Greenhouse Gas Emissions Model (GEM) User Guide

United States
Environmental Protection
Agency

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

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The Greenhouse gas Emissions Model was developed by EPA as a means for determining compliance with the proposed GHG emissions and fuel consumption vehicle standards for Class 7 and 8 combination tractors and Class 2b-8 vocational vehicles developed by EPA and NHTSA respectively. The model itself is part of the proposed rule. See Section II.B.2 of the preamble and Chapter 4 of the draft RIA. It is a free, desktop computer application.

GEM is designed to operate on a single computer. The downloadable installation file located on the EPA website at http://www.epa.gov/otaq/climate/regulations.htm contains the application executable file and other supporting files, which will be described in this guide. To request a CD of this software instead of downloading it, or to request assistance if you have trouble with accessibility of this software, please contact:

Assessment and Standards (ASD) Hotline at:
734-214-4636 or
Email: ASDInfo@epa.gov

This user guide contains the model documentation with details on the model's input files, algorithms, and output files. It also includes instructions on how to use GEM. In addition, this document includes the input file which was used to determine the baseline and proposed greenhouse gas emissions and fuel efficiency standards for Class 7 and 8 tractors and Class 2b-8 heavy-duty vehicles. Some of the information provided here are also contained in Chapter 4 of the draft RIA.

1. GEM Documentation v1.0

This section describes the GEM vehicle model architecture, the list of pre-defined input parameters, output calculations, and the installation and usage of the MATLAB/Simulink version of GEM.

1.1. Vehicle Model Architecture

Table 1 outlines the Class 2b-8 vehicle compliance model architecture, which is comprised of six systems: Ambient, Driver, Electric, Engine, Transmission, and Vehicle. With the exception of "Ambient" and "Driver," each system consists of two to four component models. The function of each system and their respective component models, wherever applicable, is discussed in this section.

Table 1: Vehicle Model Architecture

System	Component Models
Ambient	none
Driver	none
Electric	Starter; Electrical Energy System; Alternator; Accessory (electrical)
Engine	Cylinder; Accessory (mechanical)
Transmission	Clutch; Gearbox
Vehicle	Chassis; Final Drive

- Ambient – This system defines ambient conditions such as pressure, temperature, and road gradient, where vehicle operations are simulated.
- Driver – GEM is a forward-looking driving model. Rather than constantly matching the exact drive cycle, the driver model considers the current speed and the desired future speed to try to predict the necessary power required to close the gap and follow the driving trace. If the driver misses the target, a different power request is sent to the engine and/or brakes are applied. This search for the proper vehicle speed occurs at every simulation time step. The feedback loop uses a PID controller.
- The "Electric" system consists of four components: *Starter, Electrical Energy System, Alternator, and Electrical Accessory*
  - Starter – This models the starter for the engine, which is identical for most vehicles.
  - Electrical Energy System – GEM simulates a standard 12 or 24 volt lead-acid battery, which provides currents to the starter and electrical systems for engine starting, lighting, and vehicle controls. This module estimates State-of-Charge (SOC), internal ohmic resistance and open circuit voltage, voltage and current of electrical energy storage system.
  - Alternator – This models the alternator that generates electricity for the battery and electrical system. The model calculates voltage and current of the AC alternator based on alternator performance maps and charge control strategy.
  - Electrical Accessory – All vehicles have a number of electrical loads, some of which are necessary to operate the vehicle. The engine control unit (ECU), fuel injectors and fuel pump for instance are electrical loads that are constantly on the battery, and these are already taken into account in the fuel map.
- The "Engine" system consists of two components: *Cylinder and Mechanical Accessory*
  - Cylinder – The cylinder model is based on a fuel map and torque curves at wide open throttle (full load) and closed throttle (no load). The engine fuel map features three sets of data: engine speed, torque, and fueling rate at pre-specified engine speed and torque intervals. The fuel map was developed from experimental results adjusted to reflect projected future engine performance. It is not a physics-based model and does not attempt to model in-cylinder combustion process. The engine torque and speed are used to select a fuel rate based on the fuel map. This map is adjusted automatically by taking into account three different driving types: acceleration, braking, and coasting. The fuel map, torque curves, and the different driving types can be adjusted by the user, but there are a number of default engines pre-programmed into GEM.

- Mechanical Accessory – Most vehicles run a number of accessories that are driven *via* mechanical power from the engine. Some of these accessories are necessary for the vehicle to run, like the coolant pump, while others are only used occasionally and at the operator's discretion such as the air conditioning compressor. Some heavy-duty vehicles also use Power Take Off (PTO) to operate auxiliary equipment, like booms, and these would also be modeled as a mechanical accessory.

- The manual "Transmission" system consists of two components: a *Clutch* and a *Gearbox*
    - Clutch – This component model simulates the clutch for a manual transmission.
    - Gearbox – A simple gearbox model is used for a manual transmission, and the number of gears and gear ratios are predefined for compliance purposes. This component model consists of a map using gearbox speed and torque as inputs to model the efficiency of each gear.
- The "Vehicle" system consists of two components: *Chassis and Final Drive*
    - Chassis – This portion models the shell of the vehicle including the tires. The drag coefficient, mass of the vehicle, frontal area and other parameters are housed in this component. For tire simulation, the user specifies the configuration of each axle on the vehicle, including the tire diameter and the rolling resistance.
    - Final Drive – The gear ratio for the differential is predefined for compliance purposes. The efficiency is defined by a map based on the transmission output speed and torque.

1.2. List of Predefined Input Parameters for Class 7/8 Combination Tractor Models

Although many technologies can potentially achieve GHG emission and fuel consumption reductions, EPA and NHTSA are of the initial view that for the rule's proposed timeframe, some may be too complex to model (e.g., hybrid control) while others require standardization such as the calculation of GHG and fuel consumption benefits due to aerodynamic improvements which would require an input for the tractor frontal area. To better capture the GHG emission and fuel consumption benefits in the simulation model as well as to avoid unintended consequences in the real world, the agencies have identified a set of parameters that are consistent across various manufacturers for this rulemaking period and are proposing that these parameters be used as predefined inputs to the model. EPA and NHTSA are proposing to standardize the tractor frontal area, tractor-trailer total and payload weight, gear box and its efficiency, final drive ratio, engine/transmission/wheel inertia, accessory load, axle base, tire radius, trailer tire coefficient of rolling resistance (Crr, trailer tires), and engine fuel map. The agencies are proposing to use these standardized input parameters in the simulation model for all seven proposed subcategories of combination tractors. The predefined values, if finalized, then will remain in force unless and until EPA and NHTSA amend the rule to change the values. Table 2 lists the specific values of these parameters.

Table 2: Combination Tractor Modeling Input Parameters

MODEL TYPE	CLASS 8	CLASS 8	CLASS 8	CLASS 8	CLASS 8	CLASS 7	CLASS 7
Regulatory Subcategory	Sleeper Cab High Roof	Sleeper Cab Mid Roof	Sleeper Cab Low Roof	Day Cab High Roof	Day Cab Low/Mid Roof	Day Cab High Roof	Day Cab Low/Mid Roof
Fuel Map	15L - 455 HP					11L - 350 HP	
Gearbox	10-speed Manual	10-speed Manual	10-speed Manual	10-speed Manual	10-speed Manual	10-speed Manual	10-speed Manual
Gearbox Ratio	14.8, 10.95, 8.09, 5.97, 4.46, 3.32, 2.45, 1.81, 1.35, 1					11.06, 8.19, 6.05, 4.46, 3.34, 2.48, 1.83, 1.36, 1, 0.75	
Gearbox Efficiency	0.96, 0.96, 0.96, 0.96, 0.98, 0.98, 0.98, 0.98, 0.98, 0.98					0.96, 0.96, 0.96, 0.96, 0.98, 0.98, 0.98, 0.98, 0.98, 0.98	
Engine Inertia ($kg\text{-}m^2$)	4.17	4.17	4.17	4.17	4.17	3.36	3.36
Transmission Inertia ($kg\text{-}m^2$)	0.2	0.2	0.2	0.2	0.2	0.2	0.2
All Axle Inertia ($kg\text{-}m^2$)	360	360	360	360	360	233.4	233.4
Loaded Tire Radius (m)	0.489	0.489	0.489	0.489	0.489	0.489	0.489
Body Mass (kg)	14742	13041	13154	14061	12474	11340	9752
Cargo Mass (kg)	17236	17236	17236	17236	17236	11340	11340
Total weight (kg)	31978	30277	30391	31298	29710	22680	21092
Total weight (lbs)	70500	66750	67000	69000	65500	50000	46500
Frontal Area (m^2)	9.8	7.7	6	9.8	6	9.8	6
Coefficient of Aerodynamic Drag	OEM Input	OEM Input	OEM Input	OEM Input	OEM Input	OEM Input	OEM Input
Axle Base	5	5	5	5	5	4	4
Electrical Accessory Power (W)	360	360	360	360	360	360	360
Mechanical Accessory Power (W)	1000	1000	1000	1000	1000	1000	1000
Final Drive Ratio	2.64	2.64	2.64	2.64	2.64	3.73	3.73
Tire CRR (kg/metric ton)	= 0.425 × Trailer CRR + 0.425 × Drive CRR + 0.15 × Steer CRR						
Trailer Tire CRR (kg/metric ton)	6	6	6	6	6	6	6
Steer Tire CRR (kg/metric ton)	OEM Input	OEM Input	OEM Input	OEM Input	OEM Input	OEM Input	OEM Input
Drive Tire CRR (kg/metric ton)	OEM Input	OEM Input	OEM Input	OEM Input	OEM Input	OEM Input	OEM Input
Vehicle Speed Limiter (mph)	OEM Input	OEM Input	OEM Input	OEM Input	OEM Input	OEM Input	OEM Input

1.3. List of Predefined Input Parameters for Class 2b-8 Vocational Vehicle Models

Likewise, EPA and NHTSA are proposing to standardize a set of parameters for the three proposed Class 2b-8 vocational vehicle types, which the agencies refer to as Vocational Light-Heavy (VLH), Vocational Medium-Heavy (VMH), and Vocational Heavy-Heavy (VHH). These predefined parameters include the coefficient of aerodynamic drag, truck frontal area, truck total and payload weight, the gear box and its efficiency, final drive ratio, engine/transmission/wheel inertia, accessory load, axle base, tire radius, and the engine fuel map. The predefined values, if finalized, then will remain in force unless and until EPA and NHTSA amend the rule to change the values. The specific values of these parameters are listed in Table 3.

Table 3: **Vocational Vehicle Modeling Input Parameters**

Model Type	Heavy Heavy-Duty	Medium Heavy-Duty	Light Heavy-Duty
Regulatory Subcategory	Vocational Truck (Class 8)	Vocational Truck (Class 6-7)	Vocational Truck (Class 2b-5)
Fuel Map	15L - 455 HP	7L - 270 HP	7L - 200 HP
Gearbox	10-speed Manual	6-speed Manual	6-speed Manual
Gearbox Ratio	14.8, 10.95, 8.09, 5.97, 4.46, 3.32, 2.45, 1.81, 1.35, 1	9.01, 5.27, 3.22, 2.04, 1.36, 1	9.01, 5.27, 3.22, 2.04, 1.36, 1
Gearbox Efficiency	0.96, 0.96, 0.96, 0.96, 0.98, 0.98, 0.98, 0.98, 0.98, 0.98	0.92, 0.92, 0.93, 0.95, 0.95, 0.95	0.92, 0.92, 0.93, 0.95, 0.95, 0.95
Engine Inertia (kg-m^2)	4.17	2.79	2.79
Transmission Inertia (kg-m^2)	0.2	0.1	0.1
All Axle Inertia (kg-m^2)	200	60	60
Loaded Tire Radius (m)	0.489	0.389	0.378
Body Mass (kg)	13154	6328	4672
Cargo Mass (kg)	17236	5080	2585
Total weight (kg)	30391	11408	7257
Total weight (lbs)	67000	25150	16000
Frontal Area (m^2)	9.8	9	9
Coefficient of Aerodynamic Drag	0.7	0.6	0.6
Axle Base	3	2	2
Electrical Accessory Power (W)	360	360	360
Mechanical Accessory Power (W)	1000	1000	1000
Final Drive Ratio	2.64	3.36	3.25
Tire CRR (kg/ton)	= 0.5 × Drive CRR + 0.5 × Steer CRR		
Trailer Tire CRR (kg/metric ton)	Not applicable	Not applicable	Not applicable
Steer Tire CRR (kg/metric ton)	OEM Input	OEM Input	OEM Input
Drive Tire CRR (kg/metric ton)	OEM Input	OEM Input	OEM Input

1.4. Output Processes

The outputs produced by GEM include post processes to calculate the final weighted results.

GEM produces a cycle-weighted gram CO2/ton-mile and gallon/1000 ton-mile result which incorporates the proposed drive cycle weightings of the ARB transient cycle, 55 mph steady state cruise, and 65 mph steady state cruise cycle, as shown in Table 4.

Table 4: Drive Cycle Weighting

CATEGORY	CLASS 8 SLEEPER CAB TRACTORS	CLASS 7/8 DAY CAB TRACTORS	CLASS 2b-8 VOCATIONAL VEHICLES
ARB Transient	5%	19%	42%
55 mph Cruise	9%	17%	21%
65 mph Cruise	86%	64%	37%

GEM converts the mile per gallon result into ton-mile space by using the proposed payload for each regulatory class – 19 tons for Class 8 tractors, 12.5 tons for Class 7 tractors, 19 tons for HHD vocational vehicles, 5.6 tons for MHD vocational vehicles, and 2.85 tons for LHD vocation vehicles.

GEM calculates the gallons/1000 ton-mile weighted result by converting the weighted grams CO_2/ton-mile result. The gram CO_2/ton-mile result is multiplied by 1000 and divided by 10,180 grams CO_2 per gallon of diesel fuel.

2. Instructions on How to Install and Use GEM

The executable form of GEM can be downloaded from the website. Please follow the procedure below to run the executable version.

1. Unzip the file (GEM Setup.zip), and run the executable "GEM_Run.exe".
2. If the executable file runs and launches a Graphical User Interface (GUI) as shown in Figure 1, then your computer system is ready to run the model.
3. If you receive the error message "application configuration is incorrect," then run "setup.bat". The error message is related to missing system Visual Studio Redistributable dll files and "setup.bat" will automatically run the Microsoft vcredist_x86.exe on the client systems experiencing this issue.
4. Now, rerun the executable file "GEM_Run.exe". You should be able to see the GUI as shown in Figure 1.
5. The simulation output is created in a folder "C:\GEM_Results\Month_Day_Year-Time". The output file in XML format can be opened with Excel to see the results. Each simulation creates a different folder using the above naming format.

The GEM input screen, as shown in Figure 1, provides the user the ability to enter the required parameters into the model. There are essentially two types of parameters – ones required for information and ones which impact the model. The first set of parameters which are required to provide information to EPA and NHTSA and where GEM copies the information from the input screen to the output screen. These include the following:

- Manufacturer Name
- Email Address
- Date
- VERIFY User ID
- VERIFY ID
- Vehicle Family
- Vehicle Subfamily
- Engine Family
- Engine Subfamily
- Engine Model Year

The second set of parameters affects how GEM calculates the final result. The list below describes each input and how it is used within GEM.

- Vehicle Model Year: The pull-down allows the user to select either Pre 2014 MY, 2014-2016 MY, or Post 2017 MY. The Vehicle Model Year selects the appropriate fuel map in the model. The Pre 2014 MY allows users to evaluate the baseline heavy-duty vehicle's engine fuel map. The 2014-2016 MY selection uses the engine fuel maps which meet the proposed 2014 MY engine standards. The Post 2017 MY option uses engine fuel maps which meet the 2017 MY proposed engine standards.
- Regulatory Class: The user must select one of the designated regulatory subcategories. The selection leads the model to use the appropriate predefined inputs and post processing parameters, as outlined in Sections 1.2, 1.3, and 1.4 of this Guidance.
- Coefficient of Drag: The Cd value is input by the user based on the proposed aerodynamic bins, as discussed in both the preamble and draft RIA. This input is only required for combination tractors. No input is required for vocational trucks.
- Steer Tire Rolling Resistance: The coefficient of rolling resistance for the steer tires should be input by the user in terms of kg/metric ton. Please note that the units are in kg/metric ton where the typical value is greater than 5.5 kg/metric ton. The units are <u>not</u> in kg/kg or lb/lb (the other industry norm) where the values are typically greater than 0.0055 kg/kg or lb/lb.
- Drive Tire Rolling Resistance: The coefficient of rolling resistance for the drive tires should be input by the user in terms of kg/metric ton. Please note that the units are in kg/metric ton where the typical value is greater than 5.5 kg/metric ton. The units are <u>not</u> in kg/kg or lb/lb (the other industry norm) where the values are typically greater than 0.0055 kg/kg or lb/lb.
- Vehicle Speed Limiter: If the vehicle contains a vehicle speed limiter, then the setting corresponding to the nearest whole mile per hour should be selected. GEM will limit the maximum speed of the vehicle to the value selected. This input is only available for combination tractors. No input is allowed for vocational trucks.
- Vehicle Weight Reduction: If a combination tractor contains lighter weight wheels or tires, as described in the preamble, draft RIA, and regulations, then the user would input the sum of the weight reductions prescribed by the weight bins. This input is only available for combination tractors. No input is allowed for vocational trucks.

- Extended Idle Reduction: If a sleeper cab combination tractor contains an extended idle reduction technology and a 5 minute automatic engine shut-off, then the user would select the 5 g/ton-mile reduction. If not, then 0 should be selected. This input is only available for sleeper cab combination tractors. No input is allowed for day cab combination tractors or vocational vehicles.

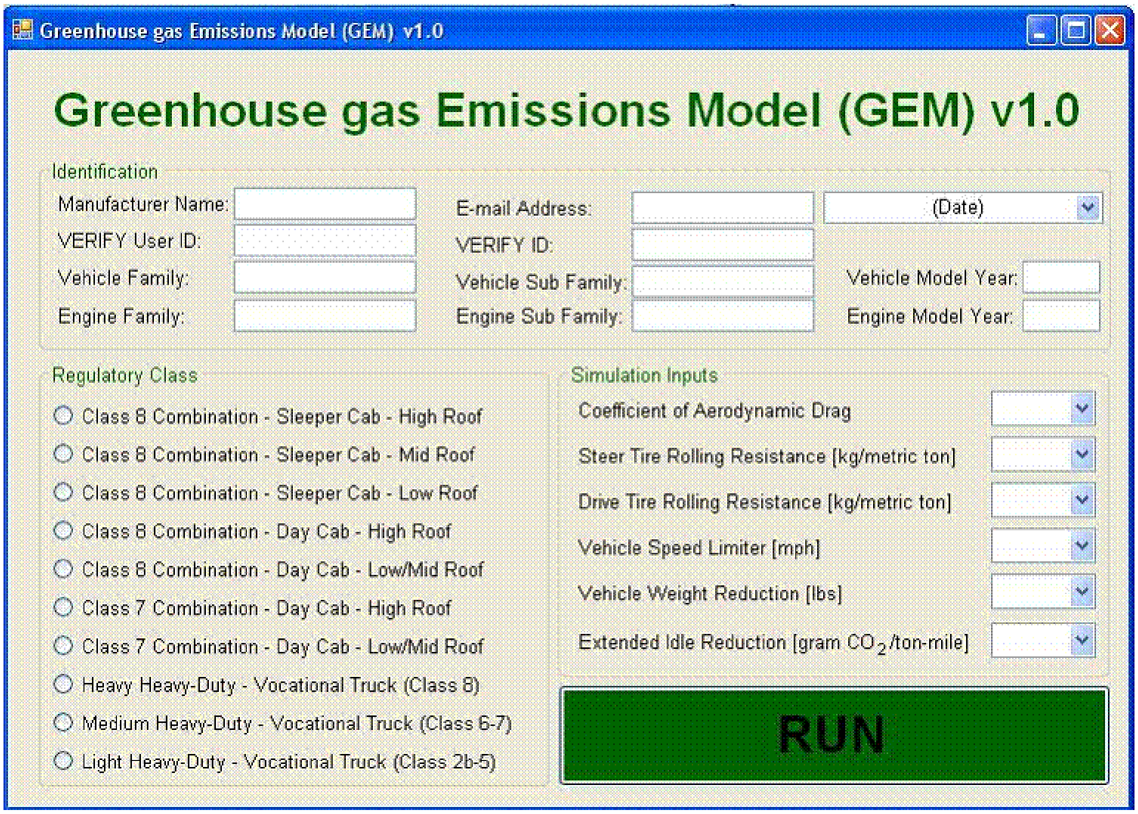

Figure 1 – GEM Input Screen

After the user selects "RUN," GEM will conduct the simulation of each of the drive cycles. The output will provide both the gram CO_2/ton-mile and gallon/1000 ton-mile result in the .xml file, as shown in Figure 2. The simulation output is created in a folder "C:\GEM_Results\Month_Day_Year-Time." The output file is in xml format and can be opened with Excel. Each simulation creates a different folder using the "Month_Day_Year-Time" naming format.

Greenhouse gas Emissions Model (GEM) Simulation Results					
MANUFACTURER IDENTIFICATION					
Manufacturer Name:		E-mail Address:		Date:	10/12/2010
VERIFY User ID:		VERIFY ID:			
Vehicle Family:		Vehicle Sub Family:		Vehicle Model Year:	2014-16 MY
Engine Family:		Engine Sub Family:		Engine Model Year:	
SIMULATION INPUTS					
Regulatory Class	Class 8 Combination - Sleeper Cab - High Roof				
Coefficient of Aerodynamic Drag	0.85				
Steer Tire Rolling Resistance [kg/metric ton]	6				
Drive Tire Rolling Resistance [kg/metric ton]	6				
Vehicle Speed Limiter [mph]	65				
Vehicle Weight Reduction [lbs]	0				
extendedIdleReductionLabel	0				
SIMULATION OUTPUTS					
Model Year = 2014					
Transient Cycle Simulation					
Percent Time Missed by 2mph [%]	0.81				
Fuel Consumption for Entire Cycle [mpg]	3.69				
CO2 Emissions [g/ton-mile]	145.25				
55 mph Steady-State Cycle Simulation					
Percent Time Missed by 2mph [%]	0				
Fuel Consumption during Steady State [mpg]	7.39				
CO2 Emissions [g/ton-mile]	72.52				
65 mph Steady-State Cycle Simulation					
Percent Time Missed by 2mph [%]	0				
Fuel Consumption during Steady State [mpg]	6.04				
CO2 Emissions [g/ton-mile]	88.66				
Cycle-Weighted Results					
Weighted Fuel Consumption [mpg]	6.05				
--> in gal/1000 ton-mile	8.84				
Weighted CO2 Emission [g/1000 ton-mile]	90.04				

Figure 2 – Sample GEM Output .xml File

3. MATLAB/Simulink Version of GEM

In addition to providing executable file which the agencies have proposed to be used for certification purposes, the agencies are also furnishing a MATLAB/Simulink version of GEM to allow stakeholders to review the model architecture in detail. The system requirements for GEM include a minimum RAM of 1 GB, MATLAB, Simulink and Stateflow (version 2009b or later), and approximately 250 MB of disk storage.[1,2,3] No separate license is required to run the program other than for MATLAB, Simulink, and Stateflow. Although the source code is available to users, all of the component initialization files, control strategies and the underlying MATLAB/Simulink/Stateflow-based models should remain fixed and should not be manipulated by the users when assessing their compliance. For these reasons, the stand-alone executable model independent of MATLAB/Simulink/Stateflow licenses has been created. The agencies recommend using the executable file for the evaluation of various truck configurations, as it was developed for the end user.

3.1 Installation Instructions for the MATLAB/Simulink Version

Copy the entire directory from the web link into the user's hard drive, then follow the procedures below.

[1] http://www.mathworks.com/products/matlab © 1994-2010 The MathWorks, Inc.
[2] http://www.mathworks.com/products/simulink © 1994-2010 The MathWorks, Inc.
[3] http://www.mathworks.com/products/stateflow © 1994-2010 The MathWorks, Inc.

1. Start the MATLAB and change the current directory to the location where the tool is unzipped and saved.
2. Run the MATLAB script "Run_GEM_sim.m" to launch the GUI window to start using the tool.
3. Select one radial button on the left-hand side of the window to choose an appropriate truck subcategory.
4. Enter proper values for "Coefficient of Aerodynamic Drag," "Steer Tire Rolling Resistance," and "Drive Tire Rolling Resistance" on the right-hand side of the window (see Section 2 above which describes each input).
5. Click the "RUN" button. Then, the tool will simulate the three different driving cycles (ARB transient, 55 mph, and 65 mph) and display the final results in the Matlab Command Window. The tool will also display plots of vehicle speed for all three cycles.

3.2 Input File Structures

The programs that are downloaded from website consist of the following files in the main directory:

Run_GEM_sim.m: a Matlab file used to launch the simulation
GEM_manual_v1.mdl: Simulink file containing vehicle and all submodels
run_preproc.m
run_postproc.m
GEM_sim.m
run_55mph.m
run_65mph.m
run_transient.m
drive_cycles folder
executable folder
param_files folder

4. Input Files Used to Calculate the Proposed GHG Emissions and Fuel Efficiency Standards

The agencies developed the baseline and proposed standards using the input tables included in Table 5 and Table 6.

Table 5: Input Parameters for Proposed Tractor Standards

CLASS	CLASS 8	CLASS 8	CLASS 8	CLASS 8	CLASS 8	CLASS 7	CLASS 7
Regulatory Subcategory	Sleeper Cab High Roof	Sleeper Cab Mid Roof	Sleeper Cab Low Roof	Day Cab High Roof	Day Cab Low/Mid Roof	Day Cab High Roof	Day Cab Low/Mid Roof
Baseline							
Fuel Map	2010 MY	2010 MY	2010 MY	2010 MY	2010 MY	2010 MY	2010 MY
Cd	0.69	0.76	0.81	0.69	0.81	0.69	0.81
Steer Tire CRR	7.8	7.8	7.8	7.8	7.8	7.8	7.8
Drive Tire CRR	8.2	8.2	8.2	8.2	8.2	8.2	8.2
Weight Reduction (lbs)	0	0	0	0	0	0	0
Extended Idle	None	None	None	N/A	N/A	N/A	N/A
2014 MY Proposed Standard							
Fuel Map	2014 MY	2014 MY	2014 MY	2014 MY	2014 MY	2014 MY	2014 MY
Cd	0.60	0.72	0.76	0.62	0.77	0.62	0.77
Steer Tire CRR	6.54	6.87	6.87	6.87	6.99	6.87	6.99
Drive Tire CRR	6.92	7.26	7.26	7.26	7.38	7.26	7.38
Weight Reduction (lbs)	400	400	400	400	400	400	400
Extended Idle	Yes	Yes	Yes	N/A	N/A	N/A	N/A
2017 MY Proposed Standard							
Fuel Map	2017 MY	2017 MY	2017 MY	2017 MY	2017 MY	2017 MY	2017 MY
Cd	0.60	0.72	0.76	0.62	0.77	0.62	0.77
Steer Tire CRR	6.54	6.87	6.87	6.87	6.99	6.87	6.99
Drive Tire CRR	6.92	7.26	7.26	7.26	7.38	7.26	7.38
Weight Reduction (lbs)	400	400	400	400	400	400	400
Extended Idle	Yes	Yes	Yes	N/A	N/A	N/A	N/A

Table 6: Input Parameters for Proposed Vocational Vehicle Standards

Model Type	Heavy Heavy-Duty	Medium Heavy-Duty	Light Heavy-Duty
Regulatory Subcategory	Vocation Truck (Class 8)	Vocation Truck (Class 6-7)	Vocation Truck (Class 2b-5)
Baseline			
Fuel Map	2010 MY	2010 MY	2010 MY
Tire C_{RR} (kg/metric ton)	9.0	9.0	9.0
2014 MY Proposed Standard			
Fuel Map	2014 MY	2014 MY	2014 MY
Tire C_{RR} (kg/metric ton)	8.1	8.1	8.1
2017 MY Proposed Standard			
Fuel Map	2017 MY	2017 MY	2017 MY
Tire C_{RR} (kg/metric ton)	8.1	8.1	8.1