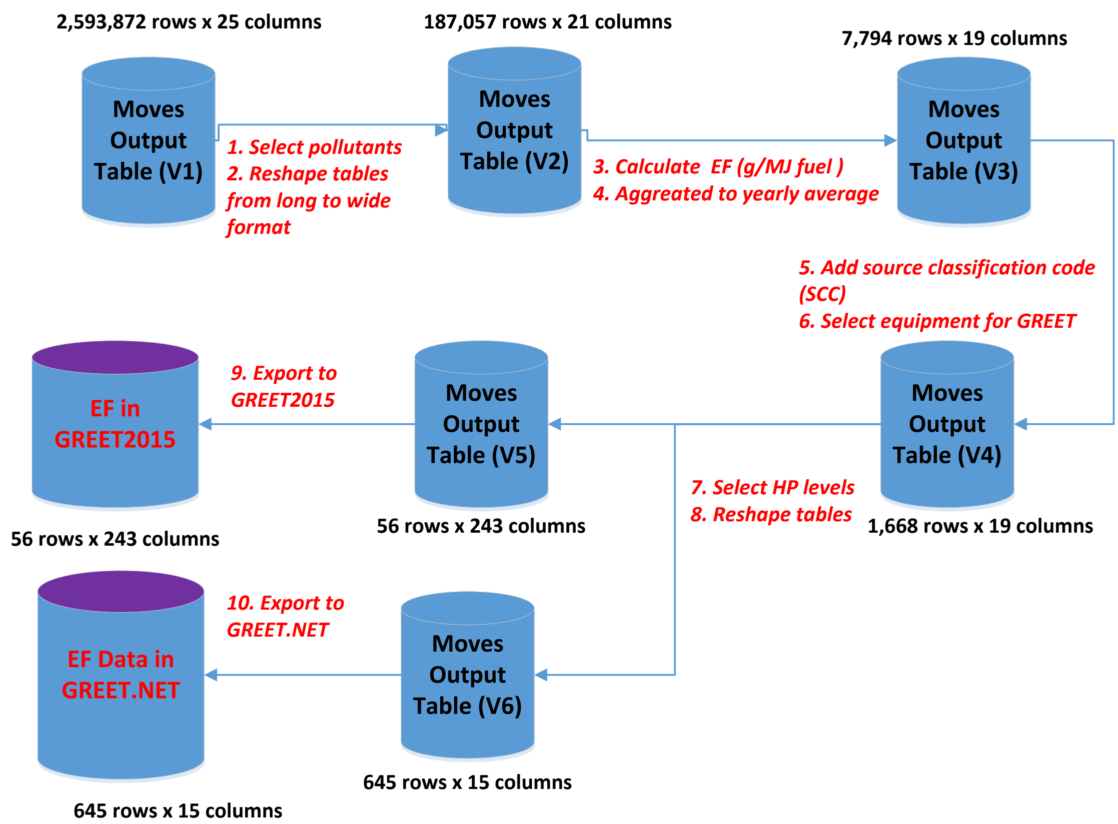

Figure A - 2. MOVES output database processing for GREET 2015 and GREET.NET

APPENDIX B: EMISSION FACTORS OF SELECTED NONROAD EQUIPMENT

Table B - 1 Agricultural irrigation sets EF (g/mmBtu CNG)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	40	4,255	4,875	47,543	1,157	5.63	5.63	0.26	920	0.55	4.72	1.96	0.304
2000	100	4,253	4,872	47,547	1,156	5.63	5.63	0.26	919	0.55	4.72	1.96	0.304
2000	175	4,253	4,872	47,547	1,156	5.63	5.63	0.26	919	0.55	4.72	1.96	0.304
2000	300	4,253	4,872	47,547	1,156	5.63	5.63	0.26	919	0.55	4.72	1.96	0.304
2000	600	4,253	4,872	47,547	1,156	5.63	5.63	0.26	919	0.55	4.72	1.96	0.304
2005	40	4,370	5,163	47,254	1,142	5.93	5.93	0.26	944	0.58	4.96	1.96	0.302
2005	100	4,443	5,150	47,123	1,163	5.89	5.89	0.26	960	0.57	4.93	1.96	0.304
2005	175	4,443	5,150	47,123	1,163	5.89	5.89	0.26	960	0.57	4.93	1.96	0.304
2005	300	4,443	5,150	47,123	1,163	5.89	5.89	0.26	960	0.57	4.93	1.96	0.304
2005	600	4,443	5,150	47,123	1,163	5.89	5.89	0.26	960	0.57	4.93	1.96	0.304
2010	40	633	1,806	55,159	192	7.43	7.43	0.32	137	0.72	6.22	1.96	0.247
2010	100	4,486	5,213	47,027	1,165	5.94	5.94	0.26	970	0.58	4.97	1.96	0.304
2010	175	4,486	5,213	47,027	1,165	5.94	5.94	0.26	970	0.58	4.97	1.96	0.315
2010	300	4,486	5,213	47,027	1,165	5.94	5.94	0.26	970	0.58	4.97	1.96	0.308
2010	600	4,486	5,213	47,027	1,165	5.94	5.94	0.26	970	0.58	4.97	1.96	0.383
2015	40	633	1,806	55,159	192	7.43	7.43	0.32	137	0.72	6.22	1.96	0.247
2015	100	4,486	5,213	47,027	1,165	5.96	5.96	0.32	971	0.58	4.99	1.96	0.304
2015	175	4,486	5,213	47,030	1,164	3.69	3.69	0.32	972	0.36	3.09	1.96	0.315
2015	300	4,488	5,211	47,028	1,166	4.57	4.57	0.32	972	0.45	3.82	1.96	0.308
2015	600	4,491	5,221	47,030	1,160	1.20	1.20	0.32	970	0.12	1.01	1.96	0.383
2020	40	633	1,806	55,159	192	7.43	7.43	0.32	137	0.72	6.22	1.96	0.247
2020	100	4,486	5,213	47,027	1,165	5.96	5.96	0.32	971	0.58	4.99	1.96	0.304
2020	175	4,486	5,213	47,030	1,164	3.69	3.69	0.32	972	0.36	3.09	1.96	0.315
2020	300	4,488	5,211	47,028	1,166	4.57	4.57	0.32	972	0.45	3.82	1.96	0.308
2020	600	4,491	5,221	47,030	1,160	1.20	1.20	0.32	970	0.12	1.01	1.96	0.383
2025	40	633	1,806	55,159	192	7.43	7.43	0.32	137	0.72	6.22	1.96	0.247
2025	100	4,486	5,213	47,027	1,165	5.96	5.96	0.32	971	0.58	4.99	1.96	0.304
2025	175	4,486	5,213	47,030	1,164	3.69	3.69	0.32	972	0.36	3.09	1.96	0.315
2025	300	4,488	5,211	47,028	1,166	4.57	4.57	0.32	972	0.45	3.82	1.96	0.308
2025	600	4,491	5,221	47,030	1,160	1.20	1.20	0.32	970	0.12	1.01	1.96	0.383
2030	40	633	1,806	55,159	192	7.43	7.43	0.32	137	0.72	6.22	1.96	0.247
2030	100	4,486	5,213	47,027	1,165	5.96	5.96	0.32	971	0.58	4.99	1.96	0.304
2030	175	4,486	5,213	47,030	1,164	3.69	3.69	0.32	972	0.36	3.09	1.96	0.315
2030	300	4,488	5,211	47,028	1,166	4.57	4.57	0.32	972	0.45	3.82	1.96	0.308
2030	600	4,491	5,221	47,030	1,160	1.20	1.20	0.32	970	0.12	1.01	1.96	0.383

Table B - 2 Agricultural tractors EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	50	1.2	959	76,316	806	142.3	138.1	106.8	226.8	106.5	29.1	2.02	0.243
2000	100	1.0	762	76,532	950	161.4	156.6	107.1	155.1	120.8	33.0	2.02	0.243
2000	300	0.9	609	76,608	1,117	128.3	124.5	107.2	128.7	96.0	26.2	2.02	0.219
2000	600	0.9	749	76,528	1,232	162.0	157.1	107.1	155.1	121.2	33.1	2.02	0.219
2005	50	1.7	609	76,624	682	102.3	99.3	107.2	123.4	76.6	20.9	2.02	0.243
2005	100	1.6	651	76,645	801	122.9	119.2	107.3	117.1	91.9	25.1	2.02	0.243
2005	300	1.5	404	76,733	910	79.8	77.4	107.4	87.6	59.7	16.3	2.02	0.219
2005	600	1.2	592	76,650	1,055	120.8	117.2	107.3	115.0	90.4	24.7	2.02	0.219
2010	50	2.9	349	76,814	616	60.4	58.6	7.77	60.1	45.2	12.3	2.02	0.243
2010	100	2.2	574	76,742	673	90.6	87.9	7.75	84.4	67.8	18.5	2.02	0.243
2010	300	2.0	272	76,813	693	50.7	49.2	7.77	60.1	37.9	10.4	2.02	0.219
2010	600	1.5	453	76,752	850	77.9	75.6	7.77	80.2	58.3	15.9	2.02	0.219
2015	50	2.9	185	76,885	535	30.9	30.0	0.46	35.9	23.2	6.3	2.02	0.243
2015	100	2.3	408	76,831	479	59.7	58.0	0.47	54.9	44.7	12.2	2.02	0.243
2015	300	2.2	157	76,869	460	30.2	29.2	0.47	42.2	22.6	6.2	2.02	0.219
2015	600	1.6	308	76,828	629	48.3	46.9	0.49	54.9	36.2	9.9	2.02	0.219
2020	50	2.1	75	76,920	434	10.6	10.3	0.40	23.2	7.9	2.2	2.02	0.243
2020	100	2.2	269	76,885	291	35.3	34.2	0.44	36.9	26.4	7.2	2.02	0.243
2020	300	2.2	93	76,901	266	17.0	16.5	0.43	31.7	12.7	3.5	2.02	0.219
2020	600	1.8	198	76,877	432	30.6	29.7	0.45	39.0	22.9	6.3	2.02	0.219
2025	50	1.7	38	76,932	396	3.8	3.7	0.38	20.0	2.9	0.8	2.02	0.243
2025	100	1.9	156	76,916	156	18.6	18.1	0.40	26.4	13.9	3.8	2.02	0.243
2025	300	2.0	49	76,918	142	8.4	8.1	0.40	25.3	6.3	1.7	2.02	0.219
2025	600	1.9	128	76,901	285	19.3	18.7	0.42	31.7	14.4	3.9	2.02	0.219
2030	50	1.7	33	76,934	389	2.8	2.7	0.37	19.0	2.1	0.6	2.02	0.243
2030	100	1.8	84	76,928	76	6.7	6.5	0.38	22.2	5.0	1.4	2.02	0.243
2030	300	1.9	27	76,925	74	3.7	3.6	0.38	23.2	2.8	0.8	2.02	0.219
2030	600	1.9	80	76,915	178	11.6	11.3	0.40	26.4	8.7	2.4	2.02	0.219

Table B - 3 Agricultural baler EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	50	1.22	981	76,258	827.9	133.4	129.4	106.7	246.9	99.8	27.3	2.02	0.244
2000	75	1.18	698	76,369	867.2	170.2	165.1	106.9	210.0	127.4	34.8	2.02	0.243
2000	100	1.18	698	76,369	867.2	170.2	165.1	106.9	210.0	127.3	34.8	2.02	0.243
2000	175	1.14	628	76,385	1033.0	157.0	152.3	106.9	203.6	117.5	32.1	2.02	0.219
2000	300	1.14	601	76,397	1012.4	154.9	150.2	106.9	200.5	115.9	31.7	2.02	0.219
2005	50	1.41	832	76,400	770.9	118.0	114.4	106.9	199.4	88.3	24.1	2.02	0.244
2005	75	1.52	639	76,503	805.8	137.7	133.6	107.1	164.6	103.0	28.1	2.02	0.243
2005	100	1.52	639	76,503	805.8	137.7	133.6	107.1	164.6	103.0	28.1	2.02	0.243
2005	175	1.58	502	76,537	939.1	118.0	114.5	107.1	153.0	88.3	24.1	2.02	0.219
2005	300	1.52	473	76,550	918.5	114.5	111.1	107.1	148.8	85.7	23.4	2.02	0.219
2010	50	1.96	675	76,531	722.4	92.2	89.5	7.7	155.1	69.0	18.9	2.02	0.242
2010	75	1.91	567	76,635	713.3	96.5	93.6	7.7	120.3	72.2	19.7	2.02	0.243
2010	100	1.94	589	76,634	715.6	100.8	97.8	7.7	120.3	75.4	20.6	2.02	0.243
2010	175	1.93	397	76,675	804.4	78.3	76.0	7.8	106.6	58.6	16.0	2.02	0.219
2010	300	1.78	364	76,690	779.1	72.5	70.3	7.8	101.3	54.2	14.8	2.02	0.22
2015	50	2.15	504	76,654	651.3	70.2	68.1	0.5	113.9	52.5	14.3	2.02	0.243
2015	75	1.99	451	76,742	616.7	67.2	65.2	0.5	84.4	50.3	13.7	2.02	0.243
2015	100	1.98	466	76,742	568.9	71.3	69.1	0.5	84.4	53.3	14.6	2.02	0.243
2015	175	2.03	281	76,777	624.4	51.2	49.6	0.5	72.8	38.3	10.5	2.02	0.219
2015	300	1.86	245	76,790	595.0	44.3	42.9	0.5	67.5	33.1	9.0	2.02	0.218
2020	50	2.13	340	76,764	570.2	48.7	47.3	0.5	77.0	36.5	10.0	2.02	0.243
2020	75	2.03	330	76,815	537.9	45.2	43.8	0.5	59.1	33.8	9.2	2.02	0.243
2020	100	2.03	343	76,815	414.1	48.5	47.1	0.5	60.1	36.3	9.9	2.02	0.243
2020	175	2.11	184	76,839	438.5	34.3	33.2	0.5	52.8	25.6	7.0	2.02	0.219
2020	300	1.95	153	76,849	414.3	28.2	27.4	0.5	48.5	21.1	5.8	2.02	0.22
2025	50	2.11	212	76,845	505.3	31.1	30.2	0.4	49.6	23.3	6.4	2.02	0.243
2025	75	2.02	234	76,867	476.5	28.4	27.6	0.4	42.2	21.3	5.8	2.02	0.243
2025	100	2.02	246	76,867	286.4	31.1	30.1	0.4	42.2	23.2	6.4	2.02	0.243
2025	175	2.14	121	76,878	295.0	22.1	21.5	0.4	39.0	16.6	4.5	2.02	0.219
2025	300	2.02	100	76,884	279.3	17.4	16.9	0.4	36.9	13.0	3.6	2.02	0.219
2030	50	2.05	135	76,885	461.0	19.4	18.8	0.4	35.9	14.5	4.0	2.02	0.243
2030	75	1.92	160	76,900	432.8	16.8	16.3	0.4	30.6	12.5	3.4	2.02	0.243
2030	100	1.92	170	76,900	185.0	18.8	18.2	0.4	31.7	14.0	3.8	2.02	0.243
2030	175	2.05	79	76,903	187.6	13.5	13.1	0.4	30.6	10.1	2.8	2.02	0.219
2030	300	1.96	64	76,907	176.2	10.0	9.7	0.4	29.5	7.5	2.0	2.02	0.218

Table B - 4 Agricultural combines EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	100	0.80	563	76,607	1059	179.1	173.7	107.2	129.8	134.0	36.6	2.02	0.243
2000	175	0.72	477	76,649	1246	166.2	161.2	107.3	115.0	124.3	34.0	2.02	0.219
2000	300	0.73	451	76,660	1225	164.0	159.0	107.3	110.8	122.7	33.5	2.02	0.219
2000	600	0.63	475	76,675	1238	154.1	149.4	107.3	106.6	115.3	31.5	2.02	0.219
2005	100	1.28	557	76,651	927	145.3	141.0	107.3	115.0	108.7	29.7	2.02	0.243
2005	175	1.32	409	76,702	1073	125.4	121.6	107.4	98.1	93.8	25.6	2.02	0.219
2005	300	1.26	380	76,714	1053	121.8	118.1	107.4	92.8	91.1	24.9	2.02	0.219
2005	600	1.01	409	76,743	1057	111.8	108.5	107.4	83.3	83.7	22.9	2.02	0.219
2010	100	1.81	551	76,709	778	106.9	103.7	7.75	96.0	79.9	21.8	2.02	0.243
2010	175	1.79	351	76,758	873	83.6	81.1	7.77	79.1	62.6	17.1	2.02	0.219
2010	300	1.65	320	76,773	848	77.7	75.3	7.77	73.9	58.1	15.9	2.02	0.219
2010	600	1.38	350	76,801	848	69.7	67.6	7.77	64.4	52.2	14.3	2.02	0.219
2015	100	1.94	453	76,774	597	76.0	73.7	0.49	73.9	56.9	15.5	2.02	0.243
2015	175	1.97	264	76,813	656	55.0	53.3	0.49	60.1	41.1	11.2	2.02	0.219
2015	300	1.80	227	76,827	626	47.8	46.4	0.49	55.9	35.8	9.8	2.02	0.219
2015	600	1.57	254	76,850	626	41.7	40.4	0.49	47.5	31.2	8.5	2.02	0.219
2020	100	2.00	339	76,832	429	52.1	50.5	0.46	54.9	39.0	10.7	2.02	0.243
2020	175	2.08	175	76,857	455	37.0	35.9	0.46	46.4	27.7	7.6	2.02	0.219
2020	300	1.93	145	76,868	431	30.7	29.8	0.45	42.2	23.0	6.3	2.02	0.219
2020	600	1.73	169	76,888	431	25.9	25.1	0.45	34.8	19.4	5.3	2.02	0.219
2025	100	2.02	245	76,875	294	33.6	32.6	0.43	40.1	25.1	6.9	2.02	0.243
2025	175	2.13	118	76,886	303	24.1	23.3	0.43	35.9	18.0	4.9	2.02	0.219
2025	300	2.00	97	76,892	287	19.0	18.5	0.43	33.8	14.2	3.9	2.02	0.219
2025	600	1.86	112	76,906	284	16.0	15.5	0.43	29.5	11.9	3.3	2.02	0.219
2030	100	1.92	171	76,903	188	20.4	19.8	0.41	30.6	15.2	4.2	2.02	0.243
2030	175	2.05	79	76,906	191	14.8	14.3	0.41	29.5	11.1	3.0	2.02	0.219
2030	300	1.96	64	76,910	179	11.0	10.6	0.40	28.5	8.2	2.2	2.02	0.219
2030	600	1.87	73	76,917	178	9.4	9.1	0.40	25.3	7.0	1.9	2.02	0.219

Table B - 5 Agricultural sprayers EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	50	1.2	979	76,259	828	132.5	128.5	106.7	246.9	99.1	27.1	2.02	0.243
2000	100	1.2	697	76,369	867	169.5	164.4	106.9	210.0	126.8	34.6	2.02	0.243
2000	300	1.2	600	76,398	1,012	154.1	149.5	106.9	200.5	115.3	31.5	2.02	0.219
2000	600	1.1	626	76,411	1,026	147.3	142.9	106.9	195.2	110.2	30.1	2.02	0.219
2000	750	1.1	626	76,411	1,026	147.3	142.9	106.9	195.2	110.2	30.1	2.02	0.219
2005	50	1.4	829	76,400	771	117.1	113.6	106.9	199.4	87.6	23.9	2.02	0.243
2005	100	1.5	638	76,503	806	137.0	132.9	107.1	164.6	102.5	28.0	2.02	0.243
2005	300	1.5	472	76,550	918	113.9	110.5	107.1	148.8	85.2	23.3	2.02	0.219
2005	600	1.3	502	76,579	924	106.5	103.3	107.2	139.3	79.7	21.8	2.02	0.219
2005	750	1.3	502	76,579	924	106.5	103.3	107.2	139.3	79.7	21.8	2.02	0.219
2010	50	2.0	673	76,532	722	91.4	88.7	7.7	155.1	68.4	18.7	2.02	0.243
2010	100	1.9	588	76,634	715	100.2	97.2	7.7	120.3	75.0	20.5	2.02	0.243
2010	300	1.8	364	76,690	779	72.0	69.8	7.8	101.3	53.9	14.7	2.02	0.219
2010	600	1.5	396	76,717	780	66.0	64.0	7.8	91.8	49.4	13.5	2.02	0.219
2010	750	1.5	396	76,717	780	66.0	64.0	7.8	91.8	49.4	13.5	2.02	0.219
2015	50	2.1	502	76,654	651	69.5	67.4	0.5	113.9	52.0	14.2	2.02	0.243
2015	100	2.0	465	76,742	569	70.8	68.7	0.5	84.4	53.0	14.5	2.02	0.243
2015	300	1.9	244	76,791	595	44.0	42.6	0.5	67.5	32.9	9.0	2.02	0.219
2015	600	1.6	273	76,814	596	39.2	38.0	0.5	60.1	29.3	8.0	2.02	0.219
2015	750	1.6	273	76,814	596	39.2	38.0	0.5	60.1	29.3	8.0	2.02	0.219
2020	50	2.1	339	76,764	570	48.2	46.8	0.5	77.0	36.1	9.9	2.02	0.243
2020	100	2.0	343	76,815	414	48.2	46.7	0.5	60.1	36.0	9.8	2.02	0.243
2020	300	2.0	153	76,849	414	28.0	27.1	0.5	48.5	20.9	5.7	2.02	0.219
2020	600	1.8	177	76,869	414	24.2	23.5	0.5	41.1	18.1	4.9	2.02	0.219
2020	750	1.8	177	76,869	414	24.2	23.5	0.5	41.1	18.1	4.9	2.02	0.219
2025	50	2.1	211	76,845	505	30.8	29.9	0.4	48.5	23.0	6.3	2.02	0.243
2025	100	2.0	245	76,867	286	30.8	29.9	0.4	42.2	23.1	6.3	2.02	0.243
2025	300	2.0	100	76,884	279	17.2	16.7	0.4	36.9	12.9	3.5	2.02	0.219
2025	600	1.9	115	76,898	277	14.9	14.4	0.4	31.7	11.1	3.0	2.02	0.219
2025	750	1.9	115	76,898	277	14.9	14.4	0.4	31.7	11.1	3.0	2.02	0.219
2030	50	2.0	134	76,885	461	19.2	18.6	0.4	35.9	14.4	3.9	2.02	0.243
2030	100	1.9	169	76,900	185	18.6	18.1	0.4	31.7	13.9	3.8	2.02	0.243
2030	300	2.0	64	76,907	176	9.9	9.6	0.4	29.5	7.4	2.0	2.02	0.219
2030	600	1.9	74	76,914	175	8.7	8.5	0.4	26.4	6.5	1.8	2.02	0.219
2030	750	1.9	74	76,914	175	8.7	8.5	0.4	26.4	6.5	1.8	2.02	0.219

Table B - 6 Agricultural swathers EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	75	0.80	557	76,608	1,057	172.5	167.3	107.2	128.7	129.0	35.3	2.02	0.243
2000	100	0.80	557	76,608	1,057	172.5	167.3	107.2	128.7	129.0	35.3	2.02	0.243
2000	175	0.72	472	76,651	1,244	159.3	154.5	107.3	113.9	119.2	32.6	2.02	0.219
2000	300	0.73	444	76,661	1,223	157.2	152.4	107.3	110.8	117.6	32.1	2.02	0.219
2005	75	1.28	551	76,652	925	139.7	135.5	107.3	113.9	104.5	28.6	2.02	0.243
2005	100	1.28	551	76,652	925	139.7	135.5	107.3	113.9	104.5	28.6	2.02	0.243
2005	175	1.32	404	76,703	1,071	119.9	116.3	107.4	97.1	89.7	24.5	2.02	0.219
2005	300	1.26	375	76,715	1,051	116.4	112.9	107.4	92.8	87.1	23.8	2.02	0.219
2010	75	1.79	522	76,711	774	98.1	95.1	7.75	95.0	73.4	20.0	2.02	0.243
2010	100	1.81	544	76,710	776	102.4	99.3	7.75	95.0	76.6	20.9	2.02	0.243
2010	175	1.79	347	76,760	872	79.7	77.3	7.77	78.1	59.6	16.3	2.02	0.219
2010	300	1.65	314	76,774	847	73.8	71.6	7.77	73.9	55.2	15.1	2.02	0.219
2015	75	1.94	433	76,774	644	68.5	66.4	0.50	72.8	51.2	14.0	2.02	0.243
2015	100	1.94	447	76,774	596	72.5	70.4	0.49	73.9	54.3	14.8	2.02	0.243
2015	175	1.96	260	76,814	654	52.2	50.6	0.49	60.1	39.0	10.7	2.02	0.219
2015	300	1.79	224	76,827	625	45.2	43.8	0.49	55.9	33.8	9.2	2.02	0.219
2020	75	1.99	321	76,832	552	46.1	44.7	0.46	53.8	34.5	9.4	2.02	0.243
2020	100	1.99	334	76,832	428	49.5	48.0	0.46	53.8	37.0	10.1	2.02	0.243
2020	175	2.08	173	76,858	454	35.0	34.0	0.46	45.4	26.2	7.2	2.02	0.219
2020	300	1.93	141	76,868	430	28.9	28.0	0.45	42.2	21.6	5.90	2.02	0.219
2025	75	2.00	230	76,875	483	29.0	28.2	0.43	39.0	21.7	5.94	2.02	0.243
2025	100	2.00	242	76,876	293	31.8	30.8	0.43	40.1	23.8	6.49	2.02	0.243
2025	175	2.13	116	76,886	302	22.7	22.0	0.43	35.9	17.0	4.63	2.02	0.219
2025	300	2.00	96	76,894	287	17.8	17.3	0.43	33.8	13.3	3.65	2.02	0.219
2030	75	1.91	159	76,903	435	17.2	16.7	0.41	29.5	12.8	3.51	2.02	0.243
2030	100	1.91	169	76,903	187	19.2	18.6	0.41	30.6	14.4	3.92	2.02	0.243
2030	175	2.05	78	76,906	190	13.9	13.4	0.41	29.5	10.4	2.83	2.02	0.219
2030	300	1.96	62	76,910	179	10.2	9.9	0.40	28.5	7.67	2.09	2.02	0.219

Table B - 7 Agricultural tillers EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	300	0.8	739	76,600	1,028	122.0	118.4	107.2	131.9	91.3	24.9	2.02	0.864
2000	600	0.7	754	76,615	1,041	113.7	110.3	107.2	126.6	85.0	23.2	2.02	0.223
2005	300	1.3	563	76,676	929	95.3	92.5	107.3	106.6	71.3	19.5	2.02	0.65
2005	600	1.1	586	76,706	934	86.4	83.8	107.4	96.0	64.6	17.7	2.02	0.222
2010	300	1.7	415	76,753	786	64.3	62.4	7.8	80.2	48.1	13.2	2.02	0.283
2010	600	1.4	441	76,782	786	56.8	55.1	7.8	70.7	42.5	11.6	2.02	0.224
2015	300	1.8	270	76,819	599	42.2	40.9	0.5	59.1	31.6	8.62	2.02	0.265
2015	600	1.6	295	76,842	599	36.1	35.1	0.5	50.6	27.0	7.39	2.02	0.223
2020	300	1.9	168	76,864	417	27.9	27.0	0.4	43.3	20.8	5.70	2.02	0.28
2020	600	1.7	191	76,883	417	23.1	22.4	0.5	36.9	17.3	4.72	2.02	0.223
2025	300	2.0	109	76,890	281	17.9	17.4	0.4	34.8	13.4	3.66	2.02	0.283
2025	600	1.9	122	76,904	278	14.7	14.3	0.4	29.5	11.0	3.01	2.02	0.219
2030	300	2.0	68	76,909	177	10.7	10.4	0.4	28.5	8.0	2.19	2.02	0.305
2030	600	1.9	77	76,916	176	9.1	8.8	0.4	26.4	6.8	1.85	2.02	0.220

Table B - 8 Agricultural other equipment EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	50	1.2	981	76,295	815	144.3	140.0	106.8	234.2	108.0	29.5	2.02	0.243
2000	100	1.1	783	76,463	1,290	190.3	184.6	107.0	186.7	142.4	38.9	2.02	0.296
2000	300	1.0	665	76,515	1,172	168.5	163.5	107.1	160.4	126.1	34.4	2.02	0.219
2000	600	0.9	727	76,484	1,224	176.3	171.0	107.0	170.9	131.9	36.0	2.02	0.219
2000	750	0.9	727	76,484	1,224	176.3	171.0	107.0	170.9	131.9	36.0	2.02	0.219
2005	50	1.6	692	76,553	711	112.0	108.6	107.1	147.7	83.8	22.9	2.02	0.243
2005	100	1.5	686	76,584	1,159	147.3	142.9	107.2	142.4	110.2	30.1	2.02	0.26
2005	300	1.5	484	76,654	985	114.0	110.5	107.3	113.9	85.3	23.3	2.02	0.219
2005	600	1.2	576	76,622	1,050	129.6	125.8	107.2	124.5	97.0	26.5	2.02	0.219
2005	750	1.2	576	76,622	1,050	129.6	125.8	107.2	124.5	97.0	26.5	2.02	0.219
2010	50	2.6	405	76,772	631	67.4	65.4	7.8	73.9	50.4	13.8	2.02	0.243
2010	100	2.0	610	76,696	994	105.2	102.1	7.8	102.3	78.7	21.5	2.02	0.279
2010	300	1.8	344	76,766	773	67.3	65.3	7.8	76.0	50.3	13.8	2.02	0.219
2010	600	1.5	444	76,737	847	82.3	79.8	7.8	85.5	61.6	16.8	2.02	0.219
2010	750	1.5	444	76,737	847	82.3	79.8	7.8	85.5	61.6	16.8	2.02	0.219
2015	50	2.9	230	76,864	551	39.2	38.0	0.5	43.3	29.3	8.0	2.02	0.243
2015	100	2.1	460	76,787	804	74.2	71.9	0.5	76.0	55.5	15.2	2.02	0.287
2015	300	2.0	208	76,838	544	41.9	40.7	0.5	52.8	31.4	8.6	2.02	0.219
2015	600	1.6	303	76,822	628	49.9	48.4	0.5	57.0	37.3	10.2	2.02	0.219
2015	750	1.6	303	76,822	628	49.9	48.4	0.5	57.0	37.3	10.2	2.02	0.219
2020	50	2.3	107	76,910	463	16.4	15.9	0.4	27.4	12.3	3.36	2.02	0.243
2020	100	2.2	319	76,853	653	47.2	45.8	0.5	55.9	35.3	9.65	2.02	0.313
2020	300	2.1	128	76,880	353	25.3	24.6	0.4	38.0	18.9	5.17	2.02	0.219
2020	600	1.8	196	76,872	432	31.3	30.4	0.5	40.1	23.4	6.40	2.02	0.219
2020	750	1.8	196	76,872	432	31.3	30.4	0.5	40.1	23.4	6.40	2.02	0.219
2025	50	1.8	47	76,929	405	5.7	5.5	0.4	21.1	4.2	1.16	2.02	0.243
2025	100	2.0	215	76,895	530	28.0	27.2	0.4	41.1	21.0	5.73	2.02	0.268
2025	300	2.0	78	76,905	211	14.2	13.7	0.4	29.5	10.6	2.90	2.02	0.219
2025	600	1.9	127	76,899	285	19.4	18.8	0.4	31.7	14.5	3.97	2.02	0.219
2025	750	1.9	127	76,899	285	19.4	18.8	0.4	31.7	14.5	3.97	2.02	0.219
2030	50	1.7	35	76,933	392	3.3	3.2	0.4	19.0	2.4	0.67	2.02	0.243
2030	100	2.1	129	76,918	444	14.9	14.5	0.4	32.7	11.2	3.05	2.02	0.274
2030	300	1.9	42	76,919	121	6.8	6.6	0.4	25.3	5.1	1.40	2.02	0.219
2030	600	1.9	80	76,914	179	11.5	11.1	0.4	26.4	8.6	2.35	2.02	0.219
2030	750	1.9	80	76,914	179	11.5	11.1	0.4	26.4	8.6	2.35	2.02	0.219

Table B - 9 Commercial gas compressors EF (g/mmBtu CNG)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	50	4,486	5,213	47,027	1165.0	5.9	5.9	0.3	969.6	0.58	4.97	1.96	0.431
2000	100	4,486	5,213	47,027	1165.0	5.9	5.9	0.3	969.6	0.58	4.97	1.96	0.431
2000	300	4,486	5,213	47,027	1165.0	5.9	5.9	0.3	969.6	0.58	4.97	1.96	0.431
2000	600	4,486	5,213	47,027	1165.0	5.9	5.9	0.3	969.6	0.58	4.97	1.96	0.431
2005	50	1,832	5,689	51,602	426.7	7.4	7.4	0.3	395.6	0.72	6.21	1.96	0.345
2005	100	1,832	5,689	51,602	426.7	7.4	7.4	0.3	395.6	0.72	6.21	1.96	0.345
2005	300	1,832	5,689	51,602	426.7	7.4	7.4	0.3	395.6	0.72	6.21	1.96	0.345
2005	600	1,832	5,689	51,602	426.7	7.4	7.4	0.3	395.6	0.72	6.21	1.96	0.345
2010	50	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2010	100	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2010	300	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2010	600	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2015	50	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2015	100	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2015	300	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2015	600	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2020	50	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2020	100	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2020	300	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2020	600	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2025	50	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2025	100	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2025	300	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2025	600	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2030	50	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2030	100	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2030	300	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345
2030	600	269	628	56,239	120.6	7.4	7.4	0.3	58.0	0.72	6.21	1.96	0.345

Table B - 10 Commercial pumps EF (g/mmBtu gasoline)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	50	77.4	9,980	76,150	1,041	6.1	5.6	10.9	568	0.55	4.68	1.96	0.416
2000	175	76.3	9,799	76,168	1,039	6.0	5.5	10.9	530	0.54	4.61	1.96	0.417
2005	50	67.0	9,031	76,311	886	6.4	5.8	4.0	512	0.57	4.89	1.96	0.399
2005	175	70.5	9,290	76,260	945	6.2	5.7	4.0	497	0.55	4.74	1.96	0.406
2010	50	33.4	4,827	76,776	580	7.0	6.5	1.7	306	0.63	5.42	1.96	0.36
2010	175	49.5	6,526	76,509	852	6.5	6.0	1.7	386	0.59	5.03	1.96	0.383
2015	50	11.3	2,047	77,153	238	7.5	6.9	1.3	132	0.67	5.78	1.96	0.338
2015	175	34.5	4,752	76,754	622	6.9	6.3	1.3	283	0.62	5.31	1.96	0.364
2020	50	6.1	1,329	77,248	151	7.6	7.0	0.5	82	0.68	5.85	1.96	0.334
2020	175	21.1	3,187	76,986	396	7.2	6.6	0.5	188	0.65	5.55	1.96	0.349
2025	50	5.3	1,205	77,263	137	7.6	7.0	0.5	74	0.68	5.86	1.96	0.334
2025	175	11.3	1,971	77,158	236	7.4	6.8	0.5	116	0.66	5.70	1.96	0.339
2030	50	5.3	1,204	77,263	137	7.6	7.0	0.5	74	0.68	5.87	1.96	0.334
2030	175	7.8	1,527	77,218	179	7.5	6.9	0.5	90	0.67	5.77	1.96	0.336

Table B - 11 Commercial hydropower EF (g/mmBtu gasoline)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	50	78.3	10,122	76,136	1,043	6.1	5.7	10.9	539	0.55	4.73	1.96	0.339
2000	175	77.1	9,929	76,155	1,041	6.0	5.5	10.8	525	0.54	4.65	1.96	0.339
2005	50	61.7	8,571	76,389	810	6.6	6.1	4.0	448	0.59	5.07	1.96	0.316
2005	175	68.3	9,133	76,292	907	6.3	5.8	4.0	476	0.57	4.87	1.96	0.316
2010	50	14.5	2,657	77,093	286	7.5	6.9	1.7	154	0.68	5.81	1.96	0.277
2010	175	39.2	5,446	76,681	674	6.9	6.3	1.7	311	0.61	5.25	1.96	0.277
2015	50	5.6	1,270	77,256	142	7.7	7.1	1.3	75	0.69	5.92	1.96	0.272
2015	175	15.9	2,645	77,072	315	7.4	6.8	1.3	153	0.66	5.68	1.96	0.272
2020	50	5.4	1,219	77,261	137	7.7	7.1	0.5	71	0.69	5.93	1.96	0.27
2020	175	7.9	1,559	77,215	181	7.5	6.9	0.4	90	0.67	5.77	1.96	0.27
2025	50	5.4	1,219	77,261	137	7.7	7.1	0.5	72	0.69	5.93	1.96	0.271
2025	175	5.6	1,248	77,259	142	7.6	7.0	0.4	72	0.68	5.87	1.96	0.271
2030	50	5.4	1,219	77,261	137	7.7	7.1	0.5	72	0.69	5.93	1.96	0.271
2030	175	5.2	1,199	77,264	136	7.6	7.0	0.5	69	0.68	5.84	1.96	0.271

Table B - 12 Commercial air compressors EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	50	1.1	614	76,365	847.1	114.4	111.0	106.9	211.0	85.61	23.39	2.02	0.175
2000	100	0.9	483	76,609	881.8	109.8	106.5	107.2	128.7	82.11	22.44	2.02	0.175
2000	300	0.8	347	76,712	1051.5	72.1	70.0	107.4	93.9	53.97	14.75	2.02	0.158
2000	600	0.7	466	76,669	1101.4	91.5	88.7	107.3	107.6	68.44	18.70	2.02	0.158
2005	50	1.7	344	76,708	695.7	75.0	72.8	107.4	96.0	56.13	15.34	2.02	0.175
2005	100	1.7	406	76,695	793.3	88.2	85.6	107.4	100.2	65.99	18.03	2.02	0.175
2005	300	1.7	215	76,787	877.7	50.4	48.9	107.5	68.6	37.71	10.30	2.02	0.158
2005	600	1.1	336	76,767	959.9	63.5	61.6	107.4	76.0	47.54	12.99	2.02	0.158
2010	50	3.2	233	76,845	632.3	46.4	45.0	7.8	49.6	34.71	9.49	2.02	0.175
2010	100	2.5	352	76,791	651.4	60.4	58.6	7.8	68.6	45.22	12.36	2.02	0.175
2010	300	2.2	139	76,852	635.1	29.3	28.4	7.8	47.5	21.89	5.98	2.02	0.158
2010	600	1.6	242	76,834	757.6	37.3	36.2	7.8	52.8	27.92	7.63	2.02	0.158
2015	50	2.8	142	76,894	529.1	23.7	22.9	0.5	32.7	17.70	4.84	2.02	0.175
2015	100	2.4	243	76,864	432.5	37.7	36.5	0.5	43.3	28.18	7.70	2.02	0.175
2015	300	2.3	82	76,890	387.8	16.6	16.1	0.5	34.8	12.39	3.39	2.02	0.158
2015	600	1.8	147	76,884	522.9	22.3	21.7	0.5	36.9	16.71	4.56	2.02	0.158
2020	50	1.9	39	76,927	413.0	5.9	5.8	0.4	21.1	4.43	1.21	2.02	0.175
2020	100	2.1	141	76,908	223.4	19.8	19.2	0.4	28.5	14.84	4.06	2.02	0.175
2020	300	2.1	43	76,915	194.4	8.6	8.3	0.4	26.4	6.40	1.75	2.02	0.158
2020	600	1.9	90	76,906	328.3	13.7	13.3	0.4	29.5	10.24	2.80	2.02	0.158
2025	50	1.7	22	76,933	394.2	3.0	3.0	0.4	19.0	2.28	0.62	2.02	0.175
2025	100	1.8	63	76,927	96.5	6.3	6.1	0.4	22.2	4.74	1.29	2.02	0.175
2025	300	1.9	19	76,924	90.0	3.3	3.2	0.4	23.2	2.46	0.67	2.02	0.158
2025	600	1.9	53	76,918	191.0	8.1	7.8	0.4	25.3	6.04	1.65	2.02	0.158
2030	50	1.7	21	76,933	393.1	2.9	2.8	0.4	19.0	2.16	0.59	2.02	0.175
2030	100	1.7	42	76,932	51.9	2.8	2.7	0.4	21.1	2.07	0.56	2.02	0.175
2030	300	1.9	14	76,926	52.6	2.0	1.9	0.4	23.2	1.46	0.40	2.02	0.158
2030	600	1.9	27	76,924	107.5	4.0	3.8	0.4	23.2	2.96	0.81	2.02	0.158

Table B - 13 Commercial generators EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	50	1.18	656	76,298	876	117.4	113.9	106.8	233.2	87.84	24.00	2.02	0.175
2000	100	0.88	538	76,572	930	116.9	113.4	107.2	141.4	87.49	23.90	2.02	0.175
2000	300	0.80	471	76,628	1090	98.1	95.2	107.2	122.4	73.42	20.06	2.02	0.158
2000	600	0.70	480	76,645	1105	89.8	87.1	107.3	116.1	67.21	18.36	2.02	0.158
2005	50	1.46	518	76,485	793	98.9	95.9	107.0	170.9	73.99	20.22	2.02	0.175
2005	100	1.35	473	76,635	860	100.8	97.8	107.3	120.3	75.41	20.60	2.02	0.175
2005	300	1.34	357	76,698	979	76.8	74.5	107.4	98.1	57.43	15.69	2.02	0.158
2005	600	1.09	371	76,729	983	68.3	66.2	107.4	87.6	51.07	13.95	2.02	0.158
2010	50	2.23	390	76,649	720	71.0	68.9	7.8	116.1	53.15	14.52	2.02	0.175
2010	100	1.87	419	76,708	753	76.9	74.6	7.8	96.0	57.56	15.73	2.02	0.175
2010	300	1.69	264	76,771	812	49.7	48.2	7.8	74.9	37.19	10.16	2.02	0.158
2010	600	1.46	280	76,799	811	42.7	41.5	7.8	65.4	31.97	8.74	2.02	0.158
2015	50	2.45	250	76,790	617	46.4	45.0	0.5	67.5	34.74	9.49	2.02	0.175
2015	100	1.96	323	76,780	588	57.2	55.4	0.5	71.7	42.75	11.68	2.02	0.175
2015	300	1.83	171	76,830	611	32.3	31.3	0.5	54.9	24.16	6.60	2.02	0.158
2015	600	1.62	187	76,852	609	26.9	26.0	0.5	47.5	20.09	5.49	2.02	0.158
2020	50	2.39	150	76,867	525	28.1	27.3	0.4	42.2	21.02	5.74	2.02	0.175
2020	100	2.00	234	76,837	422	39.8	38.6	0.5	52.8	29.78	8.14	2.02	0.175
2020	300	1.94	106	76,870	419	21.2	20.5	0.5	41.1	15.84	4.33	2.02	0.158
2020	600	1.77	119	76,889	418	17.0	16.5	0.5	34.8	12.74	3.48	2.02	0.158
2025	50	2.11	85	76,904	460	14.9	14.4	0.4	29.5	11.12	3.04	2.02	0.175
2025	100	2.00	167	76,879	288	26.0	25.2	0.4	39.0	19.43	5.31	2.02	0.175
2025	300	2.00	69	76,895	279	13.5	13.1	0.4	33.8	10.11	2.76	2.02	0.158
2025	600	1.89	77	76,906	275	10.9	10.6	0.4	29.5	8.14	2.22	2.02	0.158
2030	50	1.83	41	76,925	414	6.8	6.6	0.4	22.2	5.05	1.38	2.02	0.175
2030	100	1.92	114	76,905	184	15.9	15.5	0.4	29.5	11.92	3.26	2.02	0.175
2030	300	1.97	43	76,911	173	8.1	7.8	0.4	27.4	6.05	1.65	2.02	0.158
2030	600	1.90	49	76,917	172	6.7	6.5	0.4	25.3	5.04	1.38	2.02	0.158

Table B - 14 Mining bore drill rigs EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	50	1.17	650	76,312	871	118.1	114.5	106.8	228.9	88.33	24.14	2.02	0.176
2000	100	0.82	534	76,615	1,362	118.2	114.6	107.2	132.9	88.42	24.16	2.02	0.175
2000	300	0.75	467	76,653	1,265	99.2	96.2	107.3	113.9	74.18	20.27	2.02	0.158
2000	600	0.65	486	76,664	1,291	93.1	90.3	107.3	109.7	69.68	19.04	2.02	0.158
2000	750	0.61	486	76,670	1,284	93.9	91.1	107.3	107.6	70.27	19.20	2.02	0.158
2005	50	1.51	476	76,542	768	94.0	91.1	107.1	151.9	70.29	19.21	2.02	0.176
2005	100	1.32	471	76,683	1,226	102.8	99.7	107.3	115.0	76.91	21.01	2.02	0.175
2005	300	1.30	352	76,716	1,083	77.1	74.8	107.4	92.8	57.66	15.76	2.02	0.158
2005	600	1.03	382	76,737	1,108	72.2	70.1	107.4	85.5	54.03	14.76	2.02	0.158
2005	750	0.91	398	76,744	1,104	73.4	71.2	107.4	83.3	54.93	15.01	2.02	0.158
2010	50	2.47	314	76,745	678	59.6	57.8	7.8	83.3	44.62	12.19	2.02	0.176
2010	100	1.87	417	76,750	1,051	78.9	76.5	7.8	92.8	59.01	16.12	2.02	0.175
2010	300	1.68	255	76,783	856	48.9	47.4	7.8	70.7	36.57	9.99	2.02	0.158
2010	600	1.41	291	76,799	885	46.4	45.0	7.8	64.4	34.72	9.49	2.02	0.158
2010	750	1.29	323	76,804	884	47.5	46.1	7.8	63.3	35.57	9.72	2.02	0.158
2015	50	2.76	195	76,850	579	36.8	35.7	0.5	47.5	27.54	7.52	2.02	0.176
2015	100	1.98	322	76,796	845	58.8	57.1	0.5	69.6	44.02	12.03	2.02	0.175
2015	300	1.85	165	76,838	621	32.3	31.4	0.5	52.8	24.20	6.61	2.02	0.158
2015	600	1.59	197	76,850	652	29.9	29.0	0.5	47.5	22.35	6.11	2.02	0.158
2015	750	1.50	226	76,854	651	30.9	30.0	0.5	46.4	23.11	6.31	2.02	0.158
2020	50	2.34	103	76,902	483	18.1	17.5	0.4	29.5	13.50	3.69	2.02	0.176
2020	100	2.05	230	76,845	683	39.9	38.7	0.5	50.6	29.83	8.15	2.02	0.175
2020	300	1.97	99	76,877	415	20.8	20.2	0.5	39.0	15.55	4.25	2.02	0.158
2020	600	1.76	127	76,887	446	19.1	18.5	0.5	35.9	14.30	3.91	2.02	0.158
2020	750	1.68	154	76,891	445	20.0	19.4	0.5	33.8	14.96	4.09	2.02	0.158
2025	50	1.88	42	76,926	416	6.9	6.7	0.4	21.1	5.13	1.40	2.02	0.176
2025	100	2.04	161	76,884	550	25.5	24.7	0.4	39.0	19.04	5.20	2.02	0.175
2025	300	2.05	63	76,899	264	12.8	12.4	0.4	31.7	9.57	2.61	2.02	0.158
2025	600	1.89	81	76,905	292	12.3	11.9	0.4	29.5	9.17	2.51	2.02	0.158
2025	750	1.83	107	76,907	293	12.8	12.4	0.4	28.5	9.59	2.62	2.02	0.158
2030	50	1.74	27	76,932	399	3.8	3.7	0.4	20.0	2.86	0.78	2.02	0.176
2030	100	2.08	108	76,909	457	15.0	14.6	0.4	32.7	11.25	3.07	2.02	0.175
2030	300	1.96	38	76,915	158	7.3	7.1	0.4	26.4	5.48	1.50	2.02	0.158
2030	600	1.90	52	76,916	181	7.6	7.4	0.4	26.4	5.69	1.55	2.02	0.158
2030	750	1.88	71	76,917	181	7.8	7.6	0.4	25.3	5.87	1.60	2.02	0.158

Table B - 15 Mining crawler tractor dozers EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	100	1.0	672	76,661	1,151	126.3	122.6	107.3	122.4	94.52	25.83	2.02	0.243
2000	300	0.8	391	76,756	940	69.9	67.8	107.4	79.1	52.32	14.29	2.02	0.219
2000	600	0.6	507	76,742	1,043	75.4	73.2	107.4	83.3	56.45	15.42	2.02	0.219
2000	1000	0.6	605	76,661	1,151	88.1	85.5	107.3	110.8	65.95	18.02	2.02	0.219
2000	2000	0.6	605	76,661	1,151	88.1	85.5	107.3	110.8	65.95	18.02	2.02	0.218
2005	100	2.1	545	76,745	1,012	94.6	91.8	107.4	86.5	70.77	19.34	2.02	0.243
2005	300	2.1	209	76,826	730	49.8	48.3	107.5	57.0	37.24	10.18	2.02	0.219
2005	600	1.3	360	76,833	835	52.4	50.8	107.5	52.8	39.19	10.71	2.02	0.219
2005	1000	0.8	430	76,745	1,012	66.7	64.7	107.4	82.3	49.91	13.64	2.02	0.219
2005	2000	0.8	430	76,745	1,012	66.7	64.7	107.4	82.3	49.91	13.64	2.02	0.218
2010	100	3.0	503	76,829	812	67.1	65.1	7.8	55.9	50.22	13.72	2.02	0.243
2010	300	2.8	177	76,869	514	34.2	33.1	7.8	42.2	25.56	6.98	2.02	0.219
2010	600	1.9	253	76,888	601	33.2	32.2	7.8	34.8	24.86	6.79	2.02	0.219
2010	1000	1.4	280	76,829	812	39.5	38.3	7.8	54.9	29.53	8.07	2.02	0.219
2010	2000	1.4	280	76,829	812	39.5	38.3	7.8	54.9	29.53	8.07	2.02	0.219
2015	100	2.4	304	76,900	579	39.6	38.4	0.5	43.3	29.60	8.09	2.02	0.243
2015	300	2.3	91	76,909	266	17.3	16.8	0.4	28.5	12.96	3.54	2.02	0.219
2015	600	2.1	145	76,911	363	20.3	19.7	0.5	27.4	15.18	4.15	2.02	0.219
2015	1000	2.4	190	76,865	579	24.1	23.4	0.5	43.3	18.03	4.93	2.02	0.219
2015	2000	2.4	190	76,865	579	24.1	23.4	0.5	43.3	18.03	4.93	2.02	0.218
2020	100	2.4	111	76,928	430	13.7	13.3	0.4	32.7	10.27	2.81	2.02	0.243
2020	300	1.9	30	76,925	97	4.1	4.0	0.4	23.2	3.10	0.85	2.02	0.219
2020	600	2.0	73	76,922	180	10.6	10.3	0.4	24.3	7.93	2.17	2.02	0.219
2020	1000	2.4	111	76,897	430	13.7	13.3	0.4	32.7	10.27	2.81	2.02	0.219
2020	2000	2.4	111	76,897	430	13.7	13.3	0.4	32.7	10.27	2.81	2.02	0.219
2025	100	2.2	57	76,934	365	7.6	7.4	0.4	26.4	5.72	1.56	2.02	0.243
2025	300	1.9	18	76,927	47	1.7	1.7	0.4	22.2	1.28	0.35	2.02	0.219
2025	600	1.9	33	76,926	81	3.7	3.6	0.4	23.2	2.79	0.76	2.02	0.219
2025	1000	2.2	54	76,915	365	7.6	7.4	0.4	26.4	5.72	1.56	2.02	0.219
2025	2000	2.2	54	76,915	365	7.6	7.4	0.4	26.4	5.72	1.56	2.02	0.219
2030	100	1.9	51	76,934	348	5.5	5.3	0.4	23.2	4.08	1.12	2.02	0.243
2030	300	1.9	17	76,927	40	1.5	1.4	0.4	22.2	1.11	0.30	2.02	0.219
2030	600	1.9	23	76,927	50	2.0	2.0	0.4	22.2	1.53	0.42	2.02	0.219
2030	1000	1.9	27	76,925	348	5.5	5.3	0.4	23.2	4.08	1.12	2.02	0.219
2030	2000	1.9	27	76,925	348	5.5	5.3	0.4	23.2	4.08	1.12	2.02	0.219

Table B - 16 Mining crushing processing equipment EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	50	1.13	606	76,381	841	113.9	110.4	106.9	205.7	85.18	23.27	2.02	0.175
2000	100	0.92	488	76,639	1303	106.8	103.6	107.3	124.5	79.87	21.82	2.02	0.175
2000	300	0.76	317	76,734	1071	65.2	63.2	107.4	86.5	48.76	13.32	2.02	0.158
2000	600	0.62	438	76,702	1211	83.6	81.1	107.4	97.1	62.54	17.09	2.02	0.158
2000	1000	0.61	488	76,639	1303	91.9	89.1	107.3	118.2	68.74	18.78	2.02	0.157
2005	50	1.76	307	76,752	676	69.8	67.7	107.4	81.2	52.24	14.27	2.02	0.175
2005	100	1.77	392	76,725	1133	85.2	82.6	107.4	96.0	63.74	17.42	2.02	0.175
2005	300	1.75	187	76,804	853	46.4	45.0	107.5	63.3	34.71	9.49	2.02	0.158
2005	600	1.14	303	76,794	981	54.8	53.2	107.5	66.5	41.03	11.21	2.02	0.158
2005	1000	0.71	340	76,725	1133	63.7	61.8	107.4	89.7	47.64	13.02	2.02	0.159
2010	50	3.43	224	76,857	626	44.7	43.4	7.78	46.4	33.47	9.14	2.02	0.175
2010	100	2.63	342	76,807	949	56.9	55.2	7.77	66.5	42.55	11.63	2.02	0.175
2010	300	2.35	130	76,860	603	27.2	26.4	7.78	45.4	20.37	5.57	2.02	0.158
2010	600	1.66	216	76,856	735	32.4	31.5	7.78	46.4	24.27	6.63	2.02	0.158
2010	1000	1.22	244	76,795	949	39.7	38.5	7.77	66.5	29.71	8.12	2.02	0.158
2015	50	2.76	132	76,898	517	21.6	20.9	0.45	31.7	16.13	4.41	2.02	0.175
2015	100	2.52	230	76,879	709	33.7	32.6	0.47	51.7	25.18	6.88	2.02	0.175
2015	300	2.34	74	76,899	342	14.7	14.2	0.45	31.7	10.97	3.00	2.02	0.158
2015	600	1.89	127	76,896	482	18.8	18.2	0.47	32.7	14.06	3.84	2.02	0.158
2015	1000	2.09	162	76,842	709	25.6	24.8	0.47	51.7	19.15	5.23	2.02	0.158
2020	50	1.79	32	76,929	405	4.6	4.5	0.38	20.0	3.47	0.95	2.02	0.175
2020	100	2.24	118	76,918	537	16.0	15.5	0.43	38.0	11.95	3.26	2.02	0.175
2020	300	2.04	34	76,919	157	6.5	6.3	0.40	25.3	4.84	1.32	2.02	0.158
2020	600	1.98	74	76,913	280	11.2	10.9	0.43	27.4	8.40	2.29	2.02	0.158
2020	1000	2.24	96	76,882	537	16.0	15.5	0.43	38.0	11.95	3.26	2.02	0.158
2025	50	1.69	21	76,934	393	2.9	2.8	0.37	19.0	2.17	0.59	2.02	0.175
2025	100	2.26	58	76,930	425	10.4	10.1	0.40	30.6	7.77	2.12	2.02	0.175
2025	300	1.91	16	76,925	66	2.5	2.4	0.38	23.2	1.87	0.51	2.02	0.158
2025	600	1.94	40	76,922	149	6.0	5.8	0.40	24.3	4.48	1.23	2.02	0.158
2025	1000	2.26	58	76,903	425	10.4	10.1	0.40	30.6	7.77	2.12	2.02	0.157
2030	50	1.69	21	76,933	393	2.9	2.8	0.37	19.0	2.17	0.59	2.02	0.175
2030	100	2.07	37	76,933	373	6.9	6.7	0.38	26.4	5.17	1.41	2.02	0.175
2030	300	1.88	12	76,927	46	1.6	1.6	0.37	22.2	1.21	0.33	2.02	0.158
2030	600	1.90	21	76,926	78	2.9	2.8	0.38	23.2	2.15	0.59	2.02	0.158
2030	1000	2.07	31	76,917	373.4	6.9	6.7	0.38	26.4	5.17	1.41	2.02	0.158

Table B - 17 Mining excavators EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	100	1.06	666	76,679	1,142	125.4	121.6	107.3	120.3	93.81	25.63	2.02	0.243
2000	600	0.60	496	76,770	1,019	73.8	71.6	107.5	73.9	55.20	15.08	2.02	0.219
2000	1000	0.57	607	76,679	1,142	88.3	85.7	107.3	104.5	66.08	18.05	2.02	0.219
2000	2000	0.57	607	76,679	1,142	88.3	85.7	107.3	104.5	66.08	18.05	2.02	0.219
2000	3000	0.57	607	76,679	1,142	88.3	85.7	107.3	104.5	66.08	18.05	2.02	0.22
2005	100	2.26	523	76,761	989	89.6	86.9	107.4	80.2	67.03	18.31	2.02	0.243
2005	600	1.38	325	76,859	793	47.2	45.8	107.6	44.3	35.35	9.66	2.02	0.219
2005	1000	0.78	403	76,761	989	63.5	61.6	107.4	77.0	47.53	12.99	2.02	0.219
2005	2000	0.78	403	76,761	989	63.5	61.6	107.4	77.0	47.54	12.99	2.02	0.219
2005	3000	0.78	403	76,761	989	63.5	61.6	107.4	77.0	47.54	12.99	2.02	0.219
2010	100	3.19	500	76,849	771	64.3	62.4	7.78	52.8	48.09	13.14	2.02	0.243
2010	600	2.06	235	76,897	561	31.3	30.4	7.78	32.7	23.42	6.40	2.02	0.219
2010	1000	1.52	235	76,849	771	34.5	33.4	7.78	48.5	25.79	7.05	2.02	0.219
2010	2000	1.52	235	76,849	771	34.5	33.4	7.78	48.5	25.79	7.05	2.02	0.219
2010	3000	1.52	235	76,849	771	34.5	33.4	7.78	48.5	25.79	7.05	2.02	0.218
2015	100	2.61	280	76,909	535	37.2	36.1	0.45	41.1	27.84	7.61	2.02	0.243
2015	600	2.09	127	76,916	318	18.8	18.2	0.45	26.4	14.05	3.84	2.02	0.219
2015	1000	2.61	176	76,873	535	21.5	20.9	0.45	41.1	16.09	4.40	2.02	0.219
2015	2000	2.61	176	76,873	535	21.5	20.9	0.45	41.1	16.09	4.40	2.02	0.219
2015	3000	2.61	176	76,873	535	21.5	20.9	0.45	41.1	16.09	4.40	2.02	0.218
2020	100	2.51	96	76,932	397	11.4	11.0	0.40	31.7	8.52	2.33	2.02	0.243
2020	600	1.95	54	76,924	143	7.6	7.4	0.40	23.2	5.70	1.56	2.02	0.219
2020	1000	2.51	96	76,901	397	11.4	11.0	0.40	31.7	8.52	2.33	2.02	0.219
2020	2000	2.51	96	76,901	397	11.4	11.0	0.40	31.7	8.52	2.33	2.02	0.219
2020	3000	2.51	96	76,901	397	11.4	11.0	0.40	31.7	8.52	2.33	2.02	0.22
2025	100	2.05	52	76,934	354	6.4	6.2	0.38	24.3	4.77	1.30	2.02	0.243
2025	600	1.88	27	76,927	62	2.8	2.7	0.38	22.2	2.10	0.57	2.02	0.219
2025	1000	2.05	39	76,921	354	6.4	6.2	0.38	24.3	4.77	1.30	2.02	0.219
2025	2000	2.05	39	76,921	354	6.4	6.2	0.38	24.3	4.77	1.30	2.02	0.219
2025	3000	2.05	39	76,921	354	6.4	6.2	0.38	24.3	4.77	1.30	2.02	0.219
2030	100	1.91	51	76,934	345	5.1	4.9	0.37	23.2	3.81	1.04	2.02	0.243
2030	600	1.86	21	76,927	44	1.6	1.5	0.37	22.2	1.19	0.32	2.02	0.219
2030	1000	1.91	23	76,926	345	5.1	4.9	0.37	23.2	3.81	1.04	2.02	0.219
2030	2000	1.91	23	76,926	345	5.1	4.9	0.37	23.2	3.81	1.04	2.02	0.219
2030	3000	1.91	23	76,926	345.0	5.1	4.9	0.37	23.2	3.81	1.04	2.02	0.218

Table B - 18 Mining off-highway tractor EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	300	0.83	781	76,734	1,195	112.1	108.8	107.4	132.9	83.88	22.92	2.02	0.219
2000	600	0.72	690	76,672	1,094	100.3	97.3	107.3	107.6	75.08	20.51	2.02	0.219
2000	1000	0.69	781	76,596	1,195	112.1	108.8	107.2	132.9	83.88	22.92	2.02	0.219
2000	2000	0.69	781	76,596	1,195	112.1	108.8	107.2	132.9	83.88	22.92	2.02	0.219
2000	3000	0.69	781	76,596	1,195	112.1	108.8	107.2	132.9	83.88	22.92	2.02	0.218
2005	100	1.99	493	76,822	1,033	74.6	72.4	107.5	90.7	55.81	15.25	2.02	0.219
2005	600	1.27	426	76,805	867	61.3	59.4	107.5	62.2	45.85	12.53	2.02	0.219
2005	1000	0.77	493	76,722	1,033	74.6	72.4	107.4	90.7	55.81	15.25	2.02	0.219
2005	2000	0.77	493	76,722	1,033	74.6	72.4	107.4	90.7	55.81	15.25	2.02	0.219
2005	3000	0.77	493	76,722	1,033	74.6	72.4	107.4	90.7	55.81	15.25	2.02	0.219
2010	100	2.66	314	76,866	836	43.7	42.4	7.78	60.1	32.69	8.93	2.02	0.219
2010	600	1.84	276	76,878	627	36.1	35.1	7.78	38.0	27.04	7.39	2.02	0.219
2010	1000	1.36	314	76,814	836	43.7	42.4	7.77	60.1	32.69	8.93	2.02	0.219
2010	2000	1.36	314	76,814	836	43.7	42.4	7.77	60.1	32.69	8.93	2.02	0.219
2010	3000	1.36	314	76,814	836	43.7	42.4	7.77	60.1	32.69	8.93	2.02	0.219
2015	100	2.31	200	76,907	603	25.7	25.0	0.46	45.4	19.25	5.26	2.02	0.219
2015	600	2.03	155	76,907	389	21.4	20.7	0.46	28.5	15.99	4.37	2.02	0.219
2015	1000	2.31	200	76,860	603	25.7	25.0	0.46	45.4	19.25	5.26	2.02	0.219
2015	2000	2.31	200	76,861	603	25.7	25.0	0.46	45.4	19.25	5.26	2.02	0.219
2015	3000	2.31	200	76,860	603	25.7	25.0	0.46	45.4	19.25	5.26	2.02	0.219
2020	100	2.39	120	76,924	451	15.3	14.8	0.41	33.8	11.42	3.12	2.02	0.219
2020	600	1.98	83	76,920	203	12.2	11.9	0.42	24.3	9.16	2.50	2.02	0.219
2020	1000	2.39	120	76,894	451	15.3	14.8	0.41	33.8	11.42	3.12	2.02	0.219
2020	2000	2.39	120	76,894	451	15.3	14.8	0.41	33.8	11.42	3.12	2.02	0.219
2020	3000	2.39	120	76,894	451	15.3	14.8	0.41	33.8	11.42	3.12	2.02	0.219
2025	100	2.23	63	76,927	374	8.6	8.3	0.38	28.5	6.40	1.75	2.02	0.219
2025	600	1.90	38	76,926	96	4.5	4.3	0.38	23.2	3.34	0.91	2.02	0.219
2025	1000	2.23	63	76,911	374	8.6	8.3	0.38	28.5	6.40	1.75	2.02	0.219
2025	2000	2.23	63	76,911	374	8.6	8.3	0.38	28.5	6.40	1.75	2.02	0.219
2025	3000	2.23	63	76,911	374	8.6	8.3	0.38	28.5	6.40	1.75	2.02	0.218
2030	100	1.96	31	76,927	352	5.8	5.6	0.38	24.3	4.35	1.19	2.02	0.219
2030	600	1.87	25	76,927	55	2.4	2.4	0.38	22.2	1.81	0.50	2.02	0.219
2030	1000	1.96	31	76,924	352	5.8	5.6	0.38	24.3	4.35	1.19	2.02	0.219
2030	2000	1.96	31	76,924	352	5.8	5.6	0.38	24.3	4.35	1.19	2.02	0.219
2030	3000	1.96	31	76,923	352	5.8	5.6	0.38	24.3	4.35	1.19	2.02	0.219

Table B - 19 Mining off-highway trucks EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	300	0.99	594	76,814	1113	80.9	78.5	107.5	103.4	60.55	16.54	2.02	0.219
2000	600	0.63	440	76,803	949	60.2	58.4	107.5	63.3	45.07	12.32	2.02	0.219
2000	1000	0.60	594	76,681	1113	80.9	78.5	107.3	103.4	60.55	16.54	2.02	0.219
2000	2000	0.60	594	76,681	1113	80.9	78.5	107.3	103.4	60.55	16.54	2.02	0.219
2000	3000	0.60	594	76,681	1113	80.9	78.5	107.3	103.4	60.55	16.54	2.02	0.219
2005	100	2.76	312	76,839	929	54.1	52.4	107.6	65.4	40.43	11.05	2.02	0.219
2005	600	1.67	261	76,891	714	38.4	37.2	107.6	33.8	28.72	7.85	2.02	0.219
2005	1000	0.87	312	76,796	929	54.1	52.4	107.5	65.4	40.43	11.05	2.02	0.219
2005	2000	0.87	312	76,796	929	54.1	52.4	107.5	65.4	40.43	11.05	2.02	0.219
2005	3000	0.87	312	76,796	929	54.1	52.4	107.5	65.4	40.43	11.05	2.02	0.219
2010	100	2.82	190	76,888	702	33.9	32.9	7.78	39.0	25.37	6.93	2.02	0.219
2010	600	2.32	208	76,907	480	30.0	29.1	7.78	28.5	22.48	6.14	2.02	0.219
2010	1000	1.77	190	76,876	702	28.9	28.1	7.78	39.0	21.65	5.92	2.02	0.219
2010	2000	1.77	190	76,876	702	28.9	28.1	7.78	39.0	21.65	5.92	2.02	0.219
2010	3000	1.77	190	76,876	702	28.9	28.1	7.78	39.0	21.65	5.92	2.02	0.219
2015	100	3.04	159	76,924	445	16.8	16.3	0.42	39.0	12.55	3.43	2.02	0.219
2015	600	2.08	92	76,921	233	14.6	14.1	0.42	24.3	10.90	2.98	2.02	0.219
2015	1000	3.04	159	76,882	445	16.8	16.3	0.42	39.0	12.55	3.43	2.02	0.219
2015	2000	3.04	159	76,882	445	16.8	16.3	0.42	39.0	12.55	3.43	2.02	0.219
2015	3000	3.04	159	76,882	445	16.8	16.3	0.42	39.0	12.55	3.43	2.02	0.219
2020	100	2.37	65	76,927	354	7.74	7.51	0.38	28.5	5.79	1.58	2.02	0.219
2020	600	1.88	28	76,927	75	2.98	2.89	0.38	22.2	2.23	0.61	2.02	0.219
2020	1000	2.37	65	76,910	354	7.74	7.51	0.38	28.5	5.79	1.58	2.02	0.219
2020	2000	2.37	65	76,910	354	7.74	7.51	0.38	28.5	5.79	1.58	2.02	0.219
2020	3000	2.37	65	76,910	354	7.74	7.51	0.38	28.5	5.79	1.58	2.02	0.219
2025	100	1.91	23	76,927	344	5.11	4.95	0.37	23.2	3.82	1.04	2.02	0.219
2025	600	1.86	20	76,927	42	1.50	1.45	0.37	22.2	1.11	0.30	2.02	0.219
2025	1000	1.91	23	76,926	344	5.11	4.95	0.37	23.2	3.82	1.04	2.02	0.219
2025	2000	1.91	23	76,926	344	5.11	4.95	0.37	23.2	3.82	1.04	2.02	0.219
2025	3000	1.91	23	76,926	344	5.11	4.95	0.37	23.2	3.82	1.04	2.02	0.219
2030	100	1.86	19	76,927	344	4.90	4.75	0.37	22.2	3.66	1.00	2.02	0.219
2030	600	1.86	20	76,927	40	1.50	1.45	0.37	22.2	1.11	0.30	2.02	0.219
2030	1000	1.86	19	76,927	344	4.90	4.75	0.37	22.2	3.66	1.00	2.02	0.219
2030	2000	1.86	19	76,927	344	4.90	4.75	0.37	22.2	3.66	1.00	2.02	0.219
2030	3000	1.86	19	76,927	344	4.90	4.75	0.37	22.2	3.66	1.00	2.02	0.219

Table B - 20 Mining rubber tire loader EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	300	0.78	601	76,745	1183	101.9	98.8	107.4	105.5	76.21	20.82	2.02	0.219
2000	600	0.58	519	76,746	1090	91.2	88.5	107.4	82.3	68.25	18.65	2.02	0.219
2000	1000	0.56	601	76,677	1183	101.9	98.8	107.3	105.5	76.21	20.82	2.02	0.219
2000	2000	0.56	601	76,677	1183	101.9	98.8	107.3	105.5	76.21	20.82	2.02	0.219
2000	3000	0.56	601	76,677	1183	101.9	98.8	107.3	105.5	76.21	20.82	2.02	0.219
2005	100	1.87	460	76,811	1041	73.5	71.3	107.5	85.5	55.02	15.03	2.02	0.219
2005	600	1.17	399	76,813	888	61.5	59.6	107.5	60.1	46.00	12.57	2.02	0.219
2005	1000	0.72	460	76,736	1041	73.5	71.3	107.4	85.5	55.02	15.03	2.02	0.219
2005	2000	0.72	460	76,736	1041	73.5	71.3	107.4	85.5	55.02	15.03	2.02	0.219
2005	3000	0.72	460	76,736	1041	73.5	71.3	107.4	85.5	55.02	15.03	2.02	0.219
2010	100	2.52	332	76,861	864	46.8	45.4	7.8	62.2	35.02	9.57	2.02	0.219
2010	600	1.72	288	76,871	663	38.8	37.7	7.8	41.1	29.04	7.94	2.02	0.219
2010	1000	1.28	332	76,806	864	46.8	45.4	7.8	62.2	35.02	9.57	2.02	0.219
2010	2000	1.28	332	76,806	864	46.8	45.4	7.8	62.2	35.02	9.57	2.02	0.219
2010	3000	1.28	332	76,806	864	46.8	45.4	7.8	62.2	35.02	9.57	2.02	0.219
2015	100	2.35	216	76,902	636	28.4	27.6	0.5	47.5	21.25	5.81	2.02	0.219
2015	600	1.95	173	76,902	429	23.5	22.8	0.5	30.6	17.56	4.80	2.02	0.219
2015	1000	2.18	216	76,852	636	28.4	27.6	0.5	47.5	21.25	5.81	2.02	0.219
2015	2000	2.18	216	76,852	636	28.4	27.6	0.5	47.5	21.25	5.81	2.02	0.219
2015	3000	2.18	216	76,852	636	28.4	27.6	0.5	47.5	21.25	5.81	2.02	0.219
2020	100	2.30	134	76,921	485	17.6	17.0	0.4	35.9	13.13	3.59	2.02	0.219
2020	600	1.98	99	76,917	240	14.2	13.8	0.4	25.3	10.66	2.91	2.02	0.219
2020	1000	2.30	134	76,887	485	17.6	17.0	0.4	35.9	13.13	3.59	2.02	0.219
2020	2000	2.30	134	76,887	485	17.6	17.0	0.4	35.9	13.13	3.59	2.02	0.219
2020	3000	2.30	134	76,887	485	17.6	17.0	0.4	35.9	13.13	3.59	2.02	0.219
2025	100	2.25	77	76,926	393	10.2	9.9	0.4	29.5	7.67	2.09	2.02	0.219
2025	600	1.91	49	76,924	122	6.3	6.1	0.4	23.2	4.71	1.29	2.02	0.219
2025	1000	2.25	77	76,907	393	10.2	9.9	0.4	29.5	7.67	2.09	2.02	0.219
2025	2000	2.25	77	76,907	393	10.2	9.9	0.4	29.5	7.67	2.09	2.02	0.219
2025	3000	2.25	77	76,907	393	10.2	9.9	0.4	29.5	7.67	2.09	2.02	0.219
2030	100	1.98	36	76,927	359	6.4	6.2	0.4	24.3	4.81	1.31	2.02	0.219
2030	600	1.88	30	76,927	65	3.0	2.9	0.4	22.2	2.25	0.62	2.02	0.219
2030	1000	1.98	36	76,922	359	6.4	6.2	0.4	24.3	4.81	1.31	2.02	0.219
2030	2000	1.98	36	76,922	359	6.4	6.2	0.4	24.3	4.81	1.31	2.02	0.219
2030	3000	1.98	36	76,922	359	6.4	6.2	0.4	24.3	4.81	1.31	2.02	0.219

Table B - 21 Mining tractor loader backhoes EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	50	1.16	900	76,374	783	137.2	133.1	106.9	207.8	102.66	28.05	2.02	0.101
2000	100	0.96	676	76,677	1183	129.1	125.2	107.3	123.4	96.57	26.39	2.02	0.101
2000	300	0.78	601	76,745	1183	101.9	98.8	107.4	105.5	76.21	20.82	2.02	0.091
2005	50	1.88	446	76,761	628	83.5	81.0	107.4	78.1	62.47	17.07	2.02	0.101
2005	100	1.89	576	76,736	1041	101.7	98.6	107.4	95.0	76.08	20.79	2.02	0.101
2005	300	1.87	460	76,811	1041	73.5	71.3	107.5	85.5	55.02	15.03	2.02	0.091
2010	50	3.52	279	76,861	601	50.6	49.1	7.78	44.3	37.88	10.35	2.02	0.101
2010	100	2.79	512	76,810	864	71.5	69.4	7.77	62.2	53.52	14.62	2.02	0.101
2010	300	2.52	332	76,861	864	46.8	45.4	7.78	62.2	35.02	9.57	2.02	0.091
2015	50	2.66	132	76,902	502	20.3	19.7	0.44	30.6	15.22	4.16	2.02	0.101
2015	100	2.54	334	76,884	636	43.1	41.8	0.46	47.5	32.23	8.81	2.02	0.101
2015	300	2.35	216	76,902	636	28.4	27.6	0.46	47.5	21.25	5.81	2.02	0.091
2020	50	1.74	39	76,932	397	4.1	4.0	0.38	20.0	3.05	0.83	2.02	0.101
2020	100	2.30	156	76,922	485	18.1	17.6	0.42	35.9	13.56	3.70	2.02	0.101
2020	300	2.30	134	76,921	485	17.6	17.0	0.42	35.9	13.13	3.59	2.02	0.091
2025	50	1.68	33	76,934	389	2.9	2.8	0.37	19.0	2.16	0.59	2.02	0.101
2025	100	2.25	77	76,932	393	10.2	9.9	0.39	29.5	7.67	2.09	2.02	0.101
2025	300	2.25	77	76,926	393	10.2	9.9	0.39	29.5	7.67	2.09	2.02	0.091
2030	50	1.68	33	76,934	389	2.9	2.8	0.37	19.0	2.16	0.59	2.02	0.101
2030	100	1.98	53	76,934	359	6.4	6.2	0.38	24.3	4.81	1.31	2.02	0.101
2030	300	1.98	36	76,927	359	6.4	6.2	0.38	24.3	4.81	1.31	2.02	0.091

Table B - 22 Mining underground equipment EF (g/mmBtu diesel)

Year	HP	CH_4	CO	CO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	BC	OC	N_2O	Fuel consumption (lb/hr/hp)
2000	50	2.39	1,576	75,490	854	219.6	213.0	105.6	506	164.32	44.9	2.02	0.101
2000	100	1.34	1,065	76,148	1009	209.1	202.8	106.6	284	156.43	42.7	2.02	0.101
2000	300	1.12	960	76,288	1288	155.5	150.8	106.8	236	116.31	31.8	2.02	0.091
2000	600	1.24	978	76,209	1440	192.4	186.6	106.7	264	143.95	39.3	2.02	0.091
2005	50	3.57	1,325	75,794	788	194.1	188.3	106.1	404	145.24	39.7	2.02	0.101
2005	100	2.30	1,045	76,223	864	185.3	179.8	106.7	260	138.65	37.9	2.02	0.101
2005	300	2.49	826	76,403	1078	116.8	113.3	106.9	198	87.36	23.9	2.02	0.091
2005	600	1.98	821	76,385	1182	144.7	140.4	106.9	205	108.27	29.6	2.02	0.091
2010	50	6.18	718	76,482	640	118.4	114.8	7.73	174	88.58	24.2	2.02	0.101
2010	100	4.82	939	76,387	747	138.0	133.9	7.72	206	103.26	28.2	2.02	0.101
2010	300	4.90	615	76,523	864	78.9	76.5	7.73	159	59.02	16.1	2.02	0.091
2010	600	2.74	664	76,542	960	95.0	92.2	7.74	152	71.10	19.4	2.02	0.091
2015	50	7.10	491	76,727	587	90.8	88.1	0.52	92	67.92	18.6	2.02	0.101
2015	100	7.16	828	76,538	656	98.8	95.8	0.52	156	73.88	20.2	2.02	0.101
2015	300	7.06	419	76,624	686	53.2	51.6	0.52	127	39.83	10.9	2.02	0.091
2015	600	3.46	528	76,653	816	70.5	68.4	0.52	115	52.77	14.4	2.02	0.091
2020	50	7.22	462	76,757	581	87.4	84.8	0.52	82	65.40	17.9	2.02	0.101
2020	100	8.70	750	76,637	603	71.7	69.6	0.52	123	53.67	14.7	2.02	0.101
2020	300	8.29	305	76,678	591	39.5	38.3	0.52	110	29.56	8.1	2.02	0.091
2020	600	4.08	410	76,743	705	51.9	50.3	0.52	85	38.79	10.6	2.02	0.091
2025	50	7.22	462	76,757	581	87.5	84.8	0.52	82	65.42	17.9	2.02	0.101
2025	100	9.23	723	76,671	585	62.2	60.4	0.52	112	46.55	12.7	2.02	0.101
2025	300	8.71	265	76,697	558	34.7	33.7	0.52	103	25.96	7.1	2.02	0.091
2025	600	4.46	337	76,796	638	40.4	39.2	0.52	68	30.21	8.3	2.02	0.091
2030	50	7.22	462	76,757	581	87.5	84.9	0.52	82	65.45	17.9	2.02	0.101
2030	100	9.42	712	76,684	578	58.8	57.1	0.52	109	44.02	12.0	2.02	0.101
2030	300	8.86	251	76,704	546	33.1	32.1	0.52	101	24.74	6.8	2.02	0.091
2030	600	4.62	306	76,819	610.6	35.7	34.6	0.52	60.1	26.69	7.3	2.02	0.091

APPENDIX C: N_2O EMISSIONS FROM NONROAD DIESEL ENGINES AND EQUIPMENT

Engine	Intended Application	Fuel energy (MJ/kg)	Fuel energy (mmBtu/lb)	BSFC (lb/hp-hr)	N_2O (g/hp-hr)	N_2O (g/lb fuel)	N_2O (g/mmBtu)
Kubota V2203E	Forklift truck	43.717	0.019	0.438	0.012	0.0274	2.000
	Forklift truck	43.717	0.019	0.423	0.010	0.0236	1.258
	Forklift truck	43.717	0.019	0.440	0.020	0.0455	2.418
Cummins QSL9	Construction equipment	43.717	0.019	0.377	0.026	0.0690	3.669
Caterpillar 3408	Marine propulsion engine	43.717	0.019	0.359	0.008	0.0223	1.186
Deere 6068T	Motor grader	43.717	0.019	0.359	0.022	0.0613	3.261
Cummins M11C	Excavator	43.717	0.019	0.342	0.011	0.0322	1.711
Caterpillar 3196	Agricultural tractor	43.717	0.019	0.324	0.012	0.0370	1.971
Caterpillar 3408	Marine propulsion engine	43.717	0.019	0.373	0.006	0.0161	0.856

Data source: Helmer, Cook et al. (2004)