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CAN/CGSB-3.517-2020

Supersedes CAN/CGSB-3.517-2017

Diesel fuel

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NATIONAL STANDARD OF CANADA **CAN/CGSB-3.517-2020**

Supersedes CAN/CGSB-3.517-2017

Diesel fuel

CETTE NORME NATIONALE DU CANADA EST DISPONIBLE EN VERSIONS FRANÇAISE ET ANGLAISE.

ICS 75.160.20

Published February 2020 by the
Canadian General Standards Board
Gatineau, (Quebec) Canada K1A 1G6

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Acknowledgment is made for the translation of this National Standard of Canada by the Translation Bureau of Public Services and Procurement Canada.

This National Standard of Canada CAN/CGSB-3.517 supersedes the 2017 edition.

Changes since the previous edition

- Explicit inclusion of synthetic hydrocarbons
- Deleted reference to CAN/CGSB-3.0 No 20.9 CGSB cetane index of diesel fuels
- Modified definitions of 2.5% low-end design temperature, ultra-low sulphur diesel, biodiesel, diesel fuel, low level biodiesel blend
- Addition of a definition for synthetic hydrocarbons
- New paragraph 6.1.3 regarding bias in alternate test methods
- Additional test methods for biodiesel and kinematic viscosity
- Change in referee test method for water and sediment
- Various editorial changes to align 3.517, 3.520 and 3.522
- Revised wording for cautions on fuel colour
- Revised wording on stability and ignition quality in Annex C
- Added ASTM D8183 test method for ignition quality
- Added discussion on distillation in Annex C, C7
- Added discussion on net energy content to Annex C, C18
- Added discussion on synthetic hydrocarbons content to Annex C, C19

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Diesel fuel

1 Scope

This standard applies to two types of diesel fuel, Type A and Type B. Both are suitable for use in high-speed diesel engine powered equipment for on-road and off-road applications and in select equipment powered by medium speed diesel engines.

Type A is intended for use in selected applications such as urban buses and underground mining or when ambient temperatures require better low-temperature properties than Type B.

Fuel meeting this standard may be used for underground mining applications that were formerly covered by CAN/CGSB-3.16 (see table footnote a and Annex C for notes related to flashpoint).

See Annex B for regulations that apply to diesel fuels.

The testing and evaluation of a product against this standard may require the use of materials and/or equipment that could be hazardous. This document does not purport to address all the safety aspects associated with its use. Anyone using this standard has the responsibility to consult the appropriate authorities and to establish appropriate health and safety practices in conjunction with any applicable regulatory requirements prior to its use.

Units of measurement – Quantities and dimensions used in this standard are given in metric units, mainly SI units.

2 Normative references

The following normative documents contain provisions that, through reference in this text, constitute provisions of this National Standard of Canada. The referenced documents may be obtained from the sources noted below.

NOTE The addresses provided below were valid at the date of publication of this standard.

An undated reference is to the latest edition or revision of the reference or document in question, unless otherwise specified by the authority applying this standard. A dated reference is to the specified revision or edition of the reference or document in question.

2.1 Canadian General Standards Board (CGSB)

CAN/CGSB-3.0 — *Methods of testing petroleum and associated products:*

No. 28.8 — *Visual haze rating of liquid fuels*

No. 140.1 — *Low temperature flow test (LTFT) for diesel fuels*

CAN/CGSB-3.2 — *Heating fuel oil*

CAN/CGSB-3.520 — *Diesel fuel containing low levels of biodiesel (B1–B5)*

CAN/CGSB-3.522 — *Diesel fuel containing biodiesel (B6–B20).*

2.1.1 Source

The above may be obtained from the Canadian General Standards Board, Sales Centre, Gatineau, QC, Canada K1A 1G6. Telephone: 819-956-0425 or 1-800-665-2472. Fax: 819-956-5740. E-mail: ncr.cgsb-ongc@tpsgc-pwgsc.gc.ca. Web site: www.tpsgc-pwgsc.gc.ca/ongc-cgsb/index-eng.html.

It may also be obtained from the Government of Canada Publications, Publishing and Depository Services, Public Services and Procurement Canada, Ottawa, ON, K1A 0S5. Telephone: 1-800-635-7943 or 613-941-5995. Fax: 1-800-565-7757 or 613-954-5779. Email: publications@tpsgc-pwgsc.gc.ca. Web site: http://publications.gc.ca/site/eng/home.html.

2.2 Canadian Fuels Association

Weather Data.

2.2.1 Source

Web site: http://www.canadianfuels.ca/Fuels-and-Transportation/Conventional-Transportation-Fuels/.

2.3 ASTM International

Annual Book of ASTM Standards (see Annex A).

2.3.1 Source

The above may be obtained from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, U.S.A., telephone: 610-832-9585, fax: 610-832-9555, Web site: www.astm.org, or from IHS Markit, 200-1331 MacLeod Trail SE, Calgary, Alberta T2G 0K3, telephone: 613-237-4250 or 1-800-267-8220, fax: 613-237-4251, Web site: www.global.ihs.com.

2.4 SAE International

SAE Paper 952370 — *The Lubricity of Winter Diesel Fuels.*

SAE Paper 961180 — *The Lubricity of Winter Diesel Fuels — Part 2: Pump Rig Test Results.*

SAE Paper 981363 — *Continued Evaluation of Diesel Fuel Lubricity by Pump Rig Tests.*

2.4.1 Source

The above may be obtained from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, U.S.A., telephone: 877-606-7323, fax: 724-776-0790, Web site: https://www.sae.org/publications.

3 Terms and definitions

For the purposes of this National Standard of Canada, the following terms and definitions apply.

3.1
2.5% low-end design temperature (*température minimale de calcul de 2,5 %*)
the temperature at or below which 2.5% of the hourly outside air temperatures are observed to occur for an indicated half month. The 2.5% low-end design temperature for most weather stations in Canada by half month period is available on the Canadian Fuels Association Web site (see 2.2). This dataset is based upon a statistical analysis of hourly weather readings from weather stations across Canada over the thirty-year period from 1981 to 2010 inclusive.

3.2
biodiesel (*biodiesel*)
mono-alkyl esters of long chain fatty acids derived from renewable sources. In its neat form, biodiesel is commonly designated as B100 or fatty acid alkyl esters (FAAE) with fatty acid methyl esters (FAME) being the most common.

3.3
conventional hydrocarbons (*hydrocarbures classiques*)
hydrocarbons derived from natural gas liquid condensates, crude oil, heavy oil, shale oil and oil sands, which are generally accompanied by low levels of naturally occurring non-hydrocarbons.

3.4
diesel fuel (*carburant diesel*)
middle distillate fuel composed of conventional hydrocarbons, synthetic hydrocarbons or mixtures of conventional and synthetic hydrocarbons that boils in the range of 130°–400°C and that is intended for use as a fuel in compression-ignition engines.

3.5
representative fuel (*carburant représentatif*)
sample of finished fuel with inspection properties that are typical of the fuel as commercially supplied.

3.6
synthetic hydrocarbons (*hydrocarbures synthétiques*)
hydrocarbons derived from non-petroleum sources such as biomass, natural gas, coal, fats and oils by processes such as gasification, reforming, Fischer-Tropsch synthesis, hydroprocessing or hydrocracking (including co-processing with petroleum).

3.7
ultra low sulphur diesel (ULSD) (*carburant diesel à très faible teneur en soufre*)
diesel fuel with a maximum sulphur content of 15 mg/kg (see 6.9).

4 Classification

4.1 The distillate fuel shall be supplied in the following types, as specified (see 8.1):

4.1.1 Types

Type A,

Type B.

5 General requirements

5.1 The diesel fuels specified shall be hydrocarbons (and may contain trace amounts of petroleum-derived, naturally occurring non-hydrocarbons) that may contain additives designed to improve their properties or performance, for example, ignition quality, low-temperature flow properties and electrical conductivity. Synthetic hydrocarbons may be present in any concentration in fuel complying with this standard (see Annex C, C.19). Biodiesel is not allowed in this standard except at concentrations below 1.0%. For diesel fuel containing at least 1.0% biodiesel, refer to CAN/CGSB-3.520 or CAN/CGSB-3.522.

5.2 The diesel fuel shall be a stable homogeneous liquid free from foreign matter that is likely to clog filters or nozzles, or to damage equipment.

5.3 There shall be no intentional addition of used lubricating oils, used solvents, triglycerides (such as raw vegetable oils, animal fats, fish oils or used cooking oils) or other fluids which are not normal components of the diesel fuel.

6 Detailed requirements

For an explanation of the significance of tests and the methods used, see Annex C.

6.1 Specified limiting values

6.1.1 The diesel fuel shall comply with the specified limiting values. The specified limiting values shall not be changed. This precludes any allowances for the test method precision and adding or subtracting digits.

6.1.2 For purposes of determining conformance with the specified limiting values, an observed value or a calculated value shall be rounded off “to the nearest unit” in the last right-hand digit used in expressing the specified limiting value, in accordance with the rounding-off method of ASTM E29. There is one exception (see 6.4).

6.1.3 If an alternate test method referenced in this standard provides a bias correction to the referee method, adherence to the specified limiting value shall be based on the bias-corrected result.

6.1.4 Where test values differ between two parties, a resolution shall be in accordance with ASTM D3244 in order to determine conformance with the specified limiting values, with the criticality of the limits set at $P = 0.5$.

6.1.5 Zeroes trailing the last nonzero digit for numbers represented with a decimal point are significant digits, in accordance with ASTM E29.

6.2 Test methods

6.2.1 Test methods other than those referenced in this standard may be used only if they have been validated in accordance with ASTM D3764 or D6708.

6.2.2 Validated test methods shall correlate with methods referenced in the standard. Differences in precision, sensitivity and bias between methods referenced in the standard and the validated methods shall be noted when using results from validated methods.

6.2.3 Validated test methods shall only be used within the bounds of the data covered in their validation.

6.2.4 In the event of a dispute, the procedures given in 6.1 shall be used.

6.2.5 If parties in a dispute cannot agree on an analytical method to resolve the dispute, the referee method listed in the standard shall be used.

6.3 Low-temperature flow properties

6.3.1 Low-temperature flow properties of the diesel fuel shall be designed (see 8.1) to give satisfactory performance at the temperatures indicated by the 2.5% low-end design temperature data for the period and location of intended use. However, when the 2.5% low-end design temperature is colder than -48°C, a fuel meeting a -48°C operability limit may be provided (see 3.1).

6.3.2 The following shall be reported:

a) The 2.5% low-end temperature to which the diesel fuel is designed.

b) The test method used to determine the operability temperature:

   i) Cloud point (ASTM D2500, D5771, D5772 or D5773. In the event of a dispute, ASTM D5773 shall be the referee method.); or

   ii) Low-temperature flow test (LTFT) for diesel fuels (CAN/CGSB-3.0 No. 140.1 or ASTM D4539. In the event of a dispute, CAN/CGSB-3.0 No. 140.1 shall be the referee method).

c) The test method result.

	Property	Specified limiting values				
		Type A		Type B		Test method
		Min.	Max.	Min.	Max.	ASTM
6.4	Flash point[a], °C (see 6.17 and 8.2)	40.0	—	40.0	—	D93[b], D3828[c] or D7094
6.5	Kinematic viscosity at 40°C, mm^2/s (cSt)[d]	1.30	3.60	1.70[e]	4.10	D445[b], D7042 or D7945[f]
6.6	Distillation, 90% recovered, °C (see 6.18)	—	290.	—	360.	D86[b], D2887 or D7345
6.7	Water and sediment, % by volume (see 6.19)	—	0.02	—	0.02	D1796 (modified) or D2709[b]
6.8	Acid number, mg KOH/g	—	0.10	—	0.10	D664 or D974[b]
6.9	Sulphur[g], mg/kg	—	15	—	15	D2622, D5453[b] or D7039
6.10	Copper strip corrosion, 3 h at a minimum test temperature of 50°C (see C.13)	—	No. 1	—	No. 1	D130
6.11	Carbon residue on 10% bottoms, % by mass (see 6.20)	—	0.1	—	0.2	D524 or D4530[b]
6.12	Ash, % by mass	—	0.010	—	0.010	D482
6.13	Ignition quality, cetane number (CN), derived cetane number (DCN) or indicated cetane number (ICN) (see 6.21 and 8.2)	40.0	—	40.0	—	D613[b], D6890, D7668[h] or D8183[h]
6.14	Electrical conductivity, at point, time and temperature of delivery to purchaser, pS/m (see 9.1)	25	—	25	—	D2624
6.15	Low-temperature flow properties (see 8.1)	As specified in 6.3				
6.16	Lubricity (see 9.2)	As specified in 6.22				
	- Continued (footnotes) -					

[a] A higher flash point may be specified in special applications such as marine on-board use (see Annex B, B1). For underground mining applications, the authority having jurisdiction may specify a different flash point requirement (see Annex B, B.2).

[b] The referee method to be used in the event of a dispute.

[c] The results obtained by ASTM D3828 can be more than 2°C lower than those obtained by ASTM D93, the referee method.

[d] The SI unit for kinematic viscosity is the square metre per second. The preferred multiple for fluids in the viscosity range is the square millimetre per second, which is equivalent to a centiStokes (i.e. 1 mm^2/s = 1 cSt).

[e] If the 2.5% low-end design temperature is -10°C or colder for the period and location of intended use, then the minimum viscosity shall be 1.50 cSt. If the 2.5% low-end design temperature is -20°C or colder for the period and location of intended use, then the minimum viscosity shall be 1.30 cSt.

[f] This test method only has valid precision data exceeding 2.06 cSt.

[g] Maximum limit may be higher for some applications when allowed by federal regulation (see Annex B, B.1.1.3).

[h] The precision data for test methods D7668 and D8183 were obtained from results using externally provided pre-blended calibration reference materials. Test method D8183 requires the use of these pre-blended calibration materials but test method D7668 does not.

6.17 Flash point

The test values shall be reported to the nearest 0.5°C in accordance with ASTM D93, D3828 or D7094 (see 8.2).

6.18 Distillation

When testing in accordance with ASTM D2887, the method in the appendix shall be used to convert the results to estimates of ASTM D86. In the event of a dispute, the automated method of ASTM D86 shall be the referee test method.

6.19 Water and sediment

The test in ASTM D1796 shall be modified by substituting the centrifuge tube specified in ASTM D2273 for that in ASTM D1796.

6.20 Carbon residue

Testing may be performed prior to the addition of any additives to the fuel.

6.21 Ignition quality

The calculated cetane index according to ASTM D976 or D4737 or other calculation techniques that approximate cetane number by ASTM D613, may be used for control purposes. Calculation techniques should not be used for determining the ignition quality of field fuel samples if they are suspected of containing cetane improver additives. ASTM D976 and D4737 should be used within the scopes of the methods.

6.22 Lubricity

A lubricity additive shall be incorporated (see 9.2).

6.22.1 Lubricity additive requirements

The lubricity additive and its dosage shall be shown to provide acceptable lubricity performance in a representative fuel (see 3.4) and to give acceptable lubricity performance in accordance with any one of the following criteria:

6.22.1.1 Pump wear with a representative fuel in a distributor-type diesel fuel injection pump in a vehicle field test

The required vehicle field test methodology is described in SAE Paper 952370. An acceptable pump-wear result is defined as an overall pump rating of 4.0 or less using the rating method described in SAE Paper 961180.

6.22.1.2 Pump wear with a representative fuel in a distributor-type diesel fuel injection pump rig test

The required pump rig test methodology is described in SAE Paper 981363. SAE Papers 961180 and 952370 provide additional background information. An acceptable pump-wear result is defined as an overall pump rating of 4.0 or less using the rating method described in SAE Papers 981363 and 961180.

6.22.1.3 Lab bench test results with a representative fuel using the high frequency reciprocating rig test

The required high frequency reciprocating rig test is described in ASTM D6079 and D7688 and shall be run at 60°C. An acceptable test result is defined as a wear scar diameter of less than or equal to 460 µm. In the event of a dispute, ASTM D6079 shall be the referee test method for this criterion.

7 Inspection

7.1 Sampling

7.1.1 Sampling equipment and procedures shall be designed and used to obtain representative fuel samples of a product. Sampling lines, hoses, etc. should be adequately flushed prior to taking a sample. Samples should be stored in a cool, dark place. Procedures shall be in accordance with ASTM D4057, D4177 or D5854.

7.1.2 Sample volume should be consistent with the requirement of the testing laboratory or the authority having jurisdiction or both. Unless otherwise specified (see 8.2), a sample of at least 2.7 L shall be collected.

8 Options

8.1 The following options shall be specified in the application of this standard:

a) Type of fuel (see 4.1);

b) Low-temperature design requirements for period and location of intended use (see 6.3).

8.2 The following options may be specified if the requirements are more stringent than those stipulated in this standard:

a) Flash point (see 6.4);

b) Ignition quality (see 6.13 and 9.9);

c) Sample size (see 7.1.2).

9 Precautions

9.1 Conductivity depletion

Due to the normal depletion of fuel conductivity during commingling, storage, and distribution, or at low temperatures, the fuel should be sufficiently treated with conductivity-improver additive to ensure that the electrical conductivity requirement in 6.14 is met. The temperature at the point of use and the method of distribution could require a substantially higher conductivity level than 25 pS/m at the point of additive treatment. It should also be noted that samples in clear bottles exposed to sunlight can show a rapid depletion in conductivity. For more information, refer to Annex C, C.14, ASTM D4865 and D2624.

9.2 Fuel lubricity

Processes used to desulphurize diesel fuel reduce the natural lubricating qualities of the diesel fuel. Since engines require the diesel fuel to act as a lubricant for their injection systems, the diesel fuel should have sufficient lubricity to give adequate protection against excessive injection system wear. Additives are used to improve diesel fuel lubricity. Lubricity additives can have unwanted side effects particularly when used at excessive concentrations or in combination with other additives or contaminants.

9.3 Heating oil application

At times diesel fuel can be used in a heating oil application. In these cases, refer to CAN/CGSB-3.2 for detailed requirements.

9.4 Manufacturing processes

Contamination from manufacturing processes or treatments can be carried over in trace quantities into the fuel and cause unexpected problems. These contaminants might not be detected by the requirements listed in this standard. It is recommended that adequate quality assurance procedures be put in place to ensure that manufacturing processes capable of such contamination are identified and controlled. Sodium, calcium, chlorides, sulphates, clay, sand, acids, caustics, soaps, and amine process additives are examples of possible contaminants or potential precipitates.

9.5 Visual haze

The solubility of water in fuel is a function of temperature. When fuel is exposed to low ambient temperatures, water can separate causing a haze or cloudy appearance. It has been a common industry practice to perform the visual haze test at 4°C for fuel destined for use in winter and at 15°C for fuel destined for use in summer. Experience has indicated that fuel passing these requirements has been acceptable in the appropriate season. For further information on the visual haze test, refer to CAN/CGSB-3.0 No. 28.8 or to ASTM D4176, Procedure 2.

9.6 Fuel flammability

A number of properties should be considered in assessing the overall flammability hazard of a fuel. Flash point is the minimum fuel temperature at which a mixture of air and fuel vapour can form and be ignited by a spark or flame under specified laboratory conditions. However, the flash point is only an indication of the potential flammability risk of a fuel. Oxygen concentration in the atmosphere is an additional factor affecting flammability. Investigation of fuel-related fires in marine vessel engine rooms and underground mining applications has shown that these fires are generally initiated through direct contact of a fuel spray or spill with hot surfaces having a temperature exceeding the auto-ignition temperature of the fuel. The flash point of the fuel has little bearing on the probability of such fires occurring. Similarly, fires in fuel tanks are typically initiated as a result of hot work (e.g., welding) on the exterior surface of the tank causing fuel adhering to the interior tank wall surface to evaporate and spontaneously ignite after having exceeded its auto-ignition temperature.

9.7 Fuel colour

Fuels having unusual shades of colour should be investigated to determine fitness for use.

9.7.1 Existing fuel colour

Although this standard does not have a colour requirement, colour can be a useful indicator of fuel quality or contamination. Diesel fuel can present several different hues or colours depending on feedstock type and/or manufacturing processes.

9.7.2 Change in fuel colour

Fuel in long term storage can darken owing to oxidation of trace components. If the darkening is accompanied by the formation of sediment, the fuel could be rendered unacceptable for use.

9.8 Hydrogen sulphide

Hydrogen sulphide (H_2S) can occasionally be found in limited concentration in the vapour phase above diesel fuels. H_2S is toxic even at low concentrations in air. Additives are available that can react with H_2S in the liquid phase and reduce the concentration of H_2S both in the fuel and in the vapour phase.

9.9 Ignition Quality

Fuel having a higher ignition quality (cetane number [CN], derived cetane number [DCN] or indicated cetane number [ICN]) can be necessary for some engines. Conditions of operation can also dictate the specification of a higher ignition quality. Users should consult the equipment manufacturer for further details. It should also be noted that samples in clear bottles exposed to sunlight can begin to degrade, forming peroxides, which can give an erroneously high CN, DCN or ICN.

Annex A
(normative)

Referenced ASTM International publications (see 2.3)

Annual Book of ASTM Standards

D86 Standard Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure

D93 Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

D130 Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test

D445 Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

D482 Standard Test Method for Ash from Petroleum Products

D524 Standard Test Method for Ramsbottom Carbon Residue of Petroleum Products

D613 Standard Test Method for Cetane Number of Diesel Fuel Oil

D664 Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration

D974 Standard Test Method for Acid and Base Number by Color-Indicator Titration

D976 Standard Test Method for Calculated Cetane Index of Distillate Fuels

D1796 Standard Test Method for Water and Sediment in Fuel Oils by the Centrifuge Method (Laboratory Procedure)

D2273 Standard Test Method for Trace Sediment in Lubricating Oils

D2500 Standard Test Method for Cloud Point of Petroleum Products and Liquid Fuels

D2622 Standard Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry

D2624 Standard Test Methods for Electrical Conductivity of Aviation and Distillate Fuels

D2709 Standard Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge

D2887 Standard Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography

D3244 Standard Practice for Utilization of Test Data to Determine Conformance with Specifications

D3764 Standard Practice for Validation of the Performance of Process Stream Analyzer Systems

D3828 Standard Test Methods for Flash Point by Small Scale Closed Cup Tester

D4057 Standard Practice for Manual Sampling of Petroleum and Petroleum Products

D4176 Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures)

D4177 Standard Practice for Automatic Sampling of Petroleum and Petroleum Products

D4530 Standard Test Method for Determination of Carbon Residue (Micro Method)

D4539 Standard Test Method for Filterability of Diesel Fuels by Low-Temperature Flow Test (LTFT)

D4737 Standard Test Method for Calculated Cetane Index by Four Variable Equation

D4865 Standard Guide for Generation and Dissipation of Static Electricity in Petroleum Fuel Systems

D5453 Standard Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence

D5771 Standard Test Method for Cloud Point of Petroleum Products and Liquid Fuels (Optical Detection Stepped Cooling Method)

D5772 Standard Test Method for Cloud Point of Petroleum Products and Liquid Fuels (Linear Cooling Rate Method)

D5773 Standard Test Method for Cloud Point of Petroleum Products and Liquid Fuels (Constant Cooling Rate Method)

D5854 Standard Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products

D6079 Standard Test Method for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFRR)

D6708 Standard Practice for Statistical Assessment and Improvement of Expected Agreement Between Two Test Methods that Purport to Measure the Same Property of a Material

D6890 Standard Test Method for Determination of Ignition Delay and Derived Cetane Number (DCN) of Diesel Fuel Oils by Combustion in a Constant Volume Chamber

D7039 Standard Test Method for Sulfur in Gasoline, Diesel Fuel, Jet Fuel, Kerosine, Biodiesel, Biodiesel Blends, and Gasoline-Ethanol Blends by Monochromatic Wavelength Dispersive X-ray Fluorescence Spectrometry

D7042 Standard Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)

D7094 Standard Test Method for Flash Point by Modified Continuously Closed Cup (MCCCFP) Tester

D7345 Standard Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure (Micro Distillation Method)

D7668 Standard Test Method for Determination of Derived Cetane Number (DCN) of Diesel Fuel Oils — Ignition Delay and Combustion Delay Using a Constant Volume Combustion Chamber Method

D7688 Standard Test Method for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFRR) by Visual Observation

D7945 Standard Test Method for Determination of Dynamic Viscosity and Derived Kinematic Viscosity of Liquids by Constant Pressure Viscometer

D8183 Standard Test Method for Determination of Indicated Cetane Number (ICN) of Diesel Fuel Oils using a Constant Volume Combustion Chamber—Reference Fuels Calibration Method

E29 Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications.

Annex B
(informative)

Federal, provincial and other regulations applicable to diesel fuels[1,2,3]

B.1 Federal regulations

B.1.1 *Canadian Environmental Protection Act*

The following federal regulations have been enacted under the *Canadian Environmental Protection Act*: 1999.

B.1.1.1 ***Fuels Information Regulations, No. 1*** (C.R.C. c. 407 amended by SOR/DORS/79-280, 80-138 and 2000-104)

These regulations require producers and importers to submit information on sulphur and additive contents (other than lead) of liquid fuels.

B.1.1.2 ***Contaminated Fuel Regulations*** (SOR/DORS/91-486)

These regulations prohibit the importation of fuels that have been contaminated with hazardous wastes.

B.1.1.3 ***Sulphur in Diesel Fuel Regulations*** (SOR/DORS/2002-254)

These regulations define the sulphur limits for fuels used in diesel engines.

B.1.1.4 ***Renewable Fuels Regulations*** (SOR/DORS/2010-189)

These regulations define the renewable fuel content requirements for gasoline, diesel and heating oil.

B.1.2 The following federal regulations also apply to fuels meeting this standard:

B.1.2.1 ***Marine Machinery Regulations*** (SOR 90/264)

These regulations, enacted under the *Canada Shipping Act, 2001*, specify details related to the construction, installation and inspection of marine machinery. Safety requirements for diesel fuels used in marine applications are also specified.

B.1.2.2 ***Transportation of Dangerous Goods Regulations*** (SOR/DORS/2001-286)

These regulations, enacted under the *Transportation of Dangerous Goods Act, 1992*, give detailed packaging, labelling and documentation requirements for transporting fuels in Canada.

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[1] The regulations listed are subject to revision by the relevant authority. The user should consult the relevant authority to confirm the current regulations. The information provided about the regulations is for information only. In case of conflict, the text of the regulation takes precedence.

[2] The requirements in jurisdictions other than those listed above will be added, as information becomes available in future revisions and amendments to this standard.

[3] This list is provided for information only and may not be complete. Please advise the CGSB of any other regulation that could apply on this standard.

B.2 Provincial and territorial regulations

B.2.1 Alberta

B.2.1.1 ***Renewable Fuels Standard Regulation*** (Alta. reg. 29/2010)

This regulation, enacted under the *Climate Change and Emissions Management Act,* defines the requirements for renewable fuels in Alberta.

B.2.2 British Columbia

B.2.2.1 ***Renewable and Low Carbon Fuel Requirements Regulation*** (B.C. reg. 394/2008)

This regulation, enacted under the *Greenhouse Gas Reduction (Renewable and Low Carbon Fuel Requirements) Act*, defines the requirements for renewable fuels in British Columbia.

B.2.2.2 ***Occupational Health and Safety Regulation*** (B.C. reg. 296/97)

This regulation, enacted under the *Workers Compensation Act*, specifies diesel fuel requirements for underground mining applications.

B.2.3 Manitoba

B.2.3.1 ***Storage and Handling of Petroleum Products and Allied Products Regulation*** (Man. reg. 188/2001)

This regulation, enacted under the *Dangerous Goods Handling and Transportation Act*, specifies requirements for storage and handling of fuels in Manitoba.

B.2.3.2 ***Operation of Mines Regulation*** (Man. reg. 212/2011)

This regulation, enacted under the *Workplace Safety and Health Act*, specifies diesel fuel requirements for underground mining applications.

B.2.4 New Brunswick

B.2.4.1 ***Underground Mine Regulation*** (N.B. reg. 96-105)

This regulation, enacted under the *Occupational Health and Safety Act*, specifies diesel fuel requirements for underground mining applications.

B.2.5 Newfoundland and Labrador

B.2.5.1 ***Mines Safety of Workers Regulations*** (NRL 5/12)

These regulations, enacted under the *Occupational Health and Safety Act*, specify diesel fuel requirements for underground mining applications.

B.2.6 Northwest Territories

B.2.6.1 ***Mine Health and Safety Regulations*** (N.W.T. reg. 125-95)

These regulations, enacted under the *Mine Health and Safety Act*, specify diesel fuel requirements for underground mining applications.

B.2.7 Nova Scotia

B.2.7.1 ***Underground Mining Regulations*** (N.S. reg. 296/2008)

These regulations, enacted under the *Occupational Health and Safety Act*, specify diesel fuel requirements for underground mining applications.

B.2.8 Nunavut

B.2.8.1 ***Mine Health and Safety Regulations*** (N.W.T. (Nu.) reg. 125-95)

These regulations, enacted under the *Mine Health and Safety Act*, specify diesel fuel requirements for underground mining applications.

B.2.9 Ontario

B.2.9.1 ***Liquid Fuels Handling Code, 2017***

This code, published by the *Technical Standards and Safety Authority* and adopted by reference under the *Technical Standards and Safety Act, 2000*, specifies safety related requirements for handling liquid fuels.

B.2.9.2 ***Mines and Mining Plants*** (R.R.O. 1990, reg. 854)

This regulation, enacted under the *Occupational Health and Safety Act*, specifies diesel fuel requirements for underground mining applications.

B.2.9.3 ***Greener Diesel — Renewable Fuel Content Requirements for Petroleum Diesel Fuel*** (Ontario regulation 97/14)

This regulation, enacted under the *Environmental Protection Act*, defines the requirements for renewable fuels in Ontario.

B.2.10 Quebec

B.2.10.1 General requirements

The general requirements are controlled under the latest version of the *Loi sur les produits pétroliers*, RLRQ, chapitre P-30.01, *Règlement sur les produits pétroliers*, RLRQ, chapitre P-30.01, r.2 or *Petroleum Products Act*, CQLR, chapter P-30.01, *Petroleum Products Regulation*, CQLR, chapter P-30.01, r.2. This regulation lists Quebec quality requirements for aviation gasolines, aviation turbine fuels, automotive gasolines, gasolines containing denatured fuel ethanol for use in automotive spark ignition fuels, diesel fuels, diesel fuels containing biodiesel (B100) for blending in middle distillate fuels, fuel oil types 0, 1 and 2, and fuel oil types 4, 5 and 6. Amendments and editions published apply only 90 days after the last day of the month that the French text of the amendments or editions was published. The Direction générale des hydrocarbures et des biocombustibles of the ministère de l'Énergie et des Ressources naturelles is responsible for the application and revision of this regulation. Web site: https://mern.gouv.qc.ca/english/energy/index.jsp.

B.2.10.2 ***Regulation Respecting Occupational Health and Safety in Mines*** (CQLR., c. S-2.1, r. 14)

This regulation, also known as *Règlement sur la santé et la sécurité du travail dans les mines*, was enacted under *An Act respecting Occupational health and safety* and specifies diesel fuel requirements for underground mining applications.

B.2.11 Saskatchewan

B.2.11.1 ***Mines Regulations, 2003*** (R.R.S. c. O-1.1 reg. 2)

These regulations, enacted under the *Occupational Health and Safety Act, 1993*, specify diesel fuel requirements for underground mining applications.

B.2.12 Yukon

B.2.12.1 ***Mine Safety Regulations*** (Y.O.I.C. 1986b/164)

These regulations, enacted under the *Occupational Health and Safety Act*, specify diesel fuel requirements for underground mining applications.

Annex C
(informative)

Significance of requirements for diesel fuels

C.1 Introduction

The properties of commercial diesel fuels depend on the refining practices employed and the nature of the feedstocks from which they are produced. For example, diesel fuel produced within the boiling range of 130°-400°C may have many possible combinations of various properties such as volatility, ignition quality and viscosity.

C.2 Types of diesel fuel

C.2.1 CAN/CGSB-3.517 is intended as a statement of permissible limits of significant fuel properties used for specifying the wide variety of commercially available diesel fuels meeting regulated sulphur requirements. Limiting values of significant properties are prescribed for two types of diesel fuel. These types and their general applicability for use in diesel engines are broadly indicated as follows.

C.2.2 Type B is seasonally adjusted to meet the low temperature operability requirements for the period and location of intended use for most locations in Canada. This adjustment affects the other properties of the fuel.

C.2.3 Type A diesel fuel is applicable for use where the low temperature operability of Type B is insufficient.

C.2.4 CAN/CGSB-3.520 is a parallel standard allowing from 1.0% up to 5% by volume biodiesel.

C.3 Selection of a particular grade

The selection of a particular diesel fuel from one of these two types for use in a given engine requires consideration of the following factors:

a) Legal requirements

b) Expected ambient temperatures at location and time of use

c) Availability

d) Maintenance frequency and requirements

e) Engine size and design

f) Speed and load changes

g) Engine manufacturer’s recommendations and fuel specifications.

Some of these factors (a-g) may influence the required fuel properties outlined in C.4 to C.19.

C.4 Flash point

The flash point as specified is not directly related to engine performance. It is, however, of importance in connection with legal requirements, such as the *Transportation of Dangerous Goods* (TDG) *Regulations,* and safety precautions involved in fuel handling and storage. It is normally specified to meet insurance and fire regulations.

C.5 Ignition quality

Cetane number, derived cetane number and indicated cetane number are measures of the ignition quality of the fuel and influence combustion characteristics. The ignition quality requirements depend on engine design and size, nature of speed and load variations, and starting and atmospheric conditions. Higher ignition quality fuels generally give better performance in aspects such as emissions, noise, cold-starting and white smoke generation.

C.6 Viscosity and lubricity

C.6.1 A minimum viscosity is specified to minimize power loss due to injection pump and injector leakage and ensure sufficient hydrodynamic lubrication of fuel system components. Maximum viscosity is limited to ensure fuel pumpability and proper functioning of the injection system.

C.6.2 For some engines, diesel fuel is a lubricant for the injection system; therefore, it must have sufficient lubricity to ensure fuel system durability and hence emission durability requirements. Diesel fuel lubricity can be defined as the ability of a fuel to prevent or minimize wear in diesel fuel injection equipment.

C.7 Distillation

Fuel volatility requirements depend on engine design and size, nature of speed and load variations, as well as starting and atmospheric conditions. More volatile fuels can provide better startability and reduced white smoke under cold engine operation. The maximum 90% distillation temperature limits of 290°C for Type A and 360°C for Type B are based on Canadian experience with petroleum-derived diesel fuel.

C.8 Carbon residue

Carbon residue is a measure of the carbon-depositing tendencies of a diesel fuel after evaporation and pyrolysis under prescribed conditions. While not directly correlating with engine deposits, this property can be considered a guide.

C.9 Sulphur

The use of sulphur levels higher than 15 mg/kg can contribute to the weight of particulates in the exhaust and can have a deleterious effect on catalytic after-treatment systems. Diesel fuel with a maximum sulphur level of 15 mg/kg is required to ensure compatibility with exhaust after-treatment technology of modern diesel-powered equipment.

C.10 Low-temperature operability

C.10.1 Low-temperature operability of diesel fuels can be defined by either the cloud point or the low-temperature flow test or some combination thereof.

C.10.2 Cloud point defines the temperature at which the smallest observable cluster of hydrocarbon crystals first appears in a fuel upon cooling under prescribed test conditions. It is the most common measure of low-temperature operability.

C.10.3 The low-temperature flow test was developed in order to predict low-temperature operability of fuels to which a flow improver has been added. A cloud point test on such additized fuels might not accurately predict the operability limit of the fuel due to the use of these additives.

C.10.4 The viscosity of a fuel blend will increase under cold ambient temperatures. In some situations the fuel's viscosity can be the limiting low temperature operability factor as opposed to wax formation in the fuel.

C.11 Ash

Ash-forming materials can be present in diesel fuels as abrasive solids and soluble metallic soaps. Abrasive solids can contribute to injector, fuel pump, piston and ring wear, and also to engine deposits. Soluble metallic soaps have little effect on wear but can contribute to engine deposits.

C.12 Acidity

There is directional evidence that acidic fuels can have poorer stability, can cause increased corrosion of mild steel, and can cause deposit formation in some types of fuel injection equipment.

C.13 Copper strip corrosion

This test serves as a measure of possible corrosion of copper, brass or bronze parts in the fuel system due to corrosive sulphur species. Copper corrosion testing for 2 h at 100°C has been shown to be more severe than 3 h at 50°C.

C.14 Electrical conductivity

The ability of a fuel to dissipate electric charge that has been generated during pumping and filtering operations is controlled by its conductivity. If a fuel's conductivity is sufficiently high, the static electric charge dissipates fast enough to prevent its accumulation, so that dangerously high electrical potentials are avoided.

C.15 Recommended practices for the storage and handling of diesel fuels

Diesel fuels should be stored under cool, clean and dry conditions. Free water should regularly be drained from storage tanks and filter housings. Diesel fuels that are to be kept in storage may require the addition of a biocide to minimize potential microbial contamination and related degradation in fuel quality (should free water be present). Organic sediment may appear in diesel fuels in long-term storage. Primary filtration of these fuels is recommended prior to use. Where long-term storage of diesel fuels is contemplated, use of stability additives (e.g. anti-oxidants, metal deactivators and dispersants) should be considered and the fuel supplier should be consulted. Fuel storage containers and tanks should be opaque. Some translucent (plastic) tanks exposed to light have proven to be unsatisfactory for the storage of diesel fuels.

C.16 Used lubricating oils or extraneous fluids

Used lubricating oils or fluids are not suitable components for use in diesel fuels. The addition of used lubricating oils or fluids to diesel fuels can increase exhaust emissions, increase wear of engine components such as injectors, increase deposits in the engine, and cause premature fuel filter plugging.

C.17 Stability

C.17.1 Storage stability

During storage, diesel fuel can degrade at ambient temperature due to oxidation. These oxidative reactions produce acidic compounds, fuel-soluble polymers and fuel-insoluble materials, such as gum, varnish/lacquer and sediment. The acids produced can further react with trace metal ions to produce soaps that can plug filters and also cause fuel injection equipment to malfunction. The gums that are produced can adhere to surfaces and cause fuel injection equipment to fail. Any sediment produced can plug fuel filters. Notably the presence of certain metals such as copper or zinc will accelerate these oxidative reactions.

C.17.2 Thermal stability

Heat transfer is a design function of diesel fuel in many modern diesel engines. In some engines, only a portion of the fuel that is circulated and pressurized by the fuel injection system is actually combusted. The remainder of the fuel is recycled back to the equipment's fuel tank. Over time the bulk temperature of this fuel can be well above ambient levels. Inadequate high-temperature stability of a diesel fuel can result in the formation of insoluble degradation products that can then cause filter plugging.

C.17.3 Test methods

Traditional test methods for measuring the stability of diesel fuels, such as ASTM D2274 and ASTM D6468, generally indicate a high degree of stability for ultra-low sulphur diesel fuels (ULSD). To differentiate or monitor stability for ULSD, ASTM D7545 may be used. At present, performance of Canadian diesel fuels in ASTM D7545 has not been established. It is also known that ASTM D7545 can indicate significantly reduced stability in the presence of cetane improver (2-ethylhexyl nitrate), and variants of the method at lower temperatures (e.g., 120°C) are being considered to reduce this effect.

C.18 Density and net energy content

While density is not a requirement of this standard, the density of a batch of diesel fuel should be measured and reported on the Certificate of Analysis for quality control purposes and to allow calculation of the mass of a given volume of fuel. Knowledge of the original density of a batch of fuel is useful to someone receiving the fuel. If the density of the fuel as received is significantly different from its original density measurement, it indicates possible contamination and is cause for further product quality investigation. Liquid density can be measured in diesel using ASTM D1298, D4052 or D7042. The density of diesel fuel varies depending on the refinery processes used, the crude from which the fuel is produced and the overall composition of the fuel.

For diesel engine applications (as the water in the exhaust is still in vapour form), fuel consumption and power output are related to net energy content (also known as net calorific value, lower heating value or net heat of combustion). For diesel fuels, lower fuel consumption or higher power output is generally obtained with higher density fuels because of their higher net energy content per unit volume.

C.19 Synthetic hydrocarbons

Synthetic hydrocarbons include hydrocarbons derived from non-petroleum sources such as biomass, natural gas, coal, fats and oils by processes such as gasification, reforming, Fischer-Tropsch synthesis, hydroprocessing or hydrocracking (including co-processing with petroleum). Other terms used to refer to synthetic hydrocarbons for diesel engines include: biomass-to-liquid (BTL) diesel, gas-to-liquid (GTL) diesel, coal-to-liquid (CTL) diesel, hydrogenation-derived renewable diesel (HDRD), hydrotreated vegetable oil (HVO), renewable hydrocarbon diesel (RHD), hydroprocessed esters and fatty acids (HEFA) and synthesized paraffinic diesel (SPD).