NATIONAL
STANDARD
OF CANADA

CAN/ULC-S615-14

STANDARD FOR FIBRE REINFORCED PLASTIC UNDERGROUND TANKS FOR FLAMMABLE AND COMBUSTIBLE LIQUIDS

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NATIONAL STANDARD OF CANADA

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STANDARD FOR FIBRE REINFORCED PLASTIC UNDERGROUND TANKS FOR FLAMMABLE AND COMBUSTIBLE LIQUIDS

PREFACE

This is the Third Edition of the Standard for Fibre Reinforced Plastic Underground Tanks for Flammable and Combustible Liquids, CAN/ULC-S615-14.

This Edition of the Standard was developed by the ULC Standards Task Group on Fibre Reinforced Plastic Underground Tanks for Flammable and Combustible Liquids, and has been formally approved by the ULC Standards Committee on Stationary Nonmetallic Storage Containers for Flammable and Combustible Liquids.

Only metric SI units of measurement are used in this Standard. If a value for measurement is followed by a value in other units in parentheses, the second value may be approximate. The first stated value is the requirement.

In Canada, there are two official languages, English and French. All safety warnings must be in English and French. Attention is drawn to the fact that Canadian authorities may require markings and/or installation instructions to be in either or both official languages except as stated elsewhere in the Standard.

Appendices A, B, C and D, identified as informative, are for guidance and informational purposes only.

This Third Edition National Standard of Canada is based on, and now supersedes, the Second Edition ULC-S615-1998.

Attention is drawn to the possibility that some of the elements of this Canadian standard may be the subject of patent rights. ULC Standards shall not be held responsible for identifying any or all such patent rights.

Requests for interpretation of this Standard should be sent to ULC Standards. The requests should be worded in such a manner as to permit a “yes” or “no” answer based on the literal text of the requirement concerned.

The initiation of the review of this Standard will commence within 5 years of the date of publication, unless the Standard is identified as fitting within a stabilized category, whereby the review will commence within the appropriate time frame set out by ULC Standards.

This Standard is intended for conformity assessment.

1 SCOPE

1.1 This Standard sets forth minimum design and construction requirements for *fibre reinforced plastic*, *non-pressure tanks* that are used for the underground storage of *flammable* and *combustible liquids*, such as:

A Petroleum products, including petroleum hydrocarbon fuels with low bio-blends, per specifications, and similar *flammable* or *combustible liquid* petroleum derivatives, such as fuel components (cetane, hexane, heptane), and oils (lubricating, hydraulic, machine);

B Oxygenated fuel blends, including all ″petroleum product″ liquids; plus petroleum hydrocarbon fuels with low-biofuels blends;

C Oxygenates, including all “petroleum product” and ″oxygenated fuel blends″ liquids; plus pure/denatured or highest oxygenated blend stocks for use in mixing of dispensed lower fuel-blends and components, such as biodiesel and ethanol; and

D Other *flammable* and *combustible liquids* that can be demonstrated to be compatible with the reinforced plastic underground tank materials.

NOTE: Refer to Appendix A (Informative) for a list of Standards on fuels and other *flammable* and *combustible liquids*.

1.2 This Standard covers tanks of either single, double or multiple wall construction.

NOTE: Tanks covered by these requirements are generally cylindrical or spherical in shape.

1.3 Tanks covered by this Standard are fabricated, inspected, and tested for leakage and structural strength prior to shipment from the factory as completely assembled vessels.

1.4 This Standard covers tanks where the *primary tank* may have a single compartment or have multiple compartments.

1.5 This Standard covers tanks where the total combined capacities of all compartments of the *primary tank* may be up to, and including 250 000 L.

1.6 The installation, maintenance and operation of these tanks may be covered by any of, but not limited to, the following documents:

A National Fire Code of Canada;

B CAN/CSA-B139, Installation Code for Oil Burning Equipment;

C CCME Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products; and

D Regulations of the *authority having jurisdiction*.

2. REFERENCE PUBLICATIONS

2.1 The documents shown below are referenced in the text of this Standard. Unless otherwise stated elsewhere in this Standard such reference shall be considered to indicate the edition and/or revisions of the document available at the date on which the Committee approved this ULC Standard. All undated references shall be interpreted as referring to the latest edition of that document.

Documents Published by the American Petroleum Institute (API)
1220 L Street, N.W., Washington, DC 20005 U.S.A.
Telephone: (202) 682-8159
www.api.org

• API 650-2013, Standard for Welded Steel Tanks for Oil Storage

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Documents Published by the American Society for Testing and Materials (ASTM)
100 Barr Harbour Drive, PO Box C700, West Conshohocken, PA 19428-2959 U.S.A.
Telephone: (610) 832-9585
www.astm.org

• ASTM C33/C33M-13, Standard Specification for Concrete Aggregates

• ANSI/ASTM D396-13, Standard Specification for Fuel Oils

• ASTM D471-12 (Rev A), Standard Test Method for Rubber Property - Effect of Liquids

• ASTM C581-03 (R2008), Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures Intended for Liquid Service

• ASTM D664-11, Standard for Acid Number of Petroleum Products by Potentiometric Titration

• ASTM D790-10,Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Material

• ASTM D910-13 Rev A, Standard Specification for Aviation Gasolines

• ASTM D975-14, Standard Specification for Diesel Fuel Oils

• ANSI/ASTM D3699-13 (Rev B), Standard Specification for Kerosene

• ASTM D4304-13, Standard Specification for Mineral and Synthetic Lubricating Oil Used in Steam or Gas Turbines

• ASTM D4814-14, Standard Specification for Automotive Spark-Ignition Engine Fuel

• ANSI/ASTM D5798-13 (Rev A), Standard Specification for Ethanol Fuel Blends for Flexible-Fuel Automotive Spark Ignition Engines

• ASTM D6158-10, Standard Specification for Mineral Hydraulic Oil

• ASTM D6615-14, Standard Specification for Jet B Wide-Cut Aviation Turbine Fuel

• ASTM D7719-13, Standard Specification for High-Octane Unleaded Fuel

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Standards Published by the American National Standards Institute and American Society for Mechanical Engineers (ANSI/ASME)
11 W. 42nd Street, New York, NY 10036 U.S.A.
Telephone: (212) 642-4900
www.ansi.org

• ANSI/ASME B16.5-13, Pipe Flanges and Flanged Fittings NPS ½ through NPS 24 Metric/Inch Standard

• RTP-1-13, Reinforced Thermoset Plastic Corrosion Resistant Equipment

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Published by Canadian Council of Ministers of the Environment (CCME)
c/o Manitoba Statutory Publications, Lower Level,
200 Vaughan Street, Winnipeg, MB R3C 1T5
Telephone: (204) 945-4664

• CCME PN 1326-2003, Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products

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Standards published by the Canadian General Standards Board (CGSB)
Place du Portage III, 6B1, 11 Laurier Street, Gatineau, Quebec K1A AG6
Telephone: (819) 956-0425
www.tpsgc-pwgsc.gc.ca/cgsb

• CAN/CGSB 3.2-2013, Heating Fuel Oil

• CAN/CGSB 3.3-2014, Kerosene

• CAN/CGSB 3.5-2011 Amd 1 (2012), Automotive Gasoline

• CAN/CGSB 3.6-2010, Off-Road Diesel Fuel

• CGSB 3.11-2010, Naval Distilate Fuel

• CAN/CGSB 3.18-2010, Diesel Fuel for Locomotive - Type Medium - Speed Diesel Engines

• CAN/CGSB 3.22-2012 , Wide-Cut Type Aviation Turbine Fuel (Grade JET B)

• CAN/CGSB 3.23-2012 Amd 1 (2013), Aviation Turbine Fuel (Grades JET A and Jet A-1)

• CAN/CGSB 3.24-2012 Amd 1 (2013), Aviation Turbine Fuel (Military Grades F-34 and F-44)

• CAN/CGSB 3.27-2012, Naphtha Fuel

• CAN/CGSB 3.511-2011 Amd 1 (2012), Oxygenated Automotive Gasoline Containing Ethanol (E1 – E10)

• CAN/CGSB 3.516-2011 Amd 1 (2013), Denatured Fuel Ethanol for Use in Automotive Spark Ignition Engines

• CAN/CGSB 3.517-2013 Amd 1 (2014), Diesel Fuel

• CAN/CGSB 3.520–2011, Automotive Diesel Fuel Containing Low Levels of Biodiesel (B1-B5)

• CAN/CGSB 3.524-2011, Biodiesel (B100) for Blending in Middle Distillate Fuels

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Published by CSA Group
5060 Spectrum Way, Mississauga, On L4W 5N6

Telephone: (800) 463-6727
www.csa.ca

• CAN/CSA-B139, Installation Code for Oil Burning Equipment

Published by the National Research Council of Canada (NRC)
Publication Sales M20, Montreal Road, Ottawa, ON K1A 0R6
Telephone: (613) 993-2463
www.nrc-cnrc.gc.ca

• National Fire Code of Canada 2010

Documents Published by SAE International, Society of Automobile Engineers
400 Commonwealth Drive, Warrendale, PA 15096-0001 U.S.A.
Telephone: (724) 776-4841

• SAE J1681-2000, Gasoline, Alcohol, and Diesel Fuel Surrogates for Material Testing

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Standard Published by The Society for Protective Coatings (SSPC) and the National Association of Corrosion Engineers (NACE) International
P.O. Box 218340, Houston, TX, US.A. 77218
Telephone: (713) 492-0535
www.nace.org

• SSPC-SP6-1999/NACE No. 3-2014, Joint Surface Preparation Standard- Commercial Blast Cleaning

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Documents Published by ULC Standards
171 Nepean Street, Suite 400 Ottawa, ON K2P 0B4 Canada
Telephone: (613) 755–2729 or 1-866-9373-ULC
www.ulc.ca

• CAN/ULC-S603.1-2011, External Corrosion Protection Systems for Steel Underground Tanks for Flammable and Combustible Liquids

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3 GLOSSARY

Note: Terms used in this Standard that are in *italic* print are defined as follows:

3.1 *ASTM REFERENCE FUEL C* - A mixture of 50% Isooctane and 50% Toluene by volume

3.2 *AUTHORITY HAVING JURISDICTION* - The governmental body responsible for the enforcement of any part of this Standard or the official or agency designated by that body to exercise such a function.

3.3 *COMBUSTIBLE LIQUID* - Any liquid having a flash point at or above 37.8 °C and below 93.3 °C and as defined in the National Fire Code of Canada.

3.4 *CRUSHED STONE* - Washed, crushed aggregate or crushed gravel with an angular particle size of not more than 13 mm diameter that is clean and free flowing and with no mopre than 5% passing a No. 8 sieve (2.38 mm screen size opening). The material has a minimum dry gravel density of 1520 kg/m^3 and meets the requirements of ASTM C33/C33M, Standard Specification for Concrete Aggregates, for quality and soundness.

3.5 *DOUBLE WALL TANK* - A *primary tank* with an integral *secondary containment* where the *interstice* is capable of being monitored.

3.6 *FIBRE REINFORCED PLASTIC* - A composite material consisting of a combination of rigid thermoset resin and glass fibre reinforcements. The glass fibre reinforcements may take the form of short randomly oriented fibre and/or woven or non-woven fabrics and/or glass fibre rovings.

3.7 *FLAMMABLE LIQUID* - Any liquid having a flash point below 37.8 °C and a vapour pressure not exceeding 275 kPa (absolute) at 37.8 °C and as defined in the National Fire Code of Canada.

3.8 *INTERSTICE / INTERSTITIAL SPACE* - The space that is capable of being monitored for leakage through:

A the *primary tank* and the *secondary containment* wall;

B the multiple *containment* walls; or

C *monitorable bulkheads*.

3.9 *MANWAY* - An opening on a tank designed to provide personnel access to the interior of the tank.

3.10 *MONITORABLE BULKHEAD / BULKHEAD* - An impermeable partitioning structure within a *primary tank* separating the *primary tank* into independent liquid *containment* compartments and consisting of two layers of material with a space between them that is capable of being monitored for leaks. These two layers may not have the same thickness of materials.

3.11 *MULTIPLE WALL TANK* - A *double wall tank*, which incorporates additional integral layers of *containment* where the *interstices* are capable of being monitored.

3.12 *NON-PRESSURE TANK* - A horizontal tank that is normally vented to atmosphere and is not intended to accommodate internal pressures at the top of the tank greater than 7 kPa (gauge) nor internal vacuum greater than 300 Pa (gauge).

3.13 *PEA GRAVEL* - A naturally rounded aggregate, actual size no greater than 19 mm, free-flowing and with no more than 5% passing a No. 8 sieve (2.38 mm screen size opening). The material has a minimum dry gravel density of 1520 kg/m3 and meet the requirements of ASTM C33, Standard Specification for Concrete Aggregates, for quality and soundness. Local names vary and include *"pea gravel"*, "pea stone", "roofing gravel", etc.

3.14 *PRIMARY TANK* - The product storage tank or compartment.

3.15 *SECONDARY CONTAINMENT / CONTAINMENT* - A structure that is external to the *primary tank* designed to create an *interstice* and capture and contain leakage in case of failure of the *primary tank*.

4 CONSTRUCTION

4.1 GENERAL

4.1.1 Tanks that constructed in accordance with this Standard shall use *fibre reinforced plastic* materials formed to the required shape.

4.1.2 Tanks shall be capable of being anchored against upheaval by ground water levels higher than the top of the tank.

4.1.3 Tanks meeting the requirements of this Standard shall be designed for burial with a maximum depth of 2.1 m of backfill above the tank, unless specifically tested for greater depth of burial.

4.1.4 The tank shall be constructed in accordance with the applicable requirements of this Standard.

4.1.5 Multi-compartment tanks shall be provided with *monitorable bulkheads*.

4.1.6 The *interstice* of *monitorable bulkheads* for multiple compartment tanks shall be tested in accordance with the requirements of *double wall tanks*.

4.1.7 All *containment* spaces shall cover a minimum of 300° of the circumferential surface area of the *primary tank*, or a surface area corresponding to 95% of the internal volume of the *primary tank*, whichever is greater, including 100% coverage of the *primary tank* heads and excluding the area immediately adjacent to the tank fittings and *manways*.

NOTE: The *authority having jurisdiction* may require that the tank have 360° *containment* except for the areas penetrated by fittings and *manways*.

4.1.8 Each *containment* space shall provide a continuous *interstice*.

4.1.9 The actual capacity of a completed tank shall be not less than the nominal capacity but not more than the nominal capacity plus 2.5%.

4.2 ACCESS TO LEAK MONITORING

4.2.1 Access to the *interstice*, used for monitoring shall be available at ground level through a suitable connection or access chamber.

4.3 VENT OPENINGS

4.3.1 Each tank or each compartment of a multi-compartment tank (as the case may be) shall have provisions for venting. This entails the provision for the attachment of a vent pipe of a size not less than that specified in Table 1.

4.4 LIFTING

4.4.1 All tanks shall be equipped with a clearly identified lifting method, as described in the manufacturer’s Installation Instructions.

4.4.2 Where lifting lugs are used, they shall be in accordance with the requirements of Subsection 5.5, Lifting Lugs. The lifting lugs shall be located in such a manner as to allow the tank to be lifted in an essentially horizontal attitude.

4.4.3 When multiple lugs are required for lifting, a label shall be included adjacent to at least one lug identifying the minimum number of lugs required for lifting.

4.4.4 The lifting lugs shall incorporate a minimum 50 mm diameter hole or equivalent opening, and shall be so designed as to accommodate lifting hooks.

4.5 MANWAYS

4.5.1 When required, the *manway* shall have a minimum inside diameter of 560 mm and shall have the flange located at a minimum of 100 mm, above the interior top at the vertical axis of the tank. The materials used for construction shall meet the structural and immersion performance requirements of this Standard.

4.5.2 Each *manway* shall be provided with a gasket not less than 3 mm in thickness which shall be of a material compatible with the stored product.

NOTE: The selection of the gasket needs to consider the product to be stored, as determined by the buyer, with reference to the gasket manufacturer's documentation.

4.6 INTERNAL PROTECTION

4.6.1 Deflection plates (also known as impact pads, or other shock absorbing devices), designed to prevent possible damage to the inside tank wall surface from repeated impact of dipsticks or other devices used to gauge tank contents, shall be installed under all openings potentially used as fill and gauging locations.

4.6.2 The tank shall have a deflection plate of steel at least 1.35 mm thick or aluminum at least 3.2 mm thick. The deflection plate shall be overlaid with 2 mm of the laminate used in the construction of the inner tank. The deflector plate shall be at least 230 mm wide, and at least 0.09 m^2 in area under each opening.

4.7 TANK CONNECTIONS

4.7.1 Openings for tank connections of pipe with outside diameters up to and including 219 mm (NPS 8), shall be provided with:

A Threaded steel flanges, or steel pipe couplings conforming to the latest revision of API 650, Standard for Welded Steel Tanks for Oil Storage, or ANSI/ASME B16.5, Pipe Flanges and Flanged Fittings NPS ½ through NPS 24 Metric / Inch Standard. For pipe outside diameters over 219 mm (NPS 8), connections shall be flanged and the wall thickness of the pipe shall be not less than 6.30 mm (See Figure 1); or

B Flanges conforming to ANSI/ASME RTP-1, Standard for Reinforced Thermoset Plastic Corrosion Resistant Equipment.

4.7.2 The centre of all openings in a cylindrical tank shall be located not more than 305 mm from the longitudinal centre line in at the top of the tank. If the tank is spherical, the centre of all the openings shall be located within a 305 mm radius from the top centre of the tank.

4.7.3 The upper end of each pipe coupling or other fitting for pipe connection shall terminate above the top of the shell.

4.7.4 All flange connections shall be terminated 125 ±25 mm above the interior top of the tank and be installed with bolt holes straddling the centre line.

4.7.5 All threaded openings shall be fitted at the manufacturer's plant with thread protectors or malleable or cast iron plugs. Where plugs are used, threads shall have temporary non-hardening sealing compound applied and the plugs shall be hand-tightened into the tank fittings. At least one temporary venting or shipping plug shall be used. It shall be plastic, malleable or cast iron painted red and shall be provided with the equivalent of a minimum 4.5 mm diameter opening to permit venting of the tank during transit and storage.

4.7.6 For shipping purposes only, all flanged openings shall be fitted with suitable flange protectors.

4.8 SUPPLEMENTARY EQUIPMENT AND MANUALS

4.8.1 The following items shall be provided by the tank manufacturer with each tank:

A One gauge chart showing the capacity of the tank in litres, measured at 0.5 cm (or less) spacings from the bottom of the tank. Charts are to be based on the actual tank capacity and shall be accurate to ±0.5%; and

B Two copies of the manufacturer's installation instructions, one of which shall be permanently attached to the exterior of the tank. See Section 8, Installation Instructions.

NOTE 1:

Where applicable, the installation instructions attached to the exterior of the tank may be a condensed version of the full installation instructions pertaining only to the burial instructions for the tank.

NOTE 2:

If agreed by the tank manufacturer and owner, certain supplementary equipment may be omitted to avoid unnecessary duplication of items where multiple tanks are to be installed.

4.9 CORROSION PROTECTION

4.9.1 All externally exposed metal parts, excluding lifting or guide lugs, shall be:

A Coated with the same resin used to manufacture the tank of at least 0.25 mm thickness; or

B Shall have corrosion protection in accordance with CAN/ULC-S603.1, Standard for External Corrosion Protection Systems for Steel Underground Tanks for Flammable and Combustible Liquids.

5 PERFORMANCE

5.1 GENERAL

5.1.1 The largest length of each given tank diameter shall be tested in accordance with Subsections 5.2, Leakage Test through 5.7, Flood Loading. However, the same tank sample is not required to be subjected to all tests. For spherical tanks that differ only in diameter, only the largest diameter tank is required to be tested.

5.1.2 All references to values of pressure and vacuum, unless otherwise indicated, shall be considered "gauge".

5.2 LEAKAGE TEST

5.2.1 Single wall tanks shall be tested and proved tight against leakage by applying a minimum internal air pressure of 35 kPa (21 kPa for tanks larger than 3050 mm diameter). The test pressure shall be held for not less than 30 min. When the required pressure is achieved, the source of pressure shall be removed and the tank, including all joints and plugs, shall be tested for leakage with a soap solution or other acceptable liquid.

5.2.2 *Double wall tanks*, *multiple wall tanks* and multi-compartment tanks shall be checked for leakage by applying 35 kPa pressure or vacuum (21 kPa for tanks larger than 3050 mm diameter) to each *interstitial space* and/or *monitorable bulkheads* while all compartments of the *primary tank* are vented to atmosphere. When the required pressure is achieved, the source of pressure shall be removed and the test pressure or vacuum shall be held for 30 min without loss or gain of 1.0 kPa.

5.2.3 As an alternative to Clause 5.2.2, and where pressure is used to check for leakage of the tank, the primary and exterior wall of the tank may be checked for leakage by application of a soap solution to both the interior surface of each compartment of the *primary tank* and the exterior surface of the tank and checked for bubbles. Any wall not capable of soap testing will require the pressure or vacuum test in accordance with Clause 5.2.2.

NOTE: Vacuum or pressure levels may be adjusted to compensate for changes in temperature or atmospheric pressure that occur during the test period in accordance with the Ideal Gas Law (PV = nRT).

5.3 TANK INTEGRITY TESTING

5.3.1 The empty sample of a *primary tank* or each compartment of a multi-compartment tank and simultaneously the *interstitial space* of a *double wall tank* or *multiple wall tank*, if applicable, shall be subjected to a continuous internal pressure or vacuum of not less than 35 kPa (21 kPa for tanks larger than 3050 mm diameter) for a period not less than 30 min. The tank shall not collapse and the *interstitial space* and/or space between *monitorable bulkheads* and the tank shall not leak when tested in accordance with the requirements of Subsection 5.2, Leakage Test, as applicable.

5.3.2 Each *interstice* of a *double wall* or *multiple wall tank* shall be tested by connecting a vacuum or pressure source to the *interstice*, depending on the intended method of monitoring, at a vacuum or pressure not less than 1.5 times the manufacturer's recommended monitoring vacuum or pressure. The developed vacuum or pressure shall be maintained for not less than 30 min. The tank shall not collapse and the *interstitial space* and/or space between *monitorable bulkheads* and the tank shall not leak when tested in accordance with the requirements of Subsection 5.2, LeakageTest, as applicable.

5.3.3 Each *interstice* of a *double wall* or *multiple wall tank* intended for liquid filled monitoring shall be tested at a pressure equal to 1.5 times the static pressure developed when filled in accordance with the manufacturer's printed instructions and maintained for a minimum of 30 min. The tank shall not leak when tested in accordance with the requirements of Subsection 5.2, LeakageTest, as applicable or as indicated by loss of liquid in the monitoring system if the *interstice* is tested by filling with liquid.

5.4 MANWAYS

5.4.1 Where *manway* assemblies are provided, the largest size *manway*, shall be assessed by including it in a performance tested tank design as provided for in this Standard.

5.5 LIFTING LUGS

5.5.1 The lifting lugs shall be designed to withstand a load equal to three times the mass of the empty tank without evidence of buckling or failure in accordance with Clause 5.5.2. The pull force equal to three times the mass of the tank shall be applied to the lifting lugs in an upward lifting direction and shall be maintained for 5 min.

5.5.2 The tank shall then be subjected to a pneumatic leakage test in accordance with Subsection 5.2, Leakage Test, as applicable, and there shall be no evidence of leakage.

5.6 HYDROSTATIC PRESSURE

5.6.1 The tank shall be designed to withstand hydrostatic testing at a pressure of 175 kPa (103 kPa for tanks larger than 3050 mm in diameter), with no evidence of rupture or leakage when conducted in accordance with the requirements of Clauses 5.6.2 and 5.6.3.

5.6.2 A sample tank complete with fittings and of the capacity and design for which acceptance is required, shall be placed on a 300 mm *crushed stone* or *pea gravel* bed. At the manufacturer's option, placement of the tank with backfill to a maximum of 25% of the vertical height of the tank shall be permitted to prevent bending of the tank due to static water load. The *primary tank* shall be filled with water and subjected to an internal hydrostatic pressure of 175 kPa (103 kPa for tanks larger than 3050 mm diameter), (measured at the top of the tank), which should be gradually applied in increments of 35 kPa and held for 5 min at each pressure level. This pressure shall be maintained for 60 min.

5.6.3 For multi-compartment tank *bulkheads*, a hydrostatic pressure of 175 kPa (103 kPa for tanks larger than 3050 mm in diameter) shall first be applied to one compartment, while the adjacent compartment is full of water and vented, as described in Clause 5.6.2. Then, after release of the pressure on one compartment, the same pressure shall be applied, in the same manner, to each other compartment. As an alternative, the tank may be buried for this test in accordance with Clause 5.7.2.

5.6.4 The sample tank shall then be emptied and then tested in accordance with Subsection 5.2, Leakage Test, as applicable.

5.7 CONCENTRATED LOADING

5.7.1 The tank shall be designed to withstand a concentrated load of 10 600 kg on the top centre line of the tank applied in the manner described in Clause 5.7.2 with no evidence of buckling or failure.

5.7.2 A sample tank in an empty condition shall be installed in a pit and anchored in accordance with the manufacturer's printed instructions. The tank shall then be backfilled with *crushed stone* or *pea gravel* to a level of 900 mm above the top centre line of the tank.

NOTE: Backfill materials other than *pea gravel* or *crushed stone* may be used at the specification of the manufacturer when the purpose of the test is to qualify the tank for installation in such alternate backfill materials.

5.7.3 Measurements of tank diameter shall be recorded at the approximate centre point of the tank, for comparison purposes, before and after the backfilling process and 18 h after the installation has been completed. The change in diameter shall not exceed ±1% of the original diameter.

5.7.4 While installed , the sample tank shall be subjected to a concentrated load of 10 600 kg at grade level applied through 480 by 480 mm contact area above the centre of the tank at the midpoint of its length for a minimum of 120 min.

5.7.5 After the test period, the load, and then backfill shall be removed and the tank examined for structural damage. As an alternative, this may be done at the completion of the flood loading test, as described in Subsection 5.8, Flood Loading.

5.7.6 The tank shall then be subjected to a leakage test in accordance with Subsection 5.2, Leakage Test, as applicable, and there shall be no evidence of leakage.

5.8 FLOOD LOADING

5.8.1 The tank shall be designed to withstand the unusual loading conditions resulting from flooding at the site and shall be tested as described in Clauses 5.8.2 through 5.8.7 with no evidence of buckling or failure. For *double wall* and *multiple wall tanks*, the *interstice* and the *primary tank* shall be manifolded during the test.

5.8.2 The sample tank, in an empty condition, shall be installed in accordance with Clause 5.7.2. The test pit shall be filled with water, level with the top of the backfill, and maintained in this condition for a period of 18 h.

5.8.3 Measurement of vertical diameter at the approximate centre point of the tank shall be recorded before and after flooding.

5.8.4 Following the 18 h test, the change in diameter shall not exceed ±1% of the original diameter before flooding.

5.8.5 Following the above test period, the sample tank shall be subjected to an internal vacuum of 35 kPa for a period of not less than 5 min while maintaining the conditions described in Clause 5.8.2.

5.8.6 The backfill shall be removed and the tank examined for structural damage.

5.8.7 The tank shall then be tested in accordance with Subsection 5.2, Leakage Test, as applicable. There shall be no evidence of leakage.

5.9 TANK CONNECTIONS

5.9.1 Each connection shall be capable of withstanding a torque applied in accordance with the test method described in Clauses 5.9.2 and 5.9.3 with no evidence of damage or leakage as a result of these tests.

5.9.2 Torque shall be applied to representative threaded connections attached to the shell of the sample tank, to the minimum values shown in Table 2.

5.9.3 The torque specified in Table 2 shall be applied in approximately 5 equal increments over a 10 min interval.

5.9.4 The tank and connections shall be examined for evidence of cracking, splitting or stripping of threads, or failure of the bond between the tank and a connection.

5.9.5 The tank shall then be subjected to an aerostatic leakage test in accordance with Subsection 5.2, Leakage Test, as applicable. There shall be no evidence of leakage.

5.9.6 Each connection shall be capable of withstanding a bending moment of 2700 N•m applied in accordance with the test method described in Clauses 5.9.7 and 5.9.8. There shall be no evidence of leakage or damage.

5.9.7 A total bending moment of 2700 N•m acting in a vertical plane coincident with, or parallel to, the longitudinal axis of the tank, shall be applied to representative tank connections in approximately 5 equal increments over a 10 min interval.

5.9.8 A total bending moment of 2700 N•m acting in a vertical plane at right angles to the longitudinal axis of the tank, shall be applied to representative tank connections in approximately 5 equal increments over a 10 min interval.

5.9.9 The tank and connections shall be examined for evidence of cracking or splitting or failure of the bond between the tank and a connection.

5.9.10 The tank shall then be subjected to an pneumatic leakage test in accordance with Subsection 5.2, Leakage Test, as applicable. There shall be no evidence of leakage.

5.10 IMMERSION

5.10.1 All *fibre reinforced plastic* materials of tank construction shall be capable of withstanding the effects of deterioration resulting from the action of stored materials or surrounding soil conditions as described in this Subsection.

5.10.2 Except as determined in Clause 5.10.3, samples of the laminates employed in the construction of the *primary tank* and *containment* walls of a double wall or *multiple wall tank* shall be immersed in environments conforming to Table 3 for 180 d and shall retain at least 50% of their flexural strength values as obtained in the “As Received” condition when tested in accordance with ASTM D790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials with the coupon tested with the tank interior surface in tension.

5.10.3 All materials which do not comprise the essential structural components of the tank shall retain sufficient physical properties to perform their intended functions after immersion in the environments described in Table 3.

5.10.4 Laminates as described in Clause 5.10.2 shall be cut into 130 mm by 230 mm test coupons. The edges shall be treated with resin to compensate for unrepresentative exposure when immersed in test environments. The test coupons shall be representative of longitudinal and circumferential fibre orientation.

5.10.5 Following the prescribed exposure period, the procedure for handling the test coupons after they are removed from the environments shall be in accordance with the procedure specified in ASTM C581, Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber Reinforced Structures Intended for Liquid Service.

5.10.6 Where the tank has been evaluated to be compatible with other *flammable* and *combustible liquids* in accordance with Clause 1.1 (D) and Table 3, it shall be marked in accordance with Sub-clause 7.1(J) or (K).

6 PRODUCTION TESTS

6.1 LEAKAGE TEST

6.1.1 Each *primary tank*, tank compartment and *interstice* shall be tested and proved tight against leakage in accordance with Subsection 5.2, Leakage Test.

7 MARKING

7.1 The following information shall be incorporated on a metal label or other materials of equivalent durability bonded to the tank and located on or within 150 mm of the top centre line:

A "NAME OF TANK MANUFACTURER;

B "SERIAL NUMBER OF TANK";

C "SINGLE WALL TANK" or "DOUBLE WALL TANK", as applicable;

D For *double wall tanks*, "CONTAINMENT WRAP IS X° ", where X identifies the angular value;

E "TANK CAPACITY IN LITRES";

F "YEAR AND MONTH OF MANUFACTURE";

G "MAXIMUM OPERATING VACUUM AND PRESSURE (kPa)";

H "MANUFACTURER'S MAXIMUM OPERATING VACUUM AND PRESSURE (kPa — EMPTY TANK)";

I "COMPARTMENT TANK - CAP: Comp 1 * L; Comp 2 * L (where applicable)";

* Specify capacity;

J "SUITABLE FOR PETROLEUM PRODUCTS, OXYGENATES AND OXYGENATED FUEL BLENDS or X",

where X is the special fluid to which the tank has been tested in accordance with Table 3, part B; and

K Where the tank has been tested to Fuel Oil #6, in accordance with Table 3, part B, a marking shall be included to state:

"SUITABLE FOR STORAGE OF FUEL OIL #6 UP TO TEMPERATURE OF X °C".

where X is the temperature to which the tank has been tested to.

NOTE: Manufacturers should be aware that the *authority having jurisdiction* may also require that the mark of the certifying agency be included on each tank in an equivalent location as described above.

7.2 Each tank shall bear the following information in letters 25 mm high, in a contrasting colour:

A "HANDLE WITH CARE - DO NOT DROP" and « MANIPULER AVEC SOIN - NE PAS LAISSER TOMBER »;

B "LARGE STONES AND OTHER SHARP OBJECTS WILL DAMAGE THIS TANK" and

« LES GROSSES PIERRES ET LES OBJETS TRANCHANTS ENDOMMAGERONT CE RÉSERVOIR »;

C "FOLLOW MANUFACTURER'S INSTALLATION INSTRUCTIONS" and « RESPECTER LES INSTRUCTIONS D'INSTALLATION DU FABRICANT»

D “REMOVE SHIPPING PLUGS AND THREAD PROTECTORS” and « ENLEVER LES CAPUCHONS DE PROTECTION ET LES PROTECTEURS DE FILETS »;

E “MAXIMUM TANK WEIGHT * kg” and « MASSE MAXIMALE DU RÉSERVOIR * kg » (located at the lifting lugs of the tank) * Specify weight;

F “MAXIMUM TEST PRESSURE X kPa” and « PRESSION MAXIMALE DE L’ESSAI X kPa », in which X is 35 kPa for tanks 3050 mm in diameter or less and 21 kPa for tanks larger than 3050 mm in diameter;

G “ENSURE THAT THE STORED PRODUCT IS COMPATIBLE WITH THE CONSTRUCTION MATERIAL, INCLUDING GASKETS”; and

H “MAXIMUM BURIAL DEPTH TO TANK TOP - X m”

7.3 Each *double wall tank*, where applicable shall be clearly marked in letters 25 mm minimum height, of a contrasting colour with the following information:

A ″DOUBLE WALL TANK -- VACUUM IS DRAWN BETWEEN WALLS -- IF GAUGE READING IS LESS THAN * kPa VACUUM -- CONTACT MANUFACTURER PRIOR TO TANK INSTALLATION″ (located at the negative pressure (vacuum) gauge when applicable);

* Specify vacuum pressure

B ″THIS TANK IS EQUIPPED WITH A FACTORY ATTACHED PERMANENT VACUUM MONITOR -- FOLLOW TANK MANUFACTURER’S INSTRUCTIONS″;

or

C “THIS TANK IS EQUIPPED WITH LIQUID MONITORING -- FOLLOW TANK MANUFACTURER’S INSTRUCTIONS” (located at factory attached monitor, when applicable).

7.4 Where multiple lugs are required for lifting, a label must be included adjacent to at least one lug identifying the minimum number of lugs required for lifting.

8 INSTALLATION INSTRUCTIONS

8.1 Complete installation instructions and maintenance recommendations shall accompany each tank and shall include but not be limited, to the following information:

A Instruction that the tank installer shall consult with the *authority having jurisdiction* to ensure that the requirements of this Standard as well as all the Federal, Provincial and Local Codes are met prior to installation;

B Base preparation and backfill requirements;

C Installation and use, such as burial depth, monitoring type, maximum vacuum or pressure for leak testing and monitoring;

D Requirement that the stored product and gaskets are compatible with the material of construction, including temperature limitations;

E Lifting and handling instructions, including the use of spreader bars, when necessary; and

F Venting.

Refer also to Appendix B (Informative), Installation Instructions.

TABLES

TABLE 1

VENT PIPE SIZES

(Reference: Clause 4.3.1)

MAXIMUM NOMINAL CAPACITY OF TANK (L)	MINIMUM SIZE OF VENTS NPS
2 500	1–1/4
10 000	1–1/2
35 000	2
75 000	2–1/2
250 000	3

NOTE: For guidance in sizing the vent piping, refer to Appendix C (Informative), Guidelines for Minimum Vent Line Internal Diameters - Millimetres (versus flow rate and pipe length).

TABLE 2

MINIMUM TORQUE STRENGTH OF FITTINGS

(Reference: Clauses 5.9.2 and 5.9.3)

PIPE SIZE NPS 40	TORQUE N•m
2	373
2–1/2	395
3	407
3–1/2	418
4	429
6	475
8	520

TABLE 3

IMMERSION TEST

(Reference: Clauses 5.10.2, 5.10.3, 5.10.6 and 7.1(K))

TEST LIQUIDS OR ENVIRONMENT	TEMP. °C	SINGLE WALL TANK	*DOUBLE WALL* OR *MULTIPLE WALL TANK*	
			PRIMARY TANK	ADDITIONAL *CONTAINMENT*
PART A. GENERAL TEST FUELS				
ASTM Reference Fuel F	40 ±2 °C	X	X	X
CE25a[1]	40 ±2 °C	X	X	X
CE85a[1]	40 ±2 °C	X	X	X
FB25a	40 ±2 °C	X	X	X
PART B. SPECIAL USE MARKED FOR RATINGS				
E100	40 ±2 °C	X	X	X
B100a	40 ±2 °C	X	X	X
MeOH	40 ±2 °C	X	X	X
Fuel Oil #6	**	X	X	X

IMMERSION TEST (Continued)

PART C. EXTERNAL SOIL AND ENVIRONMENTAL FLUIDS				
pH 10 Sodium Carbonate - Sodium Bicarbonate[2]	23 °C	X		X
Saturated Sodium Chloride	23 °C	X		X
Sulphuric Acid Dilute - pH 3	23 °C	X		X

NOTES:

** - in accordance with the manufacturer's rating + 10 °C

X = Immersion Test Required

(1) The ″C″ prefix indicates the use of *ASTM Reference Fuel C* as a standardized test fluid to represent gasoline; Fuel C is comprised of 50% isooctane and 50% toluene as defined in ASTM D471, Standard Test Method for Rubber Property - Effect of Liquids; and The ″a″ suffix indicates use of

aggressive ethanol test fluid made through the introduction of defined amounts of water, sodium chloride, sulphuric acid and glacial acetic acid in accordance with SAE J1681, Gasoline, Alcohol and Diesel Surrogates for Materials Testing.

(2) A pH of 10 is to obtained by mixing 10.6 g/L of sodium carbonate and 8.4 g/L of sodium bicarbonate.

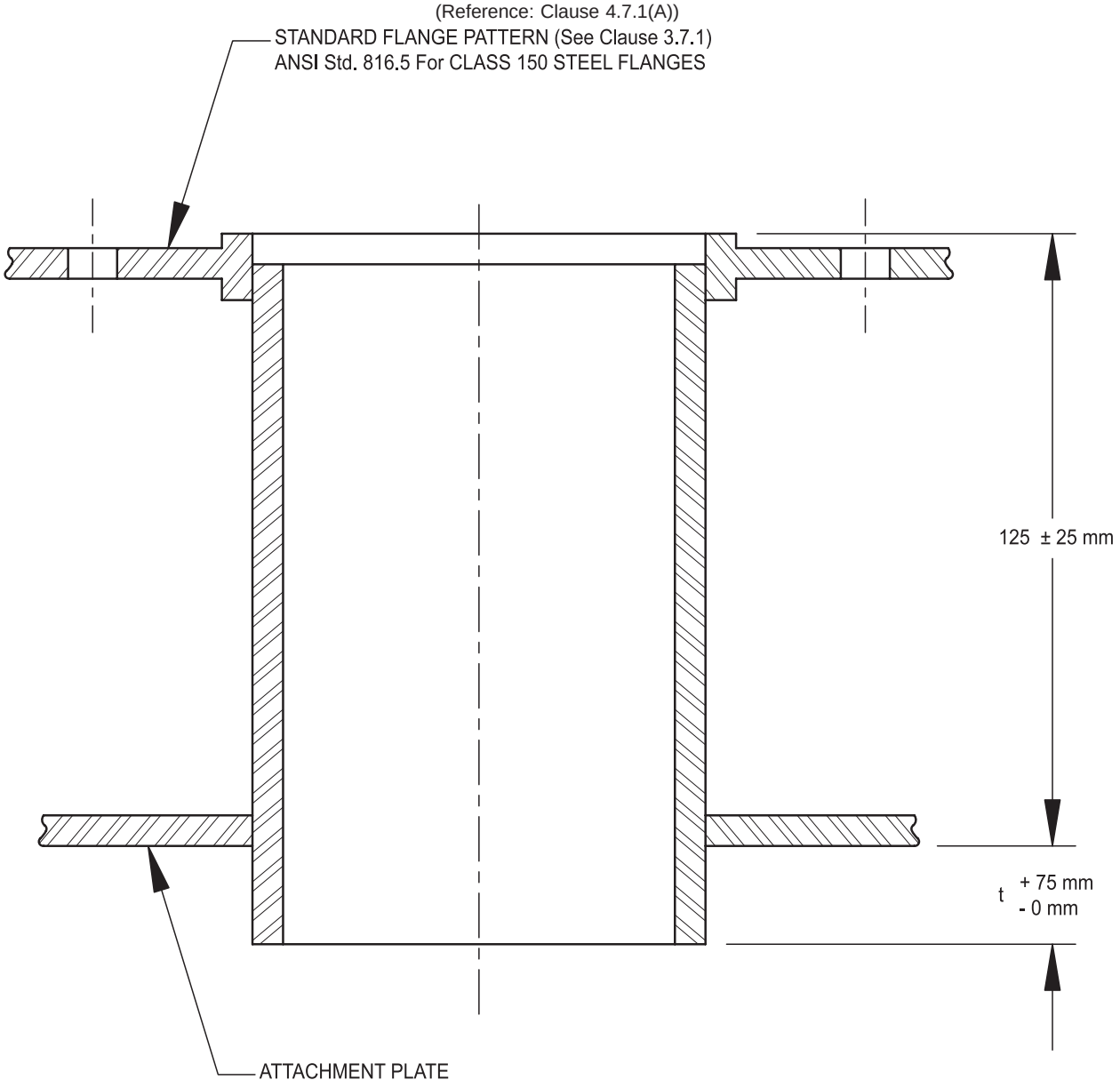
A pH meter is to be used and the ratio of sodium carbonate to sodium bicarbonate is to be adjusted to obtain a pH of 10. The pH value is to be checked several times during the test.

Please refer to Appendix D (Informative), Test Fuel Formulations, for more information.

FIGURES

FIGURE 1
GENERAL CONFIGURATION OF FITTINGS

(Reference: Clause 4.7.1(A))



NOTE: "t" IS TANK SHELL THICKNESS

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APPENDIX A (INFORMATIVE)

LIST OF STANDARDS ON FUELS AND OTHER FLAMMABLE AND COMBUSTIBLE LIQUIDS

A1.1 The tanks covered by this Standard are intended for the storage of *flammable* and *combustible liquids* that have been formulated in accordance with, but not limited to, the following Standards and are to be tested to the appropriate test fuels:

PETROLEUM PRODUCTS, OXYGENATED FUEL BLENDS AND OXYGENATES[1]	TEST FUELS	ASTM AND CGSB STANDARDS
PETROLEUM PRODUCTS		
Includes petroleum hydrocarbon fuels with low bio-blends per Specs and similar *flammable* or *combustible liquid* petroleum derivatives, such as fuel components (cetane, hexane, heptane, etc.), and oils (lubricating, hydraulic, machine, etc.).	*ASTM Reference Fuel C* (Gasoline) (Class I *flammable liquids*)	• CAN/CGSB 3.5, Automotive Gasoline • ASTM D910, Standard Specification for Aviation Gasolines • ASTM D7719, Standard Specification for High-Octane Unleaded Fuel
	ASTM Reference Fuel F (Diesel/Fuel Oil) (Class II & III *combustible liquids*)	• CAN/CGSB 3.18, Diesel Fuel for Locomotive-Type Medium-Speed Diesel Engines • CAN/CGSB 3.2, Heating Fuel Oil • CAN/CGSB 3.3-2014, Kerosene • CAN/CGSB 3.6, Off-Road Diesel Fuel • CGSB 3.11, Naval Distillate Fuel • CAN/CGSB 3.1, Diesel Fuel for Locomotive-Type Medium-Speed Diesel Engines • CAN/CGSB 3.22, Wide-Cut Type Aviation Turbine Fuel (Grade JET B) • CAN/CGSB 3.23, Aviation Turbine Fuel (Grades JET A and Jet A-1) • CAN/CGSB 3.24, Aviation Turbine Fuel (Military Grades F-34 and F-44) • CAN/CGSB 3.2, Naphtha Fuel • CAN/CGSB 3.517, Automotive (On-road) Diesel Fuel • ANSI/ASTM D396, Standard Specification for Fuel Oils • ANSI/ASTM D975, Standard Specification for Diesel Fuel Oils • ASTM D1655, Standard Specification for Aviation Turbine Fuels • ANSI/ASTM D3699, Standard Specification for Kerosene • ASTM D4304, Standard Specification for Mineral and Synthetic Lubricating Oil Used in Steam or Gas Turbines • ASTM D4814, Standard Specification for Automotive Spark-Ignition Engine Fuel • ASTM D6158, Standard Specification for Mineral Hydraulic Oils • ASTM D6615, Standard Specification for Jet B Wide-Cut Aviation Turbine Fuel
	#6 Fuel Oil (Special Option) (Tested to the temperature rating provided by the manufacturer +10 °C)	• CAN/CSA-A123.3, Asphalt Saturated Organic Roofing Felt • Bunker fuel • Asphalt / tar
OXYGENATED FUEL BLENDS		

Table (Continued)

Includes all ″Petroleum Products″ liquids; plus petroleum hydrocarbon fuels with low-biofuels blends. For low-level 3–10% ethanol blends:	CE25a (Class I *flammable liquids*) (EtOH Blends)	• CAN/CGSB-3.511, Oxygenated Automotive Gasoline Containing Ethanol (E1-E10) • ASTM D4806, Denatured Fuel Ethanol for Blending with Gasoline for Use as Automotive Spark-Ignition Engine Fuel
	CE85a (Class I *flammable liquids*) (EtOH Blends)	• CAN/CGSB -3.512, Automotive Ethanol Fuel (E50-E85) • ANSI/ASTM D5798, Standard Specification for Ethanol Fuel Blends for Flexible-Fuel Automotive Spark Ignition Engines Includes Iso-butanol
	FB25a (BioDiesel Blends) (Class II & III *combustible liquids)*)	• CAN/CGSB-3.520, Automotive DieselFuelContaining Low Levels of Biodiesel (B1–B5) • CAN/CGSB-3.522, Diesel Fuel Containing Biodiesel (B6–B20) • CAN/CGSB -3.524, Biodiesel (B100) for Blending in Middle Distillate Fuels
OXYGENATES		
Includes all “Petroleum Product” & ″Oxygenated Fuel Blends″ liquids; plus pure/ denatured or highest oxygenated blend stocks for use in mixing of dispensed lower fuel-blends and components, such as biodiesel and ethanol.	Special Option (EtOH Blend Stock) (Class I *flammable liquids*)	• CAN/CGSB-3.512, Automotive Ethanol Fuel (E50-E85) • CAN/CGSB-3.516, Denatured Fuel Ethanol for Use in Automotive Spark Ignition Fuels
	M100 or MeOH Special Option (MeOH Blend Stock) (Class I *flammable liquids*)	• 3-GP-531M, Methanol, Technical
	B100a Special Option (Diesel/Fuel Oil) (Class II & III *combustible liquids*)	• CAN/CGSB-3.524, Biodiesel (B100) for Blending in Middle Distillate Fuels
[1]Combines sub-groups of commercially available fuels for general-purpose commercial engines (SI or CI) and heating/burning appliances and other equipment		

APPENDIX B (INFORMATIVE)
INSTALLATION INSTRUCTIONS

B1.1 The manufacturer shall supply installation instructions with each tank, which shall include, but not be limited to, the conditions described in this Appendix.

B1.2 *Fibre reinforced plastic* underground tanks for *flammable* and *combustible liquids* shall be handled and installed in accordance with the regulations of the *authority having jurisdiction*.

B1.3 In freezing weather conditions, special measures shall be employed to ensure an unfrozen firm bed under the tank and a compacted backfill free of ice, snow or other frozen material, without use of calcium chloride. Under such conditions, backfilling shall be completed in one working day.

B1.4 Each tank shall be visually inspected prior to the time of installation for any indication of damage or defect with special attention given to those tanks stored under exposure to ultraviolet light.

B1.5 The excavation shall provide a minimum of 600 mm clearance between tanks (where more than one share a common excavation) and 450 mm between the tank and the excavation sides.

B1.6 Excavation and any de-watering shall be performed in a manner that shall provide a firm, uniform, foundation support for bedding the tank.

B1.7 The tank shall be bedded in the excavation on a minimum 300 mm layer of *pea gravel* or *crushed stone*.

B1.8 The tank shall be carefully lowered into the excavation by the use of lifting lugs and hooks, and a spreader bar when necessary and under no circumstances shall chains or slings be used around the tank nor shall any other method of handling be used which may result in damage to the tank.

B1.9 After plugging all the openings, air or nitrogen at a pressure of 35 kPa shall be applied to the tank and the tank piping connections examined for leakage with soap or other leak testing solution. The source of the test pressure shall be removed with the test pressure remaining in the tank. The test pressure shall be held for a minimum of 2 h.

B1.10 For *double wall* and multi-compartment tanks, the tests for reaffirming the integrity of the *primary tank(s)*, the *interstice*, each compartment, and each *monitorable bulkhead* space(s), as applicable, shall be performed in accordance with the manufacturer's instructions.

B1.11 In high water-table areas, the tank shall be anchored.

B1.12 Anchoring shall be engineered on the basis of tank size, ground cover, water-table elevation, and calculated uplift force on the empty tank. Anchoring shall be accomplished in such a manner that the anchor straps can be hand tightened and so designed and applied that they do not damage the tank. The tank shall not be in direct contact with concrete but shall be separated by at least 300 mm of bedding material. (See Clause B1.7)

B1.13 If ballasting is to be accomplished with a petroleum product:

A No product shall be placed in the tank until the fill pipe and permanent vent line have been installed in the tank and until all other openings have been plugged; and the test specified in Clause B1.9 or B1.10 has been successfully completed; and

B The level of the liquid in the tank shall not vary from the level of the backfill material surrounding the tank by more than 600 mm to prevent uneven loading of the tank during installation.

B1.14 A minimum clearance of 50 mm shall exist between the top of the fill pipe cap and the bottom of a fill box (spill containment) cover, if provided. Where the fill pipe extends above grade it shall be protected from vehicular traffic. The pump well, fill box (spill containment) and connecting pipe work shall not bear directly, nor through spacers, on the tank.

B1.15 The excavation shall be backfilled with *pea gravel* or *crushed stone* to a level 300 mm above the top centre line of the tank. While compaction is not required, careful placement of the backfill around the lower portions of the tank, to eliminate voids, is essential.

B1.16 The *pea gravel* or *crushed stone* shall be of material that is clean and free flowing and have no more than 3% passing a No. 8 sieve (2.38 mm screen size opening). The material shall have a minimum dry gravel density of 1520 kg/m3 and meet the requirements of ASTM C33, Standard Specification for Concrete Aggregates, paragraph 7.1 for quality and soundness.

B1.17 Where *pea gravel* or *crushed stone* is not obtainable, clean, free-flowing sand, mechanically compacted in not greater than 300 mm layers to maximum density, may be used, subject to the approval of the original tank manufacturer and the *authority having jurisdiction*.

A1.18 A tank, which is not likely to be subjected to vehicular traffic, shall be installed so that the top of the tank is at least 600 mm below grade level. This will require an additional minimum of 300 mm of backfill material, over and above the 300 mm of backfill material referenced in Clause B1.15.

A1.19 A tank, which is, or is likely to be, subjected to vehicular traffic, shall be installed in accordance with the manufacturer's installation instructions.

B1.20 Measurements of the tank diameter shall be taken before and after backfilling.

B1.21 If the deflection is greater than ±1% of the measured internal diameter, as calculated using the measurements from Clause B1.20, the manufacturer shall be notified and the manufacturer's further instructions shall be followed.

B1.22 All measurements shall be made using a standard non-metallic gauging stick through the fill tube(s) located on the top centre line of the tank in the fitting(s) closest to the centre of the tank.

NOTE: The suggested procedure for achieving these measurements is as follows:

A Drive a small nail into the gauging stick 2 cm from the bottom end;

B Lower the gauging stick to the bottom of the tank. Record measurement at the top of the fill pipe;

C Lift the gauging stick until the nail catches on the lip of the top of the tank. Record measurement at the top of the fill pipe;

D The length of the fill pipe is then equal to: the measurement from "C" minus 2 cm;

E The internal diameter of the tank is then equal to: the measurement from "B" minus the length of the fill pipe from "D".

B1.23 Any repairs required as a result of transportation, off loading or installation, shall be made by the original tank manufacturer or his designated representative.

APPENDIX C (INFORMATIVE)

GUIDELINES FOR MINIMUM VENT LINE INTERNAL DIAMETERS

Flow Rate versus Pipe Length (Millimeters)

MAX FLOW RATE L/min	PIPE LENGTH (Plus 7 Elbows)		
	15 m	30 m	60 m
	MINIMUM VENT SIZE		
750	42.2 mm	42.2 mm	42.2mm
1 000	42.2 mm	42.2 mm	48.3 mm
1 500	42.2 mm	48.3 mm	60.3 mm
2 000	48.3 mm	48.3 mm	60.3 mm
2 300	48.3 mm	60.3 mm	60.3 mm
2 700	60.3 mm	60.3 mm	60.3 mm
3 800	60.3 mm	60.3 mm	88.9 mm

APPENDIX D (INFORMATIVE)
TEST FUEL FORMULATIONS

D1 REPRESENTATIVE AGGRESSIVE COMBUSTIBLE TEST FUEL MIXTURES AND UL-B100

D1.1 The following test fuels represent chemical and physical characteristics of typical commercial diesel, biodiesel and blends thereof with aggressive contaminants that may be found in these fuels:

A F75/B25a where the numbers indicate the percentage by volume mixture, and

F = ASTM D 471 (Standard Test Method for Rubber Property - Effect of Liquids) Reference Fuel ″F″ except Grade D2 S15 is to be used

B = ASTM D 6751, Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels, Biodiesel except 100 % Soy Feedstock types are to be used.

a = Aggressive components mixed with B to form UL B100 Aggressive Biodiesel Stock for additional blending with F.

B UL B100 Aggressive Biodiesel Stock containing less than 0.5 % volume combined water and decanoic acid shall be based on the approximate formula below (*) to achieve a final 1.00 ± 0.02 Acid Number of the mixture in accordance with ASTM D 664, Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration.

1.00 L Biodiesel (per ″B″ above)

2.00 g DI Water (!)

2.60 g Decanoic Acid (!)

D1.2 Final adjustments after measuring the mixture in accordance with ASTM D 664 shall be done by adding biodiesel or decanoic acid as necessary to achieve the 1.00 ±0.02 Acid Number.

NOTES:

(*) The formula is approximate since each source of biodiesel may have variations in specific gravity and initial Acid Number that require measurement and final adjustment as specified.

(!) Decanoic acid crystals are insoluble in water, so it is recommended they be finely ground and thoroughly dissolved in the biodiesel before adding water to the overall solution.

D2 REPRESENTATIVE AGGRESSIVE FLAMMABLE TEST FUELS AND MIXTURES

D2.1 The following test fuels represent chemical and physical characteristics of typical commercial Gasoline, Oxygenated Gas, Low Blend Ethanol, High Blend Ethanol, and Mid Range Blends thereof with aggressive contaminants that may be found in these fuels:

CE25a and CE85a where the numbers indicate the percentage by volume mixture; and

C = ASTM D 471 Reference Fuel ″C″ (50/50 mix of iso-octane and toluene)

E = Ethanol in accordance with SAE J1681 App E

a = Aggressive components in aggressive alcohols in accordance with SAE J1681 App E.