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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1376

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Fuel Economy Measurement Test (Engineering Type) for Trucks and Buses

1. ***Scope***—This procedure incorporates test cycles that produce relative fuel economy data relating to long haul, short haul, and local driving patterns, or any combination of these and to those components developed to improve fuel economy for these patterns. The tests conducted on a specific vehicle are to reflect that vehicle's general mode of operation. The procedure is intended to be used under controlled, warmed-up conditions on a test tract or on suitable roads. A minimum of two vehicles running simultaneously is required. Test condition recommendations are provided for undertaking this engineering test. If it is necessary to conduct a test outside of these test conditions, the purpose of the test and the variant conditions should be recorded and noted whenever the results are reported.

1.1 **Purpose**—To provide uniform testing procedures for measuring relative fuel economy of trucks and buses over 10 000 lb GVWR.

1.1.1 OVERVIEW—The objective of this test procedure is to provide the user with a standard test procedure for evaluating the relative fuel economy of given vehicles. The test procedure employs test cycles which reflect different modes of vehicle operation and provides the basis for evaluating the effects of those modes on fuel economy of the vehicle. The fuel can be measured either by weight or by volume. Fuel economy is expressed in mpg.

The test procedure requires a control vehicle to be run simultaneously with the test vehicle on the same course and at the same time. The assumption is made that during a test both vehicles are affected by the ambient conditions in the same manner. The ratios of the mpg values of the control vehicle and the test vehicle should remain relatively constant regardless of the mpg variations from test to test. This ratio is applied in calculating the test results and for spotting errors while in the process of conducting the tests.

Correction factors applied to the observed mpg values are for standard fuel heating value and standard 60 °F fuel temperature. Correction factors for barometric pressure and ambient temperature are not available. The ambient temperature has a pronounced effect on the fuel economy; therefore, to minimize the effect the procedure recommends a rather narrow temperature range for conducting the tests.

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2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1210—Medium and Heavy Duty Truck and Bus Categorization System

2.1.2 TIRE AND RIM ASSOCIATION PUBLICATION—Tire and Rim Association, 175 Montrose West Avenue, Suite 150, Copley, OH 44321.

Tire and Rim Yearbook

3. Definitions

3.1 Test Cycles

3.1.1 LONG HAUL CYCLE—The driving pattern defined by 9.1 and Figure 1 reflects interstate highway operation and provides a basis for evaluating those components affecting steady-state high speed fuel economy.

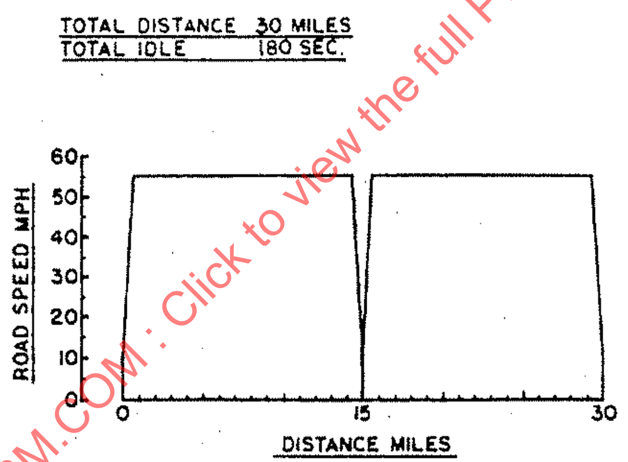


FIGURE 1—LONG HAUL TEST CYCLE

3.1.2 SHORT HAUL CYCLE—The driving pattern defined by 9.2 reflects inter- and intra-city operation and provides a basis for evaluating those components affecting acceleration, deceleration, and steady-state-speed fuel economy.

3.1.3 LOCAL CYCLE—The driving pattern defined by 9.3 reflects intra-city operation (pick-up and delivery) and provides a basis for evaluating those components affecting stop and go fuel economy.

3.1.4 TRANSIT CYCLE—The driving patterns defined by 9.4 reflect those published by DOT and UMTA as the Baseline Advanced Design Transit Coach Specification, Part II, paragraph 1.2 (17), Procurement Document for New 30 and 40 Foot Coach Designs.

3.2 Test Vehicle—Truck, truck-tractor, bus, or motor home with GVWR over 10 000 lb prepared for test per Section 7.

3.2.1 MODEL IDENTIFICATION—Test vehicles shall be identified by manufacturer's name, model year, series/model, and GVW or GCW rating.

3.2.2 COMPONENT IDENTIFICATION—All vehicle components requiring identification on the Test Vehicle Specification Sheet shall be entered as indicated on this sheet.

3.2.3 CONTROL VEHICLE—A control vehicle is used to measure variability associated with a specific test course caused by changes from time period to time period of such factors as wind speed and direction, ambient temperature, humidity, etc., beyond practical control. A preferred control vehicle is of such configuration that the above mentioned variables will generally be expected to affect the control vehicle and test vehicle in a similar fashion. Attention must be placed on maintaining and operating the control vehicle in such a manner that if the aforementioned variables did not exist, identical results would be obtained each time the same test cycle was run.

3.3 Test Vehicle Description

3.3.1 CATEGORY—The category of the test vehicle as defined by SAE J1210, Medium and Heavy Duty Truck and Bus Categorization System. (NOTE: Tractors, when tested in combination with trailers, may have more than one category and require more than one testing basis.)

3.3.2 VEHICLE SPECIFICATIONS—The itemization of pertinent data about the test vehicle as defined by Section 10, Data Recording.

3.4 Test Vehicle Weights

3.4.1 UNLOADED VEHICLE WEIGHT—The weight of the vehicle with maximum capacity of all fluids necessary for operation of the vehicle including fuel. For transit buses, this weight is defined as Unseated Passenger Weight.

3.4.2 GROSS VEHICLE TEST WEIGHT (GVTW)—Unloaded vehicle weight plus the payload necessary to reach maximum vehicle test weight (refers to trucks). For transit buses, this test weight is defined as Seated Passenger Weight.

3.4.3 GROSS COMBINATION TEST WEIGHT (GCTW)—Unloaded vehicle and trailer(s) weight plus payload to reach maximum combined test weight.

3.4.4 AXLE BY AXLE WEIGHT—Scale weight of each individual axle. No axle should be loaded in excess of its rating.

3.4.5 The maximum vehicle test weight is (1) the gross vehicle weight rating (GVWR) of the vehicle or (2) the maximum legal load at the test location, whichever is lower.

3.4.6 The maximum combination test weight is (1) the gross combination weight rating (GCWR) of the vehicle and trailer(s) or (2) the maximum legal load at the test location, whichever is lower.

3.5 Observed Economy—The fuel economy is determined during a test cycle by dividing the actual miles driven on the cycle by the measured and uncorrected number of gallons of fuel consumed. Economy is expressed as miles per gallon. Fuel consumption is expressed as gallons per mile and is a different parameter. If fuel is measured by weight, the observed fuel economy is the miles traveled divided by the fuel weight converted to gallons using the fuel specific weight determined at 60 °F fuel temperature. This corresponds to the volumetric measurement as: Volumetric observed mpg x C_2. Refer to Section 11.

3.6 Corrected Economy—Corrected economy is the observed economy adjusted by the corrections listed in Section 11.

3.7 Reference Conditions—Standard ambient conditions of 70 °F and 29.00 in Hg. The reference temperature lies halfway between test temperature limits of 60 and 80 °F.

4. Instrumentation—All instrumentation shall be calibrated per manufacturer's specifications.

4.1 Fuel—Volumetric fuel measurement system must be compatible with the vehicle fuel system and shall alter the fuel temperature and pressure as little as possible. The fuel measuring device must be accurate within 0.5% of the actual fuel consumption. Fuel temperature through a volumetric fuel measuring device should be recorded.

Fuel consumption can also be measured by weighing the fuel at the start and finish of each test. The fuel temperature shall be recorded after each test. Fuel employed in the test should be contained in a tank equipped with leak proof quick disconnect fittings. Scales employed in weighing the fuel shall be calibrated and be capable of being read to the nearest 0.5 oz.

4.2 Speed—The speed indicating device shall indicate vehicle speed in miles/hour and be accurate within 0.5 mph.

4.3 Acceleration—The acceleration indicating device must be capable of indicating both positive and negative acceleration. It shall indicate acceleration/deceleration in feet/second^2 and be accurate within 0.5 ft/s^2.

4.4 Time—The time measuring instrument must be capable of measuring time interval to 0.5 s and be accurate within 0.5 s in 1 h.

4.5 Temperatures—The temperature indicating device must be capable of being read to the nearest 2 °F. Accuracy must be within 2 °F. The sensing element shall be shielded from radiant heat sources. Wet bulb temperature and dry bulb temperatures are to be recorded.

4.6 Atmospheric Pressure—An aneroid or mercury barometer should be used. This device should be accurate within 0.1 in Hg.

4.7 Wind—Wind speed should be measured at the test location with a device which provides an indication of wind speed that is accurate within 2 mph between 4 and 20 mph. Wind direction should be indicated in a 16 point (360 deg) compass reading.

4.8 Distance—A distance-indicating device is required if the tests are not conducted on a premarked course. This device must be capable of indicating distance to within 0.5% of the course distance.

4.9 Course Direction—Course direction will be determined by drawing a line from the beginning to end of the test course or test leg.

4.10 Vehicle Weight—Vehicle weight should be measured with a device that is accurate within 1.0%. Resolution should be 50 lb or less.

5. Test Material

5.1 Test Vehicle—The test vehicle shall be completely defined as specified on the Test Vehicle Specification Sheet and Test Vehicle Preparation Sheet. (See Appendices A and B.)

5.2 Test Fuel—Normally, service station fuel will be satisfactory for test purposes. The specific gravity of the fuel at 60 °F (referred to water at 60 °F) and the Reid vapor pressure should be recorded. The 50% distillation temperature is also needed for diesel fuel. Grades of fuel, as specified by engine manufacturer, shall be used.

5.3 **Lubricants**—Lubricants used shall conform to the manufacturer's recommendation for the predominant weather condition in which the vehicle is being tested.

6. Test Conditions

6.1 **Ambient Temperature**—Tests should be conducted at ambient temperatures between 60 and 80°. Temperatures outside of this range shall be noted on the Test Vehicle Data Sheet and reported with the fuel economy values.

6.2 **Wind Velocity**—Tests must not be conducted when average wind speed exceeds 15 mph or when gusts exceed 20 mph.

6.3 **Road Conditions**—Roads used should be surveyed and must be dry, clean, and smooth. The maximum change in elevation throughout the course should not exceed ±150 ft in one mile. The maximum grades must be such that the vehicle can be operated within the speed variations specified in 8.3.1.6 while in the same gear ratio that would be used for the specified test element on level road.

6.4 It is recommended that roadside markers be used to indicate the points at which speed changes are to be made, as indicated in Section 9.

6.5 Total course distance to be within 2% of that as defined by the driving schedule.

7. Test Vehicle Specification

7.1 **Break-In**—The vehicle should have accumulated a minimum of 2000 miles of operation prior to the test. At least 1000 miles must have been driven at cycling speeds between 40 mph and maximum legal highway speeds. If a closed track is available for break-in, the maximum speed should not exceed 70 mph. Chassis dynamometer break-in is acceptable, providing the tires have operated at least 100 miles under load prior to the test.

7.2 **Inspection**—The vehicle must be inspected including, if possible, a chassis dynamometer power test. Fuel rate at governed or maximum speed at wide open throttle should be ascertained and adjusted where necessary to meet manufacturer's specifications. These inspections include wheel alignment and brake release. Checks are specified on the Test Vehicle Preparation Sheet.

7.3 **Instrumentation**—The fuel measuring device and other instrumentation, as necessary, must be installed in such a manner as not to hinder the vehicle operation or operating characteristics.

7.4 **Test Weight**—The vehicle weight must be adjusted to provide the test weight indicated in 9.1, 9.2, 9.3, and 9.4. (This test weight includes instrumentation and operator.)

7.5 **Tire Pressure**—The inflation pressure of each tire must be measured cold and should be adjusted to the value specified in the current Yearbook of the Tire and Rim Association, for either the gross axle rating or the gross tire rating, whichever is lower. This pressure should not exceed the maximum tire rating.

NOTE—As specified in 3.4.4, no axle should be loaded beyond the Gross Axle Weight Rating (GAWR).

8. Test Procedure

8.1 **Warm-Up**—The vehicle should be driven a minimum of 1 h at approximately 55 mph or maximum legal highway speed to stabilize engine and drivetrain operating temperatures before running the first test cycle.

CAUTION: The time interval between warm-up and start of the test should be held to a minimum.

8.2 Vehicle Controls

8.2.1 Air conditioner compressor, headlamps, and other accessories that consume power should be in the same mode for both vehicles, preferably in the turned off condition unless required for safe vehicle operation, except for a specific component under evaluation.

NOTE—The air conditioner compressor operates when some defroster systems are on.

8.2.2 It is preferable that vehicle windows remain closed while fuel consumption is being measured during the long haul, short haul, and transit cycles. If this is not the case, it should be recorded.

8.2.3 Care should be taken that accessories for both vehicles are in the same mode and these data are recorded.

8.2.4 To minimize the effects of driver skills on the test results, it is recommended that drivers should be utilized in the following manner:

8.2.4.1 *Control Vehicle*—The control vehicle should be driven by the same driver throughout the test period.

8.2.4.2 *One Control Vehicle—One Test Vehicle*—If only one test vehicle is used and components are changed on the vehicle, then only one driver is required for that vehicle. In this instance, the effect of the driver is the same with and without test component.

8.2.4.3 *One Control Vehicle—Two or More Test Vehicles*—Normally, each vehicle should be driven by the same test driver. Ratios of test/control vehicle mpg may be compared only for configuration changes made on the same vehicle with the same driver on the same route. Only one of these three elements should be changed at a time. The effect of different drivers should be treated in the same manner as a configuration or a test cycle change and a complete duplicate series of tests should be run.

8.3 Driving Schedules

8.3.1 GENERAL DRIVING INSTRUCTIONS

8.3.1.1 Vehicle(s) incapable of attaining speed or acceleration rates specified by the test cycles will be driven at maximum attainable speed until the next maneuver point is reached. Note on Data Form any departure from the specified cycle. (See Appendix C.)

8.3.1.2 Vehicle(s) equipped with automatic transmission should be driven with the transmission in "drive" range, unless this is contrary to the manufacturer's recommendation for the type of service represented by the test cycle, in which case the manufacturer's recommended procedure should be used and so noted on the Test Vehicle Data Sheet. If transmission "hunting" should be encountered at a specified speed, the lower range should be selected to maintain the vehicle speed and this departure from the schedule noted on the Test Vehicle Data Sheet. During deceleration, the throttle is to be closed and the transmission is to remain in the same position that it was in when deceleration began.

8.3.1.3 Vehicle(s) equipped with manual transmission will be operated in the following manner. Starting from rest, the deepest normal highway starting gear recommended by the manufacturer of the vehicle, as equipped and loaded, will be selected. During the acceleration mode of any element, gear ratios selected should be those that produce a positive acceleration after making the upshift. Upshifts should be made at the manufacturer's recommended maximum rated engine speed in each gear. Upon reaching the speed at which the vehicle will be driven at constant speed, the gear ratio selected will be the one which will produce the lowest engine rpm but which will also allow:

a. Vehicle speed to be maintained constant over the remainder of the test element.
b. If the engine manufacturer recommends a minimum operating rpm, no gear should be used which results in operating the engine below this rpm.
c. If a minimum operating rpm is not specified by the manufacturer, it is recommended that the engine not be operated at less than 1000 rpm.

During decelerations, the throttle will be closed, the transmission will remain in gear, and the clutch will be disengaged when the vehicle speed reaches 5 mph or the engine speed reaches 700 rpm, whichever comes first.

8.3.1.4 Test vehicle(s) are to be run against the control vehicle for fuel economy improvement data generation. The vehicles must be tested concurrently, but should not aerodynamically interfere with each other.

8.3.1.5 The vehicle(s) are to be accelerated at W.O.T. (wide open throttle) not to exceed 5 ft/s^2 and acceleration rate is to be monitored unless otherwise prescribed by the test cycle.

8.3.1.6 During the constant speed elements of any test cycle, the speed shall be maintained within ±3 mph of the required speed. The average speed of the constant speed portion of the test must be within ±1 mph of the average speed specified for the cycle (except as noted in 8.3.1.1).

8.3.1.7 The vehicle(s) deceleration is to be initiated by coasting in gear with subsequent brake application to produce the speed change within the given course length of the test cycle. The test cycles are based on an average of 3 ft/s^2 deceleration rate of combined coasting and braking.

8.3.1.8 The fuel measurement by weight or volume shall be taken from the start of any test cycle until the end of that test cycle. Exceptions to this procedure are to be noted on the Test Vehicle Data Sheet. (Turnaround fuel, distance, and time are to be excluded.)

9. ***Test Cycles***—Test cycles are described in 9.1, 9.2, 9.3 and 9.4. Vehicles should be tested a sufficient number of times utilizing the following cycles to meet the criteria defined in 11.5.4. If multiple test segments are conducted before turnaround, data for each segment in the first direction should be paired to corresponding test segments in the return direction.

NOTE—The distance, fuel consumed, and elapsed time for turnaround maneuvers are not to be included in the test cycle results. Turnaround is not required on closed loop test tracks.

9.1 Long Haul at 100% and 50% GVTW (see 3.4 and Table 1)

TABLE 1—LONG HAUL TEST CYCLE FIGURE 1

Element	Maneuver	End Point Distance (ft)
0	Start Engine	0
1	Acc to 55 mph (Full throttle)	—
2	Cruise at 55 mph	78 115
	Coasting Deceleration	—
3	Braking Dec to 0 mph	79 200 (15 miles)
4	Acc to 55 mph (Full throttle)	—
5	Cruise at 55 mph	157 315
6	Coasting Deceleration	—
7	Braking Dec to 0 mph	158 400 (30 miles)
8	Idle 180 s	
9	Turn Off Engine	
10		

If track is not closed loop, conduct elements 5–8 in opposite directions from 1–4, allowing for turnaround.
Total distance - 30 miles.
A minimum of three separate tests should be run.

9.2 Short Haul at 100% and 50% GVTW (see 3.4)—Test cycle 9.2.1 is the preferred short haul test cycle and should be used if a suitable test track is available. Test cycle 9.2.2 is more readily adaptable to the public highways if a suitable test track is not available. A minimum of three separate tests should be run.

9.2.1 PREFERRED SHORT HAUL TEST CYCLE (SEE TABLE 2 AND FIGURE 2):

TABLE 2—PREFERRED SHORT HAUL TEST CYCLE

Element	Maneuver	End Point, Distance (ft)
0	Start Engine	—
1	Acc to 10 mph (1/2 Throttle)	—
2	Acc to 25 mph (Full Throttle, All remaining accels)	
3	Cruise at 25 mph	2640
4	Acc to 30 mph	—
5	Cruise at 30 mph	5280
6	Acc to 35 mph	—
7	Cruise at 35 mph	10 560
8	Acc to 40 mph	—
9	Cruise at 40 mph	18 480
10	Acc to 45 mph	—
11	Cruise at 45 mph	26 400
12	Acc to 50 mph	—
13	Cruise at 50 mph	34 320
14	Acc to 55 mph	—
15	Cruise at 55 mph	38 515
16	Coasting Dec-Dec to 15 mph	—
17	Braking Dec to 0 mph	39 600
18	Idle 60 s	—
REPEAT ONE TIME		
19	Turn Off Engine	

Total distance - 15 miles.
If track is not closed loop, conduct repeat of elements 1–18 in opposite direction allowing for turnaround.

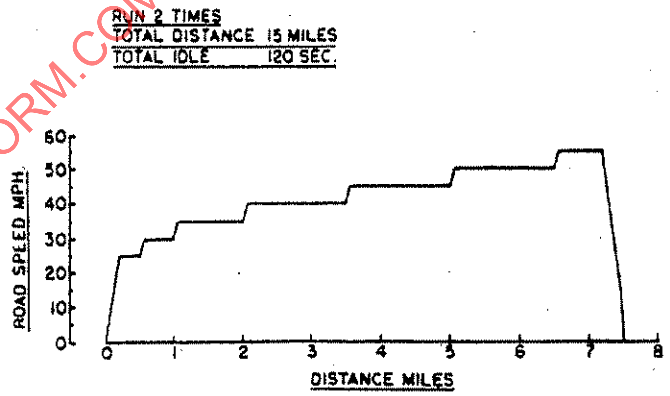


FIGURE 2—SHORT HAUL TEST CYCLE

9.2.2 Short Haul Test Cycle Without Suitable Test Track (see Table 3 and Figure 3):

TABLE 3—SHORT HAUL TEST CYCLE WITHOUT SUITABLE TEST TRACK

Element	Distance at End. Miles	Speed, mph	Idle time, s	Mode of Operation
0	0	0	—	Start Engine
1	0	0	60	Low idle in gear
2	D	0–25	—	Accelerate to 25 mph
3	5.0	25	—	Constant Speed
4	D	25–35	—	Accelerate to 35 mph
5	10.0	35	—	Constant Speed
6	D	35–55	—	Accelerate to 55 mph
7	14.80	55	—	Constant Speed
8	15.0	55-0	—	Decelerate to 0 mph
9	15.0	0	60	Low idle in gear
10	15.0	0	—	Turn Off Engine

Run elements 1–9 two times (one time in each direction).
Reference 11.5.4. Turnaround is not included (except for closed loop test track).
Total distance - 30 miles.
Idle time - 240 s.
D = Distance required to accelerate to maximum speed indicated.

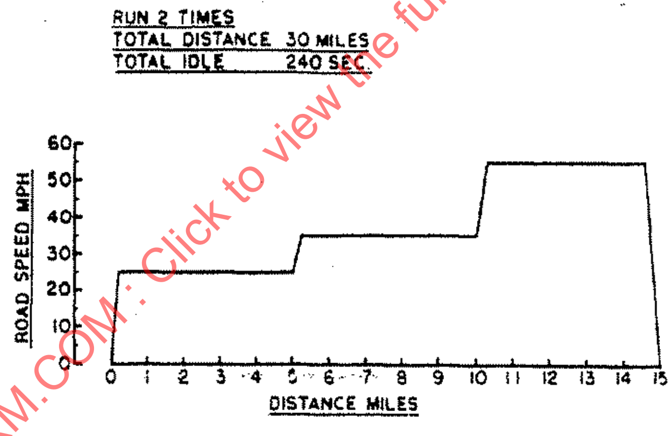


FIGURE 3—SHORT HAUL TEST CYCLE

9.3 Local at 100% and 50% GVTW (see 3.4):—Test cycle 9.3.1 is the preferred local test cycle and should be used if a suitable test track is available. Test cycle 9.3.2 is more readily adaptable to the public highways if a suitable test track is not available.

A minimum of three separate tests should be run.

9.3.1 PREFERRED LOCAL TEST CYCLE (SEE TABLE 4 AND FIGURE 4):

TABLE 4—PREFERRED LOCAL TEST CYCLE

Element	Maneuver	End Point, Distance (ft)
0	Start Engine	0
1	Idle 30 s	0
2	Acc to 5 mph	—
3	Cruise at 5 mph	792
4	Acc to 10 mph	—
5	Cruise at 10 mph	2551
6	Dec to 0 mph, coasting and braking	2587
7	Idle 20 s	—
8	Acc to 20 mph	—
9	Cruise at 20 mph	5137
10	Dec to 0 mph, coasting and braking	5280 (1 mile)
11	Idle 20 s	—
12	Acc to 30 mph	—
13	Cruise at 30 mph	7597
14	Dec to 0 mph, coasting and braking	7920
15	Idle 20 s	—
16	Acc to 35 mph	—
17	Cruise at 35 mph	10 121
18	Dec to 0 mph, coasting and braking	10 560 (2 miles)
19	Idle 20 s	—
20	Acc to 25 mph	—
21	Cruise at 25 mph	13 515
22	Dec to 0 mph, coasting and braking	13 739
23	Idle 20 s	—
24	Acc to 15 mph	—
25	Cruise at 15 mph	15 759
26	Dec to 0 mph, coasting and braking	15 840 (3 miles)
27	Idle 20 s	—
28	Turn Off Engine	—

Repeat elements 1–27 in opposite direction unless on a closed loop course for a total of six miles.

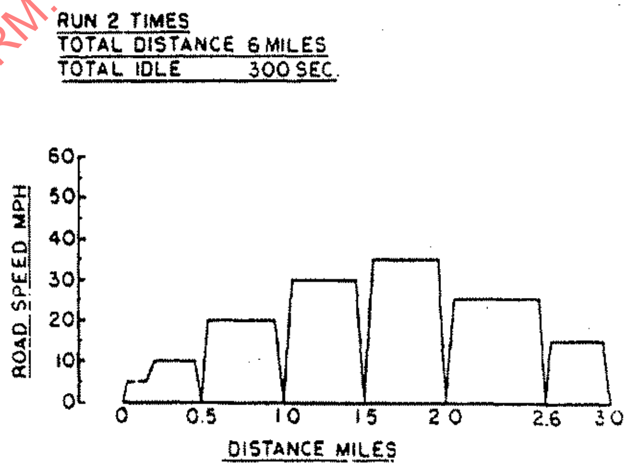


FIGURE 4—LOCAL TEST CYCLE

9.3.2 Local Test Cycle Without Suitable Test Track (See Table 5 and Figure 5):

TABLE 5—LOCAL TEST CYCLE WITHOUT SUITABLE TEST TRACK

Element	Distance at End, miles	Speed, mph	Idle Time, s	Mode of Operation
0	0		—	Start Engine
1	0	0	20	Low idle in gear
2	D	0–20	—	Accelerate to 20 mph
3	0.97	20	—	Constant Speed
4	1.00	20-0	—	Decelerate to 0 mph
5	1.00	0	20	Low idle in Gear
6	D	0–30	—	Accelerate to 30 mph
7	1.94	30	—	Constant Speed
8	2.00	30-0	—	Decelerate to 0 mph
9	2.00	0	20	Low idle in gear

Run elements 1–9 12 times (six times in each direction). Reference 11.5.4. Turnaround is not included (except for closed loop test track).

Total distance - 24 miles

Idle time - 720 s

D = Distance required to accelerate to maximum speed indicated.

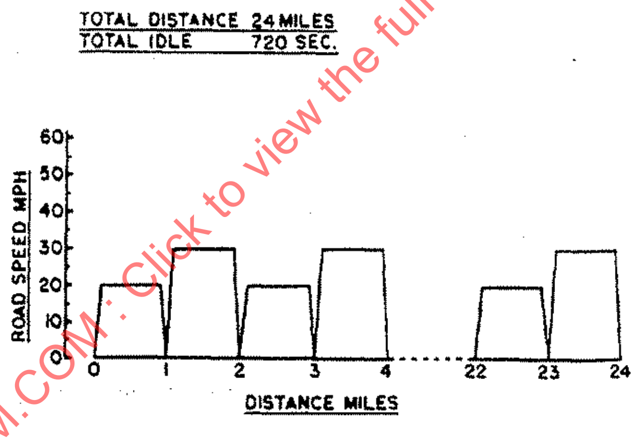


FIGURE 5—LOCAL TEST CYCLE

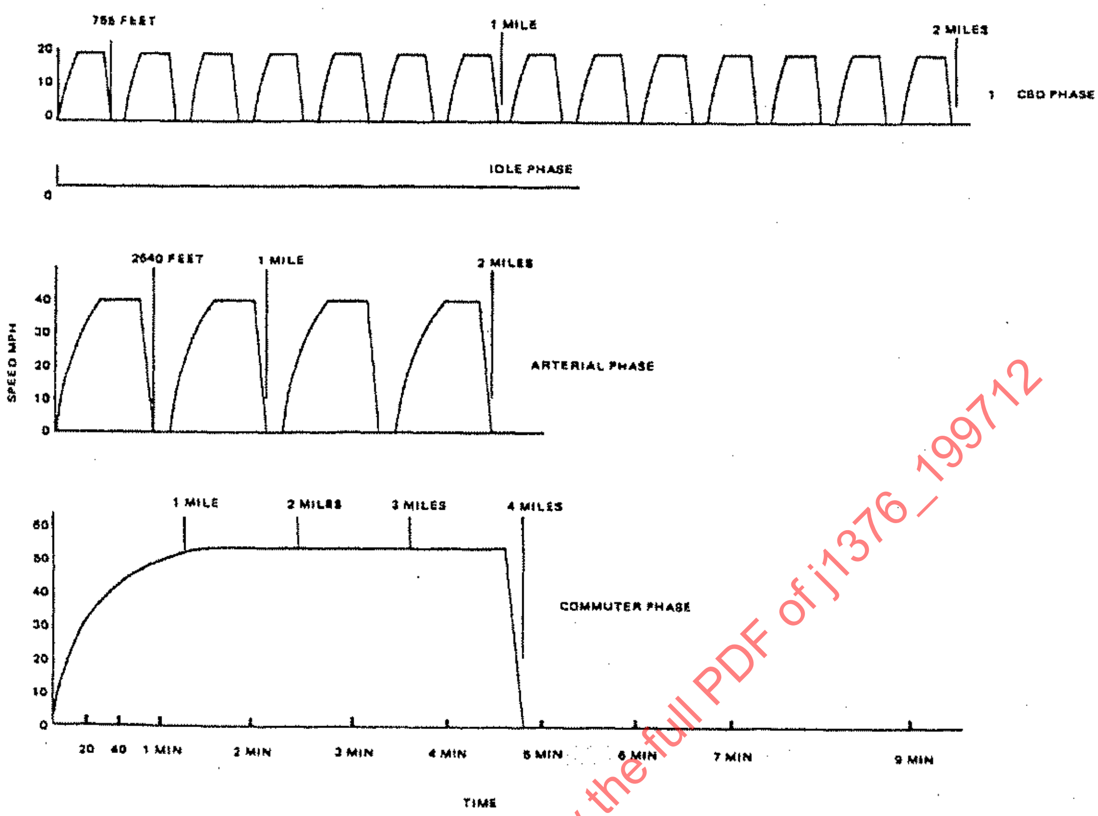


FIGURE 6—TRANSIT COACH DESIGN OPERATING PROFILE DUTY CYCLE

9.4 Transit Coach Design Operating Duty Cycle (see Figure 6 and Table 6):

TABLE 6—TRANSIT COACH DESIGN OPERATING DUTY CYCLE

Phase	Stops/ Miles	Top Speed (mph)	Miles	Accel. Distance (ft)	Accel. Time (s)	Cruise Distance (ft)	Cruise Time (s)	Decel. Rate (fpsps)	Decel. Distance (ft)	Decel. Time (s)	Dwell Time (s)	Cycle Time (min-s)	Total Stops
CBD	7	20	2	155	10	540	18.5	6.78	60	4.5	7	9–20	14
Idle	—	—	—	—	—	—	—	—	—	—	—	5-0	—
Arterial	2	40	2	1035	29	1350	22.5	6.78	255	9	7	4–30	4
CBD	7	20	2	155	10	510	18.5	6.78	60	4.5	7	9–20	14
Arterial	2	40	2	1035	35	1350	22.5	6.78	255	9	7	4–30	4
CBD	7	20	2	155	10	510	18.5	6.78	60	4.5	7	9–20	14
Commuter	1 stop for phase	Maximum or 55	4	5500	90	2 miles + 4580 ft	188	6.78	480	12	20	5–10	1
Total			14									47-10	51

Average Speed - 17.8 mph

9.5 School Bus—Not yet determined.

10. Data Recording—Data should be entered as required on test data forms. (See Appendices.)

10.1 OEM Test Vehicle Specifications Sheet (Six Pages Each Vehicle)—See Appendix A.

10.2 Test Vehicle Preparation Sheet (Two Pages Each Vehicle)—See Appendix B.

10.3 Test Vehicle Data Sheet (Two Pages Each Vehicle)—See Appendix C.

11. Data Correction U.S. Units

11.1 Reference Conditions

Ambient Temperature70 °F	
Fuel Temperature	60 °F Table 3
Barometric Pressure	29.00 in Hg
Fuel Gravity (Gasoline)	0.737 Specific Gravity, 60.5° API Gravity (6.15 lb/gal at 60 °F)
Fuel Gravity (ASTM 1D)	0.820 Specific Gravity, 41.0° API Gravity (6.84 lb/gal at 60 °F)
(ASTM 2D)	0.845 Specific Gravity, 36.0 API Gravity (7.05 lb/gal at 60 °F)
Fuel Net Heating Value	
(ASTM 1D)	126 700 Btu/gal
(ASTM 2D)	129 900 Btu/gal

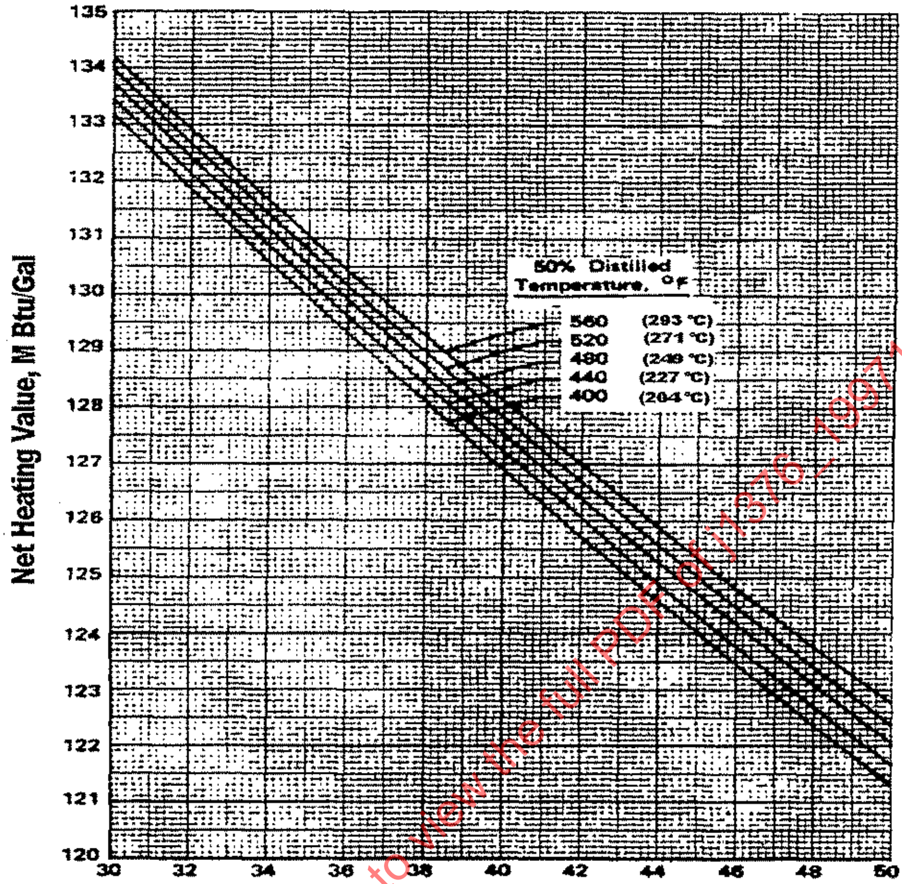
11.2 Definitions for Fuel Economy Correction (U.S. Units)

T_A = Average ambient temperature during test cycle (°F).
T_f = Average fuel temperature at measuring instrument during test cycle (°F).
P = Average barometric pressure during test cycle (in Hg).
G_S = Specific gravity of test fuel at 60 °F. Referred to water at 60 °F.
G_A = API Gravity of test fuel at 60 °F. Referred to water at 60 °F.
FE_o = Observed Fuel Economy (mpg) - Volumetric or gravimetric fuel measurement method. Refer to 3.5 and 11.3.
FE_c = Fuel economy (mpg) corrected to reference conditions.
H = Volumetric heating value of diesel test fuel (Btu/gal) (See Figure 7).
Q = Volumetric heating value of standard reference fuel (Btu/gal).
G_w = 8.3373 lb/gal, density of water at 60 °F.

11.3 Correction Formula

$$FE_C = FE_O \times C_1 \times C_2 \quad \text{(volumetric)} \qquad FE_O = \frac{\text{miles}}{\text{obs., uncorrected gallons}} \quad \text{(Eq. 1)}$$

$$FE_C = FE_O \times C_1 \quad \text{(gravimetric)} \qquad FE_O = \frac{\text{miles}}{\text{pounds fuel}/G_s \times 8.3373}$$



NOTE: 1 Btu/gal = 278.7 J/L
K Btu/gal = 1000 Btu/gal

FIGURE 7—VOLUMETRIC NET HEAT CONTENT OF DIESEL FUELS

11.4 Correction Factors

NOTE—This test procedure does not contain correction factors for ambient temperature and barometric pressure since valid corrections are unknown at this time. The development of such factors is under further study.

11.4.1 C_1—Multiplying factor to correct mpg from test fuel heating value to standard fuel heating value.

$$\text{Gasoline} - C_1 = 1.0 + 0.8\,(0.737 - G_s) \qquad \text{(Eq. 2)}$$

or

$$C_1 = 1.0 + 0.0032\,(G_A - 60.5) \qquad \text{(Eq. 3)}$$

Diesel ASTM 1D – C_1 = Q/H = 126700/H Read H from Figure 1

Diesel ASTM 2D – C_1 - Q/H = 129900/H Read H from Figure 1

11.4.2 C_2—Multiplying factor to correct mpg from test fuel temperature to standard 60 °F fuel temperature.

Read C_2 from Table 10 based on the observed fuel temperature, T_F, and the gravity of the fuel at 60 °F (API) or specific gravity, or

$$C_2 = z + bT_F + cT_F^2 \quad \text{(Eq. 4)}$$

where:

Coefficient	ASTM FUEL GROUP 1	2	3	4
a	$9.7645(10)^{-1}$	$9.7108(10)^{-1}$	$9.6513(10)^{-1}$	$9.5982(10)^{-1}$
b	$3.8674(10)^{-4}$	$4.6590(10)^{-4}$	$5.5473(10)^{-4}$	$6.3156(10)^{-4}$
c	$9.3735(10)^{-8}$	$2.6156(10)^{-7}$	$4.3541(10)^{-7}$	$6.2624(10)^{-7}$

11.5 Sample Calculations with Control Vehicle (Volumetric Measurement of Fuel)—Calculations are shown here for four long haul tests for a test vehicle (1) and a control vehicle (2). See Table 7.

11.5.1 GIVEN DATA

Test Mileage—30.12 miles, predetermined as 15.06 miles outbound and 15.06 miles inbound
Test Fuels—measured values
Gasoline—GA = API Gravity (60/60) - 54.93 °
#2 Diesel
GA = API Gravity (60/60) - 33.23 °
50% distillation temp. - 500 °F

TABLE 7—

Both Vehicles Run No.	Both Vehicles Bar. Press. in Hg	Both Vehicles Air Temp. °F	Test Vehicle #1 Gasoline Powered Obs. Gal	Test Vehicle #1 Gasoline Powered Fuel Temp. °F	Control Vehicle #2 #2 Diesel Powered Obs. Gal	Control Vehicle #2 #2 Diesel Powered Fuel Temp. °F
1	29.52	79.0	8.49	101.5	5.24	85.0
2	29.52	79.0	9.05	103.0	5.53	88.5
3	29.83	71.5	8.45	96.0	5.27	80.0
4	29.49	76.0	8.66	101.0	5.28	85.0

11.5.2 CALCULATIONS FOR RUN NO. 1—FE_o (Veh. 1) = 30.12 miles/5.21 gal obs. = 5.781 mpg

FE_o (Veh. 2) = 30.12/3.21 = 9.383
C_1 - Vehicle 1 - 1.0 + 0.0032 (54.93-60.5) = C_1 = 0.9822
Vehicle 2 - From Figure 1.
H = 131750 Btu/gal
C_1 = Q/H = 129900/131750 = 0.9860
C_2 - Use Table 1
This test gasoline is in group 3.
For 101.5 °F fuel temperature, read 1.0239.
This test diesel fuel is in group 1.
For 85 °F diesel fuel temperature, read 1.0100.
Vehicle 1
FE_c = 5.781 x 0.9322 x 1.0259 = 5.825 mpg
Vehicle 2
FE_c = 9.383 x 0.9860 x 1.0100 = 9.344 mpg
mpg ratio: 9.344/5.825 = 1.604
Runs 2, 3, and 4 are calculated similarly.

11.5.3 CALCULATED DATA (LONG HAUL ROUTE)—See Table 8.

TABLE 8—

Run No.	FE_o, Obs. mpg	C_1, C.F. to Std. H.V.	C_2, C.F. to 60°F Fuel	FE_c, Corr. mpg	Ratio of Corr. mpg
Vehicle #1					
1	5.781	0.9822	1.0259	5.825	—
2	5.427	0.9822	1.0270	5.474	—
3	5.815	0.9822	1.0223	5.839	—
4	5.672	0.9822	1.0256	5.714	—
	5.674			5.713	—
% Spread	6.8%			6.4%	
Vehicle #2					
1	9.383	0.9860	1.0100	9.344	1.604
2	9.885	0.9860	1.0114	8.860	1.619
3	9.325	0.9860	1.0080	9.268	1.587
4	9.296	0.9860	1.0100	9.258	1.620
	9.222			9.182	1.608
% Spread	5.4%			5.3%	2.1%
Standard Deviation σ					
Coefficient of Variation, $\frac{\sigma}{\text{mean}} \times 100$					

The average ratio of 1.608 means that the mpg of vehicle 2 is 60.8% better than that of vehicle 1.

To determine the relative change in fuel economy due to a component change, tests are run at baseline and at test conditions. The calculations to establish the mean control/test vehicle ratios as shown in the sample above are made for the baseline and test conditions. The ratios of the two mean ratios will indicate the relative change in fuel economy due to the installation of the component.

Example: Mean control/test vehicle ratio for baseline tests (bias tires) 1.107

Mean control/test vehicle ratio for radial tire tests 1.015

$$\frac{\text{Baseline Ratio}}{\text{Test Ratio}} = \frac{1.107}{1.015} = 1.0906 \text{ or } 9.06\% \text{ better mpg due to radial tires}$$

NOTE—It is important to differentiate between % change in mpg from % fuel saved. A 9.06% improvement in mpg represents 8.30% fuel savings.

11.5.4 Variations in the Data—A minimum of three test runs is required for each combination of vehicle configuration, test cycle, and driver. The number of additional runs needed, if any, depends on how well the mpg ratios of these three agree. If the total spread in the mph ratios for three or more separate runs does not exceed 3% of the mean value or if the standard deviation does not exceed 1% of the mean value, additional runs need not be considered. A large tractor-trailer on the long haul cycle may readily show repeatability within these criteria but a straight truck at 50% gross test weight on the local cycle may show considerably more scatter. The test engineer should schedule additional runs until reasonably sure that the mean value of the ratios is close to the "true" ratio.

Typically, the mpg ratios are more consistent than the mpg values themselves, particularly for individual vehicle run to run mpg variations of 3% or more. The sample calculations show 6.4% spread in mpg for one vehicle and 5.3% spread for the other, but only 2.1% spread and 1.0% coefficient of variation for the mpg ratios. Frequency distribution diagrams (number of occurrences versus mpg ratio) in band widths of 3–5% of mean mpg ratio can be used to determine whether the data has near normal distribution.

11.6 Sample Calculations with Control Vehicle (Gravimetric Measurement of Fuel)—Assume that the two vehicles of 11.5.1 had these measured fuel weights and calculated results (see Table 9):

TABLE 9—

Run No.	Veh. #1 lb	Veh. #2 lb #2	MPG Observed Economy		Heating Value Correction, C1		Corrected Economy		MPG Ratio
	Gasoline	Diesel	Veh. #1	Veh. #2	#1	#2	#1	#2	#2/#1
1	32.146	22.756	5.931	9.477	0.9822	0.9860	5.825	9.344	1.604
2	34.211	24.000	5.573	8.986	0.9822	0.9860	5.474	8.860	1.619
3	32.070	22.943	5.945	9.400	0.9822	0.9860	5.839	9.268	1.587
4	32.771	22.969	5.818	9.389	0.9822	0.9860	5.714	9.258	1.620
Mean	32.800	23.167	5.817	9.313	--	--	5.713	9.182	1.608
Spread	6.5%	5.4%	6.4%	5.3%	--	--	6.4%	5.3%	2.1%
	0.992	0.563	0.172	0.221	--	--	0.169	0.218	0.0155
%	3.0%	2.4%	3.0%	2.4%	--	--	3.0%	2.4%	1.0%

$$\frac{\text{Miles}}{\text{lb}/G_s \times 8.3373} = \text{mpg} \qquad \text{(Eq. 5)}$$

$$G_s = \frac{141.5}{°\text{API} + 131.5}$$

$$G_s \text{ (Gasoline)} = \frac{141.5}{54.93 + 131.5} = 0.759 \times 8.3373$$

$$= 6.33 \text{ lb/gal at } 60 \text{ °F}$$

$$G_s \text{ (Diesel)} = \frac{141.5}{33.23 + 131.5} = 0.859 \times 8.3373$$

$$= 7.16 \text{ lb/gal at } 60 \text{ °F}$$

$$\text{Veh. \#1 mpg} = \frac{30.12}{32.146/6.33} = 5.931 \text{ mpg observed}$$

$$\times 0.9822 = 5.825 \text{ mpg corrected}$$

$$\text{Veh. \#2 mpg} = \frac{30.12}{22.756/7.16} = 9.477 \text{ mpg observed}$$

$$\times 0.9860 = 9.344 \text{ mpg corrected}$$

These fuel weights were selected to give the same corrected mpg as the sample calculations to illustrate the similarities and the differences in the calculations using the volumetric and gravimetric fuel measurements. The observed fuel economy values are not identical. In theory the corrected values should be alike but in an actual test using both methods the agreement would not be this precise.

TABLE 10A—C2—FUEL TEMPERATURE CORRECTION FACTOR[1] (U.S. UNITS)

ASTM Group Number	Specific Gravity Range	API Gravity Range, ° API
1	0.8499–0.9659	15.0–34.9
2	0.7754–0.8498	35.0–50.9
3	0.7239–0.7753	51.0–63.9
4	0.6723–0.7238	64.0–78.9

Fuel Temp., °F	C_2				Fuel Temp., °F	C_2			
	Group 1	Group 2	Group 3	Group 4		Group 1	Group 2	Group 3	Group 4
0	0.9765	0.9711	0.9651	0.9598	76	1.0064	1.0081	1.0098	1.0114
1	0.9768	0.9715	0.9656	0.9604	77	1.0068	1.0085	1.0104	1.0121
2	0.9772	0.9720	0.9662	0.9611	78	1.0071	1.0090	1.0110	1.0129
3	0.9776	0.9725	0.9667	0.9616	79	1.0076	1.0095	1.0116	1.0136
4	0.9780	0.9730	0.9673	0.9623					
					80	1.0080	1.0100	1.0122	1.0143
5	0.9784	0.9734	0.9679	0.9629	81	1.0084	1.0105	1.0129	1.0151
6	0.9788	0.9739	0.9684	0.9636	82	1.0088	1.0110	1.0136	1.0158
7	0.9791	0.9743	0.9690	0.9642	83	1.0092	1.0115	1.0142	1.0166
8	0.9795	0.9748	0.9696	0.9649	84	1.0096	1.0120	1.0148	1.0173
9	0.9799	0.9753	0.9701	0.9655					
					85	1.0100	1.0126	1.0154	1.0180
10	0.9803	0.9758	0.9707	0.9661	86	1.0104	1.0131	1.0160	1.0187
11	0.9807	0.9763	0.9713	0.9668	87	1.0108	1.0136	1.0167	1.0195
12	0.9811	0.9768	0.9718	0.9675	88	1.0112	1.0141	1.0173	1.0202
13	0.9814	0.9772	0.9724	0.9681	89	1.0116	1.0146	1.0179	1.0209
14	0.9818	0.9777	0.9730	0.9688					
					90	1.0120	1.0151	1.0185	1.0218
15	0.9822	0.9782	0.9735	0.9695	91	1.0124	1.0156	1.0192	1.0225
16	0.9826	0.9787	0.9741	0.9701	92	1.0129	1.0162	1.0198	1.0232
17	0.9830	0.9790	0.9747	0.9708	93	1.0133	1.0167	1.0205	1.0240
18	0.9835	0.9795	0.9753	0.9714	94	1.0137	1.0172	1.0211	1.0247
19	0.9839	0.9800	0.9759	0.9721					
					95	1.0141	1.0177	1.0218	1.0254
20	0.9843	0.9805	0.9765	0.9728	96	1.0145	1.0182	1.0224	1.0262
21	0.9846	0.9810	0.9770	0.9734	97	1.0148	1.0187	1.0230	1.0269
22	0.9850	0.9814	0.9776	0.9741	98	1.0152	1.0193	1.0236	1.0276
23	0.9854	0.9819	0.9782	0.9748	99	1.0156	1.0198	1.0243	1.0285
24	0.9858	0.9824	0.9788	0.9753					
					100	1.0160	1.0203	1.0249	1.0292
25	0.9862	0.9829	0.9793	0.9760	101	1.0165	1.0208	1.0255	1.0300
26	0.9866	0.9834	0.9799	0.9767	102	1.0169	1.0213	1.0262	1.0307
27	0.9870	0.9839	0.9805	0.9773	103	1.0173	1.0219	1.0269	1.0314
28	0.9874	0.9843	0.9811	0.9780	104	1.0177	1.0224	1.0275	1.0322
29	0.9878	0.9848	0.9816	0.9787					
					105	1.0181	1.0229	1.0282	1.0330
30	0.9881	0.9853	0.9822	0.9793	106	1.0185	1.0234	1.0288	1.0338
31	0.9885	0.9858	0.9828	0.9800	107	1.0190	1.0240	1.0294	1.0346
32	0.9889	0.9863	0.9834	0.9807	108	1.0194	1.0245	1.0301	1.0353
33	0.9893	0.9868	0.9840	0.9814	109	1.0198	1.0250	1.0307	1.0360
34	0.9897	0.9873	0.9845	0.9820					
					110	1.0201	1.0255	1.0314	1.0368
35	0.9901	0.9878	0.9851	0.9827	111	1.0205	1.0261	1.0320	1.0376
36	0.9905	0.9882	0.9857	0.9834	112	1.0209	1.0266	1.0327	1.0384
37	0.9909	0.9887	0.9863	0.9841	113	1.0213	1.0271	1.0334	1.0392
38	0.9913	0.9892	0.9869	0.9847	114	1.0218	1.0276	1.0340	1.0399
39	0.9917	0.9897	0.9875	0.9854					

TABLE 10A—C2—FUEL TEMPERATURE CORRECTION FACTOR(1) (U.S. UNITS)

ASTM Group Number	Specific Gravity Range	API Gravity Range, ° API
1	0.8499–0.9659	15.0–34.9
2	0.7754–0.8498	35.0–50.9
3	0.7239–0.7753	51.0–63.9
4	0.6723–0.7238	64.0–78.9

Fuel Temp., °F	C_2 Group 1	C_2 Group 2	C_2 Group 3	C_2 Group 4
40	0.9921	0.9902	0.9880	0.9861
41	0.9925	0.9907	0.9886	0.9868
42	0.9928	0.9912	0.9892	0.9875
43	0.9932	0.9917	0.9898	0.9881
44	0.9936	0.9922	0.9904	0.9888
45	0.9940	0.9926	0.9910	0.9895
46	0.9944	0.9930	0.9916	0.9902
47	0.9948	0.9935	0.9922	0.9910
48	0.9952	0.9940	0.9928	0.9917
49	0.9956	0.9945	0.9933	0.9924
50	0.9960	0.9950	0.9939	0.9930
51	0.9964	0.9955	0.9946	0.9937
52	0.9968	0.9960	0.9952	0.9944
53	0.9973	0.9965	0.9958	0.9951
54	0.9977	0.9971	0.9964	0.9958
55	0.9981	0.9976	0.9971	0.9965
56	0.9984	0.9980	0.9977	0.9973
57	0.9988	0.9985	0.9983	0.9980
58	0.9992	0.9990	0.9988	0.9986
59	0.9996	0.9995	0.9994	0.9993
60	1.0000	1.0000	1.0000	1.0000
61	1.0004	1.0005	1.0006	1.0007
62	1.0008	1.0010	1.0012	1.0014
63	1.0012	1.0015	1.0018	1.0021
64	1.0016	1.0020	1.0024	1.0028
65	1.0020	1.0025	1.0030	1.0035
66	1.0024	1.0030	1.0036	1.0042
67	1.0028	1.0035	1.0042	1.0049
68	1.0032	1.0040	1.0049	1.0056
69	1.0036	1.0045	1.0055	1.0064
70	1.0040	1.0050	1.0061	1.0072
71	1.0044	1.0055	1.0067	1.0079
72	1.0048	1.0060	1.0074	1.0086
73	1.0052	1.0065	1.0080	1.0093
74	1.0056	1.0070	1.0086	1.0100
75	1.0060	1.0076	1.0092	1.0107

Fuel Temp., °F	C_2 Group 1	C_2 Group 2	C_2 Group 3	C_2 Group 4
115	1.0222	1.0282	1.0347	1.0407
116	1.0226	1.0287	1.0353	1.0414
117	1.0230	1.0291	1.0359	1.0422
118	1.0234	1.0296	1.0366	1.0431
119	1.0238	1.0302	1.0372	1.0438
120	1.0243	1.0307	1.0380	1.0446
121	1.0246	1.0312	1.0386	1.0454
122	1.0250	1.0318	1.0393	1.0461
123	1.0254	1.0323	1.0399	1.0469
124	1.0258	1.0328	1.0406	1.0478
125	1.0263	1.0334	1.0412	1.0485
126	1.0267	1.0339	1.0419	1.0493
127	1.0271	1.0344	1.0425	1.0501
128	1.0275	1.0350	1.0433	1.0509
129	1.0279	1.0355	1.0440	1.0517
130	1.0283	1.0360	1.0446	1.0525
131	1.0287	1.0366	1.0452	1.0533
132	1.0291	1.0371	1.0459	1.0541
133	1.0295	1.0377	1.0466	1.0548
134	1.0300	1.0382	1.0473	1.0557
135	1.0304	1.0387	1.0480	1.0565
136	1.0308	1.0393	1.0486	1.0573
137	1.0312	1.0398	1.0493	1.0581
138	1.0316	1.0404	1.0500	1.0589
139	1.0320	1.0409	1.0506	1.0598
140	1.0324	1.0414	1.0513	1.0606
141	1.0328	1.0420	1.0520	1.0613
142	1.0333	1.0425	1.0527	1.0621
143	1.0337	1.0431	1.0534	1.0630
144	1.0341	1.0436	1.0541	1.0638
145	1.0345	1.0442	1.0547	1.0646
146	1.0350	1.0447	1.0554	1.0654
147	1.0353	1.0452	1.0561	1.0662
148	1.0357	1.0458	1.0568	1.0671
149	1.0362	1.0464	1.0575	1.0679
150	1.0366	1.0469	1.0582	1.0687

1. This Table Is Based On Tables 25 And 7 Of "Petroleum Measurement Tables" Published By The American Society For Testing And Materials, 100 Barr Harbor Drive, West Conshohocken, Pa 19428-2959.

$$C_2 = \frac{1}{\text{multiplier for volume reduction to 60 °F}}$$

TABLE 10B—C_2—FUEL TEMPERATURE CORRECTION FACTOR[1] (SI UNITS)

ASTM Group Number	Specific Gravity Range	API Gravity Range, ° API
1	0.8499–0.9659	15.0–34.9
2	0.7754–0.8498	35.0–50.9
3	0.7239–0.7753	51.0–63.9
4	0.6723–0.7238	64.0–78.9

Fuel Temp., °C	C_2				Fuel Temp., °C	C_2			
	Group 1	Group 2	Group 3	Group 4		Group 1	Group 2	Group 3	Group 4
–15	0.9784	0.9734	0.9679	0.9629	25	1.0068	1.0085	1.0104	1.0121
–14	0.9791	0.9742	0.9689	0.9641	26	1.0075	1.0095	1.0115	1.0134
–13	0.9798	0.9751	0.9699	0.9653	27	1.0083	1.0104	1.0127	1.0147
–12	0.9805	0.9760	0.9710	0.9664	28	1.0090	1.0113	1.0138	1.0161
–11	0.9812	0.9768	0.9720	0.9676	29	1.0097	1.0122	1.0150	1.0174
–10	0.9818	0.9777	0.9730	0.9688	30	1.0104	1.0131	1.0161	1.0187
–9	0.9826	0.9785	0.9741	0.9700	31	1.0112	1.0141	1.0172	1.0201
–8	0.9833	0.9794	0.9751	0.9712	32	1.0119	1.0150	1.0184	1.0214
–7	0.9840	0.9803	0.9761	0.9724	33	1.0126	1.0159	1.0195	1.0228
–6	0.9847	0.9811	0.9772	0.9736	34	1.0133	1.0168	1.0207	1.0241
–5	0.9854	0.9819	0.9782	0.9748	35	1.0141	1.0177	1.0218	1.0254
–4	0.9861	0.9828	0.9792	0.9760	36	1.0148	1.0187	1.0229	1.0268
–3	0.9868	0.9837	0.9803	0.9771	37	1.0155	1.0196	1.0241	1.0281
–2	0.9875	0.9845	0.9813	0.9783	38	1.0162	1.0205	1.0252	1.0295
–1	0.9882	0.9854	0.9823	0.9795	39	1.0170	1.0214	1.0264	1.0308
0	0.9889	0.9863	0.9834	0.9807	40	1.0177	1.0224	1.0275	1.0322
1	0.9896	0.9871	0.9844	0.9820	41	1.0184	1.0233	1.0287	1.0336
2	0.9903	0.9880	0.9854	0.9832	42	1.0191	1.0243	1.0299	1.0350
3	0.9910	0.9889	0.9865	0.9844	43	1.0199	1.0252	1.0310	1.0364
4	0.9918	0.9898	0.9876	0.9856	44	1.0206	1.0262	1.0322	1.0378
5	0.9925	0.9907	0.9886	0.9868	45	1.0213	1.0271	1.0334	1.0392
6	0.9932	0.9916	0.9897	0.9881	46	1.0221	1.0281	1.0346	1.0406
7	0.9939	0.9924	0.9908	0.9893	47	1.0228	1.0290	1.0358	1.0419
8	0.9946	0.9933	0.9918	0.9906	48	1.0235	1.0300	1.0370	1.0433
9	0.9953	0.9942	0.9929	0.9918	49	1.0243	1.0309	1.0381	1.0447
10	0.9960	0.9950	0.9939	0.9930	50	1.0250	1.0318	1.0393	1.0461
11	0.9968	0.9960	0.9950	0.9943	51	1.0258	1.0328	1.0405	1.0475
12	0.9975	0.9969	0.9961	0.9956	52	1.0265	1.0338	1.0417	1.0490
13	0.9982	0.9978	0.9972	0.9968	53	1.0272	1.0347	1.0429	1.0504
14	0.9989	0.9986	0.9983	0.9981	54	1.0280	1.0357	1.0441	1.0519
15	0.9996	0.9995	0.9994	0.9993	55	1.0287	1.0366	1.0453	1.0533
16	1.0003	1.0004	1.0005	1.0005	56	1.0294	1.0376	1.0465	1.0548
17	1.0010	1.0013	1.0016	1.0018	57	1.0302	1.0385	1.0477	1.0562
18	1.0018	1.0022	1.0027	1.0031	58	1.0309	1.0395	1.0489	1.0577
19	1.0025	1.0031	1.0038	1.0044	59	1.0316	1.0404	1.0501	1.0592
20	1.0032	1.0040	1.0049	1.0056	60	1.0324	1.0414	1.0513	1.0606
21	1.0039	1.0049	1.0060	1.0069	61	1.0332	1.0424	1.0526	1.0621
22	1.0046	1.0058	1.0071	1.0082	62	1.0339	1.0434	1.0538	1.0635
23	1.0054	1.0067	1.0082	1.0095	63	1.0347	1.0444	1.0550	1.0650
24	1.0061	1.0076	1.0093	1.0108	64	1.0354	1.0454	1.0562	1.0664

1. This Table Is Based On Tables 25 And 7 Of "Petroleum Measurement Tables" Published By The American Society For Testing And Materials, 100 Barr Harbor Drive, West Conshohocken, Pa 19428-2959.

$$C_2 = \frac{1}{\text{multiplier for volume reduction to 60 °F}}$$

TABLE 11—CONVERSIONS TO MODERN METRIC SYSTEM (SI) (PROPOSED METHOD NO. 1)

1 lb force is 4.448222 Newtons (N)
1 lb mass is 0.4535924 kg
1 gal is 3.785412 L
1 mile is 1.609344 km
1 mpg is 0.4251437 km/L
1 gal/100 miles is 235.2146 L/100 km
1°F above freezing (32°F) is 1/1.8°C above freezing (0°C)
1 in of Hg at 60°F temperature of the mercury is 3.37685 kPa pressure
1 mph is 1.609344 km/h
1 ft/s^2 is 0.3048 m/s^2
1 mph/s is 1.609344 km/h/s
1 ft is 0.3048 m

PREPARED BY THE SAE TRUCK AND BUS FUEL ECONOMY COMMITTEE