Designation: D 2885 – 95 (Reapproved 1999)

An American National Standard

Designation: 360/96

Standard Test Method for Research and Motor Method Octane Ratings Using On-Line Analyzers[1]

This standard is issued under the fixed designation D 2885; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the calibration and use of automatic analyzers for determining the antiknock quality of motor gasolines. Octane numbers from analyzers operated in accordance with this test method are equivalent to ASTM research or motor method octane numbers.[2]

1.2 In this test method, inch-pound units are the preferred system of measurement.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 2699 Test Method for Research Octane Number of Spark-Ignition Engine Fuel[3]

D 2700 Test Method for Motor Octane Number of Spark-Ignition Engine Fuel[3]

D 4057 Practice for Manual Sampling of Petroleum and Petroleum Products[4]

E 178 Practice for Dealing With Outlying Observations[5]

3. Terminology

3.1 *Definitions:*

3.1.1 *octane number, n— for spark-ignition engine fuel*, any one of several numerical indicators of resistance to knock obtained by comparison with reference fuels in standardized engine or vehicle tests.

3.1.1.1 *Discussion*—In the context of this test method, octane number is understood to mean the numerical indicator of knock obtained by comparison with primary reference fuels in a standardized CFR engine operating under conditions specified in either the Research, Test Method D 2699, or Motor, Test Method D 2700, standards.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *analyzer lag or response time*—the time required for a knock testing unit/analyzer system to evaluate sample fuel quality and produce a ΔO.N. output signal. It includes measurements of both fuels for one complete comparison cycle.

3.2.2 *check fuels (A and B)*—a pair of spark-ignition engine fuels or process unit materials used for system qualification, typical of the products to be measured in terms of commercial grade or process unit characteristics. Each fuel shall be round-robin octane number (O.N.) calibrated using primary reference fuels, multiple engines, and so forth, to establish the expected difference O.N. for the fuel pair.

3.2.3 *delta O.N. (ΔO.N.)*—the octane difference between two fuels as tested by the procedures of this test method.

3.2.4 *expected difference O.N.*—the octane difference between two check fuels of a pair, based on the average results of round-robin calibrations, and expressed as a positive ΔO.N. value.

3.2.5 *octane span or calibration*—the octane number scaling or adjustment of the knock testing unit variable used to measure relative octane quality. This can be in terms of either compression ratio digital counter units or knock intensity units per octane number.

3.2.6 *overall system response time*—the time required from a process, pipe line, or in-line blender change until that change can be displayed as a ΔO.N. value. It includes the time for the slowest reacting process variable, the sampling system time, and the knock testing/analyzer response time.

[1] This test method is under the jurisdiction of ASTM Committee D-2 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.01 on Combustion Characteristics.

Current edition approved Jan. 15, 1995. Published February 1996. Originally published as D 2885 – 70 T. Last previous edition D 2885 – 93.

[2] "Research method" refers to ASTM Test Method D 2699, Test Method for Knock Characteristics of Motor Fuels by the Research Method. "Motor method" refers to ASTM Test Method D 2700, Test Method for Knock Characteristics of Motor and Aviation Fuels by the Motor Method. Test Methods D 2699 and D 2700 can be found in this volume.

[3] *Annual Book of ASTM Standards*, Vol 05.05.

[4] *Annual Book of ASTM Standards*, Vol 05.02.

[5] *Annual Book of ASTM Standards*, Vol 14.02.

3.2.7 *product O.N.*—the research or motor octane number that can result from utilization of ΔO.N. value produced by this test method and the output signal of an automatic analyzer.

3.2.7.1 *Discussion*—In the context of this test method, typical commercial analyzer instrumentation provides the capability to display and record the octane number obtained by adding the ΔO.N., produced by this test method, to the calibrated octane number of one of the two fuels compared by this test method. These knock testing unit/analyzer systems also can express the product octane number in terms of the following relationship:

$$\text{product O.N.} = \text{prototype O.N.} \pm \text{offset O.N.} + \Delta\text{O.N.} \quad (1)$$

where the offset O.N. represents the difference between the desired product O.N. and the octane number of the calibrated fuel.

3.2.8 *prototype fuel*—a spark-ignition engine fuel or process unit material which is used as a secondary standard. It is assigned an octane number based on a direct match comparison with a standard fuel.

3.2.9 *sample fuel*—the fuel to be evaluated, which is typically drawn from a flowing stream of either finished spark-ignition engine fuel product or a process unit material. It must be continuously representative of the quality being produced and suitably treated to eliminate any dirt or entrained moisture without affecting the octane number.

3.2.10 *standard fuel*—a spark-ignition engine fuel or process unit material that is round-robin octane number (O.N.) calibrated using primary reference fuels, multiple engines, and so forth, for use in subsequent calibration of prototype fuels.

3.2.11 *system dead time*—the period during analyzer operation when sample fuel quality measurement is not possible. It includes prototype testing periods and the time required to attain knock testing unit/analyzer equilibrium on the sample fuel.

4. Summary of Test Method

4.1 In this test method, the research or motor octane number of a gasoline product is determined by comparing its knock characteristics with those of a prototype of known research or motor octane number of an automated repetitive cycle. The difference in knock characteristics may be measured as (*1*) the difference in knock intensity at constant compression ratio, or (*2*) the difference in compression ratio at constant knock intensity. The test method assumes that the automatic analyzer system has been installed and adjusted according to the instructions of the manufacturer, whereby the knock intensity or compression ratio differences are automatically utilized to produce a measure identified as ΔO.N. The research or motor octane number of the product is based on the calibrated research or motor octane number of the prototype and the ΔO.N.

4.2 The primary use of this test method is to evaluate a steadily flowing sample which is continuously representative of a product stream that can originate from an in-line blender, process unit, or transfer pipeline. In addition the method can be used to analyze individual samples on a repetitive basis.

5. Significance and Use

5.1 This test method provides automatic, on-line analysis by either research or motor method conditions of test. Gasoline antiknock quality as determined by this technique has the same significance as that provided in Test Method D 2699, and Test Method D 2700. This test method is used by petroleum refiners as a primary specification measurement.

6. Reference Materials

6.1 *Primary Reference Fuels*, isooctane and n-heptane meeting the specifications which follow:

6.1.1 *isooctane* shall be no less than 99.75 % by volume pure, contain no more than 0.10 % by volume n-heptane, and contain no more than 0.002 g/US gal (0.5 mg/L) of lead.

6.1.2 *n-heptane* shall be no less than 99.75 % by volume pure, contain no more than 0.10 % by volume isooctane and contain no more than 0.002 g/US gal (0.5 mg/L) of lead.

6.2 *Standard Fuel*, is the basic reference for establishing the octane number level that defines the product octane number determined by automatic engine/analyzer systems. The characteristics, storage and handling procedures, calibration and use of a standard fuel shall conform to the following:

6.2.1 *Octane Number* shall be selected such that the prototype fuels to be calibrated shall not differ from it by more than ±0.5 octane number.

6.2.2 *Volatility* is not critical as long as the standard fuel has the full boiling characteristics of a typical gasoline. Weathering, however, can cause a change in octane number; thus the vapor pressure of the standard fuel may have to be lower than that of the product fuel. A Reid vapor pressure (RVP) less than 10 psi (68.9 kPa) is preferred but it shall not exceed 12 psi (82.7 kPa) in any case.

6.2.3 *Antiknock Compound* such as organometallic lead or manganese shall be used in the standard fuel only if the product will contain them. The standard fuel shall contain the same compound used in the product and the concentrations in the two fuels shall be similar.

6.2.4 *Octane Enhancers* such as oxygenates shall be used in the standard fuel if the product will contain them. The standard fuel shall contain the same enhancer used in the product and the concentrations in the two fuels shall be similar.

6.2.5 *Antioxidant* protection is necessary to ensure storage stability for periods of up to one year of use.

6.2.5.1 *Antioxidants* shall be added to the standard fuel prior to any octane number calibration.

6.2.6 *Metal Deactivator* may be necessary and if added shall be in accordance with supplier recommendations.

6.2.7 *Hydrocarbon Composition* shall be similar to that of the related prototype fuel to be calibrated. Users are cautioned to investigate the effects of any large differences prior to application.

6.2.8 *Storage and Handling* shall be under controlled conditions to minimize the possibility of octane number change or contamination. Systems and procedures shall conform to the recommendations set forth in Annex A1 of this standard.

6.2.9 *Octane Number Calibration* shall be the average of ratings on at least 16 different engines, preferably in as many different laboratories as possible to minimize the potential for

individual location bias. These ratings shall be in complete accordance with the requirements of the research or motor methods for octane number measurement. Systems and procedures shall conform to the requirements set forth in Annex A2 of this standard.

6.3 *Prototype Fuel* is a secondary reference for establishing the octane number level that defines the product octane number determined by automatic engine/analyzer systems. The characteristics, storage and handling procedures, calibration and use of a prototype fuel shall conform to the following:

6.3.1 *Octane Number* shall be within ± 1.0 of the target octane number.

6.3.2 *Sensitivity*, or the difference between research and motor octane numbers, shall be no more than ± 1.0 octane number different from those of the standard fuel with which it is calibrated and the product fuels with which it will be used.

6.3.3 *Volatility* is not critical as long as the prototype fuel has the full boiling characteristics of a typical gasoline. Weathering, however, can cause a change in octane number; thus the vapor pressure of the prototype fuel may have to be lower than that of the product fuel. A Reid vapor pressure (RVP) less than 10 psi (68.9 kPa) is preferred but it shall not exceed 12 psi (82.7 kPa) in any case.

6.3.4 *Antiknock Compound* such as organometallic lead or manganese shall be used in the prototype fuel only if the product will contain them. The prototype fuel shall contain the same compound used in the product and the concentrations in the two fuels shall be similar.

6.3.5 *Octane Enhancers* such as oxygenates shall be used in the prototype fuel if the product will contain them. The prototype fuel shall contain the same enhancer used in the product and the concentrations in the two fuels shall be similar.

6.3.6 *Antioxidant* protection is necessary to ensure storage stability for periods of up to one year of use.

6.3.6.1 *Antioxidants* shall be added to the prototype fuel prior to any octane number calibration.

6.3.7 *Hydrocarbon Composition* shall be similar to that of the product with which it will be used. Users are cautioned to investigate the effects of any large differences prior to application.

6.3.8 *Storage and Handling* shall be under controlled conditions to minimize the possibility of octane number change or contamination. Systems and procedures shall conform to the recommendations set forth in Annex A1 of this standard.

6.3.9 *Octane Number Calibration* shall be the average of at least 10 sets of back-to-back or direct match comparisons of the prototype fuel to the standard fuel. These comparisons may be obtained on a single research or motor method laboratory engine or on a single automatic engine/analyzer unit. Systems and procedures shall conform to the requirements set forth in Annex A2 of this standard.

6.3.9.1 The octane number calibration of the prototype fuel shall be checked with the standard fuel at least once a week and also whenever there is any indication of contamination or degradation.

6.4 *Check Fuels*— Check Fuels are a pair of fuels for system qualification check-out that are prepared, packaged, stored, and round-robin calibrated as if they were standard fuels.

6.4.1 The two check fuels shall have an expected difference 0.N. ranging from 0.2 to 1.0 octane number and be coded so the difference in the calibrated average octane numbers (Fuel B from Fuel A) is a positive value.

6.4.2 The fuel characteristics, including those for volatility, antiknock compound, octane enhancers, and antioxidant protection shall be similar for the two check fuels of a pair.

6.4.3 A standard fuel may be used interchangeably as a check fuel as long as it is paired with a second fuel that meets the requirements of a check fuel pair.

7. Apparatus

7.1 The knock testing units must be as specified in the ASTM Research or Motor Methods.

7.2 The knock testing unit shall be supplemented by automatic analyzer equipment to continuously measure the octane difference between prototype fuel and product.

7.3 The knock testing unit and analyzer installation must conform to the recommendations of the "Manual on Installation of Refinery Instruments and Control Systems."[6]

7.4 The sample system must provide a continuously representative product to the knock testing unit in accordance with the recommendations of the "Manual on Installation of Refinery Instruments and Control Systems."[7]

7.4.1 Particulate contamination must be removed by a filter of 100µ m or less.

7.4.2 Entrained water must not be present in the fuels at the inlet to the automatic analyzer fuel conditioning equipment.

8. Operating Conditions

8.1 The knock testing unit operating conditions must be those specified in the research or motor methods.

8.2 Prototype and product must be at the same temperature in the knock testing unit carburetor. The temperature shall not exceed 50°F (10°C) measured in the excess product disposal line at the carburetor.

9. Procedure

9.1 Detailed operating procedures shall conform to the recommendations of the automatic analyzer manufacturer. These must adhere to the outline provided in this section.

9.1.1 *Startup*:

9.1.1.1 Start the knock testing unit and allow it to warm up.

9.1.1.2 Select the proper prototype and connect the testing unit to it.

9.1.1.3 Span the automatic analyzer for the octane range to be used (knock intensity or compression ratio units per octane number).

9.1.1.4 Introduce the desired offset O.N. when applicable.

[6] API RP550, Second Edition, 1965, Part II, "Process Stream Analyzers," Section 14.3.

[7] *Ibid*, Sections 14.2 through 14.6.

9.1.1.5 Turn on the product and perform any flow adjustment steps.

9.1.1.6 Establish the fuel-air ratio for maximum knock intensity for both prototype and product.

9.1.2 *On-Line Operation*—Switch to automatic mode.

9.1.3 *Shutdown*—Return to manual mode and perform the conventional knock testing unit shutdown steps.

10. System Qualification Check-Out

10.1 Check the performance of the combined knock testing unit/automatic analyzer regularly and after any maintenance that affects engine performance. Operate the system using two check fuels of calibrated octane number to determine whether it produces the correct ΔO.N. value and does so with appropriate system stability.

10.2 The ΔO.N. value is dependent upon (*1*) knock testing unit sensitivity, (*2*) detonation meter sensitivity, and (*3*) automatic analyzer span setting for the octane range to be used.

10.2.1 The knock testing unit must be able to repeatedly measure the ΔO.N. for two fuels of different octane number. The latitude of engine condition is quite broad and when the unit is no longer satisfactory for automatic analyzer operation, it will be evidenced as instability of knock intensity. This condition often can be rectified through carbon blasting and ultimately by engine overhaul.

10.2.2 Span (calibrate) setting is a scaling adjustment built into the automatic analyzer instrument or computer software. It must be properly preset for the octane range so that knock intensity or compression ratio signal levels are accurately displayed in terms of ΔO.N.

10.3 Perform the qualification check-out with the measurement system operating in the same manner it is used for product quality measurement. Equal time periods of operation on the two check fuels shall be used. The time period for operation on each fuel shall be 4 min or longer.

10.4 Operate the knock testing unit/automatic analyzer system sequencing back and forth between the two check fuels until a minimum of six complete cycles are completed. A complete cycle comprises one period of operation on one fuel (A), followed by one period on the second fuel (B). Select the check fuel inlet connections to the knock testing unit/automatic analyzer system so that the delta O.N. values are determined by subtracting the fuel B result from that for fuel A.

10.5 *Determination of Average ΔO.N. and Range*:

10.5.1 Discard the ΔO.N. result for the first complete cycle determination.

10.5.2 Tabulate the last five ΔO.N. values (Fuel B from Fuel A), including the proper algebraic sign.

10.5.2.1 It is permissible to tabulate and analyze the data utilizing the updated ΔO.N. after the analysis period on each fuel (ten values) as long as each fuel is tested a minimum of six times.

10.5.3 Calculate the average ΔO.N., with respect to algebraic sign.

10.5.4 Calculate the ΔO.N. range (maximum ΔO.N.– minimum ΔO.N.).

10.6 *System Accuracy Qualification*:

TABLE 1 Accuracy Qualification Acceptance Limit Values, *K*

Test Method	Accuracy Qualification Acceptance Limit, *K*
Research	±0.4
Motor	±0.4

10.6.1 The accuracy of the system shall be assessed by comparing the measured average ΔO.N. for two check fuels to their expected difference O.N.

10.6.1.1 Calculate *Q*, the accuracy qualification value, using the following formula:

$$Q = \text{measured average } \Delta\text{O.N.} - \text{expected difference O.N.} \quad (2)$$

10.6.1.2 The system shall be qualified if *Q* is between ± *K*, the accuracy qualification acceptance limits listed in Table 1 for the respective method. In the normal and correct operation of this test method, in the long run, *Q* is expected to fall outside the accuracy qualification acceptance limit (*K*) in only one case in 20.

10.6.1.3 If *Q* is outside the accuracy qualification acceptance limits, each system component shall be evaluated to identify and correct the root cause(s) of the inaccuracy.[1]

10.7 *Assessment of System Stability*:

10.7.1 The stability of the system should be assessed by determining the range spanned by the series of ΔO.N. measurements for the two check fuels.

10.7.1.1 Compare the measured ΔO.N. range to the range limit *L* value, listed in Table 2, for the respective method. If the measured ΔO.N. range exceeds the range limit value *L*, a general inspection should be performed.[8]

NOTE 1—Range limit (*L*) values listed in Table 2 have been selected for use with data sets of five independent ΔO.N. determinations, at a Type 1 error of approximately 1 %.

11. Interpretation of Results

11.1 This test method is primarily for on-line quality control testing of in-line blended gasoline or process unit material. The evaluation normally covers long periods of time (hours to days) and control adjustment of product quality is based on automatic analyzer data. The large amount of data accumulated during these long time periods place a very high reliability on the average ΔO.N. result.

11.2 To properly indicate the ΔO.N. quality of a tender of on-line analyzed product it will be necessary to weigh the data in terms of quantity as well as quality. This can be accomplished by multiplying the instantaneous ΔO.N. by flow rate and integrating the resultant values (ΔO.N. × barrels) on a time basis. The weighted average ΔO.N. for an entire tender of product can readily be obtained through division of the totalized ΔO.N. × barrels by the total barrels in the tender.

11.3 The product O.N. will be determined by summing the target O.N. and the average ΔO.N. of the product as established in 10.2.

[8] Accuracy Qualification Acceptance Limit (*K*) and Range Limit (*L*) values are based upon statistical evaluation of test data using knock testing unit/analyzer equipment. See Research Report RR: D2-1330 for details of the study conducted in 1991 through 1993.

TABLE 2 Range Limit Values, *L*

Test Method	Range Limit, *L*
Research	0.2
Motor	0.3

11.4 The precision of the product O.N. will be that specified in 12.3.

12. Precision and Bias

12.1 *Characteristics of the Data*:

12.1.1 The overall precision of the product octane number data obtained using a knock testing unit-automatic analyzer system is made up of three parts. These are the precision of the standard fuel calibration data, the prototype calibration data and the product-prototype comparison data.

12.1.1.1 Standard fuel calibration data will provide standard deviations that agree with the historical standard deviation versus octane number range data for the research and motor methods, as shown in Table 3.

12.1.1.2 Prototype fuel calibration data will provide standard deviations that are almost an order of magnitude smaller than those for the standard fuel. This is inherent in the method of obtaining the data, which is based on a direct match procedure.

12.1.1.3 Product-prototype comparisons will have standard deviations identical to those for prototype fuel calibrations because they are also obtained by a direct match procedure.

12.1.2 The precision of the knock testing unit-automatic analyzer system product quality must be the same as that specified for the research and motor methods because these are the methods used to calibrate the standard fuels. The contribution of the prototype and product-prototype comparisons is negligible because their variances are so small with respect to the former.

12.2 *Basis for Precision Statement*— The precision is defined in terms of the statistical quantity termed confidence limits. This technique states that there is a specific probability (95 %) that the true octane number will be within the confidence interval defined by the following relationship:

$$\text{Confidence limits} = \text{product O.N.} + t\sigma/\sqrt{n} \quad (3)$$

where:

t = is determined from the statistical Student's t table for a specific probability level and the appropriate degrees of freedom ($n - 1$) which will be infinity for historical octane data,

σ = is the historical standard deviation for the research or motor methods and a specific octane number level, and

n = is the number of octane determinations involved in the calibration of the standard fuel.

TABLE 3 Confidence Limits

Octane Number	Method Standard Deviation		± Confidence Limits	
	Research	Motor	Research	Motor
80	0.43	0.43	0.21	0.21
85	0.33	0.33	0.16	0.16
90	0.25	0.39	0.12	0.19
95	0.22	0.40	0.11	0.20
100	0.25	0.54	0.12	0.26

12.3 *Product Precision*—There is a 95 % probability that the true product octane number will be within the confidence limits specified in Table 3 for various octane number levels and based on the associated research and motor method standard deviations which are also listed.

NOTE 2—Confidence limits in Table 3 are based on a 95 % probability level, the historical standard deviations of the research and motor methods, $n = 16$, and a value of Student's $t = 1.96$.

12.4 *Bias*—The bias statement is currently being developed.

13. Keywords

13.1 check fuel; delta octane number; motor octane number; on-line analyzer; product fuel; prototype fuel; research octane number; standard fuel

ANNEXES

(Mandatory Information)

A1. STANDARD CHECK, AND PROTOTYPE FUEL STORAGE AND HANDLING

A1.1 Standard fuel must meet the requirements of 6.2 and must be handled with extreme care from time of initial bulk collection until ultimate use in calibrating a prototype.

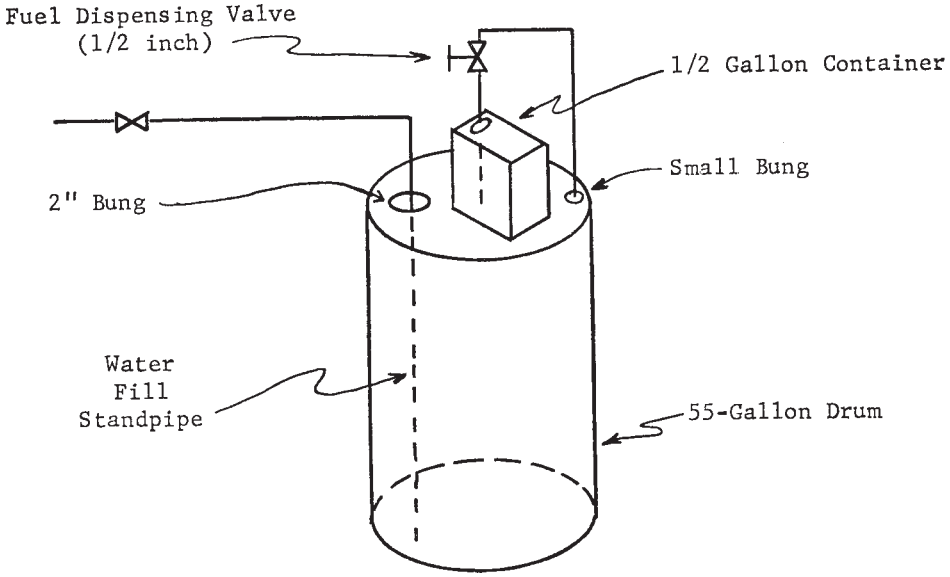
A1.1.1 *Bulk Receiver*— The volume of the receiver used for mixing and dispensing the Standard must be large enough to contain the total volume of fuel to be prepared plus an adequate excess volume (10 %) for outage and handling. The receiver must be clean, dry, and free of all hydrocarbon-soluble contaminants. It must be equipped with facilities for mixing, and have a sampling tap for dispensing the fuel into suitable containers.

NOTE A1.1—If a 55-gal (207-L) drum is used for the bulk receiver, facilities for tumbling the drum are required. For larger receivers an in-tank mixer or pumped circulation system is necessary.

A1.1.2 *Collection and Preparation*—Collection of a fuel in the bulk receiver must be accomplished in such a manner that the fuel is clean and does not contain any entrained moisture. The contents of the receiver must be mixed thoroughly to ensure uniformity. The length of mixing time will depend on the size of the receiver and the efficiency of the mixing facilities.

A1.1.3 *Storage Containers*:

A1.1.3.1 Preferably, standard fuel should be stored in new, clean, dry, ½-gal (or 2-L) cans, with screw top closure and metal seal inserts. Screw caps must be protected by a cork or paper disk faced with tin or aluminum foil. Containers which



NOTE 1—Table of Metric Equivalents

½ in. = 12.7 mm
2 in. = 50.8 mm
½ gal = approximately 2 litres
55 gal = approximately 207 litres.

FIG. A1.1 Bulk Standard Fuel Drum Receiver

are to be shipped by common carrier must conform to ICC, state, and local regulations.

NOTE A1.2—Only cans with exterior seams soldered with rosin flux are permissible. Small amounts of flux may contaminate the sample and will reduce its storage stability. Accordingly all cans must be rinsed with a quantity of standard fuel prior to filling if there is any doubt about the manner of can fabrication.

A1.1.3.2 Standard fuel may also be stored and shipped in new, clean drums that conform to ICC, state, and local regulations. When standard fuel is shipped in drums, the receiving location should consider the drum as being equivalent to the bulk receiver as described in A1.1.1 and should transfer and check the fuel in accordance with A1.1.3.1, A1.1.4.1, A1.1.5 , and A1.1.6.

A1.1.4 *Dispensing Equipment*:

A1.1.4.1 For 55-gal (207-L) drums, the water displacement process illustrated in Fig. A1.1 is the preferred method. Water is introduced through a standpipe of sufficient length to extend to the bottom of the drum. The standpipe must have a suitable adapter to fit into the large bung effecting a tight closure. Standard fuel is to be dispensed through a ½-in. (12.7-mm) valve connected to the small bung and having a fill tube arrangement that extends to the bottom of the ½-gal (or 2-L) cans to be filled.

A1.1.4.2 Nitrogen may also be used to dispense the standard fuel in which case the nitrogen is introduced through the small bung and the dispensing valve and fill tube arrangement must be installed on the standpipe.

NOTE A1.3—Pumped dispensing of standard to the ½-gal (or 2-L) cans is not recommended, neither is the use of funnels or other devices between the dispensing valve and can.

A1.1.4.3 Large bulk receivers or tanks may be utilized and they must be equipped with a sample cock similar to that shown in Fig. 3 of Practice D 4057. The apparatus should include a ½-in. (12.7-mm) valve and a delivery tube long enough to reach the bottom of the ½-gal (or 2-L) cans to be filled.

A1.1.5 *Sampling Procedure*—The filling of cans must be carried out in a sheltered location protected from direct sunlight and preferably in an area cooled to 32 to 50°F (0 to 10°C). To avoid loss of light ends, and variation between cans, the filling of the entire group of cans should be carried out as quickly as possible and without interruption.

A1.1.5.1 Prior to filling, inspect the interior of rinsed and drained cans for cleanliness with a suitable inspection lamp and reject all defective cans and those containing water or dirt.

A1.1.5.2 Discard the first ½ gal (or 2 L) of fuel drawn from the dispensing spout since this has served to purge the dispensing equipment.

A1.1.5.3 Fill the cans one at a time to within approximately 1 in. (25.4 mm) of the top (about 2 in. (51 mm) from the top of the spout) with the end of the delivery tube at the bottom of the can.

A1.1.5.4 Remove the can from under the delivery tube and immediately insert the metal seal and screw the cap on tightly.

A1.1.5.5 Tag and label each can and number each in accordance with the sequence of its preparation.

A1.1.5.6 The last 2 or 3 gal (8 to 12 L) of standard fuel should not be canned.

A1.1.5.7 After completion of the entire can-filling operation recheck each cap for tightness and make a visual check for leaky cans while they are in an upright position.