Chapter 6: Results of Proposed and Alternative Standards

The heavy-duty truck segment is very complex. The sector consists of a diverse group of impacted parties, including engine manufacturers, chassis manufacturers, truck manufacturers, trailer manufacturers, truck fleet owners and the air breathing public. The proposal the Agencies have laid out today is largely shaped to maximize the environmental and fuel savings benefits of the program respecting the unique and varied nature of the regulated industries. In developing this proposal, we considered a number of alternatives that could have resulted in fewer or potentially greater GHG and fuel consumption reductions than the program we are proposing. This section summarizes the alternatives we considered. We welcome comments on all of these alternatives.

6.1 What are the alternatives that the agencies considered?

In developing alternatives, NHTSA must consider EISA's requirement for the MD/HD fuel efficiency program noted above. 49 U.S.C. 32902(k)(2) and (3) contain the following three requirements specific to the MD/HD vehicle fuel efficiency improvement program: (1) The program must be "designed to achieve the maximum feasible improvement"; (2) the various required aspects of the program must be appropriate, cost-effective, and technologically feasible for MD/HD vehicles; and (3) the standards adopted under the program must provide not less than four model years of lead time and three model years of regulatory stability. In considering these various requirements, NHTSA will also account for relevant environmental and safety considerations.

Each of the alternatives proposed by NHTSA and EPA represents, in part, a different way the agencies could establish a HD program pursuant to EISA and the CAA. The agencies are proposing Alternative 6. The alternatives below represent a broad range of approaches under consideration for setting proposed HD vehicle fuel efficiency and GHG emissions standards. The alternatives that the agencies are proposing, in order of increasing fuel efficiency and GHG emissions reductions, are:

6.1.1 Alternative 1: No Action

A "no action" alternative assumes that the agencies would not issue a rule regarding a MD/HD fuel efficiency improvement program, and is considered to comply with NEPA and to provide an analytical baseline against which to compare environmental impacts of the other regulatory alternatives.[1] The agencies refer to this as the "No Action Alternative" or as a "no increase" or "baseline" alternative.

Table 6-1 Estimated fleet-wide fuel economy by model year for Alternative 1 (baseline)

	MY 2010-2013	MY 2014	MY 2015	MY 2016	MY 2017	MY 2018
2b3 - gasoline	15.9	15.9	16.0	16.0	16.0	16.0
2b3- diesel	14.4	14.4	14.4	14.5	14.5	14.5
Vocational – gasoline	9.3	9.4	9.4	9.4	9.3	9.3

Vocational – diesel	9.8	9.8	9.8	9.8	9.8	9.8
Comb. tractors	5.0	5.0	5.0	5.0	5.0	5.0

As described in Chapter 5, this no-action alternative is considered the reference case.

6.1.2 Alternative 2: Engine Only

The EPA currently regulates heavy-duty engines, i.e., engine manufacturers, rather than the vehicle as a whole, in order to control criteria emissions.[2] Under Alternative 2, the agencies would similarly set engine performance standards for each vehicle class, Class 2b through Class 8, and would specify an engine cell test procedure, as EPA currently does for criteria pollutants. HD engine manufacturers would be responsible for ensuring that each engine could meet the applicable vehicle class engine performance standard when tested in accordance with the specified engine cell test procedure. Engine manufacturers could improve HD engines by applying the combinations of fuel efficiency improvements and GHG emissions reduction technologies to the engine that they deem best achieve that result.

For this scenario, we assumed the following CO_2 reductions stated in Table 6-2.

Table 6-2 Estimated possible reductions in engine CO_2 emission rates in Alternative 2

GVWR class	Fuel	Model years	CO_2 Reduction from Reference Case
HHD (8a-8b)	Diesel	2014-2016	3%
		2017+	6%
MHD (6-7) and LHD 4-5	Diesel	2014-2016	5%
		2017+	9%
	Gasoline	2016+	5%
LHD 2b-3	Gasoline	2016+	5%
	Diesel	2016+	9%

Table 6-3 Estimated fleet-wide fuel economy by model year for Alternative 2

	MY 2010-2013	MY 2014	MY 2015	MY 2016	MY 2017	MY 2018
2b3 - gasoline	15.9	15.9	15.9	16.8	16.8	16.8
2b3- diesel	14.4	14.4	14.4	15.9	15.9	15.9

Vocational – gasoline	9.3	9.4	9.4	9.8	9.8	9.8
Vocational – diesel	9.8	10.1	10.1	10.1	10.4	10.4
Comb. tractors	5.0	5.1	5.1	5.1	5.3	5.3

6.1.3 Alternative 3: Class 8 Combination Tractors

Combination tractors consume the largest fraction of fuel within the medium- and heavy-duty truck segment. Tractors also offer significant potential for fuel savings due to the high annual mileage and high vehicle speed of typical trucks within this segment, as compared to annual mileage and average speeds/duty cycles of other vehicle classes. This alternative would set performance standards for both the engine of Class 8 vehicles and the overall vehicle efficiency performance for the Class 8 combination tractor segment. Under Alternative 3, the agencies would set an engine performance standard, as discussed under Alternative 2, for Class 8 tractors. In addition, Class 8 combination tractor manufacturers would be required to meet an overall vehicle performance standard by making various non-engine fuel saving technology improvements. These non-engine fuel efficiency and GHG emissions improvements could be accomplished, for example, by a combination of improvements to aerodynamics, lowering tire rolling resistance, decreasing vehicle mass (weight), reducing fuel use at idle, or by adding intelligent vehicle technologies.[3] Compliance with the overall vehicle standard could be determined using a computer model that would simulate overall vehicle fuel efficiency given a set of vehicle component inputs. Using this compliance approach, the Class 8 vehicle manufacturer would supply certain vehicle characteristics (relating to the categories of technologies noted immediately above) that would serve as model inputs. The agency would supply a standard Class 8 vehicle engine's contribution to overall vehicle efficiency, making the engine component a constant for purposes of compliance with the overall vehicle performance standard, such that compliance with the overall vehicle standard could only be achieved via efficiency improvements to non-engine vehicle components. Thus, vehicle manufacturers could use any combination of improvements of the non-engine technologies that they believe would best achieve the Class 8 overall vehicle performance standard.

This alternative in NHTSA's scoping notice involves regulating Class 8 combination tractors only. For this scenario, we assumed the following CO_2 reductions stated in Table 6-4 and road load improvements stated in Table 6-5.

Table 6-4 Estimated possible reductions in Class 8 engine CO_2 emission rates in Alternative 3

GVWR class	Fuel	Model years	CO_2 Reduction from Reference Case
HHD (8a-8b)	Diesel	2014-2016	3%
		2017+	6%

Table 6-5 Estimated reductions in rolling resistance and aerodynamic drag coefficients for model years 2014 and later in Alternative 3

Truck type	Reduction in tire rolling resistance coefficient from 2010 MY	Reduction in aerodynamic drag coefficient from 2010 MY
Combination long-haul	8.4%	7.2%
Combination short-haul	7.0%	5.3%

For this alternative, the "samplevehiclepopulation" table was altered such that only the Class 8 tractors would be output in the combination long-haul and combination short-haul source types. These source types normally include Class 7 trucks also. Since MOVES outputs results by source type and not engine class, two runs were performed for combination truck source types. The first run included the database with the above changes and with the Class 7 population set to zero. The second run did not include the above changes but with the Class 8 population set to zero. The results from these two runs gave Class 8 combination tractors affected by this alternative and Class 7 combination tractors not affected by this alternative. The two runs were meshed together, preserving the total Class 7/8 combination tractor population, while applying the changes only to the Class 8 combination tractors.

For the purpose of this analysis, it was assumed that 100 percent of Class 8 combination long-haul tractors model year 2014 and later use APUs during extended idling.

Table 6-6 Estimated fleet-wide fuel economy by model year for Alternative 3

	MY 2010-2013	MY 2014	MY 2015	MY 2016	MY 2017	MY 2018
2b3 - gasoline	15.9	15.9	16.0	16.0	16.0	16.0
2b3- diesel	14.4	14.4	14.4	14.5	14.5	14.5
Vocational – gasoline	9.3	9.4	9.4	9.4	9.3	9.3
Vocational – diesel	9.8	9.8	9.8	9.8	9.8	9.8
Comb. tractors	5.0	5.4	5.4	5.4	5.5	5.5

6.1.4 Alternative 4: Engines and Class 7 and 8 Tractors

This alternative combines Alternative 2 with Alternative 3, and additionally would set an overall vehicle efficiency performance standard for Class 7 tractors. This alternative would, thus, set standards for all HD engines and would set overall vehicle performance standards for Class 7 and 8 tractors, as described for Class 8 combination tractors under Alternative 3. Class 7 tractors make up a small percent of the tractor market, approximately 9 percent.[A] Though the

[A] MJ Bradley. Heavy Duty Market Analysis. 2009.

segment is currently small, the agencies believe the inclusion of this class of vehicles would help prevent a potential class shifting, as noted in the NAS panel report.[B]

The engine CO_2 reductions are described in Table 6-2, and the road load reductions are described in Table 6-5. A separate MOVES run was not performed for this scenario since it can be taken from Alternatives 2 and 6 (described below). The pre-2014 model year inventories were taken from the reference run results. The MY2014+ Class 7/8 combination tractor inventories were taken from the Alternative 6 run results, and the MY2014+ numbers for the remainder of the heavy-duty vehicles were taken from the Alternative 2 results. It was assumed that 100 percent of Class 7/8 combination long-haul tractors model year 2014 and later use APUs during extended idling.

Table 6-7 Estimated fleet-wide fuel economy by model year for Alternative 4

	MY 2010-2013	MY 2014	MY 2015	MY 2016	MY 2017	MY 2018
2b3 - gasoline	15.9	15.9	16.0	16.8	16.8	16.8
2b3- diesel	14.4	14.4	14.4	15.9	15.9	15.9
Vocational – gasoline	9.3	9.4	9.4	9.8	9.8	9.8
Vocational – diesel	9.8	10.1	10.1	10.1	10.4	10.4
Comb. tractors	5.0	5.4	5.4	5.4	5.6	5.6

6.1.5 Alternative 5: Engines, Class 7 and 8 Tractors, and Class 2b/3 Pickup Trucks and Vans

This alternative builds on Alternative 4 through the addition of an overall vehicle efficiency performance standard for Class 2b/3 Pickup Trucks and Vans (or work trucks). Therefore, under this alternative, the agencies would set engine performance standards for each MD/HD vehicle class, and would also set overall vehicle performance standards for Class 7 and 8 tractors, as well as for Class 2b/3 Pickup Trucks and Vans. Compliance for the Class 2b and 3 pickup trucks and vans would be determined through a fleet averaging process similar to determining passenger car and light truck compliance with CAFE standards.

This is a combination of Alternative 4 with the addition of Class 2b/3 pickup trucks and vans. As with Alterative 4, a separate MOVES run was not performed. The pre-2014 model year inventories were taken from the reference run results. The MY2014+ Class 7/8 combination tractor and Class 2b/3 pickup truck and van inventories were taken from the Alternative 6 run results, and the MY2014+ numbers for the remainder of the heavy-duty vehicles were taken from the Alternative 2 results. It was assumed that 100 percent of Class 7/8 combination long-haul tractors model year 2014 and later use APUs during extended idling.

[B] NAS. Page 6-38.

Table 6-8 Estimated fleet-wide fuel economy by model year for Alternative 5

	MY 2010-2013	MY 2014	MY 2015	MY 2016	MY 2017	MY 2018
2b3 - gasoline	15.9	16.2	16.3	16.6	17.0	17.8
2b3- diesel	14.4	14.8	14.9	15.4	15.9	17.0
Vocational – gasoline	9.3	9.4	9.4	9.8	9.8	9.8
Vocational – diesel	9.8	10.1	10.1	10.1	10.4	10.4
Comb. tractors	5.0	5.4	5.4	5.4	5.6	5.6

6.1.6 Alternative 6: Engines, Tractors, and Class 2b through 8 Trucks.

Alternative 6 represents the agencies’ preferred approach. This alternative would set engine efficiency standards, engine GHG emissions standards, overall vehicle fuel efficiency standards, and overall vehicle GHG emissions standards for Class 2b and 3 pickup trucks and vans and the remaining Class 2b through Class 8 trucks and the engines installed in them. This alternative essentially sets fuel efficiency and GHG emissions performance standards for both the engines and the overall vehicles in the entire heavy-duty truck sector. Compliance with each vehicle class's engine performance standard would be determined as discussed in the description of Alternative 2. Compliance with the tractor and vocational truck classes' overall vehicle performance standard (Class 3 through 8 trucks) would be determined as discussed in the description of Alternative 3. Compliance for the Class 2b and 3 pickup trucks and vans would be determined as described in Alternative 5.

This is the proposed rule. Details regarding this alternative are included in Chapter 5.

Table 6-9 Estimated fleet-wide fuel economy by model year for Alternative 6

	MY 2010-2013	MY 2014	MY 2015	MY 2016	MY 2017	MY 2018
2b3 - gasoline	15.9	16.2	16.3	16.6	17.0	17.8
2b3- diesel	14.4	14.8	14.9	15.4	15.9	17.0
Vocational – gasoline	9.3	9.4	9.4	9.9	9.9	9.9
Vocational – diesel	9.8	10.3	10.3	10.3	10.7	10.7
Comb. tractors	5.0	5.4	5.4	5.4	5.6	5.6

6.1.7 Alternative 7: Engines, Tractors, Trucks, and Trailers.

This alternative builds on Alternative 6 by adding a performance standard for fuel efficiency and GHG emissions of commercial trailers. Therefore, this alternative would include fuel efficiency performance standards and GHG emissions standards for Class 2b and 3 work truck and Class 3 through Class 8 vocational truck engines, and the performance standards for the overall fuel efficiency and GHG emissions of those vehicles, as described above.

This is Alternative 6 with the addition of a regulation of trailers on combination trucks. All assumptions are the same as Alternative 6 except for road load. This alternative would result in further reductions in drag coefficient and rolling resistance coefficient from the MY 2010 baseline. Table 6-10**Error! Reference source not found.** describes the road load reductions.

Table 6-10 Estimated reductions in rolling resistance and aerodynamic drag coefficients from reference case for Alternative 7 (model years 2014 and later)

Truck type	Reduction in tire rolling resistance coefficient from 2010 MY	Reduction in aerodynamic drag coefficient from 2010 MY
Combination long-haul	10.7%	9.2%
Combination short-haul	10.0%	10.6%
Straight trucks, refuse trucks, motor homes, transit buses, and other vocational trucks	10.0%	0%

Since the only difference between Alternative 6 and 7 was the inclusion of trailers, a MOVES run involving only combination tractors with the above changes was performed. For all other heavy-duty vehicles, the results from Alternative 6 were used for Alternative 7.

Table 6-11 Estimated fleet-wide fuel economy by model year for Alternative 7

	MY 2010-2013	MY 2014	MY 2015	MY 2016	MY 2017	MY 2018
2b3 - gasoline	15.9	16.2	16.3	16.6	17.0	17.8
2b3- diesel	14.4	14.8	14.9	15.4	15.9	17.0
Vocational – gasoline	9.3	9.4	9.4	9.9	9.9	9.9
Vocational – diesel	9.8	10.3	10.3	10.3	10.7	10.7
Comb. tractors	5.0	5.5	5.5	5.5	5.7	5.7

6.1.8 Alternative 8: Engines, Tractors, Trucks, and Trailers with Hybrid Powertrains

Alternative 8 includes all elements of Alternative 7, plus applies the maximum application of hybrids to the pickup trucks, vans, vocational trucks, and tractors by the 2014 and the 2017 MY. The agencies project the hybrid penetration for each class, as described in Table 6-12. The agencies are applying a 25 percent reduction to CO_2 emissions and fuel consumption, based on the findings of the NAS report.[4] The agencies also project a cost of $30,000 per vehicle for the vocational vehicles and combination tractors, which is the median value described in the NAS report for the vocational vehicles and tractors. The agencies are projecting a cost of $9,000 per vehicle for the HD pickup trucks and vans, again based on the NAS report.[5]

Table 6-12: Hybrid Penetration by Vehicle Class

	MY 2014	MY 2017
HD Pickup Trucks & Vans		
Vocational Vehicles		
Combination tractors		

Table 6-13 Estimated fleet-wide fuel economy by model year for Alternative 8

	MY 2010-2013	MY 2014	MY 2015	MY 2016	MY 2017	MY 2018
2b3 - gasoline						
2b3- diesel						
Vocational – gasoline						
Vocational – diesel						
Comb. tractors						

6.2 How do these alternatives compare in overall GHG emissions reductions and fuel efficiency and cost?

The agencies analyzed all seven alternatives through MOVES to evaluate the impact of each proposed alternative, as shown in Table 6-14. The table contains both the total savings for each alternative, along with the contribution from each truck class.

Table 6-14: Annual CO_2 and Oil Savings in 2030 and 2050

	DOWNSTREAM CO_2 SAVINGS (MMT)		OIL SAVINGS (BILLION GALLONS)	
	2030	2050	2030	2050
Alt. 1	0	0	0	0
Alt. 2 - Total	29	46	2.9	4.6
Tractors	19	27	1.8	2.6
HD Pickup Trucks	4	7	0.4	0.7
Vocational Trucks	6	13	0.6	1.2
Alt. 3 - Total	35	50	3.4	4.9

Tractors	35	50	3.4	4.9
HD Pickup Trucks	0	0	0	0
Vocational Trucks	0	0	0	0
Alt. 4 - Total	50	76	5.0	7.5
Tractors	40	57	3.9	5.6
HD Pickup Trucks	4	7	0.4	0.7
Vocational Trucks	6	13	0.6	1.2
Alt. 5 - Total	54	82	5.4	8.2
Tractors	40	57	3.9	5.6
HD Pickup Trucks	8	13	0.8	1.3
Vocational Trucks	6	13	0.6	1.2
Preferred - Total	58	91	5.8	9.0
Tractors	40	57	3.9	5.6
HD Pickup Trucks	8	13	0.8	1.3
Vocational Trucks	10	21	1.0	2.1
Alt. 7 - Total	62	96	6.1	9.5
Tractors	40	57	3.9	5.6
HD Pickup Trucks	8	13	0.8	1.3
Vocational Trucks	10	21	1.0	2.1
Trailers	4	5	0.4	0.5
Alt. 8 - Total				
Tractors				
HD Pickup Trucks				
Vocational Trucks				
Trailers				

The aggregate technology costs for each alternative are included in Table 6-15.

Table 6-15: Technology Cost Projections for the Alternatives

	TECHNOLOGY COSTS (2008$ MILLIONS)	
	2030	2050
Alt. 1	$0	$0
Alt. 2 - Total	$1,226	$1,544
Tractors	$78	$103
HD Pickup Trucks	$980	$1,140
Vocational Trucks	$168	$301

Alt. 3 - Total	$773	$1,023
Tractors	$773	$1,023
HD Pickup Trucks	$0	$0
Vocational Trucks	$0	$0
Alt. 4 - Total	$1,952	$2,506
Tractors	$805	$1,065
HD Pickup Trucks	$980	$1,140
Vocational Trucks	$168	$301
Alt. 5 - Total	$1,953	$2,506
Tractors	$805	$1,065
HD Pickup Trucks	$980	$1,140
Vocational Trucks	$168	$301
Preferred - Total	$2,016	$2,623
Tractors	$805	$1,065
HD Pickup Trucks	$980	$1,140
Vocational Trucks	$231	$418
Alt. 7 - Total		
Tractors	$805	$1,065
HD Pickup Trucks	$980	$1,140
Vocational Trucks	$231	$418
Trailers	$713	$943
Alt. 8 - Total		
Tractors		
HD Pickup Trucks		
Vocational Trucks		
Trailers		

Table 6-16 Downstream impacts relative to Alternative 1 of key non-GHGs for each alterative in 2030

	NOX	CO	PM2.5	VOC
Alt. 1	0%	0%	0%	0%
Alt. 2	0.60%	0.32%	0.47%	-0.26%
Alt. 3	-20.2%	-2.3%	6.8%	-17.1%
Alt. 4	-20.5%	-2.0%	7.4%	-17.5%
Alt. 5	-20.5%	-2.0%	7.4%	-17.6%
Preferred	-20.6%	-2.0%	7.4%	-17.7%
Alt. 7	-20.9%	-2.0%	7.3%	-17.8%

References

[1] NEPA requires agencies to consider a "no action" alternative in their NEPA analyses and to compare the effects of not taking action with the effects of the reasonable action alternatives to demonstrate the different environmental effects of the action alternatives. See 40 CFR 1502.2(e), 1502.14(d).CEQ has explained that "[T]he regulations require the analysis of the no action alternative even if the agency is under a court order or legislative command to act. This analysis provides a benchmark, enabling decision makers to compare the magnitude of environmental effects of the action alternatives. It is also an example of a reasonable alternative outside the jurisdiction of the agency which must be analyzed. [See 40 CFR 1502.14(c).] * * * Inclusion of such an analysis in the EIS is necessary to inform Congress, the public, and the President as intended by NEPA. [See 40 CFR 1500.1(a).]" Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, 46 FR 18026 (1981) (emphasis added).

[2] There are several reasons for this approach. In many cases the engine and chassis are produced by different manufacturers and it is more efficient to hold a single entity responsible. Also, testing an engine cell is more accurate and repeatable than testing a whole vehicle.

[3] See the MD/HD NAS Report for discussions of the potential fuel efficiency improvement technologies that can be applied to each of these vehicle components. MD/HD NAS Report, supra note 9, Chapter 5.

[4] NAS Report. Page 6-28.

[5] NAS Report. Page 6-28.