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Boiler, pressure vessel, and pressure piping code

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Preface

This is the nineteenth edition of CSA B51, *Boiler, pressure vessel, and pressure piping code*. It supersedes the previous editions published in 2014, 2009, 2003, 1997, 1995, 1991, 1986, 1981, 1975, 1972, 1969, 1965, 1960, 1957, 1955, 1951, 1945, and 1939.

In keeping with CSA Group's goal of harmonizing its standards with those of other countries to the greatest extent possible, CSA's Technical Committee on Boilers and Pressure Vessels and its Subcommittees have, in the course of developing this Standard, worked closely with the National Board of Boiler and Pressure Vessel Inspectors in the United States and with the American Society of Mechanical Engineers (ASME) committees responsible for producing the *National Board Inspection Code* and ASME's *Boiler and Pressure Vessel Code.*

There are three parts to this Standard:

a) Part 1 contains requirements for boilers, pressure vessels, pressure piping, and fittings. It is intended mainly to fulfill two objectives: first, to promote safe design, construction, installation, operation, inspection, testing, and repair practices; and second, to facilitate adoption of uniform requirements by Canadian jurisdictions.

b) Part 2 contains requirements for high-pressure cylinders for the on-board storage of natural gas, blends of natural gas and hydrogen (hydrogen blends), and hydrogen as fuels for automotive vehicles. It has been harmonized with International Organization for Standardization (ISO) Standard 11439:2013, *Gas cylinders — High pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles.* In addition, the CSA Subcommittee responsible for developing Part 2 has consulted with the American National Standards Institute (ANSI) committees responsible for developing CSA/ANSI NGV 2-2016, *Compressed natural gas vehicle fuel containers,* and CSA/ANSI HGV 2-2014, *Compressed hydrogen gas vehicle fuel containers.* The members of these two committees are dedicated to harmonizing their standards as far as circumstances allow.

c) Part 3 contains requirements for compressed natural gas and hydrogen refuelling station pressure piping systems and ground storage vessels. These requirements have been allotted a separate part of the Standard to emphasize the differences between them and the requirements in Part 1, thereby facilitating their application.

This Standard has undergone substantial technical and editorial revisions since the previous edition in 2014. Significant changes to Part 1 include the following:

- addition of the following definitions in Clause 3:
  - "high-energy steam (HES) piping systems"; and
  - "mechanical joint";
- addition of Clause 4.3.5 on Canadian Registration Numbers (CRNs);
- revision of Clause 4.6 on manufacturer's data reports, including a revised Clause 4.6.1 and a new Clause 4.6.6;
- revision of Clause 4.8.2 on fabrication inspection;
- deletion of Clause 4.15.1 on general requirements for piping;
- revision of Clause 5.1.1 on nameplate stamping;
- addition of Clause 6.3.4.7 on boiler installation clearances;
- addition of Clause 6.3.6 on boiler loadings;
- revision of Clause 6.6 on thermal fluid heaters and piping;
- addition of Clause 7.1.5 on the use of Part 5 of Section VIII, Division 2, of the ASME Code;
- addition of Clause 7.8 on pressure vessels designed and constructed using cold-stretch technology;
- revision of Clause 8 on piping and fittings, including the addition of Clauses 8.6 and 8.7;

- addition of Clause 12.1.1 on general requirements for pressure relief devices;
- revision of Clause 12.2.2 on the installation of pressure relief devices;
- revision of Clause 12.5.3 on periodic visual inspection of pressure relief devices;
- revision of Clause 12.7 on servicing of reclosing pressure relief devices, including the addition of Clauses 12.7.2.2 on ANSI/UL 132 pressure relief valves (PRVs) and 12.7.3.2 on testing after servicing is complete;
- addition of Clause 12.11 on CSA B149 series propane service pressure relief valves (PRVs);
- addition of Clause 13.4 on high-energy steam (HES) piping systems;
- revision of Table 5 on maximum in-service testing and service intervals;
- revision of Annex C on guidelines for safety valve, relief valve, and safety relief valve repair organizations;
- revision of Annex D sample forms;
- revision of Annex G on automotive propane vessel standards;
- revision of Annex I on historical boilers;
- revision of Annex J on requirements regarding the use of finite element analysis (FEA) to support a pressure equipment design submission, including Clause J.3 on special design equipment and Clause J.6.3 on turn angles;
- addition of Annex K on requirements for pressure vessels designed and constructed using cold-stretch technology; and
- addition of Annex L on condition assessments for high-energy steam (HES) piping systems.

Significant changes to Part 2 include the following:

- revision of Clause 6.3.2.3 on tensile tests for steel excluding than stainless steel;
- revision of Clause 6.3.6 on plastic liners;
- revision of Clause 7.3.1 on general requirements for manufacturing and production tests;
- revision of Clause 7.4.1 on material tests;
- deletion of Clause 8.6.8 on high-temperature creep test;
- deletion of Clause 10.7.4 on boss torque test;
- revision of Clause 14.13 on ambient temperature pressure-cycling test;
- revision of Clause 14.14 on extreme-temperature pressure-cycling test;
- revision of Clause 14.16 on penetration test;
- revision of Clause 14.17 on flaw tolerance test;
- deletion of Clause 14.18 on high-temperature creep test;
- revision of renumbered Clause 14.18 on accelerated stress rupture test;
- revision of Clause 14.19 on drop test;
- revision of Clause 14.21.4 on pressure cycle and pressure hold; and
- deletion of Clause 14.24 on boss torque test.

The users of this Standard should note that it is a recommendatory document only and does not have the force of law except where it has been officially adopted by a Canadian jurisdiction. Users should also note that adoption does not necessarily mean that the Standard has been adopted unchanged. For example, a jurisdiction may decide to make an informative annex normative.

In addition, owners and users of cylinders designed to the requirements of Part 2 should note that the safe operation of such cylinders requires, first, compliance with the service conditions specified by the manufacturer, and second, use of the cylinders only during the service life specified by the manufacturer. Each cylinder is marked with an expiry date, and owners and users are responsible for ensuring that a cylinder is not used after that date.

The Technical Committee intends to meet periodically to review this Standard and, if necessary, to revise it to meet changing conditions and maintain uniformity of practice throughout Canada.

The Technical Committee supports the use of the *National Board Inspection Code*. It is the responsibility of users of this Standard to be aware that applicable local regulations can take precedence over the requirements of that Code.

This Standard was prepared by the Technical Committee on Boilers and Pressure Vessels, under the jurisdiction of the Strategic Steering Committee on Mechanical Industrial Equipment Safety, and has been formally approved by the Technical Committee.

This Standard has been developed in compliance with Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

Notes:

1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*
3) *This Standard was developed by consensus, which is defined by* CSA Policy governing standardization — Code of good practice for standardization *as "substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity". It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Standard.*
4) *To submit a request for interpretation of this Standard, please send the following information to* ***inquiries@csagroup.org*** *and include "Request for interpretation" in the subject line:*
   a) *define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;*
   b) *provide an explanation of circumstances surrounding the actual field condition; and*
   c) *where possible, phrase the request in such a way that a specific "yes" or "no" answer will address the issue.*

   Committee interpretations are processed in accordance with the CSA Directives and guidelines governing standardization *and are available on the* Current Standards Activities *page at* ***standardsactivities.csa.ca****.*
5) *This Standard is subject to review within five years from the date of publication. Suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to* ***inquiries@csagroup.org*** *and include "Proposal for change" in the subject line:*
   a) *Standard designation (number);*
   b) *relevant clause, table, and/or figure number;*
   c) *wording of the proposed change; and*
   d) *rationale for the change.*

National Standard of Canada

B51-19, Part 1

General requirements for boilers, pressure vessels, and pressure piping

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B51-19, Part 1
General requirements for boilers, pressure vessels, and pressure piping

1 Scope

1.1

Except as indicated in Clause 1.2, Part 1 of this Standard applies to all boilers, pressure vessels, pressure piping, and fittings, as provided for by the Act (as defined in Clause 3) and identified in Part 1 of this Standard.

Notes:

1) *It is possible that the size limitations specified in provincial or territorial statutes or regulations will differ from those specified in Part 1 of this Standard. The applicable regulatory authority should be consulted.*
2) *The pressures specified in Part 1 of this Standard are gauge pressures above atmospheric pressure.*
3) *This Standard applies to all boilers, pressure vessels, pressure piping, and fittings installed subsequent to its adoption.*

1.2

Requirements for compressed natural gas cylinders and refuelling station pressure piping systems and containers are covered in Parts 2 and 3 of this Standard.

1.3

This Standard does not apply to

a) pressure-retaining components in hydraulic elevators;
b) pressure-containment devices for gas-filled switchgear and controlgear; and
c) pressure vessels for the transportation of dangerous goods regulated by Transport Canada.

1.4

Where a clause in Part 1 of this Standard is at variance with a code or standard referenced in Part 1 of this Standard, the requirements of Part 1 of this Standard govern.

1.5

In this Standard, “shall” is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the standard; “should” is used to express a recommendation or that which is advised but not required; and “may” is used to express an option or that which is permissible within the limits of the standard.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

1.6

The values given in SI units are the units of record for the purposes of this Standard. The values given in parentheses are for information and comparison only. Nominal pipe sizes are expressed in non-dimensional terms.

2 Reference publications

Part 1 of this Standard refers to the following publications, and where such reference is made, it shall be to the edition listed below, including all amendments published thereto.

CSA Group

ANSI Z21.13-2017/CSA 4.9-2017
Gas-fired low pressure steam and hot water boilers

CSA/ANSI HGV 2-2014
Compressed hydrogen gas vehicle fuel containers

CSA/ANSI NGV 2-2016
Compressed natural gas vehicle fuel containers

B52:18
Mechanical refrigeration code

B149.1-15
Natural gas and propane installation code

B149.2-15
Propane storage and handling code

B149.5-15
Installation code for propane fuel systems and containers on motor vehicles

CAN/CSA-ISO 9001:16
Quality management systems — Requirements

Z180.1-13 (R2018)
Compressed breathing air and systems

CAN/CSA-Z662-15
Oil and gas pipeline systems

Z7396.1-17
Medical gas pipeline systems — Part 1: Pipelines for medical gases, medical vacuum, medical support gases, and anaesthetic gas scavenging systems

ANSI/API (American National Standards Institute/American Petroleum Institute)

ANSI/API STD 530 (2015)
Calculation of Heater-tube Thickness in Petroleum Refineries

ANSI/ASQ (American National Standards Institute/American Society for Quality)

Z1.4-2013
Sampling Procedures and Tables for Inspection by Attributes

ANSI/CGA (American National Standards Institute/Compressed Gas Association)

ANSI/CGA G-2.1-2014
Requirements for the Storage and Handling of Anhydrous Ammonia

API (American Petroleum Institute)

STD 520 (2014)
Sizing, Selection, and Installation of Pressure-relieving Devices, Part I — Sizing and Selection

ARPM (Association for Rubber Products Manufacturers)

IP-2 (Ninth Edition, 2015)
Hose Handbook

ASME (The American Society of Mechanical Engineers)

Boiler and Pressure Vessel Code (2017)
Section I — Power Boilers
Section II — Materials — Part A — Ferrous Material Specifications
Section II — Materials — Part B — Nonferrous Material Specifications
Section II — Materials — Part C — Specifications for Welding Rods, Electrodes, and Filler Metals
Section II — Materials — Part D — Properties
Section IV — Heating Boilers
Section V — Nondestructive Examination
Section VIII — Rules for Construction of Pressure Vessels — Division 1
Section VIII — Rules for Construction of Pressure Vessels — Division 2 — Alternative Rules
Section VIII — Rules for Construction of Pressure Vessels — Division 3 — High Pressure Vessels
Section IX — Welding and Brazing Qualifications
Section X — Fiber-Reinforced Plastic Pressure Vessels

B31.1-2018
Power Piping

B31.3-2016
Process Piping

B31.4-2016
Pipeline Transportation Systems for Liquids and Slurries

B31.5-2016
Refrigeration Piping and Heat Transfer Components

B31.9-2017
Building Services Piping

CSD-1-2015
Controls and Safety Devices for Automatically Fired Boilers

PVHO-1-2016
Safety Standard for Pressure Vessels for Human Occupancy

CDA (Copper Development Association)
A4015-14/17
Copper Tube Handbook

CGSB/ISO (Canadian General Standards Board/International Organization for Standardization)
CAN/CGSB-48.9712-2014/ISO 9712:2012
Non-destructive testing – Qualification and certification of NDT personnel

ISO (International Organization for Standardization)
9001:2015
Quality management systems — Requirements

MSS (Manufacturers Standardization Society of the Valve and Fittings Industry)
SP-25-2018
Standard Marking System for Valves, Fittings, Flanges, and Unions

NACE International
SP0285-2011
Corrosion Control of Underground Storage Tank System by Cathodic Protection

NBBI (National Board of Boiler and Pressure Vessel Inspectors)
NB-18 (updated monthly)
National Board Pressure Relief Device Certifications

NB-23 (2017)
National Board Inspection Code

NFPA (National Fire Protection Association)
58 (2017)
Liquefied Petroleum Gas Code

UL (Underwriters Laboratories Inc.)
ANSI/UL 132
Safety Relief Valves for Anhydrous Ammonia and LP-Gas

ULC (Underwriters Laboratories of Canada)
CAN/ULC-S603.1:2017
Standard for External Corrosion Protection Systems for Steel Underground Tanks for Flammable and Combustible Liquids

3 Definitions

The following definitions shall apply in Part 1 of this Standard:

Accepted — registered and accepted by the regulatory authority.

Act — the Acts, regulations, or ordinances governing the design, fabrication, installation, repair, and alteration of boilers, pressure vessels, fittings, and piping.

Air heater coil — a non-fired heater, other than a shell-and-tube or shell-and-coil type, constructed of pipe or tubing and designed primarily to heat non-pressurized air (air not containing products of combustion such as flue gas), with cooling of the internal fluid being secondary.

Alteration — a change in an item described in an original manufacturer's data report that requires a change of design calculations or otherwise affects the pressure-containing capability of a boiler or pressure vessel. Non-physical changes such as an increase in the MAWP (internal and external) or design temperature of a boiler or pressure vessel are also considered alterations, as are reductions, e.g., in minimum temperature, such that additional mechanical tests are required.

Anhydrous ammonia tank — a container for storing anhydrous ammonia, designed and fabricated in accordance with the requirements of this Standard.

ASME Code — the American Society of Mechanical Engineers (ASME) *Boiler and Pressure Vessel Code*.

Authorized inspection agency — an inspection agency authorized by a regulatory authority to perform inspections required under the Act.

Authorized inspector — an inspector authorized by a regulatory authority to perform inspections required under the Act.

Boiler — a vessel as defined in the Act.

Brazing — a group of metal-joining processes that produce a coalescence of materials by heating them to a suitable temperature and by using a filler metal having a liquidus above 450 °C (840°F) and below the solidus of the base materials. The filler metal is distributed between the closely fitted surfaces of the joint by capillary action.

Canadian Central Registration Number (CCRN) — a registration number, allotted by a nationally recognized organization such as CSA Group in accordance with procedures accepted by more than one province, that allows a fitting to be used in such provinces.

Canadian Registration Number (CRN) — a registration number, allotted by a provincial regulatory authority, that allows a boiler, pressure vessel, or fitting to be used in the province.

Certificate — a certificate of inspection issued under the Act.

Compressed natural gas (CNG) container — a pressure vessel for storing CNG or for use as a motor vehicle fuel tank, designed in accordance with the requirements of this Standard.

Cushion tank — a pressure vessel installed in a closed hot water heating system or cooling system to provide a pneumatic cushion for the expansion of the water.

Design — calculations, drawings, specifications, specimens, models, etc.

Diameter — the inside diameter, unless otherwise specified in Part 1 of this Standard.

Fired-heater pressure coil — the total fluid-retaining piping system within the internally insulated enclosure and header boxes of a petroleum or chemical plant fired heater, including tubes, return bends, crossover piping, inlet and outlet headers, and manifolds.

Fitting — an appurtenance attached to a boiler, pressure vessel, or piping, including such items as valves, gauges, and controlling devices. It can include other pressure-retaining components installed in a piping system within the scope of the Act.

Heat exchanger — a pressure vessel such as a condenser, evaporator, heater, cooler, or similar apparatus, not specifically identified in Part 1 of this Standard, where the tube side or shell side, or both, meets the definition of a pressure vessel.

Note: *"Heat exchanger" does not include a condenser regularly used in connection with a turbogenerator or other power plant prime mover.*

High-energy steam (HES) piping systems — 4 NPS and larger piping systems, including components for main steam, hot and cold reheat steam, feedwater, and other systems with design ratings greater than 400 °C (750°F) or 7100 kPa (1025 psig).

Historical steam boiler — a steam boiler of riveted or welded construction, including steam tractors, traction engines, hobby steam boilers, and steam locomotives built prior to 1955, that is being preserved, restored, and maintained for demonstration, viewing, or educational purposes.

Hot tapping — an alteration involving cutting into a pressurized line or vessel without interruption of service in order to attach a connection, e.g., for a branch line.

Hot water tank — a pressure vessel that is used to store hot water and is not equipped with a heating unit.

Hydropneumatic tank — a pressure vessel containing both water and air, the compression of which serves only as a cushion.

Inspector — an inspector of boilers, pressure vessels, and piping appointed under the Act.

Internally insulated enclosure of a petroleum or chemical plant fired heater — that part of the structure that encloses the radiant, shield, and convection sections of a heater.

Lethal substances — poisonous gases or liquids of such a nature that a very small amount of the gas or of the liquid's vapour mixed or unmixed with air is dangerous to life when inhaled. For the purposes of Part 1 of this Standard, this definition includes substances of this nature that are stored under pressure or can generate pressure if stored in a closed vessel.

Liquefied petroleum gas tank — a pressure vessel containing liquefied petroleum gas, designed and fabricated in accordance with the requirements of this Standard.

Manufacturer — the company or person that manufactures, completely or in part, a boiler, pressure vessel, fitting, fired-heater pressure coil, or piping. The manufacturer completes the product and is responsible for the end product.

Manufacturer's data report (MDR) — a document in an accepted form by which a manufacturer certifies that a boiler, pressure vessel, or fired-heater pressure coil has been manufactured in accordance with a particular section of the ASME Code or this Standard. The document supplies a technical description of the vessel, is signed by a representative of the manufacturer, and, when required by this Standard, provides for a countersignature by an inspector or authorized inspector.

Maximum allowable working pressure (MAWP) — the pressure indicated on the design registration.

Note: *Where applicable, MAWP is as defined in the referenced construction code.*

Mechanical joint — a connection realized by the joining of parts utilizing a positive-holding mechanical construction.

Miniature pressure vessel — a pressure vessel meeting the criteria for UM stamping in Section VIII, Division 1, of the ASME Code.

National Board — the National Board of Boiler and Pressure Vessel Inspectors.

Owner — a person who is a lessee, a person in charge, a person who has care and control, and a person who holds out that the person has the powers and authority of ownership or who for the time being exercises the powers and authority of ownership.

Piping — pipes or piping as defined in the Act.

Pressure relief device (PRD) — a fitting installed on pressure equipment designed to provide primary protection from overpressurization. PRDs include both reclosing devices (e.g., safety valves, relief valves, safety relief valves) and non-reclosing devices (including rupture discs and fusible plugs).

Pressure vessel — a closed vessel for containing, storing, distributing, transferring, distilling, processing, or otherwise handling a gas, vapour, or liquid.

Province — a province or territory of Canada.

Regulatory authority — a body responsible for administering and enforcing the Act governing the design, fabrication, installation, repair, and alteration of boilers, pressure vessels, fittings, and piping.

Repair — work necessary to restore pressure equipment to a safe and satisfactory operating condition, provided that there is no deviation from the original design.

Soldering — a joining process that produces a coalescence of materials by heating them to a soldering temperature and by using a filler metal (solder) having a liquidus not exceeding 450 °C (840°F) and below the solidus of the base metals.

Thermal expansion relief valve — a valve used on piping systems solely to protect a blocked-in portion of piping from overpressurization due to thermal expansion of the fluid. A thermal expansion relief valve is not used as a primary protection from overpressurization.

Note: *A thermal expansion relief valve is also known as a line block safety or a hydrostatic relief valve, commonly used in cryogenic and refrigeration applications.*

Thermal fluids — fluids, other than water, that transfer heat with or without vaporization.

Water heater — a pressure vessel in which potable water is heated by combustion of fuel, by electricity, or by any other heat source, and from which the water is withdrawn for external use.

4 General requirements

4.1 Registration of designs

4.1.1

The calculations, drawings, and specifications pertaining to the designs of boilers, pressure vessels, fittings as specified in Clause 4.2, fired-heater pressure coils, and piping shall be submitted to the regulatory authority in the province where the item is intended to be used. The submission shall

identify the substance for which the item is intended. It shall be the responsibility of the users or an agent they designate to determine whether the substance is lethal. Figures 1 a), 1 b), and 1 c) shall be used to determine whether items are to be registered as pressure vessels or Category H fittings (see Table 1). The name of the authorized inspection agency to be employed when a boiler or pressure vessel is to be manufactured outside Canada shall also be submitted when required by the regulatory authority. Acceptance and registration shall be obtained before construction begins. Manufacturers who commence construction prior to receiving design registration shall rectify any design deficiencies that are identified in the design registration process.

4.1.2

Any number of boilers, pressure vessels, fittings, fired-heater pressure coils, and piping systems may be constructed from a registered design until a change in the applicable Act, codes, or standards invalidates the design, in which case the design shall be obsolete and no further construction to the design shall be made after the effective date of the change as established by the Act. When the Act does not specify an effective date of change, the effective date shall be the date specified in the changed document or six months from the published date of the change, whichever comes first.

4.1.3

If a registered design is subsequently found to be defective in any detail, it shall be revised.

4.1.4

Revisions to registered designs that require a change in design calculations or otherwise affect the pressure-retaining capability of a boiler, pressure vessel, fired-heater pressure coil, fitting, or piping shall be submitted for registration.

Note: *Revisions to registered designs can include, but are not limited to, post-weld heat treatment (PWHT) and non-destructive examination (NDE).*

4.1.5

When a design is submitted and not registered, the reasons for its rejection shall be supplied to the submitter. The rejected drawings and specifications may be destroyed or, if requested by the submitter, returned.

4.1.6

The registration of a design shall not relieve the manufacturer of the responsibility for the design or construction of a boiler, pressure vessel, fitting, fired-heater pressure coil, or piping in accordance with the applicable Act, codes, and standards.

4.1.7

Boilers, pressure vessels, fittings, fired-heater pressure coils, and piping that have been used or are of a design that differs from the requirements of this Standard shall not be installed in a province without written permission from the regulatory authority. The regulatory authority shall be supplied with complete design drawings and specifications, the manufacturer’s data report, and the last inspection report, as applicable.

4.1.8

The design specifications and calculations for fired-heater pressure coils shall be submitted for registration. Such coils may be considered separately or in conjunction with other pressure piping for registration purposes.

4.1.9

Pressure vessels designed to Section VIII, Division 2 or 3, of the ASME Code shall comply with the following requirements:

a) As part of the design registration submission, the user's design specification, certified by a professional engineer, shall include the following:
   i) an appropriate program for lifetime in-service monitoring of the pressure vessel, including monitoring operating conditions, quantifying operating cycles, and identifying if any degradation has taken place, to ensure the integrity of the pressure vessel during operation; and
   ii) specific limits or conditions, including cyclic and other conditions of individual components or parts of the pressure vessel, to allow it to be properly monitored during operation.
b) When an existing vessel is sold individually, not as part of a plant, the design shall be submitted for re-registration. A revised user's design specification shall be produced to address the new operating conditions.
c) When ownership of a pressure vessel changes, the new owner shall
   i) verify and certify the acceptability of the original user's design specification and the manufacturer's design report as well as the condition of the pressure vessel; or
   ii) have a professional engineer prepare a new user's design specification within the limitations of the manufacturer's design report and the condition of the pressure vessel and submit the design for design registration.

4.1.10

Finite element analysis (FEA) may be used to support pressure equipment design where the configuration is not covered by the available rules in the code of construction. When this method is used to justify code compliance of the design, the software used shall be identified and a complete FEA report shall be submitted in accordance with Annex J.

The design registration submission shall include reports from any additional tests that are performed to support the FEA (e.g., strain gauge test report, burst test report).

Note: *The designer should check with the regulatory authority to confirm that use of FEA is acceptable.*

4.2 Registration of fittings

4.2.1

Fittings shall be registered in accordance with Clauses 4.2.2 to 4.2.11 unless they form a part of a boiler or pressure vessel that is subject to inspection by an authorized inspection agency. Registrations of fittings shall be resubmitted for validation not more than 10 years after the date of acceptance by the regulatory authority in the original registering province or by a nationally recognized organization as specified in Clause 4.2.3.

4.2.2

Each category of fitting manufactured (see Table 1) shall be separately registered by the manufacturer with the regulatory authority in the province of manufacture or, for installation-specific specialized fitting designs, with the regulatory authority in the province of installation (see also Clause 4.2.5). In the latter instance, evidence that the manufacturer has in place a valid quality control program for the manufacturing of the fitting, and that this program is accepted by the regulatory authority in the province of manufacture, shall be provided. Fittings manufactured outside Canada shall be registered initially in the province where they are intended to be used first.

Initial registration with one regulatory authority may be accepted by the regulatory authority in another province if the latter is provided with an accepted copy of the statutory declaration form (see Figure D.6) and the supporting documentation specified in Clause 4.2.8.

4.2.3

As an alternative to Clause 4.2.2, when accepted by the province of installation, a fitting design may be registered through a central registration process administered by a nationally recognized organization such as CSA Group.

4.2.4

When fittings are manufactured outside Canada, the statutory declaration form specified in Clause 4.2.2 shall be accompanied by proof that the manufacturer's quality control program for the manufacturing of the fittings for which registration is sought has been accepted by an independent third-party agency acceptable to the regulatory authority in the province where registration is sought.

4.2.5

Fitting design registration shall be in the name of the organization taking responsibility for the product. Such registration may be in the name of an organization other than the manufacturer. The organization responsible shall provide a statutory declaration form and evidence of a valid quality control program acceptable to the regulatory authority in the province where the registration is sought. The manufacturer(s) shall be identified, and proof of their quality control program(s) shall also be provided.

4.2.6

Proof of a quality control program shall be submitted for each plant or facility where manufacturing takes place. When changes to manufacturers or manufacturing sites occur, the fitting registration file shall be updated to include proof of a quality control program for each new manufacturer or site and a revised statutory declaration form if any information on the form has changed.

4.2.7

It shall not be necessary to register separately each fitting design in a category.

Note: *The manufacturer may collectively register the fittings in any category listed in Table 1 by submitting to the regulatory authority a statutory declaration form with supporting documentation.*

4.2.8

At a minimum, the following documentation in support of an application for a new design registration or a re-registration shall be required:

a) for new applications for fittings that are built to a nationally recognized standard (e.g., as listed in paragraph UG44, Section VIII, Division I, of the ASME Code or Table 326.1 of ASME B31.3) that specifies the dimensions, construction materials, pressure/temperature ratings, and identification markings of the fittings:
   i) a properly completed statutory declaration form for the registration of fittings clearly identifying the applicable nationally recognized standard;
   ii) the scope of product registration within the standard; and
   iii) the required identification marking(s);
b) for new applications for fittings not covered by Item a):
   i) a properly completed statutory declaration form for the registration of fittings;
   ii) the designation of the code or standard;
   iii) the scope of product registration within the application submitted for registration;

iv) material specifications;
v) identification markings;
vi) maximum allowable working pressure (MAWP);
vii) maximum working temperature;
viii) dimensions; and
ix) detailed calculations and/or copies of proof test results witnessed by an inspector or an authorized inspector and acceptable to the regulatory authority (except for Category G fittings, for which capacity certification data sheets may be submitted in lieu of the calculations or proof test); or

c) for the resubmission for validation required by Clause 4.2.1 (provided that the documentation specified in Item a) or b) was provided to and evaluated by the regulatory authority and is still applicable, and that Clauses 4.1.2 and 4.1.4 do not apply):
i) a properly completed statutory declaration form for the registration of fittings;
ii) a copy of the manufacturer's valid quality control program certificate; and
iii) the scope of product registration within the original registration.

4.2.9

Safety valves, relief valves, safety relief valves, and rupture discs shall be registered in accordance with Clause 4.2.2. Rating sheets certified by the National Board or other agencies approved by the regulatory authority shall be submitted for each type, size, and classification of the safety valves, relief valves, safety relief valves, and rupture discs to be registered.

4.2.10

When required by the regulatory authority, sample fittings and any related data shall be submitted and returned or otherwise disposed of at the expense of the registering party.

4.2.11

The regulatory authority may select and test, at the manufacturer's expense, any registered fittings. If a representative selection proves to be faulty, or if a fitting does not fully comply with the requirements of the applicable code or standard, the registration may be cancelled immediately.

4.3 Canadian Registration Numbers (CRNs)

4.3.1

Designs and specifications that are accepted and registered by the regulatory authority shall be assigned a Canadian Registration Number. The province in which a design is registered shall be indicated by a digit or letter following a decimal point (see Clause 4.3.2).

4.3.2

When a design that is registered in a province is subsequently registered in other provinces, additional digits or letters identifying those provinces shall be added after the digit or letter representing the original registering province. The following identifications shall be used:

1	British Columbia	6	Québec	T	Northwest Territories
2	Alberta	7	New Brunswick	Y	Yukon
3	Saskatchewan	8	Nova Scotia	N	Nunavut
4	Manitoba	9	Prince Edward Island		
5	Ontario	0	Newfoundland and Labrador		

Notes:

1) *For example, a design registered in Ontario and allotted the registration number K4567 will be registered as CRN K4567.5. If this design is subsequently registered in Alberta, the CRN will be K4567.52; and if afterwards registered in Manitoba, the CRN will be K4567.524.*
2) *If a design is registered in all provinces and territories, the CRN stamped on the nameplate and marked on the data report may be shortened to include the designation of first registration plus the letter "C", e.g., K4567.5C.*
3) *If a design is registered in all provinces and territories that require registration but not in provinces and territories that do not require registration, the CRN may be shortened to include the designation of first registration plus the letters "CL", e.g., K4567.5CL. (The "L" means limited.)*

4.3.3

When submitting designs that have already been registered in one province for registration in another province, manufacturers shall provide the name of the province in which the designs have already been registered, the CRN, and evidence of registration by the original registering province. Once a design has been registered in one province, it may be submitted simultaneously to all other provinces for registration.

4.3.4

The number allotted to a registered design of a fitting shall be a number preceded by a zero and the category letter and followed by a decimal point, to the right of which shall be added the digit or letter indicating the first province in which the design is registered.

Note: *For example, a flange design registered in Manitoba will be allotted a number such as 0B675.4.*

A number allotted to a centrally registered fitting design shall be a number preceded by the initialism or acronym that represents the nationally recognized organization, followed by a zero and a letter representing the category of fitting.

Note: *For example, CSA0B123.*

4.3.5

Where a design uses allowable alternatives to the prescriptive rules in the ASME Code that are not required to be recorded on the manufacturer's data report (MDR), or where the MDR will not identify the component where an alternative rule was applied, the CRN assigned to the design shall be prefixed by "ALT", followed by a "-", followed by the CRN to identify that special consideration shall be given for in-service allowances.

4.4 Registration of welding and brazing procedures

4.4.1

Welding and brazing procedures shall be registered with the regulatory authority of the province where the welding or brazing is to be performed.

4.4.2
Welding or brazing procedures for equipment fabricated outside Canada shall be registered with the regulatory authority at the place of installation or, at the discretion of the regulatory authority, with an authorized inspection agency.

4.5 Welding and brazing qualifications

4.5.1
Welding and brazing procedures, procedure qualifications, and performance tests shall be as specified in, or the equivalent of, the procedures, qualifications, and tests specified in
a) Section IX of the ASME Code; and
b) the code to which the pressure-retaining component is either manufactured or installed.

4.5.2
Welding or brazing tests for equipment fabricated in Canada shall be acceptable for the purposes of Clause 4.5 only if approved by the regulatory authority of the province where the welding or brazing is to be performed.

4.5.3
Welding or brazing tests for equipment fabricated outside Canada shall be acceptable for the purposes of Clause 4.5 only if approved by an inspector or authorized inspection agency approved by the regulatory authority in the province of installation.

4.6 Submission of manufacturer's data report

4.6.1
On completion of construction of a boiler, pressure vessel, fired-heater pressure coil, or pressure piping covered by this Standard, a manufacturer's data report signed by a representative of the manufacturer and, except as specified in Clause 4.8.3, countersigned by the inspector or authorized inspector shall be sent by the manufacturer to the regulatory authority of the province of installation.

For samples of data report forms, refer to Annex D. The drawing number and revision level to which the CRN has been issued shall be indicated in the drawing number text box. The construction drawing number and revision level (if different) shall be included in the "Remarks" section of the data report.
Note: *ASME data reports are used for ASME code-stamped items.*

4.6.2
When welded pressure parts that require inspection under the rules of the applicable ASME construction code are constructed by an organization other than the final manufacturer, that organization shall forward a duly certified partial data report to the organization responsible for completing construction. The partial data report shall be attached to the manufacturer's data report and shall not require an original signature.

The original of the partial data report shall be retained by the parts manufacturer for the period specified by the applicable ASME construction code.

4.6.3
When a boiler or pressure vessel is manufactured for stock, the name and address of the ultimate owner and the location of installation, when not available to the manufacturer at the time the boiler or pressure vessel leaves the plant, shall be provided by the sales agent.

4.6.4
Multiple identical pressure vessels manufactured and receiving final inspection in a period not exceeding five consecutive working days, and in lots of 100 or less, may be recorded on one master data report form, which shall be sent to the regulatory authority of the province of manufacture. A copy of this form shall be sent to the regulatory authority of the province of installation for each vessel.

4.6.5
For cast iron and cast aluminum sectional boilers, the installer shall, in lieu of a manufacturer's data report, complete a form for each cast iron and cast aluminum sectional boiler installed (see Figure D.7), and the completed forms shall be sent by the installer to the regulatory authority of the province of installation.

4.6.6
When alternatives to the prescriptive rules in the ASME Code are used in the construction, the manufacturer's data report shall include a list of the alternative rules with the component parts on which they were used.

4.7 In-service repairs and alterations

4.7.1
Owners of boilers, pressure vessels, fired-heater pressure coils, and pressure piping shall ensure that pressure equipment is maintained and operated safely.

4.7.2
Repairs and alterations shall not be made to a pressure-retaining component of a boiler, pressure vessel, fired-heater pressure coil, or piping without the prior agreement of the regulatory authority in whose jurisdiction the component is installed.

Notes:

1) *Subject to the approval of the regulatory authority, Part 3 of the National Board Inspection Code may be used as a guide in developing repair or alteration procedures.*
2) *Where jurisdictional regulations permit, prior agreement for repair or alteration work may be established by the development of a quality control program that uses the guidelines in Annex B and is satisfactory to the regulatory authority. See also Clause 4.9.3 regarding quality control systems.*

4.7.3
Hot tapping should be considered only when no alternative method is feasible or practical. Regulatory authority acceptance of the proposed procedure, including joint design, welding method, and base material identification, shall be obtained when required. Appropriate safety precautions shall be taken. The hot tapping experience and competency of the company and personnel performing this activity may be considered by the regulatory authority.

4.8 Fabrication inspection

4.8.1

Shop inspection of boilers, pressure vessels, fired-heater pressure coils, or piping covered by this Standard shall be conducted as follows:

a) in Canada, by an inspector employed by the regulatory authority in the province of fabrication. The inspection may be carried out in ASME Code shops by an inspector holding a valid National Board commission and employed by an authorized inspection agency as defined in the ASME Code, in which case the boiler or pressure vessel shall be registered with the National Board; and
b) outside Canada, by an authorized inspection agency.

4.8.2

Vessels shall be subject to individual shop inspection except as follows:

a) low-pressure steel boilers with 4.5 m^2 (50 ft^2) or less of wetted heating surface;
b) cast iron and cast aluminum sectional boilers;
c) miniature pressure vessels, as defined in Section VIII, Division 1, of the ASME Code, when the manufacturer has registered its quality control manual with the regulatory authority where the manufacturing shop is located and has completed a manufacturer's data report for miniature pressure vessels [see Figure D.1 a)];
d) hot water tanks, hydropneumatic tanks, and cushion tanks not exceeding 762 mm (30 in) in diameter (with no limit on capacity);
e) electric boilers of a capacity up to 60 kW; and
f) small pressure vessels registered as Category H fittings and inspected in accordance with Figures 1 a),1 b), and 1 c).

4.8.3

The manufacturer of boilers and pressure vessels specified in Clause 4.8.2, except those specified in Clause 4.8.2 f), shall certify compliance with the requirements of this Standard by submitting a manufacturer's data report to the regulatory authority in the province where the item is intended to be used.

Note: *The report is not countersigned by the inspector or authorized inspector.*

4.9 Quality control program

4.9.1

4.9.1.1

The manufacturer of a boiler, pressure vessel, fitting, fired-heater pressure coil, or piping shall demonstrate to the regulatory authority that a satisfactory quality control system is in operation.

Note: *Recommended guidelines for quality control program requirements for manufacturers of fittings are provided in Annex F of this Standard, ISO 9001, and CAN/CSA-ISO 9001.*

4.9.1.2

Quality control programs maintained by manufacturers of fittings shall be resubmitted for validation at least every 5 years.

4.9.2

An organization wishing to set, service, or repair Category G fittings (see Table 1), except fittings of the non-reclosing type, shall first demonstrate to the regulatory authority that it has proper repair facilities and a satisfactory quality control system, including a written manual for the work to be carried out.

Note: *Guidelines for safety valve, relief valve, and safety relief valve repair organizations are provided in Annex C. A holder of a National Board VR stamp (see the National Board Inspection Code) is deemed to meet the guidelines.*

4.9.3

An organization wishing to repair or modify a boiler, pressure vessel, fitting, fired-heater pressure coil, or piping shall demonstrate to the regulatory authority that it has a satisfactory quality control system, including a written manual for the work to be carried out. An organization holding a valid R certificate of authorization issued by the National Board shall be deemed to have a satisfactory quality control system in operation.

Note: *See also Part 3 of the* National Board Inspection Code *for guidelines on in-service repair and alteration procedures.*

4.9.4

An organization that supplies materials, including piping and fittings for use in pressure piping systems, shall satisfy the regulatory authority that a quality control system is in operation.

4.10 Quality program implementation

4.10.1 Holders of ASME certificates of authorization

4.10.1.1

Manufacturers of boilers, pressure vessels, fittings, or piping holding a current certificate of authorization issued by ASME for the range of products being manufactured shall be deemed to have a satisfactory quality control system in operation for the range of products within the scope of the certificate(s).

4.10.1.2

Manufacturers in countries other than Canada that manufacture and export boilers and pressure vessels to Canada shall ensure that all boilers and pressure vessels are stamped with the appropriate ASME Code product certification mark and registered with the National Board.

4.10.2 Non-holders of ASME certificates of authorization

4.10.2.1

Manufacturers not holding an ASME certificate of authorization may be eligible for acceptance of their boilers, pressure vessels, fittings, or piping by the regulatory authority under the following conditions:

a) The manufacturer shall demonstrate by means of a written manual and by review of the manufacturing facilities and procedures that the quality control system in operation meets the requirements of the applicable section of the ASME Code (e.g., Appendix 10, Section VIII, Division 1) or conforms to the quality control program described in Clause 4.9 of this Standard.
b) The manufacturer shall be deemed acceptable if, as a result of the review, the regulatory authority concludes that the manufacturer meets the quality control program requirements as determined in Item a). The regulatory authority shall confirm its conclusion in writing.

c) The manufacturer shall continue to be acceptable if subsequent reviews demonstrate that its manufacturing facilities and procedures meet the requirements of the applicable section of the ASME Code. If it is found that the manufacturer is not adhering to or implementing the procedures outlined in the quality control system, the approval of the regulatory authority may be withdrawn.

4.10.2.2

Quality systems that are not supported by an ASME certificate of authorization shall define the scope of activities relevant to the manufacture or fabrication of the items under consideration. The quality system shall further describe the controls required for code compliance, such as design, materials, processes, inspection, examination, testing, and documentation requirements. The level of detail describing the system shall be consistent with the principles of an appropriate quality program standard.

4.10.2.3

The written manual describing the quality system shall be reviewed, and the facilities and procedures audited, by the regulatory authority or an independent third party having authority either in granting quality program accreditation or in providing compliance verification to a known quality system standard (e.g., ASME AIA, ISO 9000 quality system registrar, NBBI, regulatory authority) and shall be subject to acceptance by the regulatory authority. Documented evidence of an acceptable quality system shall be made available to the regulatory authority upon application for equipment design registration.

4.11 Non-destructive examination

Non-destructive testing personnel associated with the quality control system shall be certified in accordance with CAN/CGSB-48.9712/ISO 9712 or other standards acceptable to the regulatory authority.

4.12 Water tanks

Tanks that contain water at a temperature not exceeding 65 °C (150°F) and are not equipped with heating units shall not be subject to registration.

4.13 Requalification of vessels in liquefied petroleum gas service

4.13.1

The requirements of CSA B149.5 shall apply to the reinspection, retesting, and requalification of vehicle fuel tanks.

4.13.2

Ground storage tanks shall be inspected and tested periodically, as required by the Act.

4.14 High-pressure cylinders for compressed natural gas and hydrogen and compressed natural gas and hydrogen refuelling station pressure piping systems and containers

High-pressure cylinders for compressed natural gas and hydrogen and compressed natural gas and hydrogen pressure piping systems and containers shall meet the requirements of Parts 2 and 3 of this Standard.

4.15 Piping

When required by the regulatory authority in the province of installation, the piping fabricator or installer shall furnish an acceptable piping data report to the regulatory authority.

Note: *See Figures D.5 a), D.5 b), and D.5 c) for sample report forms.*

5 Identification

5.1 Nameplates

5.1.1

The nameplate stamping of every boiler, pressure vessel, and Category G fitting (see Table 1) shall include the Canadian Registration Number (CRN) or Canadian Central Registration Number (CCRN). The nameplate shall be stamped in accordance with the requirements of the appropriate section of the ASME Code, except for

a) fusible plugs; and
b) pressure relief valves (PRVs) used in propane service which are only UL listed as described in Clause 12.11.

The stamping for other categories of fittings shall include, at a minimum, identification traceable to the manufacturer and to the CRN or CCRN. This identification shall be submitted to the regulatory authority or a central registration agency with the fitting registration.

5.1.2

When a pressure vessel requiring a nameplate will be exposed to corrosive matter, the nameplate shall be attached in a manner that prevents accumulation of foreign material between the nameplate and the shell, head, or any other part of the pressure vessel subject to internal pressure.

5.1.3

The designer of a fired-heater pressure coil shall provide a nameplate for the complete heater. The organization responsible for the field assembly shall be shown on this nameplate.

5.1.4

Only whole numbers shall be used for specifying pressure and temperature ratings on nameplates.

5.2 Additional nameplates

When an alteration to a boiler or pressure vessel is made, or when such an item is rerated (i.e., when the MAWP, the allowable temperature, or the minimum design metal temperature is changed), an additional nameplate shall be affixed next to the original nameplate of the boiler or pressure vessel. This additional nameplate shall specify

a) whether it relates to an alteration or a rerating;
b) the name of the company responsible for the change;
c) the maximum allowable working pressure and temperature;
d) the minimum design metal temperature (where applicable);
e) the date of alteration; and
f) the CRN.

Letter sizing and other nameplate requirements shall be in accordance with the applicable section of the ASME Code.

5.3 Stamping

5.3.1
Boilers, pressure vessels, safety valves, relief valves, safety relief valves, and rupture discs shall be stamped with an ASME Code product certification mark or other stamp acceptable to the regulatory authority.

5.3.2
Individual modules and welded pressure parts of a fired-heater pressure coil shall be identified by stamping, stencilling, welded tag plates, or other appropriate means to provide traceability to the accompanying documentation.

5.3.3
At a minimum, individual pressure coils shall have a means of identification that includes the manufacturer's name, year of manufacture, maximum allowable working pressure and design metal temperature, a serial number, and the CRN.

5.3.4
Welded parts for a boiler or pressure vessel for which a manufacturer's partial data report is required shall be marked as required by the appropriate section of the ASME Code, except that the ASME Code product certification mark shall be required only if the completed boiler or pressure vessel is to be ASME stamped.

5.4 Fittings
Fittings shall be permanently marked as required by MSS SP-25.

6 Boilers and related components

6.1 General
Except as otherwise specified in this Standard, the standards governing the design, construction, installation, inspection, testing, and repair of boilers shall be those specified in

a) the following portions of the ASME Code:
   i) Section I;
   ii) Section II, Part A;
   iii) Section II, Part B;
   iv) Section II, Part C;
   v) Section II, Part D;
   vi) Section IV;
   vii) Section V;
   viii) Section VIII, Division 1;
   ix) Section VIII, Division 2;
   x) Section VIII, Division 3; and
   xi) Section IX; and
b) ASME CSD-1.

6.2 Boilers of riveted construction

6.2.1

The recommended age limit for high-pressure lap-seam riveted boilers, except for historical steam boilers, shall be 20 years, after which the factor of safety shall be increased by at least 0.1 each year. If relocated, a stationary lap-seam riveted boiler shall not be operated at a pressure higher than 103 kPa (15 psi).

6.2.2

See Annex I for requirements applicable to historical steam boilers and to new boilers that replace historical boilers and which are used for demonstration, viewing, or educational purposes.

6.3 Supplementary construction and installation requirements

6.3.1 Water gauges

6.3.1.1

When the top connection of a water gauge is more than 2 m (7 ft) and less than 6 m (20 ft) from the floor or working platform of a boiler room, it shall be fitted with rods or chains so that it can be operated from the floor or working platform. When the top connection of a water gauge is 6 m (20 ft) or more from the operating floor level, it shall be of the inclined type or other accepted type.

6.3.1.2

Safe and effective means, including adequate lighting, shall be provided to permit the level in the gauge glass to be distinctly seen at all times.

6.3.1.3

High-pressure steam boilers that have a maximum allowable working pressure of 2758 kPa (400 psi) or less and only a manually controlled water feed shall be fitted with two means for determining the water level.

6.3.2 Low-water cut-off

6.3.2.1

Steam boilers not continuously attended by a certified operator shall be equipped with at least two low-water fuel cut-off devices, each of which shall be independent of the other or others. These devices shall be installed so that they cannot be rendered inoperative. The installation shall be such that the devices can be tested under operational conditions.

Note: *The term "tested under operational conditions" refers to a procedure that involves closure of the fuel supply valve or, in the case of an electric boiler not of the probe type, an interruption of the energy source.*

6.3.2.2

Automatically fired hot water boilers not continuously attended by a certified operator shall be equipped with a low-water fuel cut-off device, except as specified in Clause 6.3.2.3. This device shall be installed so that it cannot be rendered inoperative. The installation shall be such that it can be tested under operational conditions.

6.3.2.3
In lieu of a low-water fuel cut-off device, automatically fired hot water boilers requiring forced circulation to prevent overheating (e.g., coil or fin-tube type boilers) shall be equipped with a flow-sensing device to automatically cut off the fuel supply to the burner if the flow rate is reduced to a point where it is inadequate to protect the boiler against overheating. The device shall be installed on the boiler outlet piping, be of a type certified safe and suitable by a nationally recognized testing agency, and installed so that it cannot be rendered inoperative. The installation shall be such that it can be tested under operational conditions.

6.3.3 Fusible plug
When a solid fuel firetube boiler operating at a pressure over 103 kPa (15 psi) is provided with a fusible plug, the plug shall be as specified in the ASME Code.

6.3.4 Boiler installation

6.3.4.1
Boilers shall be installed in a manner that provides adequate access for operation, inspection, and maintenance.

6.3.4.2
Except as specified elsewhere in Clause 6.3.4, a clearance of at least 0.6 m (2 ft) with no obstructions shall be provided on both sides and at the rear of each boiler (e.g., for inspection and maintenance). When necessary, this clearance shall be increased to facilitate removal or opening of closures, casings, or covers.

6.3.4.3
Boilers with a bottom opening or hand hole shall have a minimum clearance of 300 mm (12 in) above the floor or similar structure. Adequate clearance shall be provided between the floor and the lowest insulated surface of a boiler to facilitate inspection or repair.

6.3.4.4
Adequate clearance shall be provided for cleaning and replacing boiler tubes, fuel-burning equipment, and all other boiler-related equipment.

6.3.4.5
Platforms, walkways, ladders, and stairways shall be installed to provide access to important parts of boilers. They shall be of fire-resistant construction and equipped with handrails and toe-plates.

6.3.4.6
Each boiler in a battery of boilers shall have its blowoff line connected in such a manner that the boiler can be isolated from the other boilers under pressure. For the purpose of blowoff, boilers should be numbered both back and front when set in batteries.

6.3.4.7
A boiler with input of 146 kW (500 000 BTU/h) or less, certified to a CSA Group Standard, for example ANSI Z21.13/CSA 4.9, may be installed in accordance with the minimum servicing clearances identified in the manufacturer's installation instructions. The manufacturer's installation instructions shall have been used in support of the boiler certification.

Boiler sizes greater than 146 kW (500 000 BTU/h), certified with the minimum clearances [i.e., for clearances less than 610 mm (24 in)], and aggregate boiler installations shall receive regulatory authority approval prior to installation.

6.3.5 Boiler inspection openings

When manholes are specified or required for a boiler, they shall be at least 406 mm (16 in) in inside diameter or oval with inside dimensions of 305 × 406 mm (12 × 16 in).

6.3.6 Loadings

The loadings to be considered in designing a boiler shall include, when necessary, those from

a) superimposed static reactions from the weight of attached equipment, such as motors, machinery, other vessels, piping, linings, and insulation;
b) cyclic and dynamic reactions due to pressure or thermal variations, or from equipment mounted on a vessel, and mechanical loadings;
c) temperature gradients and differential thermal expansion; and
d) test pressure and coincident static head acting during the test.

Note: *Refer to Section VIII, Division 1, UG-22, of the ASME Code for interpretation.*

6.4 Boiler outlet dampers

Outlet dampers on automatically fired boilers shall be interlocked to the burner control system so that the boilers cannot be fired unless the dampers are sufficiently open.

6.5 Blowoff vessels, systems, and devices

6.5.1

When the blowoff from a boiler having a working pressure exceeding 103 kPa (15 psi) is discharged into a sewer system, a registered blowoff vessel or other suitable registered device shall be placed between the boiler and sewer to reduce the temperature of the water entering the sewer system to 65 °C (150°F) or lower. Blowoff vessels shall be designed in accordance with Clause 7.5.

Notes:

1) *Temperature-limit control devices may be attached to the vessel or water discharge line to control the temperature at or below 65 °C (150°F).*
2) *Austenitic stainless steel used in water-wetted service is susceptible to stress-corrosion cracking and should not be used.*
3) *Other regulations or codes (such as building or plumbing codes) can require further restrictions, such as lower temperatures or pH level restrictions on water entering a sewer system.*

6.5.2

Blowoff systems of a proprietary design that do not meet the requirements of Clause 7.5.1.2 or 7.5.1.3 shall be designed to meet the requirements of Clause 7.1. The design shall be submitted to the regulatory authority for registration before installation of the system.

6.6 Thermal fluid heaters and piping

6.6.1

This Clause applies to thermal fluid heaters in which heat is absorbed from the combustion of fuel or from solar radiation, infrared, or electric elements. Coils covered by Clauses 10.1 and 10.2, and vessels

in which vapour is generated incidental to the operation of a processing system, are exempt from this Clause.

Note: *Liquefied petroleum (LP) gas is not considered a thermal fluid.*

6.6.2

Thermal fluid heaters in which the fluid is vaporized shall be designed in accordance with the requirements of Part PVG, Section I, of the ASME Code.

6.6.3

Liquid phase thermal fluid heaters shall be designed in accordance with the requirements of Section I or Section VIII, Division 1, of the ASME Code.

When liquid phase thermal fluid heaters are designed to Section VIII, Division 1, of the ASME Code, controls, instrumentation, provision for thermal expansion of the fluid, overpressure protection, and a means of adding fluid to the system shall meet the requirements of Part PTFH, Section I, of the ASME Code.

6.6.4

When thermal fluid heaters are designed and constructed in accordance with Section I of the ASME Code, heater external piping shall be designed and constructed to ASME B31.1 and shall meet the requirements of Part PTFH, Section I, of the ASME Code. Non-heater external piping shall be designed and constructed to either ASME B31.1 or ASME B31.3.

When thermal fluid heaters are designed to Section VIII, Division 1, of the ASME Code, piping used with thermal fluid heaters shall be designed to ASME B31.3.

6.7 Cast iron or cast aluminum steam and hot water boilers

Each design covering a cast iron or cast aluminum steam or hot water boiler shall be accompanied by a proof test certificate indicating the destruction test pressure for each type or series submitted for approval.

6.8 Welded staybolts

Welded solid staybolts that are 8 in long or shorter shall have telltale holes in accordance with the dimensional requirements of paragraph PG-47.1, Section I, of the ASME Code.

7 Pressure vessels

7.1 Applicable codes and standards

7.1.1

Except as otherwise specified in Clause 7, the standards governing the design, construction, installation, inspection, testing, and repair of pressure vessels shall be those specified in

a) the following portions of the ASME Code:
   i) Section II, Part A;
   ii) Section II, Part B;
   iii) Section II, Part C;
   iv) Section II, Part D;

v) Section V;
vi) Section VIII, Division 1;
vii) Section VIII, Division 2;
viii) Section VIII, Division 3;
ix) Section IX; and
x) Section X; and

b) ASME PVHO-1.

Notes:

1) *Some carbon steel materials (e.g., SA-105, SA-106, SA-234) can have low toughness properties. This might be a concern since these carbon steel materials are commonly exempted from impact testing per the ASME publications listed in Clause 7.1.1 for temperatures –29 °C (–20°F) and greater. Owners, designers, fabricators, and repair organizations should carefully review the material toughness requirements on a case-by-case basis to determine if it might be necessary to apply one or more supplementary material requirements, such as heat treatment (specifying normalized material), fine grain size, impact testing, and/or more restrictive chemistry requirements (e.g., manganese-carbon ratio greater than 5.0).*
2) *Designers, fabricators, and repair organizations should review carbon steel toughness requirements with the owner, where appropriate, before applying the impact testing exemption allowed in*
   a) *paragraphs UG-20(f), UCS-66, and UCS-67 in Section VIII, Division 1, of the ASME Code;*
   b) *paragraph 3.11 in Section VIII, Division 2 of the ASME Code; or*
   c) *paragraph 323 of ASME B31.3.*

Owners, designers, fabricators, and repair organizations may consider performing impact testing irrespective of the ASME Code impact testing exemption rules, or the use of low-temperature materials (e.g., SA-350 LF2, SA-333 Gr. 6, SA-420 WPL6).

7.1.2

The designer of a pressure vessel that incorporates a quick-actuating closure shall take into consideration the requirements of Section VIII, Division 1, Appendix FF of the ASME Code.

7.1.3

In addition to the impact testing requirements specified in the ASME publications listed in Clause 7.1.1, carbon and low alloy steel used for the construction of pressure vessels at a minimum design metal temperature below –46 °C (–50°F) shall be impact tested at the minimum design metal temperature or a lower temperature, and the test results shall meet the requirements of paragraph UG 84, Section VIII, Division 1, of the ASME Code.

7.1.4

All pressure vessels designed for cyclic service and pressure vessels designed to Section VIII, Divisions 2 and 3, of the ASME Code shall comply with the following requirements:

a) In ensuring maintenance and safe operation of pressure vessels, the owner shall maintain an appropriate equipment record system containing information about and documentation of incidents affecting the safe operation of the pressure vessels. The recordkeeping media for the equipment record system shall be retrievable and legible, and the information and documentation in them shall be secured to prevent unauthorized or undocumented revisions, additions, or deletions.
b) The owner's equipment record system shall include documentation such as the user's design specification, manufacturer's design report, fabrication documents, and operation monitoring results.
c) The owner shall establish pressure vessel operation guidelines for operators of the vessels, including the definition of cyclic operations and cycles monitoring, in compliance with the user's design specifications and manufacturer's design reports.

d) The owner shall have a certification process for the training and competency of the personnel to operate the vessels within the operation guidelines.
e) For incidents where operation of the vessels deviates from the limits of the user's design specification, the operation monitoring results shall document
   i) the incidents as nonconformities; and
   ii) technical justification, by a professional engineer, for continued operation.

Note: *Cyclic service is determined for the pressure vessel by the owner in conjunction with the designer and is subject to acceptance by the regulatory authority.*

7.1.5

7.1.5.1

Use of Part 5 of Section VIII, Division 2, of the ASME Code to override provisions under Part 4 of Section VIII, Division 2, of the ASME Code is prohibited.

Note: *In Section VIII, Division 2, of the ASME Code, the term "Part" refers to the different parts of the Code and the annexes to those respective parts of the Code. In this case, "Part 5" refers to "Design by Analysis Requirements" and all associated annexes.*

7.1.5.2

Use of Part 5 of Section VIII, Division 2, of the ASME Code in addition to or to supplement requirements in Part 4 of Section VIII, Division 2, of the ASME Code is not considered as using Part 5 to override provisions under Part 4.

Note: *For example, use of Part 5 for fatigue analysis when required in accordance with a user's design specification is not considered as using Part 5 to override provisions under Part 4.*

7.2 Pressure vessel installation

7.2.1 General

7.2.1.1

Pressure vessels shall be installed in a manner that provides adequate access for operation, inspection, and maintenance.

7.2.1.2

Except as specified elsewhere in Clause 7.2, a passageway at least 0.6 m (2 ft) wide and clear of obstructions shall be provided on both sides and at the rear of each pressure vessel. When necessary, this clearance shall be increased to facilitate removal or opening of closures, casings, or covers.

7.2.1.3

Adequate clearance shall be provided between the floor and the lowest insulated surface of a pressure vessel to facilitate inspection or repair.

Note: *There should be a minimum clearance of 300 mm (12 in).*

7.2.1.4

Adequate clearance shall be provided for cleaning and replacing internal components, e.g., heat exchanger tubes.

7.2.1.5
Platforms, walkways, ladders, and stairways shall be installed to provide access to important parts of pressure vessels. They shall be of fire-resistant construction and equipped with handrails and toe-plates.

7.2.2 Propane tanks
Buried propane tank installations shall be designed to meet the requirements of CSA B149.2.

7.2.3 Other buried pressure vessels
Note: *See Annex A.*

7.2.3.1
Buried pressure vessel installations shall be designed to meet the requirements of Clauses 7.2.3.2 to 7.2.3.6. Design documentation shall be submitted to the regulatory authority before installation.

7.2.3.2
The pressure vessel shall be designed for underground service and provided with a means for placing it in position without damage to the vessel or its protective coatings.

7.2.3.3
The pressure vessel shall be externally protected in accordance with CAN/ULC-S603.1 unless an impressed-current system is employed.

7.2.3.4
The pressure vessel shall be cathodically protected by
a) a sacrificial-type system designed in accordance with CAN/ULC-S603.1;
b) an impressed-current system, using NACE SP0285 for design criteria; or
c) a system designed by a registered professional engineer accredited by NACE International.

7.2.3.5
The pressure vessel shall be installed in accordance with CAN/ULC-S603.1.

7.2.3.6
Corrosion-control monitoring shall be undertaken at least annually to ensure compliance with the design criteria. A permanently connected on-site voltmeter shall be installed to continuously indicate the cathodic protection potential (see CAN/ULC-S603.1).

7.3 Pressure vessel inspection openings
When manholes are specified or required for a pressure vessel, they shall be at least 406 mm (16 in) in inside diameter or oval with inside dimensions of 305 × 406 mm (12 × 16 in).

7.4 Water heaters and hot water, hydropneumatic, and cushion tanks

7.4.1 Water heaters

7.4.1.1
A water heater with a maximum diameter of 610 mm (24 in) is not required to be constructed to the requirements of this Standard, provided that the maximum heat input does not exceed 30 kW electrical or 400 000 BTU/h.

7.4.1.2
Water heaters shall be designed to meet the requirements of Section I; Part HLW, Section IV; or Section VIII, Division 1, of the ASME Code, but the heat input, temperature, and volume exemptions in the ASME Code shall not apply.

7.4.1.3
Relief valves for water heaters shall be of adequate capacity, with a minimum inlet size of NPS 3/4 (NPS 1 for water heaters heated indirectly by steam in a coil or pipe), and shall be provided with a suitably designed lifting device.

7.4.2 Hot water tanks

7.4.2.1
A hot water tank with a maximum diameter of 610 mm (24 in) shall not be subject to the requirements of this Standard.

7.4.2.2
Hot water tanks shall be designed to meet the requirements of Section VIII, Division 1, of the ASME Code. Corrosion-resistant potable hot water tanks may be designed to Part HLW, Section IV, of the ASME Code.

7.4.2.3
Hot water tanks shall be designed for a minimum pressure of 690 kPa (100 psi) and a minimum design temperature of 95°C (200°F).

7.4.2.4
Relief valves for hot water tanks shall be of adequate capacity, with a minimum inlet size of NPS 3/4, and shall be provided with a suitably designed lifting device.

7.4.3 Hydropneumatic tanks
Hydropneumatic tanks shall have a minimum design pressure of 690 kPa (100 psi) and meet the requirements of Section VIII, Division 1, of the ASME Code. A hydropneumatic tank with a maximum diameter of 610 mm (24 in), a total volume of 450 L (16 ft^3) or less, and a temperature of 65 °C (150°F) or less shall not be subject to the requirements of this Standard.

7.4.4 Cushion tanks
Cushion tanks having a working pressure exceeding 207 kPa (30 psi) or a diameter exceeding 610 mm (24 in) shall meet the requirements of Section VIII, Division 1, of the ASME Code. Cushion tanks with a

maximum diameter of 610 mm (24 in) and a pressure of 207 kPa (30 psi) or less shall not be subject to the requirements of this Standard.

7.5 Blowoff vessels

7.5.1 Design requirements

7.5.1.1

The design pressure for blowoff vessels shall be as specified in Table 2. A corrosion allowance of at least 3 mm (1/8 in) shall be added to the vessel thickness necessary to meet the requirements of Table 2. The plate thickness shall be at least 9.5 mm (3/8 in).

7.5.1.2

The minimum diameter and volume of blowoff vessels (other than for coil-tube boilers) shall be as specified in Table 3. When more than one boiler is connected to the same blowoff vessel, the vessel shall be designed to suit the largest boiler, except as specified in Clause 7.5.1.3.

7.5.1.3

The minimum diameter and volume of blowoff vessels for coil-tube boilers having a capacity of less than 1200 L (250 Imp gal) may be as specified in Table 4 but shall be not less than the fully flooded volume of the boiler.

7.5.2 Cleaning and inspection facilities

7.5.2.1

To facilitate internal inspection and permit cleaning, a manhole that complies with the requirements of Clause 7.3 shall be provided, except in the case of a vessel that is less than 610 mm (24 in) in diameter, where an oval hand hole with inside dimensions of 100 × 150 mm (4 × 6 in) may be used.

7.5.2.2

A drain connection of not less than NPS 1-1/2 shall be provided for cleaning and drainage and installed in the bottom of the vessel.

7.5.3 Inlets and outlets

7.5.3.1

Blowoff vessels shall be provided with an atmospheric vent pipe

a) not less than 76 mm (3 in) in inside diameter;
b) sized to ensure that the liquid drain seal cannot be blown out;
c) without consideration for the area of the water discharge pipe; and
d) having no isolating valves.

7.5.3.2

A water discharge pipe, of a size sufficient to discharge the maximum quantity of water that can enter the vessel without an appreciable rise in the water level in the vessel, shall be provided. The water discharge outlet shall be at least 51 mm (2 in) in inside diameter. The water discharge seal shall be designed for 125% of the maximum expected water flow into the vessel.

7.5.3.3
An anti-siphon device shall be fitted on the water seal.

7.5.3.4
A cold water connection shall be provided and enter separately from the blowoff inlet connection. The cold water supply line shall be a minimum of NPS 3/4.

7.5.3.5
A connection with a minimum of NPS 1/2 shall be provided on the vessel shell above the liquid level for a pressure gauge connection.

7.5.3.6
When tangential inlet connections are used, an impingement wear plate shall be provided to take the erosive wear of the entering blowoff.

7.6 Anhydrous ammonia service

7.6.1
Except as required by Clauses 7.1, 7.6.2, and 7.6.3, the design, construction, and installation of pressure vessels and piping to be used for storage and handling of anhydrous ammonia shall comply with ANSI/CGA G-2.1.

7.6.2
Anhydrous ammonia storage tanks with a water capacity of 13 660 L (3000 Imp gal) or more shall be constructed with a manhole.

7.6.3
Except for vessels used in refrigeration systems, pressure vessels intended for use in anhydrous ammonia service shall
a) be subjected to post-weld heat treatment before the hydrostatic test; and
b) have head and shell materials produced in accordance with fine-grain practice.

7.7 Liquefied petroleum gas and natural gas liquids services

7.7.1 Liquefied petroleum gas service

7.7.1.1
Pressure vessels and piping for liquefied petroleum gases shall meet the requirements of the following:
a) for fuel tanks on highway vehicles:
    i) Section VIII, Division 1, of the ASME Code;
    ii) CSA B149.2 and CSA B149.5; and
    iii) Annex G; or
b) for ground storage tanks:
    i) Section VIII, Division 1, of the ASME Code; and
    ii) CSA B149.2.

7.7.1.2
Liquefied petroleum gas vessels with a water capacity of 13 660 L (3000 Imp gal) or more shall be constructed with a manhole.

7.7.2 Natural gas liquids service
When flexible hoses are used with natural gas liquid storage tanks for loading and unloading product, an excess flow valve that is adequately sized for each tank opening used for product flow shall be installed.

7.8 Cold-stretched pressure vessels
The design, fabrication, installation, inspection, operation, repair, and alteration of cold-stretched pressure vessels shall be in accordance with Annex K.

8 Piping and fittings

8.1
Except as otherwise specified in this Standard, the design, materials, construction, installation, inspection, testing, and repair of pressure piping shall meet the requirements of the following, as applicable:

a) ASME:
   i) B31.1;
   ii) B31.3;
   iii) B31.4;
   iv) B31.5; and
   v) B31.9 (except for the requirements allowing use of soldered joints for air piping);
b) CSA Group:
   i) CSA B149.1;
   ii) CSA B149.2;
   iii) CSA Z180.1;
   iv) CAN/CSA-Z662; and
   v) CSA Z7396.1;
c) ARPM IP-2 (for flexible hose assemblies); and
d) CDA A4015 (for soldering).

8.2
Fittings used in piping systems shall be registered in accordance with Clause 4.2.

8.3
Welded joints in a pressure piping system shall not be painted or covered until all required inspections are completed by the owner and/or authorized inspection agency in accordance with the code of construction and the Act.

8.4
Soldered joints shall not be permitted in services subject to shock or vibration.

8.5
Bonding of non-metallic joints shall be performed in accordance with the applicable code of construction. Bonding procedure specifications, and procedure and performance qualification testing, shall be subject to the acceptance of the regulatory authority.

Note: *For an example of requirements for bonding, refer to Chapter VII of ASME B31.3.*

8.6
The method by which any pressure piping system is to be tested, and the test pressure to be used, shall be submitted for approval to the regulatory authority in the province of installation.

8.7
Mechanical joints whose mechanical strength or leak resistance is dependent on friction-only clamped connections shall not be used.

9 Refrigeration equipment
The design, construction, installation, inspection, testing, and repair of refrigeration equipment shall meet the requirements of CSA B52.

10 Fired-heater pressure coils in petroleum and chemical plant service

10.1
Subject to Clauses 10.2 to 10.5, and except for components designed and fabricated to Section I of the ASME Code or ASME B31.1, the design, construction, installation, inspection, and testing of fired-heater pressure coils shall meet the requirements of ASME B31.3 and ANSI/API STD 530.

10.2
The thickness of tubes, return bends, headers, and manifolds inside the internally insulated enclosure may be designed in accordance with ANSI/API STD 530 and fabricated and inspected in accordance with this Standard and ASME B31.3.

10.3
The owner or a person designated by the owner shall determine design and service conditions for pressure coils. These conditions shall be identified to the regulatory authority at the time of registration or before repairs to or alterations of such coils.

10.4
The minimum inspection requirements for welds in fired-heater pressure coils designed, constructed, installed, inspected, tested, and repaired in accordance with this Standard shall be as specified in ASME B31.3. Welds exposed to direct radiant heat shall meet the requirements of Annex E.

10.5
Piping, headers, manifolds, crossovers, and other equipment external to the enclosure are not part of the fired-heater pressure coil and shall be designed, fabricated, and inspected in accordance with this Standard. After final assembly, the completed pressure coil shall be tested in the presence of the

authorized inspector. A description of the method and test pressure shall be submitted to the regulatory authority before testing.

11 Repairs and alterations

11.1

The codes and standards referenced in Clauses 6 to 8 and 10 are intended for new construction and are not necessarily entirely applicable to repairs or alterations. For all repairs or alterations, the methods employed shall maintain the factor of safety determined in accordance with the ASME Code section referenced when the unit was first manufactured.

Note: *See Clause 4.7 for additional requirements pertaining to repairs and alterations and Figure D.8 for a recommended repair/alteration report form for boilers and pressure vessels.*

11.2

Repairs to Category G fittings (see Table 1) shall be performed in such a manner that the original manufacturer's specifications for the device are restored or maintained.

Note: *Recommended guidelines for safety valve, relief valve, and safety relief valve repair organizations are provided in Annex C. A holder of a National Board VR stamp is deemed to meet the guidelines.*

11.3

All repairs to and alterations of vessels specified in Clause 7.6 shall be made in accordance with ANSI/CGA G-2.1.

11.4

If hot tapping is to be performed, the fitting rating, joint configuration, and reinforcement shall meet the requirements of the code of construction for the piping system or vessel.

11.5

Where an alteration to an existing pressure-retaining item is proposed, the design of the alteration shall be submitted for review by the regulatory authority.

12 Pressure relief devices

12.1 General

12.1.1

Except as otherwise specified in this Standard, the standards governing the design, construction, installation, inspection, testing, and repair of PRDs shall be those specified in the ASME design code, the *National Board Inspection Code*, or this Standard as applicable to the equipment being protected.

12.1.2
Safe operation of pressure equipment requires that all pressure-retaining systems and components be protected from overpressurization by
a) pressure relief devices; or
b) other means acceptable to the authority having jurisdiction.

Clause 12 addresses only pressure equipment protected by a pressure relief device.

12.1.3
Boilers, pressure vessels, or pressure piping systems shall be operated only when
a) the pressure equipment is provided with pressure relief devices of a capacity that satisfies the system design specifications;
b) the pressure relief devices are registered as fittings and have CRNs in accordance with Clause 4.2.9;
c) at least one pressure relief device is set to open at a pressure not higher than the maximum allowable working pressure of the equipment it is protecting;
d) the pressure relief devices are in good working condition;
e) the pressure relief devices have not been altered, interfered with, or rendered inoperative; and
f) the pressure relief devices bear the markings prescribed by the code to which they were designed and certified. Thermal expansion relief valves need not be certified (see Clause 12.9.1).

Note: *See Annex H, Clause H.2.2, for certification marking requirements.*

12.1.4
Any person involved in the installation, removal, repair, inspection, and servicing of a pressure relief device shall be trained and competent in the duties for which they are responsible.

The repair, setting, and servicing of pressure relief devices shall be performed by organizations authorized in writing by the regulatory authority to perform those functions.

12.2 Design and installation

12.2.1 Design

12.2.1.1
The overpressure protection specifications for pressure-retaining systems and components shall be determined by the system designer and shall be in accordance with the applicable design and installation codes and standards. The design shall take into consideration factors including, but not limited to, service fluid, temperature and pressure of the operating conditions, fluid viscosity and flow rate, and material compatibility with the product to which the pressure-retaining systems and components, including all internal non-metal parts, are exposed.

12.2.1.2
The relieving capacity of the pressure relief devices
a) for ammonia tanks shall be as specified in ANSI/CGA G-2.1;
b) for propane tanks shall be as specified in NFPA 58; and
c) for boilers shall be as specified in Sections I and IV of the ASME Code.

Other suitable design codes shall be selected and followed for the determination of the relieving capacity for all other pressure vessels or piping systems not specified in Item a), b), or c).

12.2.2 Installation

12.2.2.1

Pressure relief devices shall be installed and positioned in accordance with the code of construction of the pressure equipment as specified by designer. The method of installation and the orientation of the PRD shall be in accordance with the PRD manufacturer.

12.2.2.2

Isolation valves shall not be installed in the relief path unless

a) an isolation valve is permitted by the code of construction;
b) the installation has been authorized by the regulatory authority; and
c) an approved management system is implemented to control the operation of the isolation valve.

12.2.2.3

Discharge from the pressure relief device shall be directed to a safe location in such a manner as to prevent any impingement of escaping fluid upon personnel, pressure equipment, or adjacent structures or surfaces (e.g., gravel, sand, etc.). If discharge piping is installed, it shall meet applicable standards and regulations.

When the location of a discharge outlet is being determined, consideration shall be given to the potential effects of prevailing winds or accumulated snow and the location of doors, operable windows, or ventilation intakes. The discharge outlet shall be located so that the discharge will not endanger passersby.

12.2.2.4

Pressure relief devices and discharge piping shall be installed so that moisture cannot collect and freeze in a manner that would interfere with operation of the device.

12.2.2.5

Pressure relief devices shall be located such that they are accessible for inspection and service.

12.2.2.6

Pressure relief device discharge piping shall have a cross-sectional area not less than that of the pressure relief device discharge opening and shall be arranged so as not to restrict the flow of escaping fluid.

12.2.2.7

Discharge piping from multiple pressure relief devices may be connected into a common header, provided that the header's design is engineered to account for backpressure sources, such as the discharge from other devices, and shall consider additional factors, as applicable, such as multiple fluids, phases, and multiple discharge pressures. The cross-sectional area of the discharge header shall be not less than the sum of the cross-sectional areas of the pipes connecting into the common header, unless permitted by the design code and verified by an engineering analysis.

Note: *Design codes and other standards, such as API 520, give guidance for the design of pressure relief device discharge systems.*

12.2.2.8
The quality of work and materials used to construct discharge piping shall be suitable for the service conditions to which the discharge piping could be subjected.

12.2.2.9
The pressure relief device and any discharge piping shall be securely supported and braced, taking into account the violent forces created when the pressure relief device releases.

Note: *Pressure relief device releases can exceed recommended noise exposure limits. Appropriate precautions should be taken.*

12.3 Marking
Pressure relief devices used to protect pressure-retaining systems and components shall be marked in accordance with Clause 5.

12.4 Inspection, testing, servicing, and replacement

12.4.1
The owner shall establish a program that addresses the required inspection, testing, servicing, and replacement of pressure relief devices as specified in Clause 12.

12.4.2
Pressure relief devices shall be serviced or replaced if there is evidence of a malfunction. Unsafe or suspect overpressure protection devices shall be replaced immediately.

12.4.3
Table 5 gives maximum intervals for frequency of in-service testing, and servicing that shall be followed in the absence of data to support extending these intervals. The owner may recommend a longer interval to the regulatory authority if the history of a reclosing pressure relief device can justify an extension; alternatively, the owner may choose to service the reclosing pressure relief devices at more frequent intervals to ensure safe operation. In corrosive and/or liquid service, shorter intervals can be necessary if the reclosing pressure relief devices have lifted to relieve pressure. Extreme caution shall be exercised during servicing of reclosing pressure relief devices in toxic or lethal service. The manufacturer’s instructions and recommendations shall be considered for guidance on inspection, testing, and servicing issues.

12.5 Inspection

12.5.1
The owner shall periodically visually inspect pressure relief devices to ensure that there are no impediments that will prevent them from operating properly.

12.5.2
The frequency of the periodic visual inspection depends on the operating environment and the manufacturer’s recommendations but shall not exceed 5 years.

12.5.3

The periodic visual inspection shall ensure that

a) the outlet and, where applicable, weep hole are open and free to discharge;
b) there are no signs of corrosion, cracks, debris, tampering, or other mechanical damage;
c) there is no leakage;
d) the manufacturer's data plate or markings are present in accordance with the applicable design code;
e) the set pressure of the pressure relief device meets the specified requirements for the system;
f) the pressure relief device discharge is discharged to a safe location and meets the requirements of Clause 12.2.2;
g) the discharge capacity of the pressure relief device is equal to or greater than the boiler output capacity stamped on the boiler nameplate and complies with Clause 12.2.1.2;
h) the seal (where applicable) has not been broken;
i) the rain cap, where applicable, has been installed; and
j) the discharge piping (where applicable) is intact, and properly supported in accordance with Clause 12.2.2.9.

Corrective action shall be taken if one or more of the above criteria are not met.

Note: *See Figure H.1 for diagrams of typical internal and external propane pressure relief valves.*

12.5.4

In addition to the periodic visual inspection specified in Clause 12.5.3, if the discharge piping in an LPG service governed by CSA B149.2 is fabricated from a material, such as carbon steel, that can corrode and form internal scale, the discharge piping shall be removed to inspect the pressure relief device and the piping. Any scale buildup in the discharge piping shall be removed.

12.6 In-service testing

Pressure relief devices in steam or hot water service shall have a periodic manual lift or system test.

Pressure relief devices with a lifting lever or equivalent device in compressed air service shall have a periodic manual lift test.

See Table 5 for the frequency of in-service testing.

12.7 Servicing of reclosing pressure relief devices

12.7.1

Reclosing pressure relief devices shall be serviced periodically in accordance with the requirements of Clauses 12.7.2 to 12.7.5 and Table 5.

12.7.2

12.7.2.1 ASME-stamped PRDs

Servicing of ASME-certified reclosing pressure relief devices shall be performed by organizations authorized by the regulatory authority. The servicing organization shall satisfy the regulatory authority that it has servicing facilities and an adequately documented quality control system for setting and servicing pressure relief valves. Where required by the regulatory authority, the servicing organization shall have a certificate of authorization to service relief devices.

Pressure relief device servicing that takes place outside the jurisdiction of the regulatory authority in which the reclosing pressure relief device is installed shall be performed by a servicing organization authorized by another Canadian jurisdiction or by an organization holding a VR stamp issued by the National Board of Boiler and Pressure Vessel Inspectors.

Note: *See Annex C for guidelines for safety valve, relief valve, and safety relief valve repair organizations.*

12.7.2.2 ANSI/UL 132 pressure relief valves (PRVs)

ANSI/UL 132 listed PRVs in propane service shall be serviced by the original equipment manufacturer, except for those that are additionally certified to ASME, which can be alternatively serviced in accordance with Clause 12.7.2.1.

Note: *If a PRV is not serviced by the original equipment manufacturer, the UL listing is invalidated.*

12.7.3

12.7.3.1

Reclosing pressure relief devices that are serviced for reuse shall be restored to their original condition and recertified. Servicing of a reclosing pressure relief device shall include

a) disassembly;
b) inspection of all internal components;
c) refurbishing;
d) replacement of parts as necessary;
e) testing; and
f) recertification.

12.7.3.2

After servicing is complete, reclosing pressure relief devices shall be tested using the following fluids:

a) Boilers:
   i) Power boiler and steam heating boiler service PRDs shall be tested on steam.
   ii) Hot water heating boiler service PRDs shall be tested on steam, air, or water.
b) Other pressure equipment types, e.g., pressure vessels, fired-heater pressure coils, and piping systems:
   i) PRDs in steam service shall be tested on steam, except that owners having their own PRD testing program acceptable to the regulatory authority may test their own ASME Section VIII PRDs on air with the manufacturer's steam-to-air correction factor.
   ii) PRDs in air or gas service shall be tested on air or another suitable gas.
   iii) PRDs in liquid service shall be tested on water or another suitable liquid.

Where servicing or testing is undertaken in-situ, reclosing pressure relief devices may be tested using the fluid in the system they are protecting, where it is safe to do so.

12.7.4

The servicing organization shall affix a dated service nameplate to the reclosing pressure relief device and use a uniquely embossed seal to seal all adjustable parts. The manufacturer's nameplate shall remain on the reclosing pressure relief device.

12.7.5

A record of the inspection, testing, and servicing, and any corrective action taken, shall be retained to establish service history.

12.8 Non-reclosing pressure relief devices

Non-reclosing pressure relief devices shall be replaced in accordance with the manufacturer's recommended service life and other applicable standards (e.g., Section I of the ASME Code for fusible plugs).

12.9 Thermal expansion relief valves

12.9.1

Thermal expansion relief valves may be non-ASME-certified pressure relief valves.

12.9.2

Thermal expansion relief valves shall be inspected periodically as specified in Clause 12.5.

Note: *Thermal expansion relief valves need not comply with the requirements of Clause 12.7.*

12.9.3

Thermal expansion relief valves shall be replaced or serviced when there is evidence of damage or malfunction.

12.10 Replacement parts

All replacement parts shall be fabricated by the pressure relief device manufacturer or to its design specification.

12.11 CSA B149 series propane service pressure relief valves (PRVs)

Newly constructed PRVs used in CSA B149 series propane service shall be designed, constructed, marked, and listed to ANSI/UL 132. UL listed PRVs may also be certified to ASME.

Notes:

1) *UL listing means that UL has tested representative samples of the product and determined that it meets UL's requirements.*
2) *ANSI/UL 132 PRVs are not mandatory for anhydrous ammonia service.*

13 In-service inspection

13.1 General

In-service inspection of systems shall be performed as required for the specific installation in accordance with the code of construction or code of inspection adopted by the authority having jurisdiction. Consideration shall be given to the manufacturer's recommendations. Personnel performing in-service inspection shall be trained and competent in the duties for which they are responsible.

Notes:

1) *In some cases, the authority having jurisdiction specifies in-service inspection intervals. Authorities having jurisdiction can be the electrical safety authority, fire services, a government ministry, etc.*
2) *In-service pressure equipment can be subject to in-service deterioration that can affect its pressure-retaining capability, and, therefore, periodic inspection is warranted to validate its continued suitability for service.*

13.2 Pressure equipment not in service

Pressure equipment not in service shall be adequately protected against damage from environmental conditions. Safety precautions for entering confined spaces shall be followed when inspection and maintenance activities are performed.

Notes:

1) *For inspection purposes, equipment not in service should be physically isolated from the process and lock-out safety measures put in place before inspection and maintenance activities begin. Safety procedures should be observed when the vessel is being prepared for inspection.*
2) *Equipment not in service should be completely disconnected from the process and content removed in accordance with approved procedures. Equipment removed from service that is intended to be returned to operation at a later date should be considered for layup or mothballing. Inspections should be carried out before such pressure equipment is returned to service.*

13.3 Inspection

13.3.1 General

Periodic inspection of pressure equipment is intended to determine the condition of the equipment and its fitness to continue to operate safely. Inspection may be external and/or internal. Where appropriate, NDE may be used to collect certain data from equipment in operation.

13.3.2 External inspection

External inspection can be a visual inspection and may be supplemented by NDE and carried out while the pressure equipment is in service to observe its behaviour under operating conditions. During external inspections, pressure equipment (e.g., its external surfaces; appurtenances such as fittings, protective devices, and foundation elements; insulation; equipment identification) shall be examined for nonconformities.

13.3.3 Internal inspection

Internal visual inspection of the internal surfaces of pressure equipment is carried out with the equipment not in service. In lieu of or in addition to visual inspection, NDE can be necessary to properly assess the condition of the equipment.

13.3.4 Documentation

Where inspection and maintenance operations are carried out according to documented procedures, the procedures and documents shall be acceptable to the authority having jurisdiction.

13.4 High-energy steam (HES) piping systems

13.4.1 General

High-energy steam (HES) piping systems are piping systems on which condition assessments shall be conducted.

13.4.2 Condition assessments

Condition assessments shall address piping runs and components, including their supports, restraints, and root valves, and shall be conducted under a site-specific HES integrity plan (IP). The condition assessment shall be initiated with a baseline inspection performed in accordance with the IP, and shall be maintained with a continued periodic inspection plan that is determined by factors such as safety risks, elevated stress and high temperature locations, material susceptibility to damage, operational

history, and industry experience. The IP will define the condition assessment inspection frequency and methods of examination.

As part of the IP, the owner shall develop operating and maintenance procedures deemed necessary to ensure safe operation based on

a) codes and standards requirements;
b) relevant industry experience;
c) owner experience and knowledge of that facility; and
d) operating conditions of the piping systems.

Note: *See Annex L of this Standard and covered piping systems (CPS) in ASME B31.1 for additional information.*

Table 1
Categories of fittings

[See Clauses 4.1.1, 4.2.2, 4.2.7, 4.9.2, 5.1.1, and 11.2 and Figures 1 a), 1 b), and 1 c).]

Category	Type of fitting
A	Pipe fittings, including couplings, tees, elbows, wyes, plugs, unions, pipe caps, and reducers
B	All flanges
C	All line valves
D	All types of expansion joints, flexible connections, and hose assemblies
E	Strainers, filters, separators, and steam traps
F	Measuring devices and indicating devices, including pressure gauges, level gauges, sight glasses, levels, and pressure transmitters
G	Certified capacity-rated pressure relief devices acceptable as primary overpressure protection on boilers, pressure vessels and pressure piping, and fusible plugs
H	Pressure-retaining components that do not fall into Categories A to G

Notes:

1) *These categories do not take into account size, materials, end connections, ratings, schedules, and methods of fabrication.*
2) *Category H can include*
   a) *small pressure vessels registered and inspected as specified in Figure 1 a), 1 b), or 1 c). Such pressure vessels shall be designed and constructed in accordance with Clause 7, except that items that fall under Figures 1 a) and 1 b) may be designed and constructed to Clause 8, provided that the pressure vessel*
      i) *does not require full radiography in accordance with the ASME Code;*
      ii) *does not have a quick-actuating closure;*
      iii) *is not in cyclic service; and*
      iv) *is 4 NPS or smaller;*
   b) *an assembly of components (including piping components), provided that the diameter of any component does not exceed 152 mm (6 in) and the total volume of the assembly does not exceed 42.5 L (1.5 ft³). Such an assembly is considered a single Category H fitting for the purposes of fitting registration; and*
   c) *condenser coils and evaporator coils as defined in CSA B52 and air heater coils, provided that the diameter of any component does not exceed 152 mm (6 in) and the design pressure does not exceed 4.14 MPa (600 psig).*

Table 2
Design pressures for blowoff vessels
(See Clause 7.5.1.1.)

Maximum boiler pressure	Vessel design pressure
103–2060 kPa (15–300 psi)	30% of the maximum boiler pressure, but shall be at least 103 kPa (15 psi)
Over 2060 kPa (300 psi)	690 kPa (100 psi)

Table 3
Minimum dimensions of blowoff vessels (other than for coil-tube boilers)
(See Clause 7.5.1.2.)

Boiler steam evaporative capacity, kg/h (lb/h)*	Minimum diameter, mm (in)	Minimum volume, m^3 (ft^3)
Up to 340 (750)	457 (18)	0.10 (3.5)
680 (1 500)	610 (24)	0.25 (8.0)
1 360 (3 000)	760 (30)	0.42 (15.0)
3 175 (7 000)	915 (36)	0.51 (20.0)
5 900 (13 000)	915 (36)	0.71 (25.0)
11 300 (25 000)	1 066 (42)	1.13 (40.0)
45 400 (100 000)	1 220 (48)	1.70 (60.0)
136 000 (300 000)	1 220 (48)	2.27 (80.0)
227 000 (500 000)	1 220 (48)	2.83 (100.0)
454 000 (1 000 000)	1 220 (48)	3.68 (130.0)
680 000 (1 500 000)	1 220 (48)	4.53 (160.0)
907 000 (2 000 000)	1 220 (48)	5.66 (200.0)

* *At 100 °C (212°F).*

Notes:

1) *Interpolation may be used for evaporative capacities less than 907 000 kg/h (2 000 000 lb/h). Extrapolation shall be used for evaporative capacities greater than 907 000 kg/h (2 000 000 lb/h).*
2) *The design of a blowoff vessel less than 457 mm (18 in) in diameter for evaporative capacities less than 340 kg/h (750 lb/h) may be accepted by the regulatory authority when supported by design analysis.*

Table 4
Minimum dimensions of blowoff vessels for coil-tube boilers
(See Clause 7.5.1.3.)

Boiler steam evaporative capacity, kg/h (lb/h)*	Minimum diameter, mm (in)	Minimum volume, m^3 (ft^3)
Up to 1585 (3500)	457 (18)	0.09 (3.2)
3945 (8700)	610 (24)	0.20 (7.0)
Over 3945 (8700)	760 (30)	0.37 (13.1)

* *At 100 °C (212°F).*

Table 5
Maximum in-service testing and service intervals for pressure relief devices
(See Clauses 12.4.3, 12.6, 12.7.1, and H.4.3.2.)

System	In-service testing — System pressure test* and lift test (assisted or manual)	Maximum servicing interval
Power boiler		
• steam operating above 103 kPa (15 psig)	Annual — System pressure test or lift test††	5 years
• hot water operating above 1103 kPa (160 psi) or 121 °C (250°F)	Annual — System pressure test or lift test††	5 years
Heating boiler		
• hot water up to 1103 kPa (160 psi) at or below 121 °C (250°F)	2 years — System pressure test or lift test††	6 years
• steam up to 103 kPa (15 psig)	Annual — System pressure test or lift test††	5 years
Hot water storage tanks		
• hot water up to 1103 kPa (160 psi) at or below 121 °C (250°F)	2 years — System pressure test or lift test	6 years
Pressure vessel and piping systems		
• steam and air	Annual – System pressure test or lift test — optional† **	5 years† **
• LPG (excluding pressure vessels in LPG service governed by CSA B149.2); NH3; flammable cryogenic and dry; flammable non-corrosive, non-toxic, non-fouling gases	Not recommended	5 years
• non-flammable cryogenic and dry; non-flammable non-corrosive, non-toxic, non-fouling gases	5 years — System pressure — optional‡	5 years‡

(Continued)

Table 5 (Concluded)

System	In-service testing — System pressure test* and lift test (assisted or manual)	Maximum servicing interval
Pressure vessel in LPG service governed by CSA B149.2		
• greater than 2500 USWG	Not recommended	10 years
• 2500 USWG or less (excluding cylinders as defined by CSA B149.2)§	Not recommended	25 years
Other boilers, pressure vessels, and piping systems not listed above	—	3 years

** In-situ system testing is a procedure used to verify operation of the pressure relief device without removing it from its location, e.g., by increasing the system or component operating pressure to the pressure relief device set point using specialized equipment.*

† Steam service shall be serviced every 5 years; servicing may be extended to a maximum of 8 years if annual system pressure test or lift tests are conducted from the beginning of the servicing interval.

‡ Servicing may be extended to every 10 years if system pressure testing is performed every 5 years.

§ See Clause H.4. If the pressure relief valve is not an internal pressure relief valve [see Figure H.1 a)], the service intervals shall meet those required for pressure vessels in LPG service governed by CSA B149.2 — greater than 2500 USWG.

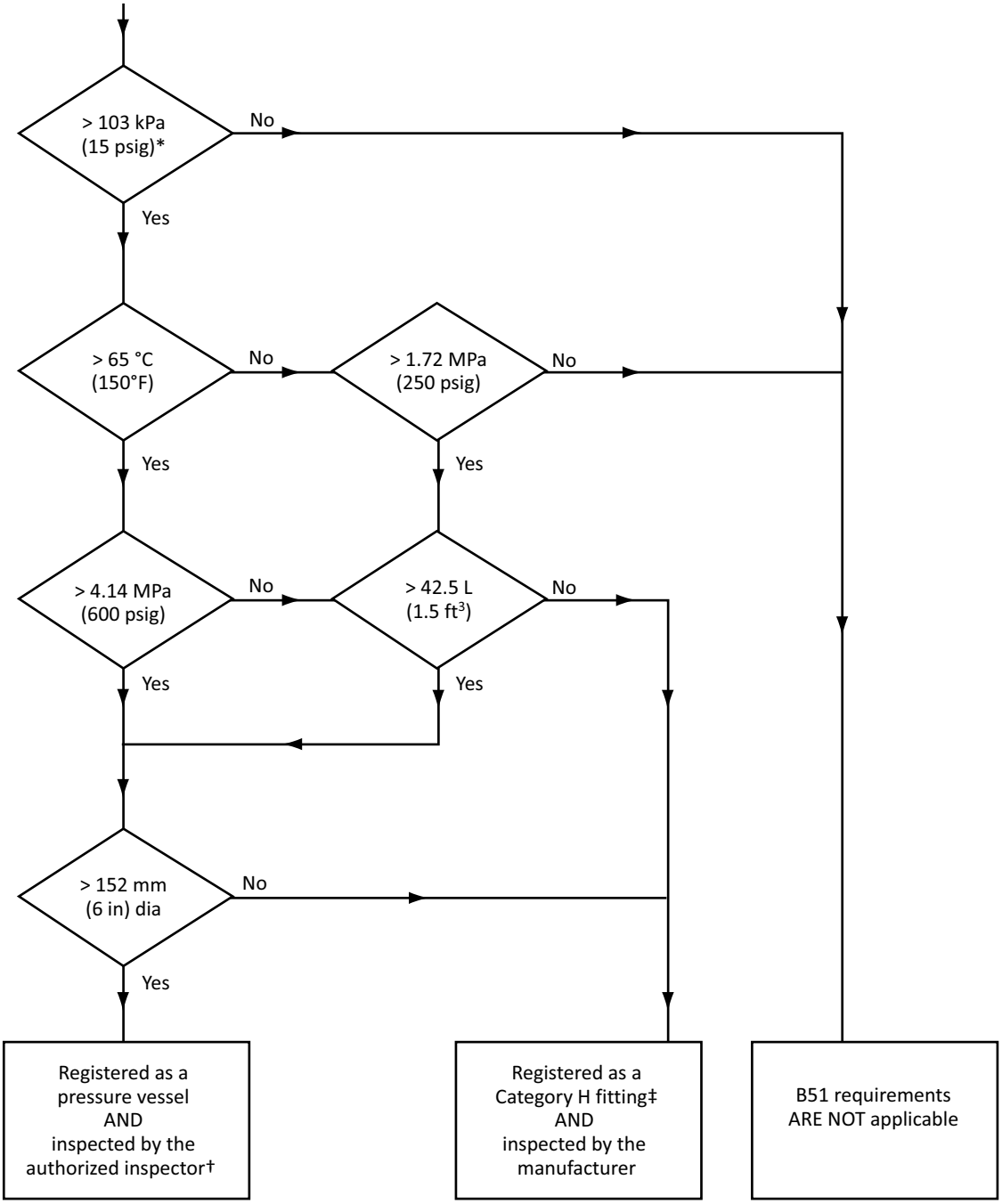
*** Air service shall be serviced every 5 years; servicing may be extended to a maximum of 10 years if annual system pressure test or lift tests are conducted from the beginning of the servicing interval.*

†† Servicing is required if a system pressure test or lift test has not been performed in accordance with the in-service testing intervals.

Note: *This Table does not apply to vessels covered by CSA B149.5.*

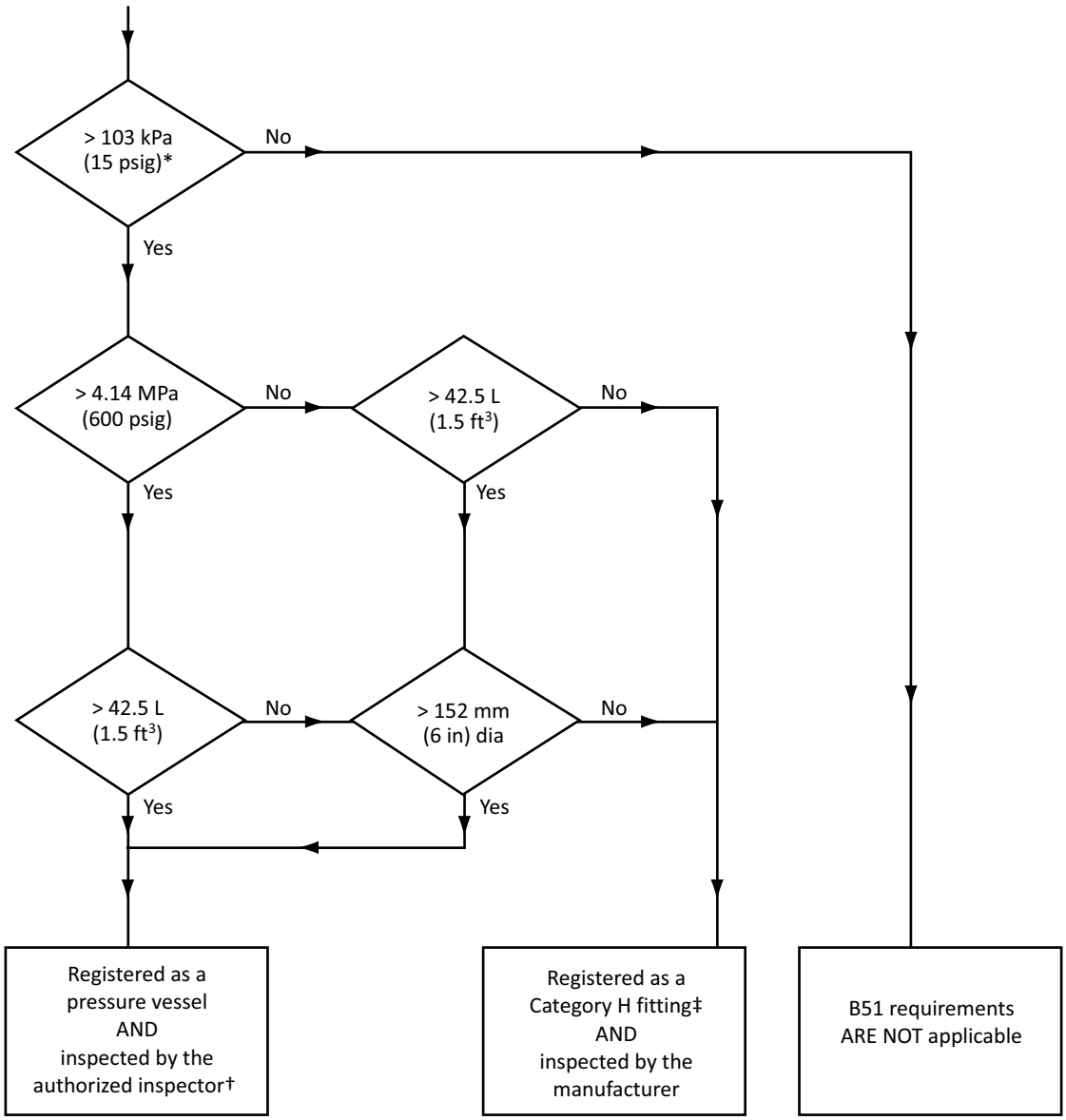
Figure 1 a)
Registration and inspection requirements for pressure vessels (and pressure vessels registered as Category H fittings) for liquid service with liquids not more hazardous than water

[See Clauses 4.1.1 and 4.8.2, Table 1, and Figure 1 b).]



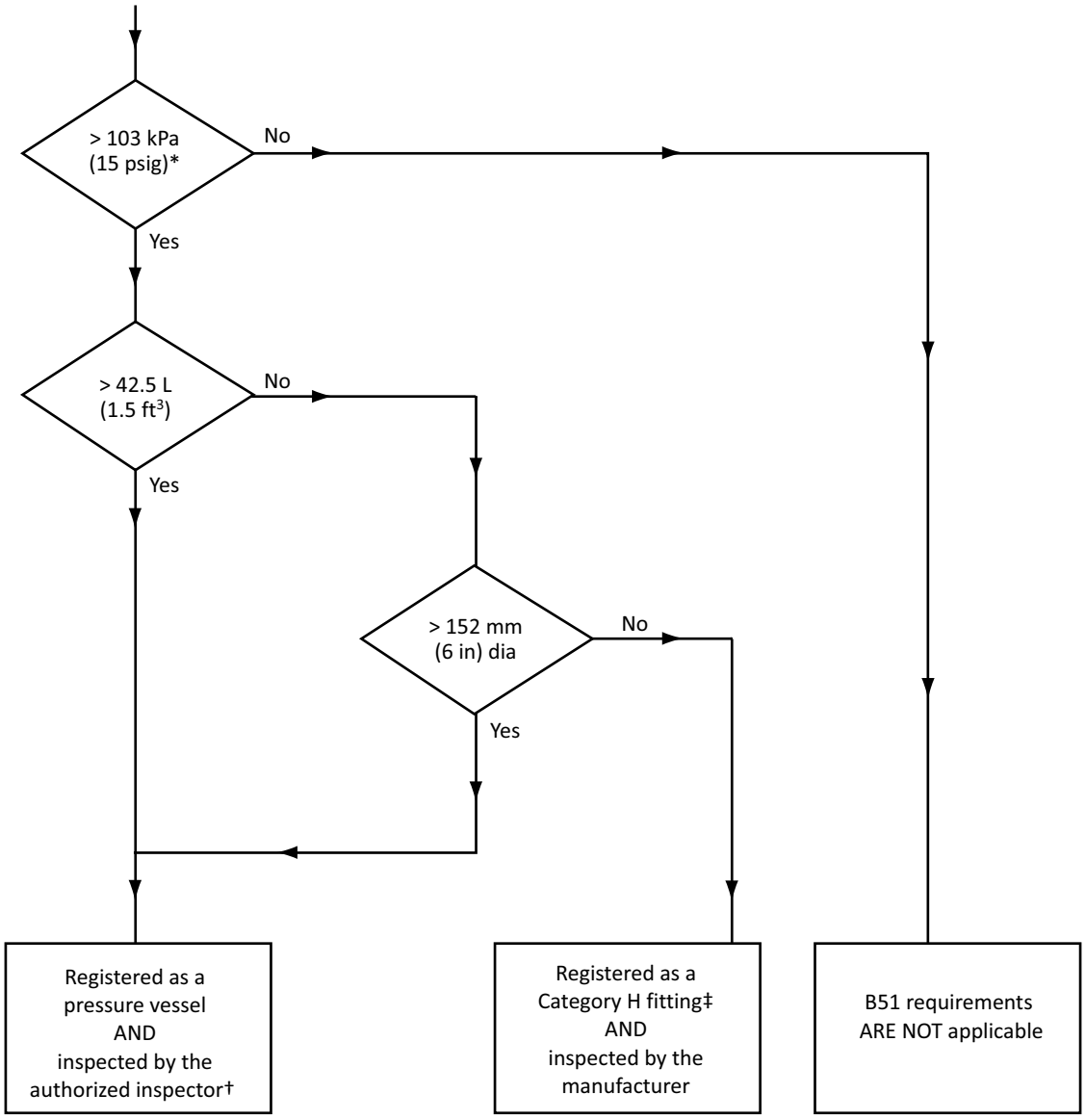
**Maximum allowable working pressure (MAWP).*
†See Clause 4.8.2 for exceptions to inspection requirements.
‡See Table 1.

Figure 1 b)
Registration and inspection requirements for pressure vessels (and pressure vessels registered as Category H fittings) containing a non-lethal gas or vapour or a non-lethal liquid not covered by Figure 1 a)
(See Clauses 4.1.1 and 4.8.2 and Table 1.)



Maximum allowable working pressure (MAWP).
†*See Clause 4.8.2 for exceptions to inspection requirements.*
‡*See Table 1.*

Figure 1 c)
Registration and inspection requirements for pressure vessels (and pressure vessels registered as Category H fittings) containing lethal substances
(See Clauses 4.1.1 and 4.8.2 and Table 1.)

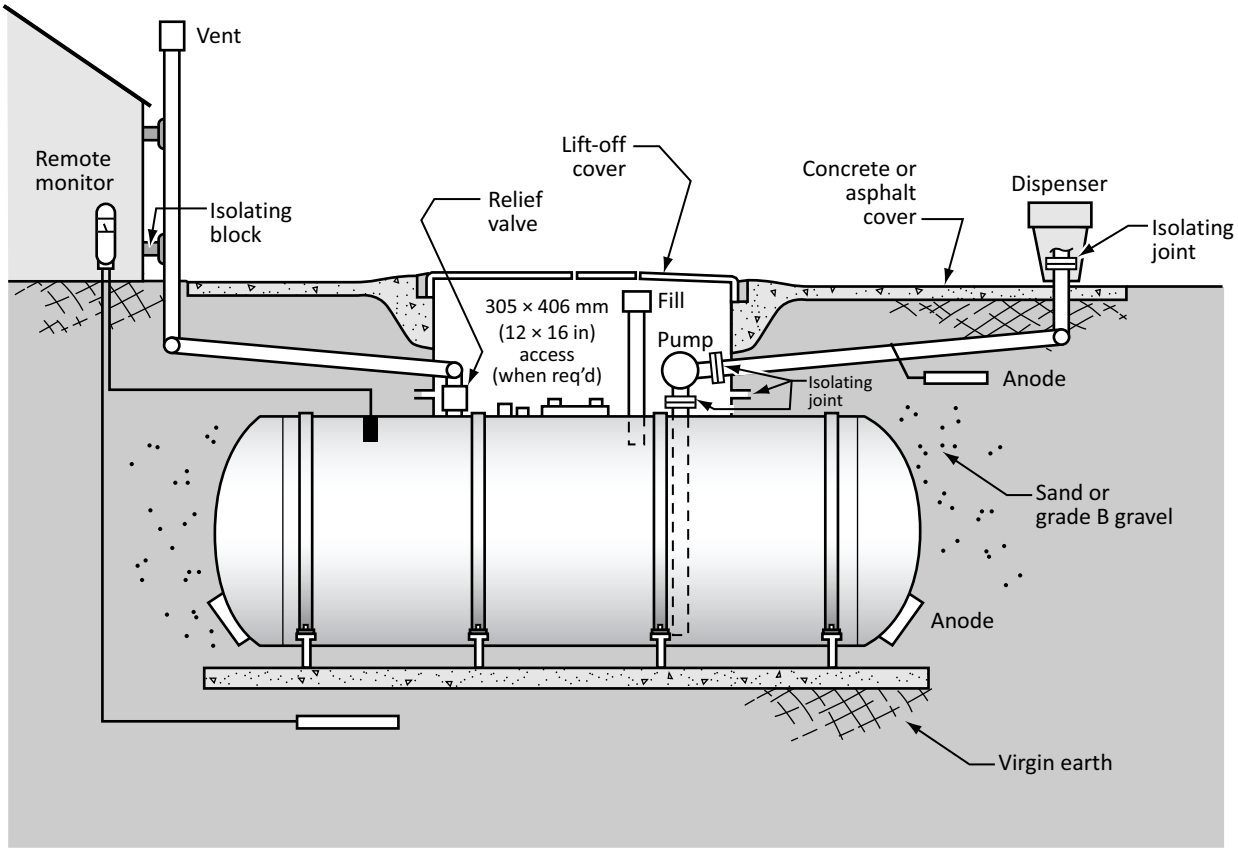


**Maximum allowable working pressure (MAWP).*
†*See Clause 4.8.2 for exceptions to inspection requirements.*
‡*See Table 1.*

Annex A (informative)
Burial of pressure vessels

Note: *This Annex is not a mandatory part of this Standard.*

Figure A.1
Typical installation of an underground pressure vessel



Note: *Vessel and piping are coated with corrosion-resistant compound complete with attached sacrificial anodes.*

Annex B (informative)
Quality control program for defect prevention and in-service reliability

Note: *This Annex is not a mandatory part of this Standard.*

B.1 Scope

This Annex describes a program that allows owners of boilers, pressure vessels, fired-heater pressure coils, or piping to enhance the safety and reliability of pressure-retaining components.

B.2 Development of the program

B.2.1

The company should establish a program of safety control, defect prevention, and in-service reliability. The person responsible for the program should be independent of the production line responsibility and have well-defined authority for making decisions relating to equipment safety and reliability.

B.2.2

The company should provide professional competence and technical experience in the application of appropriate codes and standards. The quality control group should anticipate and prevent deviations in the use of pressure plant components by coordinating efforts to control quality through planning at all stages of design, repair, maintenance, periodic testing, and operation.

B.2.3

The company should institute methods and procedures for the activities necessary to prevent and eliminate defects and control safety. For effective quality control and defect prevention, department heads should coordinate their plans for work on pressure-retaining components with the quality control group, and with the plans of other departments, to ensure that the agreed-on plans are being followed.

B.2.4

The following principles should apply:

a) Emphasis should be placed on preventing defects at all stages of design, use, examination, maintenance, repair, and operation.
b) Procedures for quality control and defect prevention should be specified in a manual and kept up-to-date (see Clause B.2.9).
c) Communication between the quality control group, suppliers of materials, and activity supervisors should be maintained to prevent misunderstandings about the requirements.
d) Design and method changes should be carefully controlled and records kept of the timing of significant changes.
e) A calibration program should be established to cover all inspection and testing equipment.

B.2.5

The company should determine the scope of repairs and alterations and develop repair methods and procedures.

B.2.6

The company should provide the facilities and equipment required for examination, testing, maintenance, supply of materials, and records as they relate to pressure plant components.

B.2.7

Tests of the pressure-retaining components should be conducted at critical points and at established intervals, and records kept to provide evidence of control.

B.2.8

Regular reviews of procedures and practices should be conducted by the quality control group to ensure that efforts to prevent defects are suitable, that approved procedures are followed, and that defect prevention is being attained.

B.2.9

The quality control group should ensure that the manual describing the activities, procedures, and methods to be used and maintained [see Clause B.2.4 b)] is adhered to in the plant. The manual should include procedures for in-plant inspection to ensure that basic materials are in compliance with specifications. It should also include in-plant defect-prevention forms and describe how they are to be processed.

B.2.10

The person responsible for the program should evaluate, at regular intervals, the degree of control achieved, the causes of deviations, and actions taken to prevent deviations from recurring, and report the results of the evaluation to senior management.

Annex C (informative)
Guidelines for safety valve, relief valve, and safety relief valve repair organizations

Notes:

1) *This informative Annex has been written in normative language to facilitate its adoption where users of the Standard or regulatory authorities wish to adopt it formally as additional requirements to this Standard.*
2) *The scope of activities in this Annex for repairs includes servicing as provided for in Clause 12.7.3 and, if required, welding and subsequent heat treatment and NDE per the applicable code.*
3) *This informative Annex does not apply to PRVs listed to ANSI/UL 132. Repair and servicing of these valves is by the original equipment manufacturer as noted in Clause 12.7.2.2.*

C.1 Administrative requirements

C.1.1 Scope

These guidelines are provided for organizations that wish to obtain a certificate of authorization for the repair of safety valves, relief valves, and safety relief valves. This certificate of authorization may be for shop repair, field repair, or both.

C.1.2 General

The general rules of this Annex apply only to the repair of registered safety valves, relief valves, and safety relief valves that have a rating sheet certified by the National Board of Boiler and Pressure Vessel Inspectors or other agencies approved by the regulatory authority. These devices may be ASME Code V-stamped (Section I), HV-stamped (Section IV), or UV-stamped (Section VIII) pressure relief valves. Manufacturers, assemblers, and organizations holding VR stamps are deemed to meet the requirements of this Annex.

C.1.3 Certificate of authorization

Repair organizations, manufacturers, assemblers, or users that repair pressure relief valves for boilers and pressure vessels may apply to the regulatory authority for acceptance of their quality control program. A provincial certificate of authorization expiring on the third anniversary of the review shall be issued.

The certificate of authorization shall be renewable every 3 years, subject to review and acceptance of the quality control program by a designated representative of the regulatory authority.

C.1.4 Documentation

The applicant shall keep copies of the following publications and make them available to any interested party on request:

a) the latest edition of and addenda to NBBI NB-23;
b) NBBI NB-18;
c) the applicable safety valve information from the ASME Code; and
d) the manufacturer’s repair information (manuals, drawings, specification sheets, etc.).

C.1.5 Performance testing

The applicant shall repair and submit for verification testing one valve for each ASME Code section and test fluid (steam, air/gas, liquid) that will appear on the certificate of authorization. A minimum of two

valves shall be required regardless of the ASME Code sections or test fluid. Before the certificate of authorization is issued or renewed, the demonstration valves shall successfully complete verification tests at the applicant's facility or at a field site in the presence of the regulatory authority representative during the quality control program review.

Valves not meeting the operational requirements to which they are manufactured shall be considered to have failed. Replacement valves shall be repaired and selected for testing as specified above, at a rate of two valves for each one that failed.

If either of the two replacement valves fails to meet the above criteria, the applicant shall document the cause of the noted deficiencies and the actions taken to prevent future occurrences. On acceptance of this information by the regulatory authority representative, the applicant shall be required to repair and resubmit one additional valve for each replacement valve that failed.

Valves marked for steam service, or having special internal parts for steam service, shall be tested with steam. Valves marked for air, gas, or vapour service shall be tested with air or gas. Valves marked for liquid service shall be tested with water or another suitable liquid. ASME Code, Section IV, hot water valves shall be tested with water, steam, or air. Each valve shall be tested to demonstrate set pressure (as defined by the valve manufacturer and as listed in NBBI NB-18), response to blowdown (if required), and seat tightness in accordance with the requirements of the applicable sections of the ASME Code.

When the applicant is unable to test a steam valve with steam because of boiler size or availability limitations, the quality control program shall provide a procedure acceptable to the regulatory authority to test valves and demonstrate the final pressure setting and sealing with steam at the customer's facilities.

C.1.6 Nameplate

C.1.6.1

When a pressure relief valve is repaired, a metal repair nameplate shall be stamped, stencilled, or by other means approved by the regulatory authority, with the information required by Clause C.1.6.2. The nameplate shall be permanently attached to the valve above, to one side of, or below the original stamping. If there is insufficient space on the valve for the repair nameplate to be permanently attached, the nameplate showing the repair nameplate information may be securely attached to the repaired valve.

C.1.6.2

C.1.6.2.1

At a minimum, the information on the valve repair nameplate shall include

a) the name of the repair organization;
b) a unique identifier (e.g., repair serial number, shop order number);
c) the date of repair;
d) the Canadian Registration Number;
e) the set pressure;
f) the capacity (only if changed); and
g) the type/model number (only if changed).

C.1.6.2.2

If the set pressure is changed, the previous set pressure, capacity, and blowdown, if applicable, on the original nameplate or stamping shall be crossed out by a single line and left legible. The new capacity shall be based on that for which the valve was originally certified.

When the original valve nameplate is missing, and the valve is not traceable, the repair organization shall not be authorized to perform repairs on the valve. Pressure valves not clearly identified or traceable shall be scrapped.

C.1.7 Performance testing equipment

Performance testing equipment shall meet the following requirements:

a) It shall include a pressure vessel with volume and pressure source capacity adequate to ensure compliance with Clause C.1.5.
b) Before use, it shall be qualified by the certificate holder to ensure that the equipment and testing procedures will provide accurate results when used within the ranges established for the equipment. This qualification shall be documented, and provision shall be made to retain such documentation for at least 5 years after the equipment is no longer in use. The documentation shall include, but not be limited to,
    i) a schematic of the equipment;
    ii) the size and pressure ranges of the valves to be tested;
    iii) the dimensions of the test vessels;
    iv) the accuracy of the pressure-measuring equipment; and
    v) the size and design type of the valves used to control flow.

Note: *This Clause also applies to auxiliary lift devices (ALD) (hydraulic, pneumatic, electronic types, etc.).*

C.2 Quality control program requirements

C.2.1 General

The repair organization shall have an operating quality control program that is documented in a manual and reviewed and accepted by the regulatory authority.

C.2.2 Outline of requirements for a quality control program

C.2.2.1 General

Each valve repair organization shall develop its own quality control program and manual, which shall meet the requirements of the organization. For this reason, it is not possible to develop one quality control program that can apply to more than one organization. At a minimum, the manual shall include the features and address the issues described in Clauses C.2.2.2 to C.2.2.16.

C.2.2.2 Title page of manual

The title page shall include the name and address of the applicant. It should also list the applicable sections of the ASME Code for the repairs.

C.2.2.3 Contents page of manual

The contents page should list the contents by paragraph and page number.

C.2.2.4 Statement of authority and responsibility

A statement of authority and responsibility shall be dated and signed by an officer of the company. It shall include:

a) a statement that the work shall be performed only on pressure relief valves that
   i) are stamped with an ASME Code V or UV symbol or marked with an ASME Code HV symbol;
   ii) have been capacity certified by the National Board or have rating sheets certified by other agencies approved by the regulatory authority; and
   iii) have been disassembled, inspected, and repaired by the certificate holder such that the repaired condition and performance are equivalent to the standards for new valves;
b) the title of the individual who is responsible for ensuring that the quality control program is followed and who has the authority and freedom to effect the responsibility;
c) a statement that if there is a disagreement concerning implementation of the quality control program, the matter is to be referred to a higher authority in the company for resolution; and
d) the title of the individual authorized to approve changes to the quality control program and the method by which such changes are to be submitted to the regulatory authority for acceptance before implementation.

C.2.2.5 Organization chart

A chart showing the relationship between management, purchasing, repair, inspection, and quality control personnel shall be included and shall reflect the actual structure of the organization.

C.2.2.6 Scope of work

The scope of work section shall indicate the scope and type of valve repairs of which the organization is capable and that it intends to perform. The location for the repairs (shop, shop and field, or field only), the test medium (air, gas, liquid, steam, or combinations thereof), and special processes (machining, welding, post-weld heat treatment, non-destructive examination (NDE), or combinations thereof) shall be addressed.

The types and sizes of valves to be repaired, pressure ranges, and other limitations, such as engineering and test facilities, shall also be addressed.

C.2.2.7 Drawings and specification control

The drawings and specification control system shall provide procedures to ensure that the most recent required drawings, specifications, and instructions are used for valve repair, inspection, and testing.

C.2.2.8 Parts and materials control

The parts and materials control section shall describe purchasing of parts from the valve manufacturer or their certified assembler/distributor (if applicable) and purchasing of materials, with requests for mill test certification as required, and proof of hydro test if applicable. It shall describe receiving, storage, and issuing.

The following information shall be provided in this section:

a) the title of the individual responsible for purchasing materials;
b) the title of the individual responsible for certification and other required records;
c) the method used to ensure that all incoming parts and materials are checked for conformance with the purchase order and, where applicable, the material specifications or drawings;
d) the means by which parts and materials are identified and identity is maintained; and
e) the method used to ensure that all parts are fabricated by the valve manufacturer or fabricated to the manufacturer's specifications.

Where such parts are supplied by an owner/user for use in the repair of their devices, this information is required.

C.2.2.9 Repair and inspection program

The repair and inspection program section shall refer to a document (e.g., a report, traveller, or checklist) that outlines the procedures used in the repair and inspection of pressure relief valves.

Arrangements shall be made to retain this document for at least 5 years. The following requirements shall also apply:

a) Each valve or group of valves shall be accompanied by the document referred to in this Clause for processing through the plant. Each valve shall have a unique identifier (e.g., repair serial number, shop order number) on the repair nameplate so that traceability to the document is established.
b) The document specified in this Clause shall describe the original nameplate information, including the ASME Code product certification mark and the repair nameplate information, if applicable. In addition, it shall include information on material check, replacement parts, welding procedure specifications, fit-up, NDE technique, heat treatment, pressure test methods to be used, etc. The text of the repair nameplate shall be recorded in this document. There should be a space for sign-offs for each operation to verify that each step has been properly performed.
c) The system shall include a method for controlling the repair or replacement of critical valve parts. The method for identifying each spring shall be indicated.
d) The system shall also describe the controls used to ensure that all personnel engaged in repairing pressure relief valves have been trained and qualified by the manufacturer or the assembler, or through National Board courses.

C.2.2.10 Welding, non-destructive examination, and heat treatment

For circumstances in which weld repairs are made by the repair organization, the quality control program manual shall describe and indicate the title(s) of the person(s) responsible for the system used in the development, approval, and qualification of welding procedure specifications and the qualifications of welders and welding operators in accordance with the requirements of Section IX of the ASME Code. Similarly, NDE and heat treatment techniques shall be covered in the quality control program manual. For circumstances in which outside services are used for NDE and heat treatment, the quality control program manual shall describe the system that ensures that the use of such services meets the requirements of the applicable Code.

Welding is not permitted on the nozzle/bushing and disc.

C.2.2.11 Valve testing, setting, and sealing

The quality control program shall include provisions that each valve shall be tested and set and that all external adjustments shall be sealed in accordance with the requirements of the applicable ASME Code section and NBBI NB-23. The seal shall identify the repair organization making the repair. Abbreviations may be used, provided that they are acceptable to the regulatory authority.

C.2.2.12 Valve repair nameplate

An effective valve identification system shall be established to ensure proper identification of each valve, as required by Clause C.1.6. The manual shall include a description or drawing of the nameplate.

C.2.2.13 Calibration of measurement and performance testing equipment

The following requirements shall apply to measurement and performance testing equipment:

a) Calibration of the measurement and test gauge system shall include periodic calibration of measuring instruments and pressure gauges.
b) Pressure gauges used for setting valves shall be checked at least every 12 months, by authorized personnel only. The calibration standard used (master gauge or dead weight tester) shall be indicated and the results recorded.
c) Calibration standards shall be calibrated against certified equipment having known valid relationships to nationally recognized standards.

C.2.2.14 Manual control

The quality control program shall include:

a) measures to control the issuance of and revisions to the quality control program manual;
b) provisions for a review of the system in order to keep the manual current with the applicable sections of the ASME Code and this Standard (including the provisions of this Annex);
c) the title(s) of the individual(s) responsible for control, revision, and review of the manual; and
d) a provision for submission of a controlled copy of the manual to the regulatory authority. Revisions shall be submitted to the regulatory authority for acceptance before implementation.

C.2.2.15 Nonconformities

The system shall establish measures for the identification, documentation, evaluation, segregation, and disposition of nonconformities. The title(s) of the individual(s) involved in this process shall be recorded.

Note: *A nonconformity is a condition of any material, item, product, or process in which one or more characteristics do not conform to the established requirements. These can include, but are not limited to, data discrepancies, procedural and/or documentation deficiencies, and material defects.*

C.2.2.16 Development, addition, and modification of performance testing equipment

The system shall include a means for controlling the development, addition, and modification of performance testing equipment to ensure that the requirements of Clause C.1.7 are met.

Annex D (informative)
Sample forms

Notes:

1) *This Annex is not a mandatory part of this Standard.*
2) *When a boiler or pressure vessel carries the ASME Code product certification mark, the appropriate ASME data report form is required in lieu of Figures D.1 a), D.1 b), D.1 c), D.1 d), D.2 a), D.2 b), D.2 c), D.2 d), D.2 e), D.3 a), and D.3 b) in all provinces.*

D.1

The following sample forms are provided in this Annex:

Figure D.1 a) — Manufacturer's data report for miniature pressure vessels

Figure D.1 b) — Manufacturer's data report for pressure vessels

Figure D.1 c) — Manufacturer's data report — Supplementary sheet for pressure vessels

Figure D.1 d) — Manufacturer's data report — Supplementary sheet for fixed shell-and-tube heat exchangers

Figure D.2 a) — Manufacturer's data report for watertube boilers

Figure D.2 b) — Manufacturer's data report — Supplementary sheet for watertube boilers

Figure D.2 c) — Engineering contractor data report for a complete boiler unit

Figure D.2 d) — Summary data report for process steam generators

Figure D.2 e) — Manufacturer's data report for pressure relief valves

Figure D.3 a) — Manufacturer's data report for boilers other than watertube boilers

Figure D.3 b) — Manufacturer's data report for cast iron and cast aluminum sectional boilers

Figure D.4 a) — Manufacturer's data report for fired process heaters

Figure D.4 b) — Engineering contractor's data report for fired process heaters

Figure D.5 a) — Pressure piping construction and test data report in Canada for piping other than ASME B31.1 boiler external piping

Figure D.5 b) — Pressure piping construction and test data report out of Canada for piping other than ASME B31.1 boiler external piping

Figure D.5 c) — Pressure piping construction and test data report for ASME B31.1 boiler external piping

Figure D.6 — Statutory declaration form for application for registration of fittings in Canada

Figure D.7 — Installation report for cast iron and cast aluminum sectional boilers

Figure D.8 — Repair or alteration report for boilers and pressure vessels

Figure D.1 a)
Manufacturer's data report for miniature pressure vessels
(See Clauses 4.8.2 and D.1.)

MANUFACTURER'S DATA REPORT
FOR MINIATURE PRESSURE VESSELS
DÉCLARATION DE CONFORMITÉ DU CONSTRUCTEUR
POUR APPAREILS SOUS PRESSION MINIATURE

Partial / *Partiel* ☐

Upon shipment of a pressure vessel, this form must be filled in and sent to the office of the Chief Inspector having jurisdiction in the province of installation.
Au moment de l'expédition d'un appareil sous pression, ce formulaire dûment rempli, doit être envoyé à l'autorité réglementaire de la province d'installation.

Manufactured by ***Construit par***	(Name and Address / *Nom et adresse*)
Manufactured for ***Construit pour***	(Name and Address / *Nom et adresse*)
Ultimate Owner ***Propriétaire final***	(Name and Address / *Nom et adresse*)
Location of Installation ***Lieu d'installation***	(Address / *Adresse*)

Pressure Vessel / *Appareil sous pression*

Type / *Genre*	Manufacturer's S N / *N° de série*	Year Built / *Année de fabrication*
CRN / *NEC*	Overall Length / Longueur totale	Drawing Number / *N° de dessin*

The chemical and physical properties of all parts meet the requirements of material specifications of the ASME Code. The design, construction and workmanship conform to CSA B51. / *Les propriétés chimiques et physiques de toutes les pièces respectent les exigences des spécifications de matériaux de code ASME. La conception, la construction et la maîtrise d'exécution sont conformes au CSA B51.*	ASME Section	Div	Edition *Édition*	Code Case No (s) *N° de code Case*
	VIII	1		

Manufacturers partial data reports properly identified and signed by authorized inspectors have been furnished for the following items of the report and attached to this report:
Les déclarations partielles du constructeur adéquatement identifiées et signées par les inspecteurs autorisés ont été produites pour les items suivants et sont attachées à cette déclaration:

Name of Part / *Nom de la composante*	Manufacturer's Name / *Nom du constructeur*	Identifying Stamp / *Sceau d'identification*

Shell / *Virole*

Material *Matériau*	Thickness *Épaisseur*	Corr Allow *Surépa s de corr*	Diameter *Diamètre*	Longitudinal Joints *Joints longitud naux* Type	RT *Radiog*	Efficiency *Efficacité*	P W H T *Traitements thermiques* Temp	Time *Durée*	Girth Jo nts *Joints de circonférence* Type	RT *Radiog*	Efficiency *Efficacité*	Number of Courses *Nombre de sections*
						%					%	
						%					%	

Body Flanges on Shells / *Brides sur les viroles*

No	Type	I D *Diam int*	O D *Diam ext*	Flange Thickness *Épaisseur de la bride*	Min Hub Thk *Épaisseur min de la collerette*	Material *Matériau*	How Attached *Méthode de fixation*	Location *Emplacement*	Bolting / *Boulonnerie* Qty and Size *Nombre et dimension*	Material *Matériau*

Heads / *Têtes*

Location Top, Bottom, Ends *Emplacement Haut, Bas, Extrémités*		Material *Matériau*	Min Thick *Épais min*	C A *Surépais de corr*	Crown Rad *Rayon couron*	Knuckle Radius *Petit rayon*	Ell pse Ratio *Rapp ellipse*	Conical Apex Angle *Angle conique*	Hemisph Radius *Rayon hémisph*	Flat D ameter *Diam plat*	Side to Pressure *Côte sous pression*
a											
b											

Body Flanges on Heads / *Brides sur les têtes*

Location *Emplacement*		Type	I D *Diam Int*	O D *Diam Ext*	Flange Th ckness *Épaisseur de la bride*	Min Hub Thk *Épaisseur min de la co lerette*	Material *Matériau*	How Attached *Méthode de fixation*	Bolting / *Boulonnerie* Qty and Size *Nombre et dimens on*	Material *Matériau*
a										
b										

Pressures and Temperatures / *Pressions et températures*

Constructed for Maximum A lowable Working Pressure *Construit pour une pression maximale de marche permise*	At Maximum Temperature *À une température maximale*	Minimum Design Metal Temperature *Température minimale de concept on*	Test Pressure (Hydrostat c, Pneumatic, or Comb nation) *Pression d'épreuve (hydrostatique, pneumatique ou combinaison)*	Proof Test *Essai de résistance*
Internal *Interne*	Internal *Interne*			
External *Externe*	External *Externe*			

Manufacturer's S gnature *Signature du constructeur*	Date

Page 1 of (*de*) 2

(Continued)

Figure D.1 a) (Concluded)

Impact Tests / *Essais de résilience* – Indicate components impact tested or exempted / *Indiquer les composants éprouvés ou exclus*

Materials / *Matériaux*			Welds / *Soudures*		
Tested *Essai*	Components / *Composants*	Test Temperature / *Température d'essai*	Tested *Essai*	Production Test / *Test de production*	Test Temperature / *Température d'essai*
Exempt *Exempté*	Components / *Composants*	Per Paragraph(s) / *Selon le(s) paragraphe(s)*	Exempt *Exempté*	Per Paragraph(s) / *Selon le(s) paragraphe(s)*	

Tube Section / *Faisceau tubulaire*

Tubesheet *Plaque tubulaire*	Material *Matériau*	Diameter *Diamètre*	Nom Thick *Épaisseur nominale*	Corr Allow *Surépaisseur de corrosion*	How Attached *Méthode de f xation*
Tube Material *Matériau des tubes*	Tube Diameter *Diamètre des tubes*	Nom Thick (gauge) *Épaisseur nominale (calibre)*	Number *Nombre*	Type (Straight or U) *Type (droit ou U)*	Heating Surface *Surface de chauffe*

Jacket / *Double enveloppe*

Type of Jacket *Genre d'enveloppe*	Jacket Closure *Fermeture d'enveloppe*	Proof Test Pressure *Pression d'épreuve*	Heating Surface *Surface de chauffe*	Sketch Reference *Schéma de référence*

Safety Valve Outlets / *Raccord pour soupape de sûreté*

Number / *Nombre*	Dimension	Locat on / *Localisation*

Nozzles and Openings / *Tuyères et ouvertures*

Purpose / *Fonction* (Inlet, Outlet, Drain, etc)	Num *№*	Diameter or Size *Diamètre ou dimension*	Type	Material / *Matériau*		Nozzle Thickness *Épaisseur de la tuyère*		Reinforcement Material *Matériau de renforcement*	How Attached *Méthode de fixation*		Location *Localisation*
				Nozzle / *Tuyère*	Flange / *Br de*	Nom	Corr		Nozzle *Tuyère*	Flange *Bride*	

Supports / *Supports*

Skirt / *Jupe*	Number of Lugs *Nombre d'ore lles*	Number of Legs *Nombre de pattes*	Other (Description) *Autres (description)*	How Attached *Méthode de fixation*
☐ Yes ☐ No				

Remarks / *Remarques*

Certificate of Compliance / *Certificat de conformité*

We certify that the statements made in this data report are correct and that the said vessel has been constructed in accordance with the Provincial Registered design below and the requirements of CSA B51
Nous certifions que les données de la déclaration de conformité sont correctes et que l'appareil a été construit en accord avec l'enregistrement provincial ci dessous et les exigences du code CSA B51

Manufacturer / *Constructeur:* CRN *NEC* _____

Name/*Nom* _____ Signature _____ Date _____

Certified Individual / *Personne certifié:*

Name/*Nom* _____ Signature _____ Date _____

Manufacturer *Constructeur* _____ Mfr's S N *N° de série* _____

Figure D.1 b)
Manufacturer's data report for pressure vessels
(See Clause D.1.)

MANUFACTURER'S DATA REPORT
FOR PRESSURE VESSELS
DÉCLARATION DE CONFORMITÉ DU CONSTRUCTEUR
POUR APPAREILS SOUS PRESSION

Partial / *Partiel* ☐

Upon shipment of a pressure vessel, this form must be filled in and sent to the office of the Chief Inspector having jurisdiction in the province of installation.
Au moment de l'expédition d'un appareil sous pression, ce formulaire dûment rempli, doit être envoyé à l'autorité réglementaire de la province d'installation.

Manufactured by ***Construit par***	(Name and Address / *Nom et adresse*)
Manufactured for ***Construit pour***	(Name and Address / *Nom et adresse*)
Ultimate Owner ***Propriétaire final***	(Name and Address / *Nom et adresse*)
Location of Installation ***Lieu d'installation***	(Address / *Adresse*)

Pressure Vessel / *Appareil sous pression*

Type / *Genre*		Manufacturer's S N / *N° de série*	Year Built / *Année de fabrication*
CRN / *NEC*	Overall Length / *Longueur totale*	National Board No / *N° National Board*	Drawing Number / *N° de dessin*

The chemical and physical properties of all parts meet the requirements of material specifications of the ASME Code. The design, construction and workmanship conform to CSA B51. / *Les propriétés chimiques et physiques de toutes les pièces respectent les exigences des spécifications de matériaux du code ASME. La conception, la construction, et la maitrise d'exécution sont conformes au CSA B51.*	ASME Section	Div	Edition *Édition*	Code Case No (s) *Nº de code Case*

Manufacturers partial data reports properly identified and signed by authorized inspectors have been furnished for the following items of the report and attached to this report:
Les déclarations partielles du constructeur adéquatement identifiées et signées par les inspecteurs autorisés ont été produites pour les items suivants et sont attachées à cette déclaration:

Name of Part / *Nom de la composante*	Manufacturer's Name / *Nom du constructeur*	Identifying Stamp / *Sceau d'identification*

Shell / *Virole*

Material *Matériau*	Thickness *Épaisseur*	Corr Allow *Surépa s de corr*	Diameter *Diamètre*	Longitudinal Joints *Joints longitud naux* Type	RT *Radiog*	Efficiency *Efficacité*	P W H T *Traitements thermiques* Temp	Time *Durée*	Girth Jo nts *Joints de circonférence* Type	RT *Radiog*	Efficiency *Efficacité*	Number of Courses *Nombre de sections*
						%					%	
						%					%	

Body Flanges on Shells / *Brides sur les viroles*

No	Type	I D *Diam int*	O D *Diam ext*	Flange Thickness *Épaisseur de la bride*	Min Hub Thk *Épaisseur min de la collerette*	Material *Matériau*	How Attached *Méthode de fixation*	Location *Emplacement*	Bolting / *Boulonnerie* Qty and Size *Nombre et dimension*	Material *Matériau*

Heads / *Têtes*

Location Top, Bottom, Ends *Emplacement Haut, Bas, Extrémités*		Material *Matériau*	Min Thick *Épais min*	C A *Surépais de corr*	Crown Rad *Rayon couron*	Knuckle Radius *Petit rayon*	Ell pse Ratio *Rapp ellipse*	Conical Apex Angle *Angle conique*	Hemisph Radius *Rayon hémisph*	Flat D ameter *Diam plat*	Side to Pressure *Côte sous pression*
a											
b											

Body Flanges on Heads / *Brides sur les têtes*

Location *Emplacement*		Type	I D *Diam int*	O D *Diam ext*	Flange Th ckness *Épaisseur de la bride*	Min Hub Thk *Épaisseur min de la co lerette*	Material *Matériau*	How Attached *Méthode de fixat on*	Bolting / *Boulonnerie* Qty and Size *Nombre et dimens on*	Material *Matériau*
a										
b										

Pressures and Temperatures / *Pressions et températures*

Constructed for Maximum A lowable Working Pressure *Construit pour une pression maximale de marche permise*	At Maximum Temperature *À une température maximale*	Minimum Design Metal Temperature *Température minimale de concept on*	Test Pressure (Hydrostat c, Pneumatic, or Comb nation) *Pression d'épreuve (hydrostatique, pneumatique ou combinaison)*	Proof Test *Essai de résistance*
Internal *Interne*	Internal *Interne*			
External *Externe*	External *Externe*			

Manufacturer's S gnature *Signature du constructeur*	Date
Authorized Inspector's Signature *Signature de l'inspecteur autorisé*	Date

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(Continued)

Figure D.1 b) (Continued)

Impact Tests / *Essais de résilience* – Indicate components impact tested or exempted / *Indiquer les composants éprouvés ou exclus*

Materials / *Matériaux*			Welds / *Soudures*		
Tested *Essai*	Components / *Composants*	Test Temperature / *Température d'essai*	Tested *Essai*	Production Test / *Test de production*	Test Temperature / *Température d'essai*
Exempt *Exempté*	Components / *Composants*	Per Paragraph(s) / *Selon le(s)paragraphe(s)*	Exempt *Exempté*	Per Paragraph(s) / Selon le(s) *paragraphe(s)*	

Tube Section / *Faisceau tubulaire*

Tubesheet *Plaque tubulaire*	Material *Matériau*	Diameter *Diamètre*	Nom Thick *Épaisseur nominale*	Corr Allow *Surépaisseur de corrosion*	How Attached *Méthode de fixation*
Tube Material *Matériau des tubes*	Tube Diameter *Diamètre des tubes*	Nom Thick (gauge) *Épaisseur nominale (calibre)*	Number *Nombre*	Type (Straight or U) *Type (droit ou U)*	Heating Surface *Surface de chauffe*

Jacket / *Double enveloppe*

Type of Jacket *Genre de double enveloppe*	Jacket Closure *Fermeture de double enveloppe*	Proof Test Pressure *Pression d'essai de résistance*	Heating Surface *Surface de chauffe*	Sketch Reference *Schéma de référence*

Safety Valve Outlets / *Raccord pour soupape de sûreté*

Number / *Nombre*	Dimension	Locat on / *Localisation*

Nozzles and Openings / *Tuyères et ouvertures*

Purpose / *Fonction* (Inlet, Outlet, Drain, etc)	Num *№*	Diameter or Size *Diamètre ou dimension*	Type	Material / *Matériau*		Nozzle Thickness *Épa sseur de la tuyère*		Reinforcement Material *Matériau de renforcement*	How Attached *Méthode de fixation*		Location *Localisation*
				Nozzle / *Tuyère*	Flange / *Br de*	Nom	Corr		Nozzle *Tuyère*	Flange *Bride*	

Supports / *Supports*

Skirt / *Jupe*	Number of Lugs *Nombre d'ore lles*	Number of Legs *Nombre de pattes*	Other (Description) *Autre (description)*	How Attached *Méthode de fixation*
☐ Yes/Oui ☐ No/Non				

Manufacturer *Constructeur*	______________	Manufacturer's S gnature *Signature du constructeur*	Date
Mfr's S N *N° de série*	______________	Authorized Inspector's Signature *Signature de l'inspecteur autorisé*	Date

Page 2 of (*de*) 3

(Continued)

Figure D.1 b) (Concluded)

Remarks / *Remarques*

Certificate of Compliance / *Déclaration de conformité*

I certify that the statements made in this data report are correct and that the said vessel has been constructed in accordance with the Provincial Registered design below and the requirements of CSA B51
Je certifie que les données de la déclaration de conformité sont correctes et que l'appareil a été construit en accord avec l'enregistrement provincial ci dessous et les exigences du CSA B51

Manufacturer / *Constructeur:* CRN *NEC* _____

Name/*Nom* _____ Signature _____ Date _____

Certificate of Shop Inspection / *Déclaration d'inspection en usine*

I, the undersigned, a duly authorized boiler and pressure vessel inspector / *Je, soussigné, inspecteur autorisé de chaudières et appareils sous pression*

employed by / *employé par* _____ of / *de* _____

have inspected the above vessel and state that to the best of my knowledge and belief the manufacturer has constructed the vessel in accordance with the CRN indicated below and the requirements of CSA B51 By signing this certificate, neither the authorized inspector nor his or her employer makes any warranty, expressed or implied, concerning the vessel described in this manufacturer's data report Furthermore, neither the authorized inspector nor his or her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection
ai inspecté l'appareil sous pression précité et, en autant que je sache, le constructeur a fabriqué l'appareil en accord avec le numéro d'enregistrement canadien ci dessous et les exigences du CSA B51 En signant cette déclaration, l'inspecteur ni son employeur ne donnent de garantie explicite ou implicite relativement à l'appareil décrit dans la présente déclaration De plus, ni l'inspecteur ni son employeur ne doivent être tenus responsables de quelque manière que ce soit des dommages, matériels ou corporels, ou des pertes de quelque nature que ce soit pouvant résulter de cette inspection

Authorized Inspector / *Inspecteur autorisé:* CRN *NEC* _____

Name*/*Nom** _____ Signature _____ Date _____

*Include nspector's National Board commission number and/or provincial certificate number *Inclure le numéro de la commission du National Board de l'inspecteur et/ou de son certif cat provincial*

Certificate of Compliance – Field Work / *Déclaration de conformité – Installation au chantier*

We certify that the field installation of all parts of the vessel conforms with the requirements of Provincial Regulations
Nous déclarons que l'installation au chantier de toutes les pièces de l'appareil est conforme à la réglementation provinciale

Installer / *Installateur:*

Name/*Nom* _____ Signature _____ Date _____

Certificate of Field Inspection / *Déclaration d'inspection – Installation au chantier*

I, the undersigned, a duly authorized boiler and pressure vessel inspector / *Je, soussigné, inspecteur autorisé de chaudières et appareil sous pression*

employed by / *employé par* _____ of / *de* _____

have inspected the items not covered by the Certificate of Shop inspection and the installation of the items and state that to the best of my knowledge and belief the construction and assembly of the items are in accordance with the provincial regulations By signing this certificate, neither the authorized inspector nor his or her employer makes any warranty, expressed or implied, concerning the vessel described in this manufacturer's data report Furthermore, neither the authorized inspector nor his or her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection
ai inspecté les composantes non couvertes par la déclaration d'inspection en usine et l'installation de l'appareil et, en autant que je sache, la construction et l'assemblage de l'appareil sont en accord avec la réglementation provinciale En signant cette déclaration, ni l'inspecteur ni son employeur ne donnent de garantie explicite ou implicite relativement à l'appareil décrit dans la présente déclaration De plus, ni l'inspecteur ni son employeur ne doivent être tenus responsables de quelque manière que ce soit des dommages, matériels ou corporels, ou des pertes de quelque nature que ce soit pouvant résulter de cette inspection

Authorized Inspector / *Inspecteur autorisé:*

Name*/*Nom** _____ Signature _____ Date _____

*Include nspector's National Board commission number and/or provincial certificate number *Inclure le numéro de la commission du National Board de l'inspecteur et/ou de son certif cat provincial*

Manufacturer *Constructeur* _____
Mfr's S N *N° de série* _____

Figure D.1 c)
Manufacturer's data report — Supplementary sheet for pressure vessels
(See Clause D.1.)

MANUFACTURER'S DATA REPORT – SUPPLEMENTARY SHEET
FOR PRESSURE VESSELS
DÉCLARATION DE CONFORMITÉ DU CONSTRUCTEUR - FEUILLE SUPPLÉMENTAIRE
POUR LES APPAREILS SOUS PRESSION

Manufactured by ***Construit par***	(Name and Address / *Nom et adresse*)
Manufactured for ***Construit pour***	(Name and Address / *Nom et adresse*)
Ultimate Owner ***Propriétaire final***	(Name and Address / *Nom et adresse*)
Location of Installation ***Lieu d'installation***	(Address / *Adresse*)

Pressure Vessel / *Appareil sous pression*

Type / *Genre*	Manufacturer's S N / *N° de série*	Year Built / *Année de fabrication*
CRN / *NEC*	National Board No / *N° National Board*	Drawing Number / *N° de dessin*

Nozzles and Openings / *Tuyères et ouvertures*

Purpose / *Fonction* (Inlet, Outlet, Drain, etc)	Num *N-*	Diameter or Size *Diamètre ou dimension*	Type	Material / *Matériau*		Nozzle Thickness *Épaisseur de la tuyère*		Reinforcement Material *Matériau de renforcement*	How Attached *Méthode de fixation*		Location *Localisation*
				Nozzle / *Tuyère*	Flange / *Br de*	Nom	Corr		Nozzle *Tuyère*	Flange *Bride*	

Other / *Autres*

Manufacturer / *Constructeur:*

Name/ *Nom* _____ Signature _____ Date _____

Authorized Inspector / *Inspecteur autorisé:*

Name*/ *Nom** _____ Signature _____ Date _____

*Include inspector's National Board commission number and/or provincial certif cate number *Inclure le numéro de la commission du National Board de l'inspecteur et/ou de son cert ficat prov ncial*

Page 1 of (*de*) 1

Figure D.1 d)
Manufacturer's data report — Supplementary sheet for fixed shell-and-tube heat exchangers
(See Clause D.1.)

MANUFACTURER'S DATA REPORT – SUPPLEMENTARY SHEET
FOR FIXED SHELL AND TUBE HEAT EXCHANGERS
DÉCLARATION DE CONFORMITÉ DU CONSTRUCTEUR - FEUILLE SUPPLÉMENTAIRE
POUR LES ÉCHANGEURS DE CHALEUR À CALANDRE

Manufactured by ***Construit par***	(Name and Address / *Nom et adresse*)
Manufactured for ***Construit pour***	(Name and Address / *Nom et adresse*)
Ultimate Owner ***Propriétaire final***	(Name and Address / *Nom et adresse*)
Location of Installation ***Lieu d'installation***	(Address / *Adresse*)

Pressure Vessel / *Appareil sous pression*

Type / *Genre*	Manufacturer's S N / *N° de série*	Year Built / *Année de fabrication*
CRN / *NEC*	National Board No / *N° National Board*	Drawing Number / *N° de dessin*

Fixed Shell-and-Tube Heat Exchanger / *Échangeur de chaleur à calandre*

Condition *Situation*	Design / Operating Pressure Ranges *Gamme de pressions de conception / de fonctionnement*		Maximum Design / Operating Metal Temperature *Température maximale de conception / de fonctionnement*				Axial Differential Thermal Expansion Range (Min / Max) *dilatation thermique axiale (min / max)*
	Shell Side *Côté de l'enveloppe*	Tube Side *Côté des tubes*	Shell *Enveloppe*	Channel *Canal de distribution*	Tubes *Tubes*	Tubesheet *Plaque tubulaire*	
Design/ *Conception*							
Operating/ *Fonctionnant*							

Other / *Autres*

Manufacturer / *Constructeur:*

Name/ Nom _____ S gnature _____ Date _____

Authorized Inspector / *Inspecteur autorisé:*

Name*/ Nom* _____ S gnature _____ Date _____

*Include inspector's Nat onal Board commiss on number and/or provincial cert ficate number *Inclure le numéro de la commission du National Board de l'inspecteur et/ou de son certificat provincial*

Page 1 of (*de*) 1

Figure D.2 a)
Manufacturer's data report for watertube boilers
(See Clause D.1.)

MANUFACTURER'S DATA REPORT
FOR WATERTUBE BOILERS
DÉCLARATION DE CONFORMITÉ DU CONSTRUCTEUR
POUR CHAUDIÈRES AQUATUBULAIRES

Partial / *Partiel* ☐

Upon shipment of a watertube boiler, this form must be filled in and sent to the office of the Chief Inspector having jurisdiction in the province of installation.
Au moment de l'expédition d'une chaudière aquatubulaire, ce formulaire dûment rempli, doit être envoyé à l'autorité réglementaire de la province d'installation.

Manufactured by ***Construit par***	(Name and Address / *Nom et adresse*)
Manufactured for ***Construit pour***	(Name and Address / *Nom et adresse*)
Ultimate Owner ***Propriétaire final***	(Name and Address / *Nom et adresse*)
Location of Installation ***Lieu d'installation***	(Address / *Adresse*)

Boiler / *Chaudière*

Description	Manufacturer's S N / *N° de série*	Year Built / *Année de fabrication*
CRN / *NEC*	National Board No / *N° National Board*	Drawing Number / *N° de dessin*

The chemical and physical properties of all parts meet the requirements of material specifications of the ASME Code. The design, construction and workmanship conform to CSA B51. ***Les propriétés chimiques et physiques de toutes les pièces respectent les exigences des spécifications de matériaux de code ASME. La conception, la construction et la maîtrise d'exécution sont conformes au CSA B51***	ASME Sect on	Div	Edition *Édition*	Code Case No (s) *Nº de code Case*

Manufacturers partial data reports properly identified and signed by authorized inspectors have been furnished for the following items of the report, and attached to this report:
Les déclarations partielles du constructeur adéquatement identifiées et signées par les inspecteurs autorisés ont été produites pour les items suivants et sont attachées à cette déclaration:

Name of Part / *Nom de la composant6e*	Manufacturer's Name / *Nom du constructeur*	Identifying Stamp / *Sceau d'identif cation*

Drums / *Ballons* – Shell / *Virole*

Material Spec fication / *Spécification du matériau*	Grade	Inside Length / *Long interne*	Inside Diameter / *Dia Interne*	Thickness / *Épaisseur*

Tubesheet / *Plaque tubulaire* | **Longitudinal Joints / *Joints longitud.*** | **Girth Joints / *Joints de circonférence***

Mat'l Spec No *Spéc du matériau*	Grade	Th ckness *Épaisseur*	Inside Dia *Dia Interne*	No *Nbre*	Seamless *Sans Soudure*	Welded *Soudé*	Joint Efficiency *Efficacité du joint*	No *Nbre*	Seamless *Sans Soudure*	Welded *Soudé*	Joint Efficiency *Efficac té du joint*
					☐	☐	%		☐	☐	%
					☐	☐	%		☐	☐	%

Heads / Têtes

Mat'l Spec No *Spéc du matériau*	Grade	Flat *Plate*	Dished *À calotte*	Ellipsoidal *Elliptique*	Thickness *Épaisseur*	D sh Radius *Ray de calotte*
		☐	☐	☐		
		☐	☐	☐		

Inspection Openings *Ouvertures d'inspection*

No /*Nbre*	Type	Dim

Hydro Test Pressure *Pression du test hydrostatique*

Tubes

No *Nbre*	Mat'l Spec No *Spéc du matériau*	Grade	Outside Diameter *Diamètre extérieur*	Gauge (Thickness) *Cal bre (épaisseur)*	**Tube Hole Lig. Efficiencies *Efficacités des lig. des trous de tubes*** Longitudinal *Long tudinaux*	Circumferent al *Circonférentiel*
					%	%
					%	%

Staybolts / *Étais*

No *Nbre*	Mat'l Spec No *Spéc du matériau*	Grade	Outside D ameter *Diamètre extérieur*	Size Telltale *Trou témoin*	Net Area *Section efficace*	Pitch *Pas*	Net Area Supported by One Staybolt *Section nette supportée par un étai*	Max A W P *Pres Max M P*

Manufacturer's S gnature *Signature du constructeur*	Date
Authorized Inspector's Signature *Signature de l'inspecteur autorisé*	Date

Page 1 of (*de*) 3

(Continued)

Figure D.2 a) (Continued)

Waterwall / *Murs d'eau*

Headers ***Collecteurs***	No / *Nbre*	Type	Dimension	Mat'l Spec No *Spéc du mat*	Thickness *Épaisseur*	**Heads** ***Têtes***	Mat'l Spec No / *Spéc du mat*	Grade	Type	Thickness *Épaisseur*
Tubes	No / *Nbre*	Outside Dia / *Dia Ext*	Thickness / *Épaisseur*	Pitch / *Pas*	Mat'l Spec No / *Spéc du mat*	Grade	Test Pressure / *Pression d'épreuve*			

Economizer / *Économiseur*

Headers ***Collecteurs***	No / *Nbre*	Type	Dimension	Mat'l Spec No *Spéc du mat*	Thickness *Épaisseur*	**Heads** ***Têtes***	Mat'l Spec No / *Spéc du mat*	Grade	Type	Thickness *Épaisseur*
Tubes	No / *Nbre*	Outside Dia / *Dia Ext*	Thickness / *Épaisseur*	Pitch / *Pas*	Mat'l Spec No / *Spéc du mat*	Grade	Test Pressure / *Pression d'épreuve*			

Superheater / *Surchauffeur*

Headers ***Collecteurs***	No / *Nbre*	Type	Dimension	Mat'l Spec No *Spéc du mat*	Thickness *Épaisseur*	**Heads** ***Têtes***	Mat'l Spec No / *Spéc du mat*	Grade	Type	Thickness *Épaisseur*
Tubes	No / *Nbre*	Outside Dia / *Dia ext*	Thickness / *Épaisseur*	Pitch / *Pas*	Mat l Spec No / *Spéc du mat*	Grade	Test Pressure / *Pression d'épreuve*			

Other / *Autres*

Headers ***Collecteurs***	No / *Nbre*	Type	Dimension	Mat'l Spec No *Spéc du mat*	Thickness *Épaisseur*	**Heads** ***Têtes***	Mat'l Spec No / *Spéc du mat*	Grade	Type	Thickness *Épaisseur*
Tubes	No / *Nbre*	Outside Dia / *Dia ext*	Thickness / *Épaisseur*	Pitch / *Pas*	Mat l Spec No / *Spéc du mat*	Grade	Test Pressure / *Pression d'épreuve*			
Other Parts / *Autres pièces*										

Openings / *Ouvertures*

	No *Nbre*	Dimension	Type
Feed *Alimentation*			
Water or Steam Outlets *Sortie d'eau ou de vapeur*			
Blowoff *Vidange*			
Safety Valve *Soupape de sûreté*			

Operation / *Opération*

Boiler *Chaudière*	MAWP *PPMP*	Max Temperature *Température max*	Heating Surface *Surface de chauffe*	Hydrotest Pressure / *Test hydrostatique* Shop *Usine*	Field *À l' nstallation*
Waterwall *Murs d'eau*					
Economizer *Économiseur*					
Superheater *Surchauffeur*					
Others *Autres*					

Maximum Design Steaming Capacity
Capacité d'évaporation maximale de conception _____

Remarks / *Remarques*

Manufacturer
Constructeur _____
Mfr's S N
N° de série _____

Manufacturer's Signature *Signature du constructeur*	Date
Authorized Inspector's Signature *Signature de l'inspecteur autor sé*	Date

Page 2 of (*de*) 3

(Continued)

Figure D.2 a) (Concluded)

Certificate of Compliance / *Certificat de conformité*

We certify that the statements made in this data report are correct and that the said vessel has been constructed in accordance with the Provincial Registered design below and the requirements of CSA B51
Nous certifions que les données de la déclaration de conformité sont correctes et que l'appareil a été construit en accord avec l'enregistrement provincial ci dessous et les exigences du CSA B51

CRN
NEC _____

Manufacturer / *Constructeur:*

Name/*Nom* _____ Signature _____ Date _____

Certificate of Shop Inspection / *Certificat d'inspection en usine*

I, the undersigned, a duly authorized boiler and pressure vessel inspector / *Je, soussigné, inspecteur autorisé de chaudières et appareil sous pression*

employed by
employé par _____ of
de _____

have inspected the above boiler and state that to the best of my knowledge and belief, the manufacturer has constructed the boiler in accordance with the CRN below and the requirements of CSA B51 By signing this certificate neither the authorized inspector nor his or her employer makes any warranty, expressed or implied, concerning the boiler described in this manufacturer's data report Furthermore, neither the authorized inspector nor his or her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection
ai inspecté la chaudière précitée et, en autant que je sache, le constructeur a fabriqué la chaudière en accord avec le numéro d'enregistrement canadien ci dessous et les exigences du CSA B51 En signant cette déclaration, l'inspecteur ni son employeur ne donnent de garantie explicite ou implicite relativement à la chaudière décrite dans la présente déclaration De plus, ni l'inspecteur ni son employeur ne doivent être tenus responsables de quelque manière que ce soit des dommages, matériels ou corporels, ou des pertes de quelque nature que ce soit pouvant résulter de cette inspection

CRN
NEC _____

Authorized Inspector / *Inspecteur autorisé:*

Name*/
*Nom** _____ S gnature _____ Date _____

*Include nspector's National Board commission number and/or provincial certificate number *Inclure le numéro de la commission du National Board de l'inspecteur et/ou de son certif cat provincial*

Certificate of Compliance – Field Work / *Certificat de conformité – Installation au chantier*

I certify that the field installation of all parts of the vessel conforms with the requirements of Provincial Regulations
Je certifie que l'installation au chantier de toutes les pièces de l'appareil est conforme à la réglementation provinciale

Installer / *Installateur:*

Name _____ Signature _____ Date _____

Certificate of Field Inspection / *Certificat d'inspection – Installation au chantier*

I, the undersigned, a duly authorized boiler and pressure vessel inspector / *Je, soussigné, inspecteur autorisé de chaudières et appareil sous pression*

employed by
employé par _____ of
de _____

have inspected the items not covered by the Certificate of Shop inspection and the installation of the items and state that to the best of my knowledge and belief the construction and assembly of the items are in accordance with the provincial regulations By signing this certificate, neither the authorized inspector nor his or her employer makes any warranty, expressed or implied, concerning the vessel described in this manufacturer's data report Furthermore, neither the authorized inspector nor his or her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection
ai inspecté les composantes non couvertes par le certificat d'inspection en usine et l'installation de l'appareil et, autant que je sache, la construction et l'assemblage de l'appareil sont en accord avec la réglementation provinciale En signant ce certificat, ni l'inspecteur ni son employeur ne donnent de garantie explicite ou implicite relativement à la chaudière décrite dans la présente déclaration De plus, ni l'inspecteur ni son employeur ne doivent être tenus responsables de quelque manière que ce soit des dommages, matériels ou corporels, ou des pertes de quelque nature que ce soit pouvant résulter de cette inspection

Authorized Inspector / *Inspecteur autorisé:*

Name*/*Nom** _____ Signature _____ Date _____

*Include nspector's National Board commission number and/or provincial certificate number *Inclure le numéro de la commission du National Board de l'inspecteur et/ou de son certif cat provincial*

Manufacturer
Constructeur _____
Mfr's S N
N° de série _____

Figure D.2 b)
Manufacturer's data report — Supplementary sheet for watertube boilers
(See Clause D.1.)

MANUFACTURER'S DATA REPORT – SUPPLEMENTARY SHEET
FOR WATERTUBE BOILERS
DÉCLARATION DE CONFORMITÉ DU CONSTRUCTEUR - FEUILLE SUPPLÉMENTAIRE
POUR CHAUDIÈRES AQUATUBULAIRES

Manufacturer or Eng. Contr. ***Constructeur ou entrepreneur intégrateur***	(Name and Address / *Nom et adresse*)
Manufactured for ***Construit pour***	(Name and Address / *Nom et adresse*)
Ultimate Owner ***Propriétaire final***	(Name and Address / *Nom et adresse*)
Location of Installation ***Lieu d'installation***	(Address / *Adresse*)

Boiler / *Chaudière*

Type / *Genre*	Manufacturer's S N / *N° de série*	Year Built / *Année de fabrication*
CRN / *NEC*	National Board No / *N° National Board*	Drawing Number / *N° de dessin*

Data Report Items / *Rubrique de la déclaration de conformité*

Other / *Autres*

Manufacturer or Engineering Contractor / *Constructeur ou entrepreneur intégrateur*

Name / *Nom* _____ Signature _____ Date _____

Authorized Inspector / *Inspecteur autorisé:*

Name*/*Nom** _____ Signature _____ Date _____

*Include nspector's National Board commission number and/or provincial certificate number *Inclure le numéro de la commiss on du National Board de l'inspecteur et/ou de son cert ficat provincial*

Page 1 of (*de*) 1

Figure D.2 c)
Engineering contractor's data report for a complete boiler unit
(See Clause D.1.)

ENGINEERING CONTRACTOR'S DATA REPORT
FOR A COMPLETE BOILER UNIT
DÉCLARATION DE CONFORMITÉ DE L'ENTREPRENEUR INTÉGRATEUR
POUR UNE CHAUDIÈRE COMPLÈTE

Engineering Contractor ***Entrepreneur intégrateur***	(Name and Address / *Nom et adresse*)
Manufactured for ***Construit pour***	(Name and Address / *Nom et adresse*)
Location of Installation ***Lieu d'installation***	(Address / *Adresse*)

Type of Boiler / *Genre de Chaudière*	Manufacturer's S N / *N° de série*	Year Built / *Année de fabrication*
CRN / *NEC*	National Board No / *N° National Board*	Drawing Number / *N° de dessin*

The design of this boiler complies with Section I of the ASME Boilers and Pressure Vessel Code, Edition _____ and code cases _____
La conception de cette chaudière est conforme à la section I du Code ASME BPVC, *édition* *et code Cases*

Partial Data Reports Attached / Déclarations partielles attachées – Use add'l sheets if necessary / *Feuilles supplémentaires si nécessaire*

No *Nbre*	Name of Part *Nom de la composante*	Part Manufacturer *Constructeur*	*Serial No N° de série*	ASME Code Section *Section du code ASME*	CRN *NEC*	MAWP *PMMP* (kPag)	Max Temp *Temp max* (°C)	Heating Surface *Surface de chauffe* (m^2)	Maximum Des Steaming Cap *Capacité vapeur conçu maximum* (kg/h)

MAWP of Completed Boiler *PMMP de la chaudière entière* _____ kPag

Maximum Design Steaming Capacity *Capacité d'évaporation maximale de conception* _____

Remarks / *Remarques*

Engineering Contractor Certificate of Compliance / *Certificat de conformité de l'entrepreneur intégrateur*

We certify the statements made in this data report, with the attached certified data reports as listed, provide documentation that the design, construction, materials, and workmanship of these components of the complete boiler unit conform with the Province of Installation Act and Regulations and CSA B51
Nous certifions que les énonces de cette déclaration, avec les déclarations jointes telles que mentionnées, fournissent la documentation confirmant que la conception, la construction, les matériaux et la maîtrise d'exécution des composantes de la chaudière complète sont conformes à la réglementation de la province d'installation et au CSA B51

CRN *NEC* _____ Quality Program Reg'n No *No d'enregistrement programme contrôle qualité* _____ Program Expiry Date *Date d'expiration* _____

Engineering Contractor / *Entrepreneur intégrateur*

Name/*Nom* _____ Signature _____ Date _____

Certificate of Field Assembly / *Certificat d'installation au chantier*

We certify that the field assembly of all parts of this boiler conforms with the requirements with the Province of Installation Act and Regulations and CSA B51
Nous certifions que l'assemblage de toutes les pièces lors de l'érection de la chaudière est conforme aux exigences de la réglementation de la province d'installation et du CSA B51

Company Name *Nom de compagnie* _____ Quality Program Reg'n No *No d'enregistrement programme contrôle qualité* _____ Program Expiry Date *Date d'expiration* _____

Engineering Contractor / *Entrepreneur intégrateur:* Hydro Test Pres *Pres d'épreuve hydro* _____

Name/*Nom* _____ Signature _____ Date _____

Certificate of Inspection / *Certificat d'inspection*

I, the undersigned, a duly authorized boiler and pressure vessel inspector / *Je, soussigné, inspecteur autorisé de chaudières et appareil sous pression*

employed by *employé par* _____ of *de* _____

have inspected the above boiler and state that to the best of my knowledge and belief the construction and assembly of the items are in accordance with the CRN listed below and provincial regulations By signing this certificate, neither the authorized inspector nor his or her employer makes any warranty, expressed or implied, concerning the boiler described in this manufacturer's data report Furthermore, neither the authorized inspector nor his or her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection
ai inspecté la chaudière précitée et, en autant que je sache, la fabrication et l'assemblage sont en accord avec le numéro d'enregistrement canadien ci dessous et les exigences du CSA B51 En signant ce certificat ni l'inspecteur ni son employeur ne donnent de garantie explicite ou implicite relativement à l'appareil décrit dans ce certificat De plus, ni l'inspecteur ni son employeur ne doivent être tenus responsables de quelque manière que ce soit des dommages, matériels ou corporels, ou des pertes de quelque nature que ce soit pouvant résulter de cette inspection

Page 1 of (*de*) 2

(Continued)

Figure D.2 c) (Concluded)

CRN
NEC
Authorized Inspector / *Inspecteur autorisé:*

Name*/*Nom** _____ Signature _____ Date _____

*Include nspector's National Board commission number and/or provincial certificate number *Inclure le numéro de la commission du National Board de l'inspecteur et/ou de son certif cat provincial*

Manufacturer
Constructeur _____

Manufacturer's S N
N° de série _____

Page 2 of (*de*) 2

Figure D.2 d)
Summary data report for process steam generators
(See Clause D.1.)

SUMMARY DATA REPORT
FOR PROCESS STEAM GENERATORS
DÉCLARATION DE CONFORMITÉ COMPLÈTE
POUR GÉNÉRATEURS DE VAPEUR

Manufacturer or Eng. Contr. **Constructeur ou Entrepreneur intégrateur**	(Name and Address / *Nom et adresse*)
Manufactured for ***Construit pour***	(Name and Address / *Nom et adresse*)
Location of Installation ***Lieu d'installation***	(Address / *Adresse*)

Boiler / *Chaudière*

Type / *Genre*	Manufacturer's S N / *N° de série*	Year Built / *Année de fabrication*
CRN / *NEC*	National Board No / *N° National Board*	Drawing Number / *N° de dessin*

The design of this boiler complies with Section I of the ASME Boilers and Pressure Vessel Code, Edition _____ and code cases _____
La conception de cette chaudière est conforme à la Section I du Code ASME BPVC édition *et code Cases*

Partial Data Reports Attached / *Déclaration de conformité partielles jointes*
Use add'l sheets if necessary / *Utiliser des feuilles supplémentaires, si nécessaire*

No *Nbre*	Name of Part *Nom de la* composante	Part Manufacturer *Constructeur*	Serial No or Identifying No *N° de série ou N° d'identif cation*	ASME Code Section *Section du code ASME*	CRN *NEC*	Data Report Form *Formulaire de Déclarat on de conformité*
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

Total Maximum Design Steam ng Capacity _____
Capacité d'évaporation maximale de conception

Remarks / *Remarques*

Certificate of Compliance / *Déclaration de conformité*

We certify that the statements made in this summary data report, with the attached certified data reports as listed, provide documentation that the design, construction, materials, and workmanship of these components of the complete boiler unit conform with the Province of Installation Act and Regulations and CSA B51
Nous certifions que les énoncés de ce document avec les déclarations de conformité partielles ci jointes fournissent la documentation témoignant que la conception, la construction, les matériaux et la maîtrise d'exécution de ces composants de la chaudière complète sont conformes à la réglementation de la province d'installation et au CSA B51

Quality Program Reg'n No _____ Program Expiry Date _____
No d'enregistrement du programme contrôle qualité *Date d'expirat on*

Manufacturer or Engineering Contractor / *Constructeur ou entrepreneur intégrateur*
Name/*Nom* _____ S gnature _____ Date _____

Figure D.2 e)
Manufacturer's data report for pressure relief valves
(See Clause D.1.)

MANUFACTURER'S DATA REPORT
FOR PRESSURE RELIEF VALVES
DÉCLARATION DE CONFORMITÉ DU CONSTRUCTEUR
POUR LES SOUPAPES DE SÛRETÉ

Boiler Manufactured by ***Chaudière construite par***	(Name and Address / *Nom et adresse*)
Boiler Manufactured for ***Chaudière construite pour***	(Name and Address / *Nom et adresse*)
Location of Installation ***Lieu d'installation***	(Address / *Adresse*)

Boiler / Chaudière

Type (Complete boiler, superheater, etc) / *Genre (chaudière complète, surchauffeur, etc)*		Manufacturer's S N / *N de série*
CRN / *NEC*	National Board No / *N National Board*	Drawing Number / *N de dessin*

Identification of Pressure Relief Valves / *Identification des soupapes de sûreté*

No	Service Location *Lieu de service*	Quantity *Quantité*	*Size Dimension*	CRN *NEC*	Manufacturer's Name *Nom du constructeur*	Design or Type No *N° de conception ou type*	Material* and Connector** *Matériau** et *Connection***	Set Pressure *Pression de réglage*	Capacity *Capacité*

*Material / Matériau **(1)** SA 216 Gr WCB, **(2)** SA 217 Gr WC6; **(3)** SA 217 Gr WC9; **(4)** SA 182 Gr F22; **(5)** Other / *Autre*

Connector Type / *Type de connection* **(A) Groove Weld / Soudée avec chanfrein ; **(B)** Socket Weld / Soudée par emboîtement ; **(C)** Threaded / *Taraudée*; **(D)** Flanged / *Bridée*

Unit Relieving Capacity / *Capacité de dégagement de l'unité*

Circuit	Minimum Required *Minimum requis*	Furnished / *Incluse*
Boiler / *Chaudière*		
Economizer / *Économiseur*		
Superheater / *Surchauffeur*		

Circuit	Minimum Required *Minimum requis*	Furnished / *Incluse*
Reheat Inlet / Entrée du réchauffeur		
Reheat Outlet / *Sortie du réchauffeur*		
Other / *Autre*		

Determination of Unit Relieving Capacity / *Détermination de la capacité de dégagement de l'unité*

Is PG-67.2.1.1 applicable to this boiler?	☐ No / *Non*	Approach taken to address capacity:	☐ PG-67.2.1.1.1
PG-67.2.1.1 applicable à cette chaudière?	☐ Yes / *Oui*	*Approche adoptée pour déterminer la capacité:*	☐ PG-67.2.1.1.2

Remarks / *Remarques*

Certificate of Compliance / *Certificat de conformité*

We certify the statements of this Manufacturer's Data Report for Pressure Relief Valves to be correct and all the details conform to the requirements of CSAB51.
Nous certifions que les données de cette déclaration des soupapes de sûreté sont correctes et que tous les détails sont conformes aux exigences du CSAB51.

☐ Certificate of Authorization Number / *Certificat de numéro d'autorisation* _____ to use the (S) or (M) / *pour utiliser le (S) ou (M)* _____ Expires / *Expire le* _____

☐ Quality Program Registration Number / *No d'enregistrement du programme de la qualité* _____ Expires / *Expire le* _____

Manufacturer or Engineering Contractor / *Constructeur ou entrepreneur* intégrateur:

Name / *Nom* _____ Signature _____ Date _____

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Figure D.3 a)
Manufacturer's data report for boilers other than watertube boilers
(See Clause D.1.)

MANUFACTURER'S DATA REPORT
FOR BOILERS OTHER THAN WATERTUBE BOILERS
DÉCLARATION DE CONFORMITÉ DU CONSTRUCTEUR
POUR CHAUDIÈRES AUTRE QU'AQUATUBULAIRES

Partial / *Partiel* ☐

Upon shipment of a boiler, this form must be filled in and sent to the office of the Chief Inspector having jurisdiction in the province of installation.
Au moment de l'expédition d'une chaudière, ce formulaire dûment rempli, doit être envoyé à l'autorité réglementaire de la province d'installation.

Manufactured by ***Construit par***	(Name and Address / *Nom et adresse*)
Manufactured for ***Construit pour***	(Name and Address / *Nom et adresse*)
Ultimate Owner ***Propriétaire final***	(Name and Address / *Nom et adresse*)
Location of Installation ***Lieu d'installation***	(Address / *Adresse*)

Boiler / *Chaudière*

Description / *Description*	Manufacturer's S N / *N° de série*	Year Built / *Année de fabrication*
CRN / *NEC*	National Board No / *N° National Board*	Drawing Number / *N° de dessin*

The chemical and physical properties of all parts meet the requirements of material specifications of the ASME Code. The design, construction and workmanship conform to CSA B51. / *Les propriétés chimiques et physiques de toutes les pièces respectent les exigences des spécifications de matériaux de code ASME. La conception, la construction et la maîtrise d'exécution sont conformes à CSA B51.*	ASME Sec	Div	Edition *Édition*	Code Case No (s) *No de code Case*

Manufacturers partial data reports properly identified and signed by authorized inspectors have been furnished for the following items of the report and attached to this report:
Les déclarations partielles du constructeur adéquatement identifiées et signées par les inspecteurs autorisés ont été produites pour les items suivants du rapport et attachés à cette déclaration:

Name of Part / *Nom de la composante*	Manufacturer's Name / *Nom du constructeur*	Identifying Stamp / *Sceau d'identification*

Boiler Shells or Drums / *Viroles ou ballons de la chaudière*

Material Specification / *Spécification du matériau*	Grade	Inside Length / *Long interne*	Inside Diameter / *Dia interne*	Thickness / *Epaisseur*

Longitudinal Joints / *Joints longitudinaux*			**Girth Joints / *Joints de circonférence***			**Heads / *Têtes***						
Seamless *Sans Soudure*	Welded *Soudé*	Joint Efficiency* *Efficacité du joint**	Seamless *Sans Soudure*	Welded *Soudé*	No of Shell Courses *Nombre de sect de virole*	Mat'l Spec'n No *Spéc du matériau*	Grade	Flat *Plate*	Dished *A calotte*	Ellipsoidal *Elliptique*	Thickness *Épaisseur*	Dish Radius *Rayon de la calotte*
☐	☐	%	☐	☐				☐	☐	☐		
☐	☐	%	☐	☐				☐	☐	☐		

*as compared to seamless/ **comparativement à un joint sans soudure*

Firetube Boilers Only / *Chaudières ignitubulaires seulement*

Tubesheet / Plaque tubulaire

Mat'l Spec No *Spéc du matériau*	Grade	Thickness *Épaisseur*	Tube Hole Diameter *Diamètre des trous*	No / *Nbre*	Mat'l Spec No *Spéc du mat*	Grade	Straight *Droit* ☐	Bend *En 'U'* ☐
			Outside Diameter (if various, give min/max) *Diamètre ext (Si variable min et max)*		Length / Longueur		Gauge (Thickness) *Calibre (Épaisseur)*	

Furnace / *Foyer*

Furnace No / *N° de foyer*	Size (O D or W x H) *Dia (dia ext ou Larg x Long)*	Length, each section / *Longueur de chaque section*	Total Length / *Longueur totale*

Mat'l Spec No *Spéc du matériau*	Grade	Thickness *Épaisseur*	Type (Plain, Adamson, Ring Reinforced, Corrugated, combined or stayed) *Type (Plat, Adamson, anneau de renfort, ondulé, combinés ou à jambette)*	Seamless *Sans soudure* ☐	Welded *Soudé* ☐

Staybolts / Étais

No *Nbre*	Mat l Spec No *Spéc du matériau*	Grade	Size Telltale *Trou témoin*	Net area *Section efficace*	Pitch (hor and vert) *Pas (hor et vert)*	MAWP *PMMP*

Manufacturer's Signature *Signature du constructeur*	Date
Authorized Inspector's Signature *Signature de l'inspecteur autorisé*	Date

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(Continued)

Figure D.3 a) (Concluded)

Firetube Boilers Only / **Chaudières ignitubulaires seulement**

Stays or Braces / ***Étais ou attaches***

Location / Localisation	Mat'l. Spec. No. / *Spéc. du mat.*	Type	No. & Size / *N° & dia.*	Max. Pitch / *Pas max.*	Total Net Area / *Surf. eff. totale*	Fig. PFT 32 or L/1 or/ Fig. HG 343 ou L/1	Dist. Tubes to Shell / *Dist. tubes à la virole*	Area to Be Stayed / *Surface à être étayée*	MAWP / *PMMP*
a) Above tubes F H / *Au dessus des tubes T AV*									
b) Above tubes R H / *Au dessus des tubes T AR*									
c) Below tubes F H / *Au dessous des tubes T AV*									
d) Below tubes R H / *Au dessous des tubes T AR*									
e) Through stays / *Étais traversants*									
f) Dome braces / *Attaches du dôme*									

Other Parts / ***Autres pièces***

Description (i e Dome, boiler piping, etc) / *Description (ex Dôme, chaudière, tuyauterie, etc)*	Mat'l Specification No / *Spéc du matériau*	Grade	Size / *Dimension*	Thickness / *Épaisseur*	MAWP / *PMMP*

Openings / ***Ouvertures***

Water or Steam (No , size, material and type) / *Vapeur (Nbre, dim , matériau et type)*	Blow off (No , size, type, material and location) / *Vidange (Nbre, dim , type, matériau et localisation)*	Feed (No , size, type, material and location) / *Alimentation (Nbre, dim , type, matériau et localisation)*
Manholes (No , size, material and location) / *Trou d'homme (Nbre, dim , matériau et localisation)*	Handholes (No , size, material and location) / *Trou de main (Nbre, dim , matériau et localisation)*	Fusible Plug (No , diam , location, Mfgs Ident) / *Boulon fusible (Nbre, dia , local , ident du constructeur)*

Safety Valves / ***Soupapes de sûreté***

No / *Nbre*	Size / *Diam*	Type	Capacity / *Capacité*	CRN / *NEC*

Boiler Supports / ***Support de chaudière***

No / *Nbre*	Type: Saddles / *Sellette*	Legs / *Pattes*	Lugs / *Oreilles*	Fixation / Attachement: Bolted / *Boulonnée*	Welded / *Soudée*
	☐	☐	☐	☐	☐

Shop Hydro Test / *Essai hydro en usine*	MAWP / *PMMP*	Based on (Code Par and/or formula) / *Selon (Para du code et/ou formule)*	Maximum Water Temp / *Température max de l'eau*	Heating Surface* / *Surface de chauffe**	Boiler Rating Max Steaming Capacity** / *Puissance de chaudière Capacité d'évaporation max **

*Firetube boilers only / *Chaudières ignitubulaires seulement*

**Rated output for hot water boilers / *Puissance à la sortie pour chaudières à eau chaude*

Electric Boiler Only / **Chaudière électrique seulement**

Heating Elements / ***Éléments chauffants***

No / *Nbre*	Size / *Dimension*	Rating / *Puissance* Auth Max / *Max aut*	Rating / *Puissance* Installed / *Installée*	Location / *Localisation*	Openings / *Ouvertures* No / *Nbre*	Dimension	Type
		kW	kW				

Electrodes / ***Électrodes***

No / *Nbre*	Size / *Dimension*	Rating / *Puissance* Auth Max / *Max aut*	Rating / *Puissance* Installed / *Installée*	Location / *Localisation*	Openings / *Ouvertures* No / *Nbre*	Dimension	Type
		kW	kW				

Remarks / ***Remarques***

Certificate of Compliance / ***Certificat de conformité***

We certify that the statements made in this data report are correct and that the said vessel has been constructed in accordance with the Provincial Registered design below and the requirements of CSA B51.
Nous certifions que les données de cette déclaration de conformité sont correctes et que l'appareil a été construit en accord avec l'enregistrement provincial ci-dessous et les exigences du code CSA B51.

Manufacturer / ***Constructeur:*** CRN / *NEC* _____

Name/*Nom* Signature Date

Certificate of Shop Inspection / ***Certificat d'inspection en usine***

I, the undersigned, a duly authorized boiler and pressure vessel inspector / *Je, soussigné, inspecteur autorisé de chaudières et appareil sous pression*

employed by / *employé par* _____ of / *de* _____

have inspected the above boiler and state that to the best of my knowledge and belief the construction and assembly of the items are in accordance with the CRN listed below and provincial regulations. By signing this certificate, neither the authorized inspector nor his or her employer makes any warranty, expressed or implied, concerning the boiler described in this manufacturer's data report. Furthermore, neither the authorized inspector nor his or her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.
ai inspecté la chaudière précitée et, en autant que je sache, la construction et l'assemblage de l'appareil sont en accord avec le numéro d'enregistrement canadien ci-dessous et la réglementation provinciale. En signant ce certificat, ni l'inspecteur ni son employeur ne donnent de garantie explicite ou implicite relativement à l'appareil décrit dans la présente déclaration. De plus, ni l'inspecteur ni son employeur ne doivent être tenus responsables de quelque manière que ce soit des dommages, matériels ou corporels, ou des pertes de quelque nature que ce soit pouvant résulter de cette inspection.

Authorized Inspector / ***Inspecteur autorisé:*** Registered CRN / NEC registré _____

Name*/*Nom** _____ Signature _____ Date _____

*Include inspector's National Board commission number and/or provincial certificate number *Inclure le numéro de la commission du National Board de l'inspecteur et/ou de son certificat provincial*

Manufacturer / *Constructeur* _____
Mfr's S N / *N° de série* _____

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Figure D.3 b)
Manufacturer's data report for cast iron and cast aluminum sectional boilers
(See Clause D.1.)

MANUFACTURER'S DATA REPORT
FOR CAST IRON AND CAST ALUMINUM SECTIONAL BOILERS
DÉCLARATION DE CONFORMITÉ DU CONSTRUCTEUR
DE CHAUDIÈRES EN SECTIONS EN FONTE ET EN FONTE D'ALUMINIUM

Partial/*Partiel* ☐

Upon shipment of a boiler, this form must be filled in and sent to the Chief Inspector having jurisdiction in the province of installation.
Au moment de l'expédition d'une chaudière, ce formulaire dûment rempli, doit être transmis à l'autorité réglementaire de la province d'installation.

Manufactured by ***Construit par***	Name and address of manufacturer/*Nom et adresse du constructeur*
Manufactured for ***Construit pour***	Name and address of purchaser or consignee/*Nom et adresse du client ou de son représentant*
Ultimate owner ***Propriétaire final***	Name and address/*Nom et adresse*
Location of installation ***Lieu d'installation***	Name and address/*Nom et adresse*

Boiler/*Chaudière*

Type/*Genre*	Serial no /*N de série*	Year bu lt/*Année de fabrication*
Cast iron and cast aluminum sectional/ *Sections en fonte et en fonte d'aluminium*		
Provincial Registration No CRN/*N d enregistrement provincial NEC*	National Board no /*Nº du National Board*	Drawing no /*N de dess n*

The chemical and physical properties of all parts meet the requirements of material specifications of the ASME Code. The design, construction and workmanship conform to CSA B51. / *Les propriétés chimiques et physiques de toutes les pièces respectent les exigences des spécifications de matériaux de code ASME. La conception, la construction et la maîtrise d'exécution sont conformes au CSA B51.*	ASME Section	Addenda/*Supplément*	Code case no / *Numéro de Code Case*
	IV		

Sections/*Sections*

Material specification no /*N° spécification du matériau*	Grade	Inside width/*Larg interne*	Inside height/*Hauteur interne*	Thickness/*Épaisseur*

Openings / *Ouvertures*

Water or steam out ets (no s ze and type) *Sortie eau ou vapeur (nombre, dimension et type)*	Blowoff (no s ze type and location) *Vidange (nombre, dimension, type et localisation)*	Feed (no size type and location) *Alimentation (nombre, dimension, type et localisation)*

Hand holes (no s ze and location) *Trou de ma n (Nombre dimension et localisation)*	Fus ble plug (no d am location mfgs ident) *Bouchon fusible (Nombre dia loca isation numéro d identification du constructeur)*

Safety valves / *Soupapes de sûreté*

No /*Nbre*	Size/*Dim*	Type	Capacity *Capacité*	Prov Reg st No *N° d'enr prov*

Boiler supports / *Support de chaudière*

No /*Nbre*	Type		Fixation	
	Saddles *Sellettes*	Lugs *Orei les*	Bolted *Boulonnée*	Welded *Soudée*

Shop hydrostatic test *Essai hydrostatique en usine*	MAWP *PMMP*	Cub cal capacity/*Volume*	Heating surface/*Surface de chauffe*	Boiler rating max steaming capacity (rated output for hot water boilers) *Puissance de la chaudière capacité d'évaporation max (Puissance à la sortie pour chaudière à eau chaude)*

Certificate of Compliance/*Certificat de conformité*

We certify that the statements made in this data report are correct and that the said boiler has been constructed in accordance with the provincial registered design below and the requirements of CSA B51
Nous certifions que les énoncés de ce rapport de données sont corrects et que l'appareil a été construit en accord avec l'enregistrement provincial ci dessous et les exigences de CSA B51

Provincial registered design
Enregistrement provincial _____

Manufacturer
Constructeur _____

Signature _____ Date _____

Figure D.4 a)
Manufacturer's data report for fired process heaters
(See Clause D.1.)

MANUFACTURER'S DATA REPORT
FOR FIRED PROCESS HEATERS
DÉCLARATION DE CONFORMITÉ DU CONSTRUCTEUR
DE SERPENTINS DE RÉCHAUFFEURS

Partial / *Partiel* ☐

Upon shipment of a direct fired process heater unit or part including coil, headers, manifolds and crossovers this form fully and correctly filled in must be sent to the office of the Chief Inspector having jurisdiction in the province of installation, in accordance with CSA B51 Clause 4 6 1
Au moment de l'expédition complète ou partielle d'un réchauffeur comprenant un serpentin, des distributeurs, des collecteurs d'échappement et des collecteurs croisés, ce formulaire, dûment rempli, doit être envoyé à l'autorité réglementaire de la province d'installation tel que prévu selon l'article 4.6.1 du CSA B51.

Manufactured by ***Construit par***	(Name and Address / *Nom et adresse*)
Manufactured for ***Construit pour***	(Name and Address / *Nom et adresse*)
Ultimate Owner ***Propriétaire final***	(Name and Address / *Nom et adresse*)
Location of Installation ***Lieu d'installation***	(Address / *Adresse*)

Fired Process Heater / *Réchauffeur*

Description/Type / *Genre/Type*	Manufacturer's S N / *N° de série*	Year Built / *Année de fabrication*
CRN / *NEC*	Owner's ID No / *N° d'identification de propriétaire*	Drawing Number / *N° de dessin*

Item / ID No *No ID du réchauffeur*	Design Pressure *Pression de conception*	Design Temp *Temp de conception*	*Design / Construction Code(s) Codes de conception / de construction*	Safety Valve / *Soupape de sûreté*	
				Size /*Dimension*	Setting / *Pression de réglage*

Coil / *Serpentin*

Type / *Type*	ID No / *No d'identification*	Tubes				End Closures/*Embouts*					Openings / Nozzles / Fittings *Ouvertures/Tuyères/Accessoires*		
		No	Mat'l Spec *Spéc du mat*	O D *Dia ext*	Thick *Épaiss*	Ret Bends/*Tubes en U* Mat'l Spec *Spéc du mat*	Thick *Épaiss*	Plug Headers/Raccords des d stributeurs Mat'l Spec *Spéc du mat*	Size *Dim*	Thick *Épaiss*	Mat'l Spec *Spéc du mat*	Type/Size *Type/ Dimens on*	Rating *Classe*

Headers and Manifolds / *Distributeurs et collecteurs d'échappement*

Type/*Type*	ID No (s)/ *No d'identificat on(s)*	Size / *Dim*	Shell / *Virole*		Ends / *Embouts*		Openings / *Ouvertures*		
			Mat'l Spec *Spéc du mat*	Thickness Épaisseur	Mat'l Spec *Spéc du mat*	Thickness *Épaisseur*	No	Type	Size Rating *Classe*

Other Items (Crossovers, etc.) / *Autres items (Collecteurs croisés, etc.)*

Type/Type	ID No / *No d'identification*	Size / *Dimension*	Mat'l Spec / *Spéc du mat*	Thickness *Épaisseur*	

Non-Destructive Examination and Heat Treatment / *Essais non destructifs et traitements thermiques*

Item Description (Coil/Manifold/Headers & Type) *Description de l'item (Serpent n/collecteurs d'échappement/distr buteurs et type)*	ID No (s) / / *No d'identific ation*	Non Destructive Exam nation (NDE) *Examens non destruct fs (END)*			Post Weld Heat Treatment *Traitement thermique post soudage*	
		Radiographic (100% or % Random) *Radiographique (100% ou % aléatoire)*	Mag Particle (MT) / Dye Pen (PT) Extent *Détails sur la magnétoscopie (MT) ou Ressuage(PT)*	Other (Ultrasonic, etc) *Autres (Ultrasons, etc)*	Temp / Température	Holding Time *Temps d'exposition*
		%				
		%				
		%				
		%				
		%				

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(Continued)

Figure D.4 a) (Concluded)

Pressure Tests / *Essais de pression*

Item Description (Coil/Manifold/Headers & Type) *Description de l'item (Serpentin/collecteurs d'échappement/distributeurs et type)*	ID No (s) *No d'identification (s)*	Shop or Field *Usine ou chantier*	Hydro Test Pressure *Pression d'épreuve hydrostatique*	Pneu Test Pressure *Pression d'épreuve pneumatique*	Alternative / Additional Tests, Pressure and Test Method e g , Sensitive Leak *Autres essais ou essais supplémentaires (méthode et pression)*

Remarks / *Remarques*

Certificate of Compliance / Déclaration *de conformité*

We certify that the statements made in this report are correct and that the said vessel has been constructed in accordance with the Provincial Registered design below and the requirements of CSA B51
Nous certifions que les données de cette déclaration de conformité sont correctes et que l'appareil a été construit en accord avec l'enregistrement provincial ci dessous et les exigences du CSA B51

Registered CRN
NEC registré _____

Manufacturer / *Constructeur:*

Name *Nom* _____ Signature _____ Date _____

Certificate of Shop Inspection / *Déclaration d'inspection en usine*

I, the undersigned, a duly authorized boiler and pressure vessel inspector / *Je, soussigné, inspecteur autorisé de chaudières et appareil sous pression*

employed by *employé par* _____ of *de* _____

have inspected the above fire process heater and state that to the best of my knowledge and belief, the construction and assembly of the items are in accordance with the registered CRN below and the requirements of CSA B51 By signing this certificate neither the authorized inspector nor his or her employer makes any warranty, expressed or implied, concerning the fire heater described in this manufacturer's data report Furthermore, neither the authorized inspector nor his or her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection
ai inspecté le serpentin de réchauffeur précité et, en autant que je sache, la construction et l'assemblage de l'appareil sont en accord avec le numéro d'enregistrement canadien ci dessous et les exigences de CSA B51 En signant ce certificat ni l'inspecteur ni son employeur ne donnent de garantie explicite ou implicite relativement à l'appareil décrit dans ce certificat De plus, ni l'inspecteur ni son employeur ne doivent être tenus responsables de quelque manière que ce soit des dommages, matériels ou corporels, ou des pertes de quelque nature que ce soit pouvant résulter de cette inspection

CRN
NEC _____

Authorized Inspector / *Inspecteur autorisé:*

Name*/ *Nom** _____ Signature _____ Date _____

*Include inspector's National Board commission number and/or provincial certificate number *Inclure le numéro de la commission du National Board de l'inspecteur ou de son certificat provincial*

Certificate of Compliance – Field Work / Déclaration *de conformité – Installation au chantier*

We certify that the field installation of all parts of the vessel conforms with the requirements of Provincial Regulations
Nous certifions que l'installation au chantier de toutes les pièces de l'appareil est conforme à la réglementation provinciale

Installer / *Installateur:*

Name / *Nom* _____ Signature _____ Date _____

Certificate of Field Inspection / *Déclaration d'inspection – Installation au chantier*

I, the undersigned, a duly authorized boiler and pressure vessel inspector / *Je, soussigné, inspecteur autorisé de chaudières et appareil sous pression*

employed by *employé par* _____ of *de* _____

have inspected the items not covered by the Certificate of Shop inspection and the installation of the items and state that to the best of my knowledge and belief the construction and assembly of the items are in accordance with the provincial regulations By signing this certificate, neither the authorized inspector nor his or her employer makes any warranty, expressed or implied, concerning the vessel described in this manufacturer's data report Furthermore, neither the authorized inspector nor his or her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection
ai inspecté les composantes non couvertes par le certificat d'inspection en usine et l'installation de l'appareil et, en autant que je sache, la construction et l'assemblage de l'appareil sont en accord avec la réglementation provinciale En signant ce certificat, ni l'inspecteur ni son employeur ne donnent de garantie explicite ou implicite relativement au Réchauffeur décrit dans la présente déclaration De plus, ni l'inspecteur ni son employeur ne doivent être tenus responsables de quelque manière que ce soit des dommages, matériels ou corporels, ou des pertes de quelque nature que ce soit pouvant résulter de cette inspection

Authorized Inspector / *Inspecteur autorisé:*

Name* *Nom** _____ Signature _____ Date _____

*Include inspector's National Board commission number and/or provincial certificate number *Inclure le numéro de la commission du National Board de l'inspecteur et/ ou de son certificat provincial*

Manufacturer *Constructeur* _____ Manufacturer's S N *N° de série* _____

Figure D.4 b)
Engineering contractor's data report for fired process heaters
(See Clause D.1.)

ENGINEERING CONTRACTOR'S DATA REPORT
FOR FIRED PROCESS HEATERS
DÉCLARATION DE CONFORMITÉ DE L'ENTREPRENEUR D'INGÉNIERIE
POUR DE SERPENTINS DE RÉCHAUFFEURS

Engineering Contractor ***Entrepreneur intégrateur***	(Name and Address / *Nom et adresse*
Manufactured for ***Construit pour***	(Name and Address / *Nom et adresse*
Ultimate Owner ***Propriétaire final***	(Name and Address / *Nom et adresse*

Type of Heater / *Genre de réchauffeur*	Manufacturer's S N / *N° de série*	Year Built / *Année de fabrication*
CRN / *NEC*	National Board No / *N° National Board*	Drawing Number / *N° de dessin*

The design of th s heater complies w th Code or Standard *La conception du réchauffeur est conforme au Code ou norme*	*Édition* *Édition*	Code Case No (s) *No de code* *Case*

Partial Data Reports Attached / *Déclaration de conformité partielles jointes* – Use add'l sheets if necessary /*Utiliser des feuilles supplémentaires si nécessaire*

No *Nbre*	Name of Part *Nom de la composante*	Part Manufacturer *Constructeur de la composante*	*Serial No* *N° de série*	ASME Code Section *Section du code de l'ASME*	CRN *NEC*	MAWP *PMMP* (kPag)	Max Temp *Temp max* (°C)	Heating Surface *Surface de chauffe* (m^2)
1								
2								
3								
4								

MAWP of Completed Heater
PMMP du réchauffeur complété _____ kPag

Remarks / *Remarques*

Engineering Contractor Certificate of Compliance / *Déclaration de conformité de* l'entrepreneur intégrateur

We certify the statements made in this data report, with the attached certified data reports as listed, provide documentation that the design, construction, materials, and workmanship of these components of the complete heater unit conform with the Province of Installation Act and Regulations, and CSA B51
Nous certifions que les énoncés de cette déclaration de conformité, avec les déclarations de conformité partielles ci jointes, attestent que la conception, la construction, les matériaux et la fabrication de ces composants du réchauffeur complet sont conformes à la réglementation provinciale et au CSA B51

CRN
NEC _____

Quality Program Reg'n No
No d'enregistrement programme contrôle qualité _____

Program Expiry Date
Date d'expiration _____

Engineering Contractor / *Entrepreneur* intégrateur

Name/*Nom* _____ Signature _____ Date _____

Certificate of Field Assembly / Déclaration de conformité *de l'assemblage en chantier*

We certify that the field assembly of all parts of this heater conforms with the requirements with the Province of Installation Act and Regulations, and CSA B51
Nous déclarons que l'assemblage en chantier de toutes les composantes de ce réchauffeur sont conformes à la réglementation provinciale et au CSA B51

Quality Program Reg'n No
No d'enregistrement du programme contrôle qualité _____

Program Expiry Date
Date d'expiration _____

Hydro Test Pres
Press d'épreuve hydrostatique _____

Engineering Contractor / *Entrepreneur* intégrateur

Name/*Nom* Signature Date

Certificate of Inspection / *Déclaration d'inspection*

I, the undersigned, a duly authorized inspector / *Je, soussigné, inspecteur autorisé*

employed by
employé par _____ of
de _____

have inspected the above boiler and state that to the best of my knowledge and belief the construction and assembly of the items are in accordance with the CRN listed below and the requirements of CSA B51 By signing this certificate, neither the authorized inspector nor his or her employer makes any warranty, expressed or implied, concerning the heater described in this manufacturer's data report Furthermore, neither the authorized inspector nor his or her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection
ai inspecté le serpentin de réchauffeur précité et, en autant que je sache, la construction et l'assemblage du serpentin sont en accord avec le NEC ci dessous et les exigences de CSA B51 En signant ce certificat ni l'inspecteur ni son employeur ne donnent de garantie explicite ou implicite relativement à l'appareil décrit dans ce certificat De plus, ni l'inspecteur ni son employeur ne doivent être tenus responsables de quelque manière que ce soit des dommages, matériels ou corporels, ou des pertes de quelque nature que ce soit pouvant résulter de cette inspection

Authorized Inspector / *Inspecteur autorisé:*

CRN
NEC _____

Name/Nom** _____ Signature _____ Date _____

*Include nspector's National Board commission number and/or provincial certificate number *Inclure le numéro de la commission du National Board de l'inspecteur et/ou de son certif cat provincial*

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Figure D.5 a)
Pressure piping construction and test data report in Canada for piping other than ASME B31.1 boiler external piping

(See Clauses 4.15 and D.1.)

PRESSURE PIPING CONSTRUCTION AND TEST DATA REPORT IN CANADA
FOR PIPING OTHER THAN ASME B31.1 BOILER EXTERNAL PIPING (NBEP)
DÉCLARATION DE CONFORMITÉ DE TUYAUTERIE AU CANADA
POUR LA TUYAUTERIE AUTRE QUE LA TUYAUTERIE EXTERNE À LA CHAUDIÈRE SELON L'ASME B31.1 (NBEP)

Shop Construction ☐ *Construction en usine* | Field Construction ☐ *Construction au chantier* | Partial Data Report* ☐ *Déclaration de conformité partiels** | Final Data Report ☐ *Déclaration de conformité finale*

*(from one provincial authorized contractor to another provincial authorized contractor)
(d'un entrepreneur autorisé provincial à un autre entrepreneur autor sé provincial)

Constructed by ***Construit par***	(Primary Contractor or Subcontractor Name and Address / *Entrepreneur principal ou sous tra tant, nom et adresse*		
	Owner's Job No *Numéro de référence du propriétaire*	Provincial Qual ty Prog No *No de programme de qualité provincial*	Exp ry Date *Date d'expiration*
Constructed for ***Construit pour***	(Secondary Contractor f Different from Above Name and Address / *Entrepreneur secondaire si différent de ci dessus, nom et adresse)*		
		Provincial Quality Prog No** *No de programme de qualité provincial***	Exp ry Date** *Date d'expiration***
Owner ***Propriétaire***	(Name and Address / *Nom et adresse*)		
		Provincial Quality Prog No *No de programme de qualité provincial***	Exp ry Date *Date d'expiration***
Location of Installation ***Lieu d'installation***	(Address / *Adresse*)		

**Required when the entity undertakes some/all of the quality functions, e g , NDE, PWHT, Tie in, fabrication, hydro test, final assembly, etc
Nécessaire lorsque l'entité s'engage dans certaines / toutes les fonctions de qualité, par exemple, NDE, PWHT, joint de raccordement , fabr cation, essai hydrostatique assemblage final, etc

Provincial P ping Design Reg stration No / *Numéro provincial d'enregistrement de la conception de la tuyauterie*	Design Responsibility / *Responsabilité de la conception* ☐Owner / *Propriétaire* ☐Contractor / *Entrepreneur*

Weld Procedures / *Specifications de soudures*

Contractor Entrepreneur	Provincial Reg No / *Nº d'enregistrement provincial*	WPS No (s) Used / *Nº(s) DMS*
Owner *Propr étaire*	Provincial Reg No / *Nº d'enregistrement provincial*	WPS No (s) Used / *Nº(s) DMS*

Construction Code / *Code de construction:*

☐ ASME B31.1 Non Bo ler External Piping only / *Autre que tuyauterie externe à la chaudière* ☐ ASME B31.5 ☐ ASME B31.9 ☐ CSA Z662 Steam / *Vapeur*

☐ ASME B31.3 ASME B31 3 Service Category / *Cat de service pour ASME B31 3* ☐ Normal ☐ Cat 'D' ☐ Cat 'M' ☐ High Pressure *Haute Press on* ☐ High Purity *Haute pureté* ☐ Elevated Temperature *Température élevée (Fluage)* ☐ Severe Cyclic *Service cyclique*

Lines / *Lignes*

Drawing & Rev No , and Line No *Nº de dessin, révision et ligne*	Fluid (air / steam / etc) *Fluide (air, vapeur, etc)*	Des Press *Pression de calcul* (kPa)	Min and Max Des Temp *Temp de calcul max et min* (°C)	Test Pressure *Pression d'épreuve* (kPa)	Test Medium *Médium d'épreuve*	P pe Mat'l Spec & Grade *Spécification du matériau et grade*	C A (mm) / *Surépaisseur de corrosion (mm)*	Pipe NPS & Schedule / *Diamètre et calibre des tuyaux*	Flange Material & Rating/ *Matériau et classe des brides*	PWHT / Preheat Temp *Temp de TTPS et préchauf* (°C)	NDE *END*

(Continued)

Figure D.5 a) (Concluded)

Partial Data Reports Attached / Déclarations partielles de conformité jointes

Partial data reports certified by subcontractors are listed below and attached to this data report

Les rapports de données partiels cert fiés par les sous traitants sont énumérés ci dessous et sont joints au présent rapport de données

No	Line No *Nº de ligne*	Spool No *Nº de la section*	Drawing No with Rev No *No dessin avec no révision*	Subcontractor Name *Nom du sous traitant*	Quality Program Number *Nº du programme de qualité*	Expiry *Expiration*

Remarks / *Remarques*

Endorse Certificate Section 'A' or 'B' / *Signer la déclaration, section 'A' ou 'B'*

SECTION A CERTIFICATE OF COMPLIANCE / *DÉCLARATION DE CONFORMITÉ*

Signed by the subcontractor when supplying this certificate as a
Signé par le sous traitant lors de l'émission de cette déclaration en tant que

Partial Data Report / *Déclarations partielles de conformité*

We certify that the statements in this Data Report are correct and that materials, construction and workmanship of the piping fabrication conform to the registered quality system and the applicable piping code(s)
This certificate is not valid unless it forms part of a Final Data Report signed by Primary Contractor.

Nous certifions que les énoncés contenus dans la présente déclaration sont corrects et que les matériaux, la construction et maîtrise d'exécution de la tuyauterie sont conformes au système de qualité enregistré et aux codes de tuyauterie applicables
Cette déclaration n'est valide que si elle fait partie d'une déclaration finale de conformité signée par l'entrepreneur principal.

Contractor / *Contracteur:*

Name (Please Print) / *Nom (en caractères d' mprimerie)*

S gnature

Date

SECTION B CERTIFICATE OF COMPLIANCE / *DÉCLARATION DE CONFORMITÉ*

Signed by the subcontractor when supplying this certificate as a
Signé par le sous traitant lors de l'émission de cette déclaration en tant que

Final Data Report / *Déclaration finale de conformité*

We certify that the statements in this Data Report are correct and that

Nous certifions que les énoncés contenus dans la présente déclaration de conformité sont corrects et que le

piping job number/
No de projet de tuyauteries

described in this Data Report was constructed in accordance with the Provincial Act and Regulations, and applicable ASME Piping Code(s)

décrit dans la présente déclaration a été construit conformément à la réglementation provinciale et aux codes de tuyauterie ASME applicables

Contractor / *contracteur*

Name (Please Print) / *Nom (en caractères d'imprimerie)*

Signature

Date

Certificate of Inspection / *Certificat d'inspection*

I, the undersigned, employed by
Je, soussigné, employé par _____ of *de* _____

have verified that all required examination and testing has been completed, and inspected the piping described in this construction data report to the extent necessary to be satisfied that it conforms to all applicable examination requirements of the ASME Code and of the engineering design, and state that, to the best of my knowledge and belief, the contractor has constructed this piping in accordance with provincial regulations By signing this certificate neither the inspector nor his or her employer makes any warranty, expressed or implied, concerning the piping described in this construction data report Furthermore, neither the inspector nor his or her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection

ai vérifié que tous les examens et essais requis ont été effectués et ai inspecté la tuyauterie décrite dans cette déclaration de conformité dans la mesure nécessaire pour m'assurer qu'elle a été construite conformément aux exigences d'examen applicables prévues par la conception et par le Code ASME J'affirme qu'au meilleur de ma connaissance, l'entrepreneur a construit cette tuyauterie conformément à la réglementation provinciale En signant cette déclaration, l'inspecteur ni son employeur ne fournissent aucune donnent de garantie explicite ou implicite relativement à la tuyauterie de la présente déclaration De plus, ni l'inspecteur ni son employeur ne doivent être tenus responsables de quelque manière que ce soit des dommages, matériels ou corporels, ou des pertes de quelque nature que ce soit pouvant résulter de cette inspection

Owner's Inspector / *Inspecteur du propriétaire:*

Name/*Nom* _____ Signature _____ Date _____

Provincial Inspector (If Required) / *Inspecteur provincial (si requis):*

Name*/ *Nom** _____ Signature _____ Date _____

*Include nspector's provincial certificate number *Inclure le numéro du certificat provincial de l'inspecteur*

Constructed by
Constructeur _____

Owner's Job Reference
Référence du projet du propriétaire _____

Page 2 of (*de*) 2

Figure D.5 b)
Pressure piping construction and test data report out of Canada for piping other than ASME B31.1 boiler external piping

(See Clauses 4.15 and D.1.)

PRESSURE PIPING CONSTRUCTION AND TEST DATA REPORT OUT OF CANADA
FOR PIPING OTHER THAN ASME B31.1 BOILER EXTERNAL PIPING (NBEP)
DÉCLARATION DE CONFORMITÉ DE CONSTRUCTION ET D'ESSAIS HORS CANADA
DE TUYAUTERIE AUTRE QUE TUYAUTERIE EXTERNE À LA CHAUDIÈRE SELON ASME B31.1(NBEP)

Final Data Report / *Déclaration de conformité finale* ☐ Partial Data Report / *Déclarations de conformité partielles* ☐

Constructed by ***Construit par***	(Primary Contractor or Subcontractor Name and Address /*Entrepreneur principal ou sous traitant, nom et adresse*
	Owner's Job No *Numéro de référence du propriétaire*
Constructed for ***Construit pour***	(Primary Contractor if Different from Above Name and Address / *Entrepreneur principal si d fférent de ci dessus, nom et adresse)*
Owner ***Propriétaire***	(Name and Address / *Nom et adresse*)
Location of Installation ***Lieu d'installation***	(Address / *Adresse*)

Provincial P ping Design Reg stration No / *Numéro provincial d'enregistrement de la conception de la tuyauterie*	Design Responsibility / *Responsabilité de la conception* ☐Owner / *Propriétaire* ☐Contractor / *Entrepreneur*

Weld Procedures / *Description des méthodes de soudage*

WPS No (s) Used / *N°(s) de DMS utilisé*

Construction Code / *Code de construction:*

☐ ASME B31.1 Boiler External Pip ng *Tuyauter e externe de la chaudière* ☐ ASME B31.1 Non Boiler External Piping *Autre que tuyauterie externe à la chaud ère* ☐ ASME B31.5 ☐ ASME B31.9 ☐ CSA Z662 Steam *Vapeur*

☐ ASME B31.3 B31 3 Service Category *Cat de service pour B31 3* ☐ Normal ☐ Cat 'D' ☐ Cat 'M' ☐ High Pressure *Haute Press on* ☐ High Purity *Haute pureté* ☐ Elevated Temperature *Haute Température* ☐ Severe Cyclic *Service sévère*

Lines / *Lignes*

Drawing & Rev No , and Line No *N° de dessin, révision, et Numéro de ligne*	Fluid (air / steam / etc) *Fluide (air, vapeur, etc)*	Des Press *Pression de calcul* (kPa)	Min and Max Des Temp *Temp de calcul Max et min* (°C)	Test Pressure *Pression d'épreuve* (kPa)	Test Medium *Flu de d'épreuve*	Pipe Mat'l Spec & Grade *Spécification du matériau et grade*	C A (mm) surépaisseur de corrosion	Pipe NPS & Schedule *Diamètre et calibre des tuyaux*	Flange Material & Rating *Matériau et pression de service nom nale des brides*	PWHT / Preheat Temp *Temp de TTPS et de préchauf* (°C)	NDE *END*

Page 1 of (*de*) 2

(Continued)

Figure D.5 b) (Concluded)

Remarks / *Remarques*

Certificate of Compliance /*Certificat de conformité*

We certify that the statements in this data report are correct and that the piping described in this data report was constructed in accordance with the Provincial Act and Regulations and the applicable ASME piping code(s)
Nous certifions que les énoncés contenus dans ce rapport de données sont corrects et que la tuyauterie identifiée dans ce rapport de données a été construite conformément à la réglementation provinciale et aux code(s) ASME applicables

Contractor / Contracteur:

Name/ *Nom* _____ Signature _____ Date _____

Certificate of Inspection / *Certficat d'inspection*

I, the undersigned have verified that all required examination and testing has been completed, and inspected the piping described in this construction data report to the extent necessary to be satisfied that it conforms to all applicable examination requirements of the Code and of the engineering design, and state that, to the best of my knowledge and belief, the contractor has constructed this piping in accordance with the ASME Code(s) By signing this certificate neither the inspector nor his or her employer makes any warranty, expressed or implied, concerning the piping described in this construction data report Furthermore, neither the inspector nor his or her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection
Je, soussigné a vérifié que tous les examens et essais requis ont été effectués et a inspecté la tuyauterie décrite dans ce rapport de données pour m'assurer qu'elle a été construite conformément aux exigences aux exigences d'examen applicables du Code ASME et de la conception J'affirme qu'au meilleur de ma connaissance, l'entrepreneur a construit cette tuyauterie conformément à la réglementation provinciale En signant ce certificat ni l'inspecteur ni son employeur ne donnent de garantie explicite ou implicite relativement à l'appareil décrit dans ce certificat De plus, ni l'inspecteur ni son employeur ne doivent être tenus responsables de quelque manière que ce soit des dommages, matériels ou corporels, ou des pertes de quelque nature que ce soit pouvant résulter de cette inspection

Owner's Inspector / *Inspecteur du propriétaire:*

Employed by *Employé par* _____ of *de* _____

Name/ *Nom* _____ Signature _____ Date _____

Authorized Inspector / *Inspecteur autorisé:*

Employed by *Employé par* _____ of *de* _____

Name*/ *Nom** _____ Signature _____ Date _____

*Include nspector's National Board commission number *Inclure le numéro de la commission du de l'inspecteur*

Constructed by *Constructeur* _____ Owner's Job Reference *Référence du projet du propriétaire* _____

Figure D.5 c)
Pressure piping construction and test data report for ASME B31.1 boiler external piping
(See Clauses 4.15 and D.1.)

PRESSURE PIPING CONSTRUCTION AND TEST DATA REPORT
FOR ASME B31.1 BOILER EXTERNAL PIPING (BEP)
DÉCLARATION DE CONFORMITÉ DE CONSTRUCTION ET D'ESSAI
DE TUYAUTERIE EXTERNE À LA CHAUDIÈRE SELON ASME B31.1 (BEP)

Shop Construction ☐ *Construction en usine* | Field Construction ☐ *Construction au chantier* | Partial Data Report* ☐ *Déclarations de conformité partielles** | Final Data Report ☐ *Déclaration de conformité finale*
*(from one provincial authorized contractor to another prov ncial authorized contractor) *(d'un entrepreneur autorisé provincial à un autre entrepreneur autorisé provincial)*

Constructed by ***Construit par***	(Primary Contractor or Subcontractor Name and Address / *Nom et adresse de l'entrepreneur principal ou du sous traitant)*		
	Owner's Job No *No de référence du propr étaire*	Prov ncial Quality Prog No *No du programme de qualité provincial*	Expiry Date *Date d'expiration*
Constructed for ***Construit pour***	(Primary Contractor if D fferent from Above Name and Address / *Entrepreneur pr ncipal si différent de ci dessus, nom et adresse)*		
		Provincial Quality Prog No ** *No du programme de qualité provincial***	Expiry Date** *Date d'expiration***
Owner ***Propriétaire***	(Name and Address / *Nom et adresse*)		
		Provincial Quality Prog No ** *No du programme de qualité provincial***	Expiry Date** *Date d'exp ration***
Location of Installation ***Lieu d'installation***	(Address / *Adresse*)		

Required when the entity undertakes some/all of the quality functions, e g , NDE, PWHT, Tie in, fabrication, hydro test, final assembly, etc
Nécessaire lorsque l'entité s'engage dans certaines / toutes les fonctions de qualité, par exemple, END, TTPS, joint de fermeture, fabricat on, essai hydrostatique, assemblage final, etc

Provincial P ping Design Reg stration No / *Numéro d'enreg strement provincial de la conception de la tuyauterie*	Design Responsibility / *Responsable de la concept on* ☐Owner / *Propriétaire* ☐Contractor / *Entrepreneur*

Weld Procedures / Méthodes de soudage

Contractor *Entrepreneur*	Provincial Reg No / *N° d'enregistrement provincial*	WPS No (s) Used / N°(s) de DMS utilisé
Owner *Propr étaire*	Provincial Reg No / *N° d'enregistrement provincial*	WPS No (s) Used / *N°(s) de DMS utilisé*

Construction Code: ASME B31.1 Boiler External Piping / *Code de construction : ASME B31.1: Tuyauterie externe à la chaudière*

Lines / *Lignes*

Drawing & Rev No , and Line No *N° de dessin, révision et ligne*	Fluid (air / steam / etc) *Fluide (air, vapeur, etc)*	Des Press / *Pression d'épreuve* (kPa)	Min and Max Des Temp / *Temp de calcul Max et min* (°C)	Test Pressure / *Pression d'épreuve* (kPa)	Test Medium / *Médium d'épreuve*	Pipe Mat'l Spec & Grade/ *Spécification du matériau et grade*	C A (mm) / *Surépaisseur de corrosion (mm)*	Pipe NPS & Schedule *Diamètre et calibre des tuyaux*	Flange Material & Rating / *Matér au et pression de serv ce nominale des brides*	PWHT / Preheat Temp / *Temp de TTPS et préchauf* (°C)	NDE *END*

(Continued)

Figure D.5 c) (Concluded)

Partial Data Reports Attached / *Rapports de données partiels attachés*

Partial data reports certified by subcontractors are listed below and attached to this data report

Les rapports de données partiels cert fiés par les sous traitants sont énumérés ci dessous et sont joints au présent rapport de données

No	Line No *N° de ligne*	Spool No *N° de la section*	Drawing No with Rev No *N° Dessin et révision*	Subcontractor Name *Nom du sous traitant*	Quality Program Number *N° du programme de qualité*	Expiry *Expiration*

Remarks / *Remarques*

Endorse Certificate 'A' or 'B' / *Signer la déclaration 'A' ou 'B'*

A. CERTIFICATE OF COMPLIANCE /
CERTIFICAT DE CONFORMITÉ A

Signed by the subcontractor when supplying this certificate as a
Signé par le sous traitant lors de l'émission de ce certificat en tant que

Partial Data Report / *Déclaration de conformité partielles*

We certify that the statements in this Data Report are correct and that materials, construction and workmanship of the piping fabrication conform to the registered quality system and the ASME B31 1 piping code
This certificate is not valid unless it forms part of a Final Data Report signed by Primary Contractor.

Nous certifions que les énoncés contenus dans ce document sont exacts et que les matériaux, la construction et la maîtrise d'exécution de la tuyauterie sont conformes au système de qualité enregistré et au code ASME B31 1
Cette déclaration n'est valide que s'il fait partie d'un rapport de données final signé par l'entrepreneur principal.

Contractor / *Entrepreneur:*

Name (Please Print) / *Nom (en caractères d'imprimerie)*

S gnature

Date

B. CERTIFICATE OF COMPLIANCE /
CERTIFICAT DE CONFORMITÉ B

Signed by the subcontractor when supplying this certificate as a
Signé par le sous traitant lors de l'émission de ce certificat en tant que

Final Data Report / *Déclaration de conformité finale*

We certify that the statements in this Data Report are correct and that

Nous certifions que les énoncés contenus dans ce document sont corrects et que le projet

piping job number
de tuyauterie no _____

described in this Data Report was constructed in accordance with the Provincial Act and Regulations, and the ASME B31 1 Piping Code

décrit dans ce rapport de données a été construit conformément à la réglementation provinciale et au code de tuyauterie ASME B31 1

Contractor / *Entrepreneur:*

Name (Please Print) / *Nom (en caractères d'imprimerie)*

Signature

Date

Certificate of Inspection /*Certificat d'inspection*

I, the undersigned, employed by *Je, soussigné, employé par* _____ of *de* _____

have verified that all required examination and testing has been completed, and inspected the piping described in this construction data report to the extent necessary to be satisfied that it conforms to all applicable examination requirements of the Code and of the engineering design, and state that, to the best of my knowledge and belief, the contractor has constructed this piping in accordance with the Provincial Act and Regulations By signing this certificate neither the inspector nor his or her employer makes any warranty, expressed or implied, concerning the piping described in this construction data report Furthermore, neither the inspector nor his or her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection
a vérifié que tous les examens et essais requis ont été effectués et a inspecté suffisamment la tuyauterie décrite dans cette déclaration de conformité pour m'assurer qu'elle a été construite conformément aux exigences d'examens applicables du Code et de la conception et affirme qu'au meilleur de ma connaissance, le constructeur a construit cette tuyauterie conformément à la réglementation provinciale En signant cette déclaration, ni l'inspecteur, ni son employeur ne donne de garantie, expresse ou implicite, relativement aux tuyauteries décrites dans la présente déclaration De plus, ni l'inspecteur ni son employeur ne doivent être tenues responsables de quelque manière que ce soit des dommages matériels ou matériels ou des pertes de quelque nature que ce soit pouvant résulter de cette inspection

Authorized Inspector / *Inspecteur autorisé:*

Name*/ *Nom** _____ S gnature _____ Date _____

*Include nspector's National Board commission number and/or provincial certificate number *Inclure le numéro de la commission du National Board de l'inspecteur ou de son certificat provincial*

Constructed by *Constructeur* _____ Owner's Job Reference *Référence du projet du propriétaire* _____

Figure D.6
Statutory declaration form for application for registration of fittings in Canada
(See Clauses 4.2.2 and D.1.)

STATUTORY DECLARATION
Registration of Fittings
Single or Multiple Fitting Designs within One Fitting Category
DÉCLARATION STATUTAIRE
Enregistrement d'accessoires
Conception unique ou multiple d'accessoires à l'intérieur d'une catégorie d'accessoires

(Show facsimile of logo or trademark, as it will appear on the fitting.)

(Apposer ici une reproduction du logo ou de sa marque de commerce tel qu'il figurera sur l'accessoire.)

I/Je,
(Name & Position, e.g., President, Plant Manager, Chief Engineer/*Nom et position, ex: président, directeur d'usine, ingénieur en chef*)

of/de (Name of Manufacturer/*Nom du constructeur*) located /*situé*

at/à (Plant Address/*Adresse de l'usine*) (Telephone # /*numéro de téléphone*) (Email or Fax # /*courriel ou télécopieur*)

do solemnly declare for the fittings listed hereunder have dimensions, construction materials, pressure/temperature ratings, and identification markings that are in accordance with the herein named standards, as supported by the attached information.
déclare solennellement que les accessoires cités ci dessous ont les dimensions, les matériaux, les pression/température de conception et le marquage conformes avec les codes mentionnés ci dessous, tel que cité au présent document.

☐ comply with the requirements of _____ (Title of recognized North American Standard), which specifies the dimensions, construction materials, pressure/temperature ratings, and identification markings of the fittings.

conforme aux exigences du _____ *(Titre de la norme nord-américaine reconnue), qui précise leurs dimensions, matériaux de fabrication, pression/température de conception et marquages des accessoires.*

☐ are not covered by the provisions of a recognized North American standard and are therefore manufactured to comply with _____ (insert title of regulation, code , guideline, or other applicable document), as supported by the attached information, which specifies the dimensions, construction materials, pressure/temperature ratings (and the basis for such ratings), and identification markings of the fittings

ne sont pas visés par une norme nord américaine reconnue, mais conçus conformément à la _____ *(insérer le titre de la réglementation, du code, du guide ou autre document pertinent) tel que le démontré par les documents ci joints qui précisent leurs dimensions, matériaux de fabrication, pression/température de conception (et les bases de ces valeurs) et marquages des accessoires.*

I further declare that the manufacturing of these fittings is subject to a quality program that has been verified as described in the below Table as being suitable for the manufacturing of these fittings to the stated standard, regulation, code, guideline or other applicable document. The fittings covered by the declaration for which I seek registration are as provided in the Supplementary Sheet(s) attached.

De plus je déclare que la fabrication de ces accessoires est soumise à un programme qualité qui a été vérifié tel que décrit dans la table ci dessous et reconnu conforme pour la fabrication de ces accessoires tel que stipulé dans les standard(s), réglementation(s), code(s) , guide(s) et autre documents applicables. Les accessoires couverts par cette déclaration pour laquelle je demande l'enregistrement sont tels que décrits sur le(s) page(s) ci jointe(s).

STATUTORY DECLARATION Registration of Fittings Page **1** of (de) **3**

(Continued)

Figure D.6 (Continued)

Quality Program Verification and Manufacturing Sites /
Vérification des Programmes Qualité des lieux de fabrication

A copy of the Quality Certificate from each manufacturing site must be included
Une copie du certificat qualité pour chaque adresse de fabrication doit être incluse.

Item # / # d'item	Product Description, Model or Series / *Description du produit, modèle ou série*	Quality Program / *Programme qualité*	Scope of Certification / *Portée de la certification*	Expiry Date / *Date d'expiration*	Verifying Organization / *Organisme d'accréditation*	Location(s) Plant name and address / *Site(s) Nom de l'usine et adresse*
1.						
2.						

In support of this application, the following information, calculations, and/or test data are attached:
Pour supporter cette demande, les renseignements, calculs et/ou rapports d'essais suivants sont joints:

(Signature of Declarer / *Signature du demandeur*) (Date)

Declared before me at in the of
J'atteste que cette déclaration a été signée devant moi à de

this day of
le jour de , .
(Month/*Mois*) (Year/*Année*)

Name (please print)
Nom (caractères d'imprimerie)

Signature

Commissioner of Oaths in and for My commission expires on
Commissaire à l'assermentation à et pour .Ma commission expire le

For regulatory authority use only / *Réservé à l'organisme de réglementation*

To the best of my knowledge and belief, this application meets the requirements of the Act and CSA Standard B51, Part 1, Clause 4.2, and is accepted for registration in Category .
Au meilleur de ma connaissance et de mes croyances, cette demande satisfait aux exigences de la réglementation et du CSA B51, Partie 1, article 4.2, et est acceptée pour l'enregistrement dans la catégorie .

CRN / NEC:

Date registered Expiry Date
Date d'enregistrement Date d'expiration

Signature

(For the Chief Inspector of)
(*Pour l'autorité réglementaire de*)

(Registration Stamp)
(*Sceau d'enregistrement*)

STATUTORY DECLARATION Registration of Fittings Page **2** of (de) **3**

(Continued)

Figure D.6 (Concluded)

SUPPLEMENTARY SHEET FOR SINGLE OR MULTIPLE FITTING DESIGNS WITHIN ONE FITTING CATEGORY
PAGE SUPPLÉMENTAIRE POUR LA CONCEPTION D'ACCESSOIRES UNIQUES OU MULTIPLES DANS UNE CATÉGORIE D'ACCESSOIRES

Table 1 Scope of Fitting Designs / *Détails techniques de la conception des accessoires*

Item #/ No. / *d'item*	Primary Pressure Bearing/ Retaining Component / *Pièces retenant la pression*	Material of Construction / *Matériau de construction*	Port Connections and Size Range / *Type d'embouts et gamme de dimension*	MDMT / *Température minimum de conception*	Rated Pressure/ /Pression de conception		Pressure Class(es) / Schedule(s) / *Classe de Pression / Épaisseurs nominales*	Design Code(s) of Construction / *Code(s) de construction*	References: Catalog (pages) or Drawing(s) / *Références: Catalogue (pages) ou dessins*
					At Ambient Temperature / *Température ambiante*	At Maximum Temperature / *À la température maximum*			

Table 2 Additional Scope Information / *Informations complémentaires*

List/Attach Additional Details and References (Product Configurations, Options, Illustrations, etc.)/*Liste/Détails additionnels et références (configurations du produit, options, illustrations, etc.)*
Example / Exemple: **SERIES X Options / *Séries X Options***

Figure D.7
Installation report for cast iron and cast aluminum sectional boilers
(See Clauses 4.6.5 and D.1.)

Installation Report for
Cast Iron and Cast Aluminum Sectional Boilers
Avis d'installation de chaudières en sections en fonte et en fonte d'aluminium

Note: *This form must be filled in and mailed to:*
Note : *Remplir ce formulaire et le faire parvenir à :*

Name and address of regulatory authority
Nom et adresse de l'autorité réglementaire

_____

_____

Manufacturer
Constructeur _____

Boiler model no.
N° de modèle de la chaudière _____

Serial no.
N° de série _____

CRN
NEC _____

Provincial identification no. (if any)
N° d'identification provincial (le cas échéant) _____

Located at
Adresse _____

This is to certify that the above-mentioned completed unit has been subjected to a hydrostatic test of _____ kPa as per the requirements of the ASME Code, Section IV, and that this test was satisfactory, with no apparent defects observed.
Ce document certifie que les appareils mentionnés ci-dessus ont été soumis à une épreuve hydrostatique à une pression de _____ kPa*, conformément à la section IV du code ASME et qu'ils n'ont subi aucun dommage apparent lors de cette épreuve.*

Signed
Signature _____

Company
Entreprise _____

Figure D.8
Repair or alteration report for boilers and pressure vessels
(See Clause 11.1 and D.1.)

REPAIR OR ALTERATION REPORT
FOR BOILERS AND PRESSURE VESSELS
DÉCLARATION DE RÉPARATION OU DE MODIFICATION
DE CHAUDIÈRES ET LES APPAREILS SOUS PRESSION

Repair / Réparation ☐ Alteration / Modification ☐ Partial / Partielle ☐ Final / Finale ☐

Repair / Alteration Organization ***Organisation responsable des travaux***	(Name and Address / *Nom et adresse*)		
	Repair Org Job Number *N° de référence de l'organisation*	Provincial Quality Prog No *No de programme qualité provincial*	Expiry Date *Date d'expiration*
Owner ***Propriétaire***	(Name and Address / *Nom et adresse*)		
Location of Installation ***Lieu d'installation***	(Address / *Adresse*)		

Boiler or Pressure Vessel / *Chaudière ou appareil sous pression*

Description / *Description*	Owner's Equipment Number / *N° d'équipement du propriétaire*	**Provincial Equipment Number / *N° d'identification provincial***
CRN / *NEC*	Manufacturer's Name / *Nom du constructeur*	Manufacturer's S N / *N° de série*

Design Conditions / *Conditions de conception*

	Original Design Conditions / *Condit ons de conception originales*		New Design Condit ons / *Conditions de conception nouvelles*	
	MAWP *PMMP*	Min / Max Design Temperature *Temp de concept on min / max*	MAWP *PMMP*	Min / Max Design Temperature *Temp de conception min / max*
a) Vessel / Shell Side / Boiler *Appareil / Virole/ Chaudière*		/		/
b) Jacket / Tubeside *Double enveloppe / Côté tube*		/		/

Description of Defects / *Description des imperfections*

Codes of Construction / *Codes de construction*

Original / *Originale*			**Repair or Alteration / *Réparation ou modification***		
ASME Section:	Year *Année*	Addenda	ASME Section:	Year *Année*	Addenda

Description of Work Performed / *Description du travail effectué* - (Step by step descript on of repair/alterat on method used Attach additional pages as required, and reference any additional documents used to provide the required nformation; such as repair or alteration procedures, drawings, and specifications) *(Descr ption étape par étape de la méthode de réparation / modification Joindre des pages supplémentaires au besoin et faire référence à tout document supplémentaire utilisé pour fournir les informations requises, telles que les procédures de réparation ou de modification, les dessins et les spécifications)*

Page 1 of (*de*) 2

(Continued)

Figure D.8 (Concluded)

Heat Treatment / *Traitements thermiques*

Preheat / *Préchauffage*	Post Weld Heat Treatment / *Traitement thermique post soudage*		Other HT / *Autres traitements thermiques*
Temperature *Température*	Temperature *Température*	T me *Durée*	

Non-Destructive Examination (Specify type and extent) **/ *Examens non destructifs*** (Indiquer le type et l'étendue)

Pressure Test Pressures / *Pressions d'épreuve*

	Hydrostatic / *Hydrostatique*	Other Test / *Autre essai*
a) Vessel / Shell Side / Boiler *Appareil / Virole / Chaudière*		
b) Jacket / Tubeside *Double enveloppe / Coté tube*		

Materials*/*Matériaux**

Item	Mater al Specification *Spécification du matériau*	Thickness *Épaisseur*	Diameter or Size *Diamètre ou dimensions*
Shell / Drums *Virole / Ballons*			
Head Têtes			
Ends *Extrém tés*			

Item	Material Specification *Spécification du matériau*	Thickness *Épaisseur*	Diameter or Size *Diamètre ou dimension*
Tubesheet / Tubes *Plaque tubulaire / tubes*			
Nozzles *Tuyères*			
Flanges / Fittings *Brides / Raccords*			

*List any materials used in repair / alteration, and any base material welded upon / *Énumérer tous les matériaux utilisés pour la réparation ou l'altération, et tout soudage sur matériau de base*

Weld Procedures / *Méthodes de soudage*

Provincial Reg No / *N° d'enregistrement provincial*	WPS No (s) Used / *N°(s) DMS utilisé par l'entrepreneur*

Welded Replacement Parts / *Pièces de rechange soudées*

Attached are Manufacturer's Partial Data Reports or Repair/Alteration Reports, properly identified and signed by the Authorized Inspector, for the following tems of this report
Joindre les déclarations partielles de conformité ou les rapports de réparation / modification correctement identifiés et signés par l'inspecteur autor sé pour les éléments suivants

Remarks / *Remarques*

Certificate of Compliance / *Déclaration de conformité*

I certify that the statements made in this Report are correct and that all design, material, construction and workmanship on this repair/alteration conform to the requirements of the Provincial Regulations
Je certifie que les énoncés de cette déclaration sont exactes et que la conception, les matériaux, la construction et la maîtrise d'exécution de cette réparation / modification sont conformes aux exigences de la réglementation provinciale

Repair / Alteration Organization Name
Nom de l'organisation _____

Quality Program Reg'n No
No d'enregistrement programme contrôle qualité _____

Program Expiry Date
Date d'exp ration _____

Authorized Representative / *Représentant autorisé:*

Name/ *Nom* _____ S gnature _____ Date _____

Date work was completed / *Date de fin des travaux* _____

Certificate of Inspection / *Déclaration de conformité d'inspection*

I have inspected the repairs and/or alterations described in this report To the best of my knowledge, this work has been done in accordance with the Provincial Regulations
Nous certifions que les énoncés de cette déclaration sont exactes et que la conception, les matériaux, la construction et la maîtrise d'exécution de cette réparation / modification sont conformes aux prescriptions de la réglementation provinciale

Authorized Inspector or Certified In Service Inspector/ *Inspecteur autorisé, ou l'inspecteur certifié:*

Name*/ *Nom** _____ Signature _____ Date _____

*Include nspector's National Board commission number and/or provincial certificate number *Inclure le numéro de la commission du National Board de l'inspecteur ou de son certificat provincial*

Report Received by Authorized Inspector / *Déclaration reçue par l'inspecteur autorisé:*

Name*/*Nom** _____ Signature _____ Date _____

*Include inspector's Nat onal Board commiss on number and/or provincial cert ficate number *Inclure le numéro de la commission du National Board de l'inspecteur ou de son certificat provincial*

Provincial Equipment Number
No d'identif cation provincial _____

Owner's Equipment Number
N° d'équipement du propriétaire _____

Annex E (informative)
Inspection of welds in pressure coils exposed to direct radiant heat

Note: *This informative Annex has been written in normative language to facilitate its adoption where users of the Standard or regulatory authorities wish to adopt it formally as additional requirements to this Standard.*

E.1 General

Radiographic, visual, magnetic particle, and liquid penetrant examination of all welds in pressure coils shall be carried out and interpreted in accordance with ASME B31.3.

E.2 Inspection requirements

E.2.1

Inspection of welds in pressure coils, including return bends, fittings, manifolds, and crossover piping inside the internally insulated enclosure, shall comply with the requirements of Clauses E.2.2 to E.2.8.

E.2.2

At least 10% of circumferential butt welds in tubes of material specifications falling within the P-No. 1 and P-No. 8 material groupings of Section IX of the ASME Code shall be fully radiographed in accordance with the random radiography requirements of ASME B31.3. The criteria for welds shall be as specified in ASME B31.3 for random radiography for normal service.

E.2.3

Except for the welds specified in Clause E.2.2, circumferential butt welds shall be 100% radiographed.

E.2.4

Longitudinal seam welds in carbon steel or alloy materials shall be

a) 100% radiographed; and
b) examined using dye penetrant or magnetic particle methods.

E.2.5

The acceptance criteria for weld radiographs carried out to meet the requirements of Clauses E.2.3 and E.2.4 shall be as specified in ASME B31.3 for 100% radiography.

E.2.6

In cases where radiographic examination is difficult to interpret (e.g., as in nozzle attachment welds), dye penetrant or magnetic particle inspection may be substituted.

E.2.7

Pressure-retaining fillet welds in materials other than carbon steel shall be examined using the liquid penetrant or magnetic particle method.

E.2.8

When post-weld heat treatment is required, radiographic examination shall be performed on completion of the heat treatment.

Annex F (informative)
Quality control program for manufacturers of fittings

Note: *This informative Annex has been written in normative language to facilitate its adoption where users of the Standard or regulatory authorities wish to adopt it formally as additional requirements to this Standard.*

F.1 General
The manufacturer shall maintain a quality control program that will establish that all of the requirements of this Standard and the standards referenced in this Standard will be met. The program that the manufacturer uses shall be suited to its circumstances and reflect the complexity of the products produced. A written description of the program that addresses, at a minimum, the requirements of Clauses F.2 to F.10 shall be available.

F.2 Authority and responsibility
The authority and responsibility of those in charge of the quality control program shall be clearly established. Persons performing quality control functions shall have sufficient and well-defined responsibilities, as well as the authority and organizational freedom to identify and correct quality control problems.

F.3 Organization chart
A chart showing the relationship between management, engineering, purchasing, manufacturing, inspection, and quality control personnel shall be prepared.

F.4 Drawings, design calculations, and specification control
Measures shall be established to ensure that fittings are produced in accordance with the required drawings and specifications.

F.5 Materials control
Measures shall be established to ensure that only proper and certified materials are used.

F.6 Welding
Measures shall be established to ensure that welding procedures used in the production or repair of fittings comply with Section IX of the ASME Code and the standards referenced in this Standard.

F.7 Heat treatment
Measures shall be established to ensure that all heat treatment meets the requirements of the material specifications and the standards referenced in this Standard.

F.8 Calibration of equipment
Measures shall be established for calibrating examination, measuring, and testing equipment used in production.

F.9 Examination, inspection, and testing program

Measures shall be established to provide for examination, inspection, and testing. Such measures shall meet the requirements of the standards referenced in this Standard. At a minimum, a sample inspection program shall meet the lowest level of ANSI/ASQ Z1.4 requirements.

F.10 Correction of nonconformities

Measures shall be established to provide for a systematic review and correction of nonconformities.

Annex G (normative)
Automotive propane vessel standards

Notes:
1) *This Annex is a mandatory part of this Standard.*
2) *Clauses G.1, G.2, and G.7 in this Standard are intended to be included in the 6th edition of CSA B149.5. Following the publication of the 6th edition of CSA B149.5, the requirements related to Clauses G.1, G.2, and G.7 in CSA B149.5 will take precedence in the event of a conflict. Clauses G.1, G.2, G.7 are intended to be removed from CSA B51 for the next edition of this Standard.*

G.1 Corrosion allowance

G.1.1
Vessels mounted outside of the interior of a vehicle shall be designed to a pressure of not less than 2150 kPa (312 psig), but rated not less than 1725 kPa (250 psig). The difference in wall thickness between the two cases shall be considered a corrosion allowance. In the event a vessel is rated at more than 1725 kPa (250 psig), the design pressure shall be 25% greater than the rated pressure. Such vessels shall have a single Canadian Registration Number (CRN) to cover vessels rated at 1725 kPa (250 psig) or higher with a corrosion allowance and at 2150 kPa (312 psig) or higher with no corrosion allowance.

G.1.2
Vessels mounted within a vehicle and protected from the corrosive and erosive effects of the automotive environment shall not require a corrosion allowance and shall be designed to at least 2150 kPa (312 psig).

G.1.3
Vessels fabricated from 300 series stainless steel or 5000 or 6000 series aluminum shall be exempt from the corrosion allowance requirements of Clause G.1.1, provided that the tank is protected from potential erosion in the automotive environment.

G.2 Vessel openings
Except for fittings specifically required by CSA B149.5 to have an internal excess flow valve, valves, gauges, and other fittings with openings greater than the diameter of a #54 drill shall be protected from shearing off and releasing the contents of the vessel by
a) being fully recessed within the body of the vessel;
b) being enclosed within a substantial fitting securely welded to, and forming part of, the vessel structure; or
c) having an internal excess flow valve integral to the fitting.

A substantial fitting shall have a wall thickness at least equal to the wall thickness of the vessel wall and shall not create crevices that provide corrosion sites.

G.3 Crush test of manifold vessels (see Figure G.1)
Notes:
1) *Manifold vessels are defined as two or more vessels fabricated by the original manufacturer; interconnected by rigid, integral, non-removable liquid and vapour passages; and braced to form a single rigid unit.*
2) *The purpose of the crush test is to prove a manifold tank can withstand at least an equal crush load per unit length as a single tank without any failure of the pressure boundary.*

G.3.1
Clause G.3 applies only to manifold vessels mounted between the rear axle and the rear bumper, or along the chassis of the vehicle. Manifold vessels in the trunk of a vehicle that are forward of the rear axle, or in the bed of a truck need not comply with the requirements of Clause G.3.

G.3.2
Manifold vessels shall be capable of withstanding, prior to developing a leak, a crushing load per unit length at least equal to the unit load withstood by a single vessel of the same diameter, material, wall thickness, and internal pressure. The length of a manifold vessel shall be the exposed length of the vessel, not the sum of the lengths of the individual shells in the manifold.

G.3.3
The unit load results from crush tests of longer single vessels shall be used as the basis for qualifying shorter manifold vessels. The acceptance criterion shall be that the crushing load per unit of length of the manifold vessel shall be at least equal to the load withstood by the longest comparable single vessel of the same diameter, material, wall thickness, etc.

Note: *For example, if a vessel 255 mm (10 in) in diameter and 2030 mm (80 in) long is capable of withstanding a unit load of "x" N/m (lbf/in), any 255 mm (10 in) diameter equivalent manifold design will need to be capable of withstanding at least the same unit load.*

G.3.4
The load shall be applied along the length of the single vessel with a flat bar of width equal to 20 to 30% of the diameter of the vessel to which the load is applied, and of a thickness such that no significant deflection of the bar can develop. The width of the bar used to test the manifold vessel shall be not less than the width of the bar used to establish the unit load for the single vessel.

G.3.5
An internal pneumatic pressure of at least 103 kPa (15 psig) and not more than 206 kPa (30 psig) shall be applied to the manifold vessel and monitored with a pressure gauge for evidence of leakage.

G.3.6
The load shall be progressively applied until the manifold vessel develops a leak in its pressure boundary. The rate of application of the load shall be the same in all tests for a given vessel diameter.

G.3.7
If the manifold is fabricated from vessels of different diameters, thicknesses, materials, etc., the qualifying single vessel shall be the corresponding single vessel with the lowest unit load.

Note: *For example, if the manifold vessel is composed of a vessel 255 mm (10 in) in diameter by 760 mm (30 in) long, with a second vessel 305 mm (12 in) in diameter by 915 mm (36 in) long, the qualifying single vessel needs to be a 255 mm (10 in) or 305 mm (12 in) diameter vessel, depending on which vessel has the lower unit load when tested as a single vessel.*

G.3.8
The manifold vessel fabricated for the purpose of crush testing shall be designed such that the centrelines of each of the vessels are all on the same plane. The applied load shall be directed through this plane. The results of this crush test may be used to qualify similar designs in which the centrelines of each vessel are not aligned on the same plane.

G.3.9
Shorter manifold vessels may be qualified by longer manifold vessels provided that their designs are substantially the same. Design changes shall include changes to such items as the number, type, shape, and location of crossover connections, and the centre-to-centre spacing of the vessels.

G.3.10
The test results shall be witnessed by a professional engineer. The test reports shall be signed and stamped by this engineer and submitted with the CRN application.

G.4 Brackets
Brackets attached to all vessels shall be designed for the loads specified in CSA B149.5. Sample calculations shall be submitted with the CRN application. For alternative styles of brackets, the appropriate calculations shall be performed and retained by the fabricator for review by the regulatory authority.

Note: *The design intent is that the likelihood of breaching of the vessel is minimized.*

G.5 Valve guards

G.5.1
Valve guards for bed-mounted and chassis-mounted vessels shall be designed to withstand a direct impact load of 50 kg (110 lb) dropped from a height of 1.5 m (4.92 ft). This impact shall be downward vertically, with the vessel oriented in its normal operating position.

G.5.2
Valve guards for undermounted vessels shall be designed to withstand a direct vertically downward impact load of 50 kg (110 lb) from a distance of 1.5 m (4.92 ft), with the vessel oriented in its normal operating position. The attachment of the guards shall be such that if a guard is pulled horizontally (with reference to the vessel's normal orientation), the attachment of the guard will fail as required in Clause G.5.3.

G.5.3
The attachment of a valve guard shall be such that the valve guard or its attachments will fail before leakage occurs or the vessel is deformed by more than 1.0 times the shell thickness.

G.6 Nameplates

G.6.1
In addition to the nameplate requirements specified in Clause 5.1, the maximum allowable working pressure given on the nameplate shall include the following stamping:

SI units	Yard/pound units
MAWP = Q kPa (No C.A.)	MAWP = Q psi (No C.A.)
MAWP = S kPa (C.A. = R mm)	MAWP = S psi (C.A. = R in)

where

Q is the maximum allowable working pressure (MAWP) per CSA B149.5

S is equal to or less than 0.8 times Q

C.A. is the corrosion allowance

R is the value for corrosion allowance and calculated using equation $R = 0.2 \times t_{min}$, where t_{min} is the minimum thickness calculated for pressure Q

G.6.2

Nameplates shall be mounted on standoffs or seal-welded to the vessel wall to minimize corrosion between the vessel wall and the nameplate. The integrity of the seal weld shall be tested using methods such as the liquid dye penetrant or magnetic particle method. Compliance with this Clause shall be recorded on the manufacturer's data report for the vessel.

G.6.3

Vessels that comply with the requirements of this Annex, with the exception of Clause G.3, shall have "B51 ANX G" stamped on the vessel nameplate. Vessels that comply with all of the requirements of this Annex shall have "B51 ANX G/CT" stamped on the vessel nameplate.

Notes:

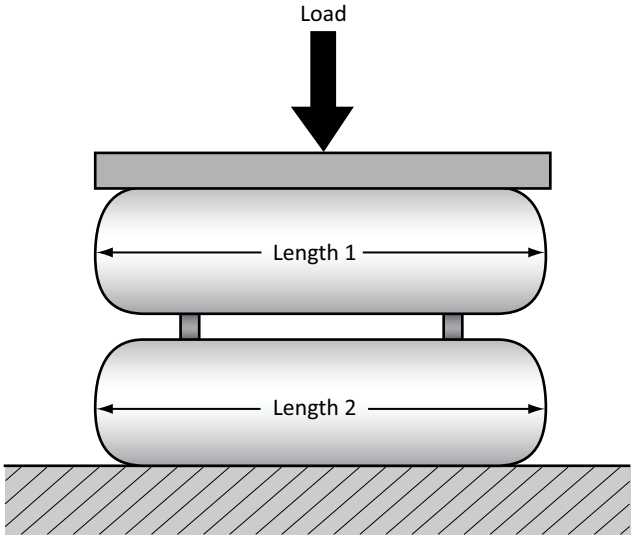
1) *"CT" means crush tested.*
2) *This requirement is identical to a clause in CSA B149.5.*

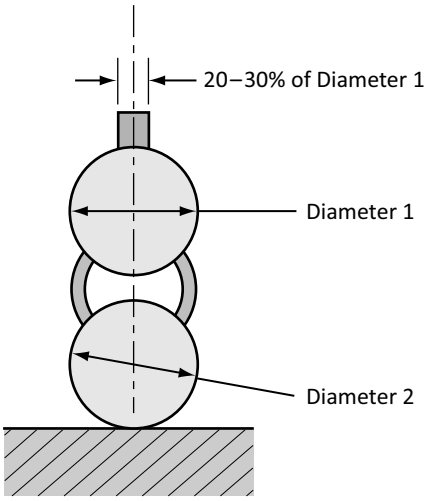
G.7 Vessel appurtenances

Vessel appurtenances shall be made of corrosion-resistant materials compatible with the vessel.

Note: *For example, aluminum fittings cannot be used in a carbon steel vessel.*

Figure G.1
Crush test set-up
(See Clause G.3.)





Annex H (informative)
Overpressure protection devices

Note: *This informative Annex has been written in normative language to facilitate its adoption where users of the Standard or regulatory authorities wish to adopt it formally as additional requirements to this Standard.*

H.1 General

This Annex provides information to complement Clause 12. It provides safety recommendations for pressure relief devices, including pressure relief valves (a generic term encompassing safety valves, safety relief valves, and relief valves) and non-reclosing overpressure relief devices.

H.2 Role of the regulatory authority

H.2.1

The Act sets requirements for pressure-retaining items by specifying compliance with codes and standards. The regulatory authority enforces compliance with these requirements. Regulatory authorities are also responsible for the auditing of companies servicing pressure relief valves and the review and registration of acceptable pressure relief device designs.

H.2.2

Compliance with the ASME Code shall be indicated by the applicable ASME Code marking, as follows:

a) Section I (power boiler valves): V;
b) Section IV (heating boiler valves): HV; and
c) Section VIII (pressure vessel valves): UV or UD.

H.2.3

Of the three types of valves listed in Clause H.2.2, V-stamped valves are subject to the most stringent ASME Code requirements and, for this reason, may be used on pressure vessels and piping in steam service.

H.3 Lifting lever

H.3.1

The primary purpose of a lifting lever (including ring-type) is to manually test a pressure relief valve to prove that it will function freely.

If a lever is not required by the ASME Code and the owner does not intend to manually test the pressure relief valve while it is in service, consideration should be given to specifying a pressure relief valve without a lifting lever when a new or replacement valve is ordered.

A lifting lever should not be used as a carrying handle. Using a lifting lever to carry a valve can cause seat damage. Many valve manufacturers and servicing companies strap down the lifting lever before shipping to reduce the possibility of such damage. These straps shall be removed when the valve is installed.

H.3.2

Section I of the ASME Code requires manual lifting levers for pressure relief valves on boilers.

Section VIII requires manual lifting levers only on pressure relief valves protecting air receivers, vessels in steam service, and vessels used for hot water over 60°C (140°F).

H.4 Service intervals for pressure relief valves in propane service

H.4.1 Pressure relief valves in service outside the scope of CSA B149.2

CSA B149.2 does not apply to propane/LPG pressure vessels

a) in marine or pipeline terminals;
b) in petroleum refineries;
c) for propane used as a feedstock in chemical plants; or
d) in refrigerated storage and underground reservoirs.

These systems are covered by other codes and standards, and the system design and operation can be different from those addressed in CSA B149.2. Process conditions are more extreme, including possible exposure to corrosive contaminants in the product.

H.4.2 Pressure relief valves within the scope of CSA B149.2

CSA B149.2 applies to

a) the storage, handling, and transfer of propane/LPG;
b) the installation of appliances, equipment, components, accessories, and containers on highway vehicles, recreational vehicles, mobile housing, outdoor food service units, and wash-mobiles when propane is to be used for fuel purposes;
c) propane used as an engine fuel in vehicles other than highway vehicles; and
d) the installation of containers and equipment to be used for propane/LPG in distribution locations and filling plants.

H.4.3 Pressure relief valves in service on pressure vessels in propane/LPG service

H.4.3.1

See Figure H.1 for sample drawings of typical propane pressure relief valves installed on a propane storage tank less than 2500 USWG.

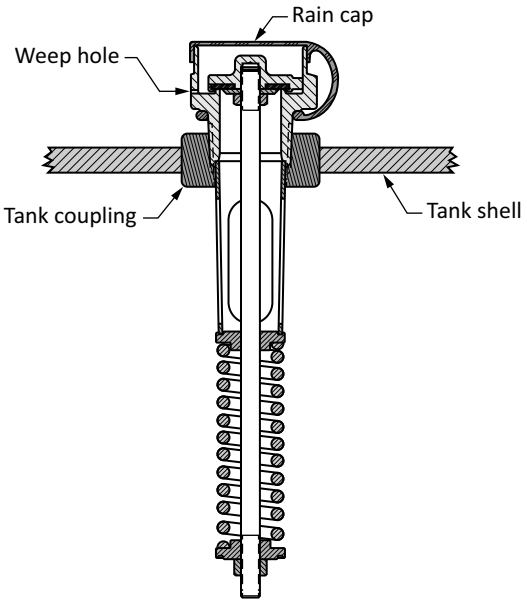
H.4.3.2

Pressure vessels within the scope of CSA B149.2 operate at relatively lower pressures than those systems listed in Clause H.4.1 and are used for clean fluid that is shipped only after it has passed chemical tests at upstream plants. On this basis, Table 5 has different pressure relief valve service intervals for pressure vessels not governed by CSA B149.2 than for those governed by CSA B149.2.

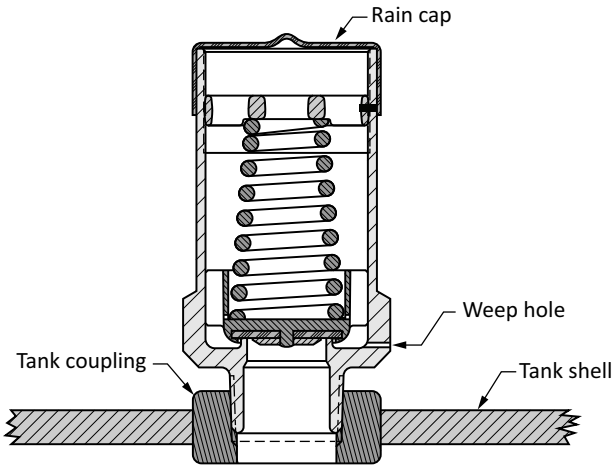
Note: *With respect to pressure relief valves in service on pressure vessels in propane/LPG service governed by CSA B149.2 and less than 2500 USWG, a report is available from the Canadian Propane Association (CPA), dated February 28, 2012, and titled "Submission to the B51 Clause 12 Subcommittee, Recommendations on Inspection, Servicing and Testing of Pressure Relief Valves (PRVs) in Propane Service", that provides information relevant to the service intervals for propane pressure relief valves. The recommendations in the CPA report are based on the results of performance testing and analysis of pressure relief valves carried out by an independent research institute. Additionally, a risk assessment associated with propane tank pressure relief valve replacement was performed by AMEC NSS Ltd. in 2012 and documented in "Propane Tank Pressure Relief Valve Replacement Risk*

Assessment". This assessment identified the hazards associated with the removal of the pressure relief valve from stationary propane tanks less than 2500 USWG.

Figure H.1
Typical propane pressure relief valves installed on a propane storage tank < 2500 USWG
(See Clauses 12.5.3 and H.4.3.1 and Table 5.)



a) Typical internal pressure relief valve



b) Typical external pressure relief valve

Annex I (normative)
Historical boilers

Note: *This Annex is a mandatory part of this Standard.*

I.1 General

The standards governing design, inspection, testing, alterations, and repairs of historical steam boilers shall be those set forth in the original code of construction, the applicable ASME Code edition and sections, the *National Board Inspection Code*, and the requirements of the authority having jurisdiction.

I.2 Design registration

I.2.1 General

Prior to the historical steam boiler being placed into service, the design shall be registered with the authority having jurisdiction.

I.2.2 Calculations for existing construction

Note: *This Clause is not applicable to historical boilers of new construction.*

The maximum allowable working pressure (MAWP) shall be calculated, based on the lesser of the original thicknesses from the affidavit/manufacturer's data report or registered drawings or thickness results from non-destructive examinations (NDE) and the original factors of safety from the code of construction used, by computing the strength of each boiler component. The MAWP shall be the lesser of

a) the MAWP based on the computed strength of the weakest component; and
b) the original design MAWP.

If the original code of construction is unknown, incomplete, or otherwise unacceptable, the appropriate edition and section(s) of the ASME Code shall be applied. Catalogues and advertising literature shall not be acceptable sources for tensile strength values and original thickness specifications.

Notes:

1) *Section I of the 1971 edition of the ASME Code is the final ASME Code edition to be used for historical boilers of riveted construction where the original code of construction is unavailable.*
2) *Section III of the 1952 edition of the ASME Code is the final ASME Code edition to be used for historical locomotives where the original code of construction is unavailable.*

I.2.3 Minimum factor of safety for new construction

Note: *This Clause is applicable to historical boilers of new construction.*

For operating temperatures at or below 260 °C (500°F), a factor of safety of not less than 4:1 shall be applied to the ultimate tensile strength to establish a maximum allowable stress value for any component of a portable, traction, or locomotive boiler.

For operating temperatures above 260 °C (500°F), a factor of safety of not less than 4:1 shall be applied to the ultimate tensile strength to establish a maximum allowable stress value for any component of a portable, traction, or locomotive boiler, and the yield or creep properties shall be taken into account in the design.

I.3 Initial inspection for existing inspection

Note: *This Clause is not applicable to historical boilers of new construction.*

Prior to being placed into service, a historical boiler shall be thoroughly inspected internally and externally and shall be subjected to an appropriate hydrostatic test based on the MAWP determined in accordance with Clause I.2

The inspection shall include visual inspection as well as volumetric and surface NDE to verify the structural integrity of the pressure-retaining components. Special attention shall be given to NDE of parts that are highly stressed or likely to have degraded in service or storage (e.g., longitudinal lap-seam joints, rivets, holes, and edges of seams for detection of grooving and cracks). Techniques such as shear wave testing shall be considered. Volumetric NDE shall be performed on a systematic grid pattern, in addition to any areas likely to be at greater risk of deterioration.

Non-destructive examinations shall be conducted by personnel qualified as Level II or III for the appropriate examination method in accordance with the requirements of the Canadian General Standards Board (CGSB). The Level II and III personnel shall demonstrate to the authorized inspector the use of NDE procedure for each NDE technique applied.

I.4 Periodic inspection

The owner of a historical steam boiler shall follow a periodic inspection program that has been approved by the authority having jurisdiction and shall retain all inspection and test documentation. Annual inspection can include internal and external visual inspections and hydrostatic testing. NDE as specified in the periodic inspection program and in accordance with Clause I.3 shall be completed at regular intervals not to exceed 5 years or as required by the authority having jurisdiction. Changes in the boiler wall thickness shall require a recalculation of the MAWP in accordance with the method provided in Clause I.2 and shall be treated as an alteration if recalculated to a different value.

Note: *Application of this Clause needs to consider variation in NDE measurement.*

I.5 Authorized inspector

All NDE reports shall be made available for the authorized inspector. Visual inspection shall be conducted annually by the authorized inspector. Hydrostatic tests shall be witnessed by the authorized inspector.

I.6 Safety valves

An appropriately sized ASME Code stamped and sealed safety valve with a CRN shall be set at or below the MAWP of the historical steam boiler. An additional relief valve set at a lower pressure may be used in conjunction with the required ASME Code stamped safety valve, although no credit for its relieving capacity shall be used when the required safety valve size is being determined.

I.7 Fusible plugs

Fusible plugs shall be used in all solid fuel fired boilers. Fusible plugs shall be replaced after 500 h of service. Fusible plug life shall not exceed 10 calendar years. If hours of service cannot be proven, the fusible plugs shall be replaced every 3 calendar years. In addition, fusible plugs shall be taken out, inspected, and scraped periodically.

I.8 Operator qualifications

A historical steam boiler shall be operated by a competent person acceptable to the authority having jurisdiction.

I.9 Changes in boiler condition

All repairs and alterations shall be approved by the regulatory authority before work commences. Changes in the boiler condition might justify recalculation of the MAWP in accordance with the method provided in Clause I.2 and shall be treated as an alteration if recalculated to a different value.

Note: *Application of this Clause needs to consider variation in NDE measurement.*

I.10 Loadings

For new construction only, where brackets (attachments or mounting locations) or other fixtures subjected to any working stress (dynamic loading) are attached to a traction or portable boiler, the plates to which these brackets are attached shall be not less than 12.5 mm (0.5 in) in thickness, or shall be reinforced with plates of equal thickness and properly riveted together to achieve the required 12.5 mm (0.5 in) minimum thickness, with the following requirements:

a) Threaded stud holes shall be tapped to not less than 11 threads per inch, and studs shall have full thread engagement to the plate.
b) Threaded stud holes crossing the pressure boundary shall be tapered, and the seal shall be verified during a hydrostatic test.
c) The use of cap screws shall not be permitted for this purpose.

Annex J (normative)
Requirements regarding the use of finite element analysis (FEA) to support a pressure equipment design submission

Note: *This Annex is a mandatory part of this Standard.*

J.1 General
This analysis method requires extensive knowledge of, and experience with, pressure equipment design, FEA fundamentals, and the FEA software involved. The FEA software selected by the designer shall be applicable for pressure equipment design.

J.2 Submission requirements
FEA may be used to support pressure equipment design where the configuration is not covered by the available rules in the ASME Code. The designer should check with the regulatory authority to confirm that use of FEA is acceptable. When this method is used to justify code compliance of the design, the requirements in Clauses J.3 to J.10 shall be met.

J.3 Special design requirement
The FEA analysis and reports shall be completed by individuals knowledgeable in and experienced with FEA methods and pressure equipment design. The FEA report shall be certified by a professional engineer.

J.4 Report executive summary
The FEA report shall contain an executive summary briefly describing how the FEA is being used to support the design, the FEA model used, the results of the FEA, the accuracy of the FEA results, the validation of the results, and the conclusions relating to the FEA results supporting the design submitted for registration.

J.5 Report introduction
The report introduction shall describe the scope of the FEA analysis relating to the design, the justification for using FEA to support the design calculations, the FEA software used for the analysis, the type of FEA analysis (static, dynamic, elastic, plastic, small deformations, large deformations, etc.), a complete description of the material properties used in the analysis, and the assumptions used for the FEA modelling.

J.6 Model description

J.6.1
The report shall include a section describing the FEA model used for the analysis. The description shall include dimensional information and/or drawings relating the model geometry to the actual pressure equipment geometry. Simplification of geometry shall be explained and justified as appropriate. The mesh and type (h, p, 2D, 3D), shape, degrees of freedom, and order (2nd order or above) of the elements used shall be described. If different types of elements (mixed meshes) are used, a description of how the different elements were connected together shall be included. When shell elements are

being used, a description of the top or bottom orientation with plots of the elements shall be included and shall indicate if they are thick or thin elements.

J.6.2

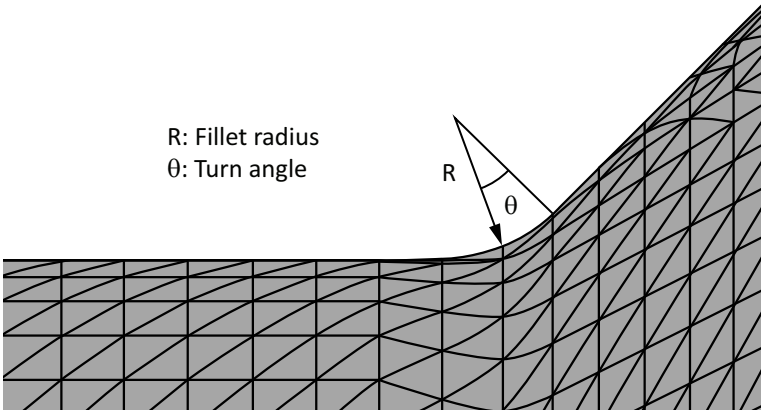
The model description shall include a list of all assumptions.

J.6.3

The turn angle of the elements used on the inside fillet radii shall be indicated.

Note: *The turn angle is the angle of the arc (defined by R, where R is the radius of the arc) of the inside fillet divided by the number of elements along the arc of the inside fillet. For example, if the inside fillet is 45° and it is defined by two elements along the arc of the inside fillet, then the turn angle is 22.5°. See Figure J.1.*

Figure J.1
Fillet radius and turn angle
(See Clause J.6.3.)



J.6.4

The method used to select the size of mesh elements with reference to global or local mesh refinement shall be indicated.

J.6.5

When items in contact (e.g., flange joints, threaded joints) are modelled, the model shall describe how two separate areas in contact are linked. Adequate mesh size shall be used to ensure that the elements are small enough to model contact stress distribution properly.

J.6.6

Boundary conditions, such as supports, restraints, loads, contact elements, and forces, shall be clearly described and shown in the report (present the figures). The method of restraining the model to prevent rigid body motion shall also be indicated and justified. When partial models are used (typically based on symmetry), the rationale for the partial model shall be described with an explanation of the boundary conditions used to compensate for the missing model sections.

J.6.7
The FEA report shall include validation and verification of FEA results. Validation should demonstrate that FEA results correctly describe the real-life behaviour of the pressure equipment, and verification should demonstrate that a mathematical model, as submitted for solution with FEA, has been solved correctly.

J.6.8
The accuracy of the FEA results shall be included in the FEA report, either by the use of convergence studies or by comparison to the accuracy of previous successful in-house models. An error of 5% or less from the convergence study shall be acceptable.

Note: *FEA inaccuracy usually consists of discretization errors, which result from matching geometry and displacement distribution due to the inherent limitation of elements, and computational errors, which are round-off errors from the computer floating-point calculation and the formulations of the numerical integration scheme.*

J.7 Acceptance criteria
The criteria for acceptance of the FEA results shall be based on the code of construction and factor of safety established under that code. The FEA methodology may be based on another code. The acceptance criteria and code reference shall be presented in the report.

Note: *For example, if the code of construction is Section VIII, Division 1, of the ASME Code, the allowable stress values are from Section VIII, Division 1, of the ASME Code. The FEA methodology could be based on Section VIII, Division 2, of the ASME Code (Figure 5.1).*

J.8 Presentation of results

J.8.1
The following information and figures in coloured prints shall be presented:

a) resultant displacements (plot);
b) deformed shape with undeformed shape superimposed;
c) stress plot with mesh that
    i) shows fringes using discrete colour separation for stress ranges or plots; and
    ii) allows comparison between the size of stress concentrations and the size of the mesh;
d) plot with element stress and a comparison of nodal (average) stress vs. element (non-averaged) stress;
e) reaction forces compared to applied loads (free-body diagrams);
f) stress linearization methodology and the stress values in the area of interest; and
g) accuracy of the FEA results.

The results shall be plotted to graphically verify convergence. The x axis of this plot shall show some indication of mesh density in the area of interest (number of elements on a curve, elements per unit length, etc.). This is necessary to show true convergence over apparent convergence that is due only to a relatively small change in the mesh.

J.8.2
When plots or figures are presented, an explanation relating to each figure shall be included to describe the purpose of the figure and its importance.

J.9 Analysis of results

Overall model results, including areas of high stress and deformation, shall be presented with acceptance criteria. The analysis shall include a comparison of the results with acceptance criteria.

Results that are to be disregarded shall be identified, and the determination to disregard them shall be justified.

J.10 Conclusion

As a minimum, the conclusion shall include

a) a summary of the FEA results in support of the design;
b) a comparison of the results and the acceptance criteria; and
c) overall recommendations.

Annex K (normative)
Requirements for pressure vessels designed and constructed using cold-stretch technology

Note: *This Annex is a mandatory part of this Standard.*

K.1 General

K.1.1
For design and construction of cold-stretched austenitic stainless steel pressure vessels, all provisions of Section VIII, Division 1, Mandatory Appendix 44, of the ASME Code shall be adhered to.

Note: *Mandatory Appendix 44 rules do not apply a design factor of 3.5 to the minimum specified tensile strength of the material to establish the allowable design stress values published in Table 44.4.1 in the Mandatory Appendix, even though the design factor of 3.5 is normally used in Section VIII, Division 1, of the ASME Code to establish allowable stress values for materials where maximum design temperatures do not exceed 50 °C (120°F).*

K.1.2
Use of Mandatory Appendix 44 combined with ASME Code Case 2695 is prohibited.

K.1.3
Use of any other ASME Code Cases or Code Interpretations in conjunction with Mandatory Appendix 44 shall be clearly specified in the design registration submission and be acceptable to the regulatory authority.

K.1.4
Cold-stretched pressure vessels shall not be used for storage of corrosive/erosive fluids or for any service where stored fluids could have any adverse effect on the pressure vessel austenitic stainless steel.

K.1.5
In addition to the requirements in Mandatory Appendix 44.2(e) of Section VIII, Division 1, of the ASME Code, the following conditions shall be met:

a) If multiple shell cylinders are used, all shell cylinder plates shall be of the same uniform nominal thickness; and
b) Ellipsoidal or torispherical dished heads are the only head shape allowed. Heads shall satisfy the following conditions:
    i) head minimum thickness after forming shall be at least equal to the minimum calculated design thickness plus the thinning allowance for cold stretching; and
    ii) the ratio of the head actual (measured) minimum thickness to the head design minimum thickness shall not exceed 1.7.

K.1.6
Cold-stretch technology is not permitted to be used for pressure vessels which are subject to loadings as defined in the following paragraphs of Section VIII, Division 1, of the ASME Code:

a) UG-22(e),(g),(h), and (i); or
b) special service defined in UW-2 (e.g., lethal service).

K.1.7

The manufacturer shall develop and qualify the cold-stretching procedure (CSP) before starting to build any pressure vessels using cold-stretch technology. In addition to all requirements specified in Mandatory Appendix 44 of the ASME Code, the CSP shall include the necessary details to produce the required results. The CSP shall include, but it is not limited to, the following:

a) scope and details of the CSP (including cold-stretching operation);
b) procedure limitations (including material and dimensional limitations);
c) allowed variation in actual plate thickness (shell and heads);
d) an explanation as to how the strain is measured and controlled;
e) locations for measuring critical dimension changes during cold stretching;
f) frequency of measuring and frequency of the strain rate calculations;
g) a repair procedure, including the acceptance criteria for the repair, if repairs are to be allowed; and
h) detailed methodology for repeating cold stretching after repair completion by welding during the manufacturing process.

A record of the CSP qualification shall be maintained.

K.1.8

The CSP shall be a controlled document with tracking of all revisions. The CSP document number and revision shall be specified both in the design submission drawings for registration and in the manufacturer's data report.

K.2 Design and design submission requirements

K.2.1

User design requirements (UDR) shall be prepared and be included in the design registration submission. It is the owner's responsibility to define the format and content of the UDR, which will be subject to review and acceptance by the regulatory authority. Among other details, the UDR shall

a) define requirements for cold stretching;
b) confirm the acceptance of the pressure vessel design and construction using cold-stretch technology;
c) specify the number of pressure vessels that will be produced under the UDR;
d) specify the list of service fluids (such as LN_2, LO_2, LAR, etc.); and
e) be reviewed and certified by a professional engineer experienced and knowledgeable in the design and construction of pressure vessels that utilize cold-stretch technology.

Note: *Non-mandatory Appendix KK of Section VIII, Division 1, of the ASME Code and/or paragraph 2.2.2 of Section VIII, Division 2, of the ASME Code may be used as a guide for preparing the UDR.*

K.2.2

The manufacturer shall submit a manufacturer's design report that includes details of the pressure vessel design and the serial numbers of the cold-stretched pressure vessels.

The manufacturer's design report shall be reviewed and certified by a professional engineer experienced and knowledgeable in the design and construction of pressure vessels that utilize cold-stretch technology. This professional engineer shall be someone other than the professional engineer that certified the user design requirements (UDR).

Note: *A manufacturer's design report should not be mistaken for the manufacturer's data report. The manufacturer's design report includes the details of the pressure vessel design and the serial numbers of the cold-*

stretched pressure vessels. Paragraph 2.3.3 of Section VIII, Division 2, of the ASME Code may be used as a guide for preparing a manufacturer's design report.

K.2.3

In addition to the requirements specified in Clause 4, the drawings and documentation submitted for design registration shall also include

a) the cold-stretching pressure (P_c);
b) reference to the CSP, including the document number and revision number;
c) design, fabrication, inspection, and stamping requirements of Mandatory Appendix 44 of the ASME Code and this Annex;
d) all non-destructive examination requirements;
e) information that full volumetric examination (RT or UT) will be performed on all butt joints before cold stretching of the pressure vessel in accordance with
   i) Mandatory Appendix 44, paragraphs 44-5(e) and 44-6.1(c), of the ASME Code;
   ii) Section VIII, Division 1, paragraphs UW-11(a) and UW-51 of the ASME Code; and
   iii) the acceptance criteria for size of indications as specified in Clause K.3.1 of this Annex;
f) a report of any physical tests conducted for the purpose of establishing the MAWP of the pressure vessel or any part thereof; and
g) other information that is necessary to support the design.

K.2.4

The CSP shall be included as a part of the design registration application submission. Changes to the CSP that impact design shall be re-registered.

K.2.5

Utilization of cold stretching is not permitted for parts with primary bending stresses.

K.2.6

Excessive rigidity and restriction of expansion shall be avoided in the design of cold-stretched pressure vessels. Circumferential reinforcement shall not be used.

Note: *In designing a cold-stretched pressure vessel, particular attention should be paid to weld details and avoidance of areas of stress concentration and high restraint.*

K.2.7

The welding procedure qualification shall comply with Mandatory Appendix 44.6.1(g)(2) for impact test requirements. The design submission shall include evidence that the specimens were tested from the welded cold-stretched plate, and indicate the impact test temperature and obtained energy values.

K.2.8

For nozzle reinforcement calculations, the rules and provisions of UG-37 of the ASME Code are permitted; however, use of alternative rules under Appendices 1-9 and 1-10 of the ASME Code and ASME Code Case 2695 are prohibited. For large openings exceeding the limits specified in UG-36(b)(1) of the ASME Code, a design submission shall address how supplemental rules of Appendix 1-7 will be satisfied in addition to the rules of UG-37 of the ASME Code.

K.2.9

In addition to the requirements of Mandatory Appendix 44, paragraph 44.2(g) and the requirements of paragraph UG-37 of Section VIII, Division 1, of the ASME Code, reinforcement calculations of openings shall comply with the following conditions:

a) spacing between nozzles shall be such that limits of reinforcement calculated according to UG-40 of the ASME Code do not overlap; and
b) provisions of paragraph UG-37 of the ASME Code are modified as follows:
   i) area of reinforcement required (A) is calculated $A = d\ t_r$, where $t_r = t$;
   ii) area of excess thickness in the pressure vessel wall available (A_1) is taken as zero;
   iii) required thickness of a nozzle wall (t_{rn}) is calculated using the rules of Section VIII, Division 1, of the ASME Code and applying the allowable stress value specified in Section II, Part D, of the ASME Code; and
   iv) area of excess thickness in the nozzle wall (A_2) is calculated using value for t_{rn} calculated in accordance with the rules in this Annex.

The opening is adequately reinforced if $A_2 + A_3 + A_{41} + A_{43} > A$.

K.3 Fabrication and inspection requirements

K.3.1

Full volumetric examination (RT or UT) per UW-11(a) of the ASME Code shall comply with paragraph UW-51 of Section VIII, Division1, of the ASME Code.

Volumetric examination shall be performed on all butt joints according to the requirements of Mandatory Appendix 44, paragraphs 44-5(e) and 44-6.1(c), of the ASME Code. The acceptance criteria for size of indications specified in paragraph UW-51(b)(2) of the ASME Code shall be modified as follows:

a) instead of UW-51(b)(2)(a), use: 5 mm (0.2 in) for t up to 19 mm (0.75 in); and
b) instead of UW-51(b)(2)(b), use: 1/4t for t from 19 mm (0.75 in) to 30 mm (1.2 in).

K.3.2

After the volumetric examination is completed, defective welds shall be repaired and re-examined. If the pressure vessel has already been cold stretched prior to repair, it shall be cold stretched again; and following the repeated cold stretching, re-examination in accordance with this Clause is required.

K.3.3

If the pressure exceeds 1.6 × MAWP during vessel cold stretching, the vessel does not meet the requirements of Mandatory Appendix 44, paragraph 44.5(c), of the ASME Code and shall not be used.

K.4 Certification, marking, and recordkeeping requirements

K.4.1

In addition to the requirements of Mandatory Appendix 44, paragraph 44-7(b), of the ASME Code, the manufacturer's data report, under the "Remarks" section, shall include/specify

a) service fluid(s);

   Note: *The manufacturer may list multiple fluids (such as LN_2, LO_2, LAR, etc.) in the "Remarks" section of the manufacturer's data report if so specified in the user's design specification and the registered design.*

b) CPS document number and revision number;

c) that the RT or UT has been performed in compliance with this Annex, and that the pressure vessel complies with the acceptance criteria specified in Clause K.3.1;
d) the statement "This pressure vessel has been designed and built in compliance with CSA B51, Annex K"; and
e) the statement "Do not weld or repair without prior authorization by the regulatory authority. Cold stretching might be required after welding on this pressure vessel".

K.4.2
The "RT-1" marking shall be applied under the certification mark on the nameplate, indicating the cold-stretched pressure vessel was constructed in accordance with UW-11(a) rules of the ASME Code and the requirements of Clauses K.2.3 and K.3.1 of this Annex.

K.4.3
The completed pressure vessels shall be clearly marked on the code-stamped vessel (inside) and on the outside non-code vessel with a warning notation (plate), e.g., "WARNING — COLD-STRETCHED VESSEL — DO NOT WELD, GRIND, OR IN ANY OTHER WAY MODIFY THE PRESSURE BOUNDARY."*

** The equivalent French wording is "AVERTISSEMENT — APPAREIL ÉTIRÉ À FROID — NE PAS SOUDER, MEULER OU ALTÉRER EN AUCUNE FAÇON LA PARTIE SOUS PRESSION".*

K.4.4
The manufacturer's data report shall also include the following documentation:
a) the UDR (see Clause K.2.1);
b) the manufacturer's design report (see Clause K.2.2); and
c) a report (RT or UT) that demonstrates that the sizes of indications in the pressure vessel comply with the acceptance criteria specified in Clause K.3.1.

K.5 Used cold-stretched pressure vessels

K.5.1
If a person intends to bring a used cold-stretched vessel into Canada, design registration and a certificate of inspection shall be obtained before the vessel is put in service.

K.5.2
If a used cold-stretched pressure vessel does not comply fully with this Annex, it shall not be put in service.

K.6 Post-construction requirements

K.6.1
After a cold-stretched pressure vessel is put into service, the owner shall comply with Clauses K.6.2 to K.6.9.

K.6.2
Overpressure protection of cold-stretched pressure vessels shall be provided through the use of pressure relief devices.

K.6.3
The owner shall maintain a file with reports and records of a pressure vessel manufactured using cold-stretch technology. Also, these reports and records will be necessary to prepare and facilitate future repairs or alterations of that vessel.

K.6.4
Re-rating (e.g., pressure increase) of the registered maximum allowable working pressure (MAWP) is not allowed for cold-stretched vessels.

K.6.5
All repair and alteration procedures for cold-stretched vessels shall be submitted for review by the regulatory authority prior to the start of work.

K.6.6
When welding is utilized for repair and/or alteration, the following conditions shall apply:
a) the pressure vessel shall be subject to cold stretching after welding is completed;
b) the cold-stretching repair/alteration procedure shall be acceptable to the owner of the pressure vessel and the regulatory authority; and
c) all nozzle attachment reinforcements shall be re-evaluated following any additional cold stretching.

K.6.7
In addition to the requirements provided in Clause 4.9.3, the cold-stretching procedure that is used for repair or alteration shall be developed and verified in accordance with Clauses K.1.7 and K.1.8.

K.6.8
Any repair or alteration of a cold-stretched pressure vessel shall be approved by the authority having jurisdiction prior to the work.

K.6.9
In the case of a change of ownership for a cold-stretched pressure vessel constructed to this Annex,
a) the equipment reports and records shall be transferred to the new owner; and
b) the requirements of Clause 4.1.9 b) and c) are also applicable.

Annex L (informative)
Condition assessments for high-energy steam (HES) piping systems

Note: *This informative Annex has been written in normative language to facilitate its adoption where users of the Standard or regulatory authorities wish to adopt it formally as additional requirements to this Standard.*

L.1 General

This Annex applies to high-energy steam (HES) piping systems and needs to be compatible with associated equipment IPs.

L.2 Operating and maintenance procedures

Written operating and maintenance procedures shall be established and issued by the owner/user and the following shall be addressed:

a) design limits that encompass the operating conditions of the piping systems;
b) identifying modes of operation, such as equipment in service, etc., and associated mode operating periods/duration;
c) recording of
    i) operating pressure;
    ii) operating temperature;
    iii) operating flows; and
    iv) significant transients as defined by the code of construction, such as overpressure, overtemperature, or operating events such as steam/water hammer, condensate and liquid slug events, etc.;
d) repairs, alterations, and replacements, including welding procedures used, and NDE results of all welded joints and/or repairs;
e) maintenance activities for pipe supports (i.e., constant supports, spring supports, sliding supports, guides, anchors, rigid supports, snubbers, etc.) for systems in creep range, vents, drains, relief valves, desuperheaters, attemperators, and instrumentation, as follows:
    i) past hanger inspection data;
    ii) travel position in the hot and cold positions;
    iii) inspection for loose hardware or signs of damage;
    iv) inspection of free thermal expansion;
    v) records for past piping or support modifications and repairs;
    vi) evidence of damaging dynamic or transient events, such as damaged insulation; and
    vii) piping system slope;
f) condition assessment and evaluation for degradation mechanisms, such as creep, fatigue, graphitization, corrosion, erosion, flow accelerated corrosion (FAC), etc.; and
g) other required maintenance.

L.3 Condition assessment

A program shall be established for assessing and documenting the condition of the operating systems based on industry practices at frequencies established by engineering evaluations that can include operating history, previous findings, and applicable NDE results.

Weld examination and hanger inspection methods are key elements to be included in the assessment program for determining material degradation mechanisms.

Documentation for each system shall include, as a minimum,

a) system name;
b) system medium;
c) original piping system specifications;
d) design diameters and schedule/wall thicknesses;
e) design pressure and temperature;
f) normal operating pressure and temperature;
g) operating hours, including cumulative time;
h) modes and number of cycling operations (such as hot, warm, and cold starts);
i) pipe supports for systems, particularly hot and cold walk-down readings;
j) system modifications, alterations, and repairs;
k) system significant transient or excursion events, including hydraulic events (i.e., steam hammers, liquid slugging, pressure surge, or impact loading), flows, pressures, and temperatures beyond design limits;
l) pipe stress analysis. Any modifications shall have an engineering assessment and/or analysis performed;

Note: *Legacy systems might not have pipe stress analysis data available.*

m) material documentation, including specifications, certified mill test reports (CMTRs), heat treatment, or other special processes; and
n) determination of applicable degradation mechanisms.

Note: *A CMTR is a quality assurance document that certifies a material's chemical and physical properties. The CMTR also certifies the material is in compliance with a specific standard published by an international standards organization (such as ANSI, ASME, etc.). A CMTR might be required for special considerations.*

L.4 Records

Records shall be maintained for the life of the piping system and include the documentation listed under

a) condition assessment;
b) repairs or alterations; and
c) failure analysis, and associated documentation for the investigation.

L.5 Walk-downs — Visual assessments

The owner shall develop and implement a program for acquiring and documenting piping support readings and piping system displacements. Baseline measurements and observations shall be established.

Hot and cold walk-downs shall be specified. Walk-down surveys shall be performed as part of routine maintenance. The walk-downs should focus on the following, as a minimum:

a) The actual operating conditions do not exceed anticipated operating conditions, including loading and/or movement of the pipe supports.
b) Pipe supports, or any component thereof, have not been damaged during operation.
c) Pipe supports have been properly maintained, including lubrication, cleaning, and adjustments.
d) Pipe supports are correctly oriented for proper functioning.
e) All stops, locks, bands, shipping bars, etc., have been removed.

Piping position changes, significant vibrations, and malfunctioning supports shall be documented and evaluated. Displacement variations from the expected shall be considered with the system integrity evaluation that might necessitate further examinations of critical weldments and support adjustments or repairs.

Consideration shall be given for annual hot walk-downs, with cold walk-down intervals not exceeding frequencies of 3 years.

L.6 Material operating in the creep range

For all materials operating within the creep range, a program shall be established to monitor, collect, and record operating data, and shall be evaluated at regular intervals as identified within the IP.

Special attention shall be directed to the specific grade of material that is affected, particularly creep strength enhanced ferritic (CSEF) materials, because they will require additional and specific monitoring instructions.

Note: *Creep is the tendency of material to plastically deform under load, and is dependent on stress, time, and temperature.*

National Standard of Canada

B51-19, Part 2
High-pressure cylinders for the on-board storage of natural gas and hydrogen as fuels for automotive vehicles

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B51-19, Part 2
High-pressure cylinders for the on-board storage of natural gas and hydrogen as fuels for automotive vehicles

0 Introduction

Part 2 of this Standard concerns high-pressure cylinders for the on-board storage of natural gas, blends of natural gas and hydrogen (hydrogen blends), and hydrogen as fuels for automotive vehicles. The use of gas cylinders is governed by the Act. Users and manufacturers should note the need to apply to the applicable regulatory authorities for approval of gas cylinders.

1 Scope

1.1

Part 2 of this Standard specifies minimum requirements for serially produced lightweight refillable gas cylinders, both original equipment and conversions, having a water capacity exceeding 20 L (0.71 ft^3) but not exceeding 1000 L (35.3 ft^3). Part 2 of this Standard applies only to cylinders for the on-board storage of high-pressure compressed natural gas and/or compressed hydrogen as fuels for automotive vehicles to which the cylinders are to be fixed. Cylinders may be of any material (steel, aluminum, or non-metallic) and constructed in accordance with any design or method of manufacture suitable for the specified service conditions.

1.2

The cylinders covered by Part 2 of this Standard are designated as follows:

a) Type 1 — metal;
b) Type 2 — metal liner reinforced with resin-impregnated continuous filament (hoop-wrapped);
c) Type 3 — metal liner reinforced with resin-impregnated continuous filament (fully wrapped); and
d) Type 4 — non-metallic liner with resin-impregnated continuous filament (all-composite).

1.3

The service conditions to which the cylinders are subjected are specified in Clause 4. Part 2 of this Standard is based on a working pressure settled at 15 °C (59°F), with a maximum filling pressure of 1.25 times the working pressure.

The service life of a cylinder is defined by the manufacturer and can vary with different applications. This Standard's definition of service life is based on filling a cylinder 750 times a year. The maximum service life of Type 2, Type 3, and Type 4 cylinders is 20 years. For all cylinders, a "safe life" design principle is used.

For metal and metal-lined cylinders, the cylinder life is based on the rate of fatigue crack growth. Ultrasonic or equivalent inspection of each cylinder or liner is necessary to ensure that there are no

flaws that exceed the maximum allowable size determined by fracture mechanics. This approach optimizes the design and manufacture of lightweight cylinders for natural gas vehicle service.

For all-composite cylinders with non-metallic non-load-bearing liners, safe life is ensured by appropriate design methods, design qualification testing, and manufacturing controls.

1.4
Part 2 of this Standard does not cover Type 1 or Type 2 welded metal cylinders or liners.

1.5
Where a clause in Part 2 of this Standard is at variance with codes or standards referenced in Part 2 of this Standard, the requirements of Part 2 of this Standard govern.

1.6
Type 1 steel cylinders may be requalified for further service in accordance with the procedure described in Annex B.

1.7
In this Standard, “shall” is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the standard; “should” is used to express a recommendation or that which is advised but not required; and “may” is used to express an option or that which is permissible within the limits of the standard.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

1.8
The values given in SI units are the units of record for the purposes of this Standard. The values given in parentheses are for information and comparison only.

2 Reference publications
Part 2 of this Standard refers to the following publications, and where such reference is made, it shall be to the edition listed below, including all amendments published thereto.

CSA Group

ANSI HPRD 1-2013 (R2018)
Thermally activated pressure relief devices for compressed hydrogen vehicle fuel containers

ANSI PRD 1-2013 (R2018)
Pressure relief devices for natural gas vehicle (NGV) fuel containers

B108-18
Natural gas refuelling stations installation code

B109-17
Natural gas for vehicles installation code

B339-18
Cylinders, spheres, and tubes for the transportation of dangerous goods

CAN/CSA-ISO 9001:16
Quality management systems — Requirements

ASTM International

B117-16
Standard Practice for Operating Salt Spray (Fog) Apparatus

D522/D552M-17
Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings

D638-14
Standard Test Method for Tensile Properties of Plastics

D1308-02 (2013)
Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes

D2344/D2344M-16
Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates

D2794-93 (2010)
Standard Test Method for Resistance of Organic Coatings on the Effects of Rapid Deformation (Impact)

D3170-14
Standard Test Method for Chipping Resistance of Coatings

D3359-17
Standard Test Methods for Rating Adhesion by Tape Test

D4138-07a (2017)
Standard Practices for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive, Cross-Sectioning Means

D4814-18c
Standard Specification for Automotive Spark-Ignition Engine Fuel

D7091-13
Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals

E8/E8M-16a
Standard Test Methods for Tension Testing of Metallic Materials

E23-16b
Standard Test Methods for Notched Bar Impact Testing of Metallic Materials

E399-17
Standard Test Method for Linear-Elastic Plane-Strain Fracture Toughness K_{Ic} of Metallic Materials

G154-16
Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

CGSB/ISO (Canadian General Standards Board/International Organization for Standardization)

CAN/CGSB-48.9712-2014/ISO 9712:2012
Nondestructive testing — Qualification and certification of NDT personnel

ISO (International Organization for Standardization)

148-1:2016
Metallic materials — Charpy pendulum impact test — Part 1: Test method

306:2013
Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)

6506-1:2014
Metallic materials — Brinell hardness test — Part 1: Test method

6508-1:2016
Metallic materials — Rockwell hardness test — Part 1: Test method

7866:2012
Gas cylinders — Refillable seamless aluminum alloy gas cylinders — Design, construction and testing

9001:2015
Quality management systems — Requirements

9809-1:2010
Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 1: Quenched and tempered steel cylinders with tensile strength less than 1 100 MPa

11114-4:2017
Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 4: Test methods for selecting metallic materials resistant to hydrogen embrittlement

11439:2013
Gas cylinders — High pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles

14687:2018
Hydrogen fuel quality — Product specification

19078:2013
Gas cylinders — Inspection of the cylinder installation, and requalification of high pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles

NACE International

TM0177-2016
Laboratory Testing of Metals for Resistance to Sulfide Stress Cracking and Stress Corrosion Cracking in H_2S Environments

UL (Underwriters Laboratories Inc.)

969:2018
Standard for Marking and Labeling Systems

U.S. DOT (United States Department of Transportation)

"Specification 3AA and 3AAX Seamless Steel Cylinders". Title 49, *Code of Federal Regulations* 178.37, 2012 ed.

3 Definitions

The following definitions shall apply in Part 2 of this Standard:

All-composite cylinder — a composite cylinder using a non-metallic liner.

Autofrettage — a pressure application procedure used in manufacturing composite cylinders with metal liners. It strains the liner past its yield point so as to cause permanent plastic deformation, which results in the liner having compressive stresses and the fibres having tensile stresses at zero internal pressure.

Autofrettage pressure — the pressure within the overwrapped cylinder at which the required distribution of stresses between the liner and the overwrap is established.

Batch —

Composite cylinders — a group of cylinders successively produced from qualified liners having the same size, design, specified materials of construction, and process of manufacture.

Limits — not more than 202 finished cylinders or liners, or one shift of continuous production as defined by the manufacturer, whichever is greater.

Metal cylinders and liners — a group of successively produced metal cylinders or liners having the same nominal diameter, wall thickness, design, specified materials of construction, process of manufacture, equipment for manufacture and heat treatment, and conditions of time, temperature, and atmosphere during heat treatment.

Non-metallic liners — a group of successively produced non-metallic liners having the same nominal diameter, wall thickness, design, specified materials of construction, and process of manufacture.

Composite cylinder — a cylinder made of resin-impregnated continuous filament wound over a metal or non-metallic liner.

Controlled-tension winding — a process used in manufacturing hoop-wrapped composite cylinders with metal liners.

Note: *Compressive stresses in the liner and tensile stresses in the overwrap at zero internal pressure are obtained by winding the reinforcing filaments under high tension.*

Filling pressure — the gas pressure in a cylinder immediately after completion of filling.

Finished cylinder — a completed cylinder that is ready for use, typical of normal production, and complete with identification marks and external coating, including integral insulation specified by the manufacturer, but free from non-integral insulation or protection.

Full-wrap — an overwrap having a filament wound in both the circumferential and axial directions of a cylinder.

Gas temperature — the temperature of gas in a cylinder.

Hoop-wrap — an overwrap having a filament wound in a substantially circumferential pattern over the cylindrical portion of a liner so that the filament does not carry any significant load in a direction parallel to the cylinder's longitudinal axis.

Hydrogen blend — a mixture of dry natural gas and at least 0.1% by volume of hydrogen gas.

Independent inspection agency — an inspection agency independent of the manufacturer and approved by the regulatory authority as competent to supervise the construction and testing of cylinders.

Liner — a container, used as a gas-tight inner shell, on which reinforcing fibres are filament-wound to reach the necessary strength. Two types of liners are specified in this Standard: metal liners that are designed to share the load with the reinforcement and non-metallic liners that do not carry any part of the load.

Manufacturer — a person or organization responsible for the design, fabrication, and testing of cylinders.

Overwrap — the reinforcement system of filament and resin applied over a liner.

Pre-stressing — the process of applying autofrettage or controlled-tension winding.

Service life — the life in years during which a cylinder can safely be used in accordance with the standard service conditions specified in Clause 4.

Service temperature range — the gas temperature range in cylinders subjected to the standard service conditions specified in Clause 4.

Settled pressure — the gas pressure when a given settled temperature is reached.

Settled temperature — the uniform gas temperature after a change in temperature caused by filling has dissipated.

Test pressure — the pressure at which a cylinder is hydrostatically tested.

Working pressure — the settled pressure at a uniform temperature of 15 °C (59°F).

4 Service conditions

4.1 General

4.1.1 Standard service conditions

The standard service conditions specified in Clause 4 are provided as a basis for the design, manufacturing, inspection, testing, and approval of cylinders that are to be mounted permanently on vehicles and used to store natural gas, hydrogen blends, or hydrogen at ambient temperatures for use as fuel for the vehicles.

4.1.2 Use of cylinders

Clause 4 is also intended to provide information on how cylinders made to this Standard can be safely used by the following:

a) owners of cylinders;
b) designers or contractors responsible for installing cylinders;
c) designers or owners of equipment used to refuel cylinders;
d) suppliers of natural gas, hydrogen blends, or hydrogen; and
e) regulatory authorities that have jurisdiction over cylinder use.

Note: *Regulatory authorities can allow cylinders conforming to this Standard to be used under conditions different from the standard service conditions specified in this Standard.*

4.1.3 Service life

The service life shall be specified by the cylinder designer on the basis of use under the service conditions specified in this Standard.

4.1.4 Periodic requalification

4.1.4.1 General

Any requirements for periodic requalification by inspection or testing during the service life shall be specified by the cylinder designer on the basis of use under the service conditions specified in this Standard. Each cylinder shall be visually inspected for external damage and deterioration at least every 36 months and at the time of any reinstallation. Inspections and tests shall be performed by an agency approved by the regulatory authority, in accordance with the inspection procedures specified in ISO 19078, and follow the manufacturer's specifications.

Cylinders without labels containing mandatory information, or with labels containing mandatory information that are illegible in any way, shall be removed from service. If a tank can be positively identified by manufacturer and serial number, a replacement label may be applied to the cylinder, and the cylinder may remain in service.

4.1.4.2 Cylinders involved in collisions

Cylinders that have been involved in a vehicular collision shall be reinspected by an agency authorized by the manufacturer and, if required, by the authority having jurisdiction. A cylinder that has not experienced impact damage from a collision may be returned to service; otherwise, it shall be returned to the manufacturer for evaluation.

4.1.4.3 Cylinders involved in fires

Cylinders that have been subject to the action of fire shall be removed from service and destroyed.

4.2 Maximum pressures

4.2.1 Maximum pressures for natural gas

A cylinder may be filled to a pressure not exceeding

a) the working pressure at a settled temperature of 15 °C (59°F);
b) 1.25 times the working pressure or a settled pressure of 260 bar (3770 psi), whichever is greater, at 57 °C (135°F); or
c) 1.25 times the working pressure or 260 bar (3770 psi), whichever is greater, immediately after filling, regardless of temperature.

Thus, to achieve a settled pressure of 200 bar (2900 psi) at a settled temperature of 15 °C (59°F), the dispensed pressure shall be temperature compensated to prevent pressures from exceeding the maximum pressure of 260 bar (3770 psi). This compensation shall be based on a gas for which

P (*bar*) = $P = 178.6 + [1.43T]$

where
T = temperature, °C

For gas mixtures that do not follow this equation, the dispensed pressure shall be reduced to ensure that the limit specified in Item b) is not exceeded and to protect the cylinder in case of exposure to heat or fire.

Notes:

1) *The working pressures commonly used for compressed natural gas service are 200 bar at 15 °C (3000 psig at 70°F) and 240 bar at 15 °C (3600 psig at 70°F).*
2) *The maximum pressure is usually achieved during the fast filling of the cylinder.*

4.2.2 Maximum pressures for hydrogen blends and hydrogen

Cylinders shall be designed to be filled up to a maximum pressure that

a) does not exceed 1.25 times the working pressure, regardless of filling conditions or temperature; and
b) settles to a pressure not greater than the working pressure at the settled temperature of 15 °C (59°F).

Notes:

1) *Working pressures commonly used for compressed hydrogen service are 248 bar (3600 psi), 350 bar (5075 psi), and 700 bar (10 150 psi) at 15 °C (59°F). Other working pressures may be used if the qualification test requirements in Part 2 of this Standard are met.*
2) *The maximum pressure is usually achieved during the fast filling of the cylinder.*

4.3 Maximum number of filling cycles

The total number of times a cylinder may be filled shall not exceed its years of specified service life multiplied by 750.

4.4 Temperature range

4.4.1 Gas temperatures

The settled temperature of natural gas or hydrogen blends in cylinders may vary from –40 °C (–40°F) to 57 °C (135°F). The settled temperature of hydrogen in cylinders may vary from –40 °C (–40°F) to 85 °C (185°F).

4.4.2 Minimum design cylinder temperatures

The temperature of the cylinder materials may vary from –40 °C (–40°F) to 85 °C (185°F). For natural gas or hydrogen blends, temperatures over 65 °C (149°F) shall be sufficiently local, or of short enough duration, that the temperature of gas in the cylinder shall not exceed 65 °C (149°F). For hydrogen, temperatures over 85 °C (185°F) shall be sufficiently local, or of short enough duration, that the temperature of gas in the cylinder shall not exceed 85 °C (185°F).

4.4.3 Transient temperatures

The developed temperatures during filling and discharge may be outside the ambient limits of Clause 4.4.2.

4.5 Gas composition

Cylinders made to this Standard are intended to be used with natural gas that complies with the gas composition requirements specified in ISO 11439 and with hydrogen that complies with ISO 14687. Methanol or glycol shall not be deliberately added to the natural gas.

4.6 External surfaces

Cylinders are not designed for exposure to leakage from cargo that might be carried on vehicles. The design of cylinders shall take into consideration the exposure of external surfaces to

a) water, either by periodic immersion or road spray;
b) salt from operation of vehicles near the ocean or where ice-melting salt is used;
c) ultraviolet radiation from sunlight;
d) the impact of gravel;
e) solvents, acids, and alkalis; and
f) automotive fluids (including gasoline), hydraulic fluids, glycol, and oils.

4.7 Gas permeation or leakage

Cylinders may be located in enclosed spaces for extended periods of time. For Type 4 cylinders, permeation of gas through the cylinder wall or leakage between the end connections and the liner shall be considered in the design.

4.8 Installation

Cylinder valves, pressure relief devices, and connections shall be protected against breakage in a collision. If this protection is mounted on the cylinder, the design and method of attachment shall be approved by the cylinder manufacturer. Factors to be considered shall include the ability of the cylinder to support the transferred impact loads and the effect of local stiffening on cylinder stresses and fatigue life.

Cylinders shall be protected from accidental cargo spillage and from mechanical damage. Cylinder locations and mountings shall be designed to provide adequate impact protection to prevent cylinder failure in a collision.

Notes:

1) *This Standard does not specify requirements for cylinder integrity in a vehicle collision.*
2) *For installation details, see CSA B109.*

5 Design approval

5.1 General

Cylinder designs shall be registered with the regulatory authority where the cylinders are to be used. The requirements of Part 1 of this Standard on the registration of designs shall apply. The following shall be submitted by the cylinder designer to the appropriate regulatory authority with a request for approval:

a) the statement of service;
b) the design data;
c) the manufacturing data;
d) information on the quality control program, including the inspection and test plan (unless waived by the regulatory authority);
e) the service life, in-service requalification requirements, and rejection criteria; and
f) the specification sheet.

5.2 Statement of service

The purpose of the statement of service is to guide users and installers of cylinders as well as to provide information to the regulatory authority receiving the request for approval. The statement of service shall include

a) a statement that the cylinder design is suitable for use in the service conditions specified in Clause 4 for the service life of the cylinder;
b) a specification of service life;
c) information on specification of the minimum in-service test and/or inspection requirement;
d) information on protection against fire (the pressure relief devices and insulation);
e) information on support methods, protective coatings, etc., required but not provided;
f) a description of the cylinder design; and
g) any other information necessary to ensure the safe use of the cylinder.

5.3 Design data

5.3.1 Drawings

At a minimum, drawings shall include the following:

a) title, reference number, date of issue, and revision numbers (with their dates of issue, if applicable);
b) a reference to this Standard, using the full designation and the cylinder type;
c) all dimensions, complete with tolerances, including details of end-closure shapes (with minimum thicknesses and details of openings);
d) masses, complete with tolerances of cylinders, liners, and overwraps;
e) material specifications, complete with minimum mechanical and chemical properties or tolerance ranges, and, for metal cylinders or metal liners, the specified hardness range; and
f) other data, e.g., autofrettage pressure range, minimum test pressure, details of the fire protection system, and details of the exterior protective coating.

5.3.2 Stress analysis report

A finite element or other stress analysis shall be provided that takes temperature into account and provides stress contours to show the stress distributions in the cylinder at

a) working pressure;
b) 20 bar;

c) specified test pressure;
d) design burst pressure;
e) specified autofrettage pressure (required only for Type 2 or Type 3 autofrettaged designs); and
f) zero pressure after pre-stress (required only for Type 2 or Type 3 pre-stressed designs).

A table summarizing the highest stresses at critical locations at the pressures listed in this Clause shall be provided.

5.3.3 Material test data

A detailed description of the materials used in the design shall be provided. Test data characterizing the mechanical properties and the suitability of the materials for service under the conditions specified in Clause 4 shall also be provided.

5.3.4 Design qualification test data

When tested in accordance with the applicable test methods specified in Clause 14, the cylinder material, design, and manufacture shall be proved to be adequate for their intended service by meeting the requirements of the tests required for the particular cylinder design.

The test data shall also document the dimensions, wall thicknesses, and weights of each of the test cylinders.

Note: *Other test methods at least as effective as those specified in Clause 14 may be used, subject to satisfactory proof and documentation, as well as the approval of the regulatory authority.*

5.3.5 Fire protection

The arrangement of pressure relief devices and insulation that will protect the cylinder from sudden rupture when exposed to the fire conditions described in Clause 14.15 shall be specified. Test data shall substantiate the effectiveness of the specified fire protection system.

Using the results of the bonfire test described in Clause 14.15, the manufacturer shall specify the registered pressure relief device and, if applicable, the thickness and thermal properties of any insulation required.

5.3.6 Cylinder supports

Details of cylinder supports or support requirements shall be provided in accordance with Clause 6.11.

5.3.7 Additional supporting data

Additional data that would support the application, e.g., the service history of the material proposed for use, or the use of a particular cylinder design in other service conditions, shall be provided where applicable.

5.4 Manufacturing data

Details of all fabrication processes, non-destructive examinations, production tests, and batch tests shall be provided.

The tolerances for all production processes, e.g., heat treatment, end forming, resin mix ratio, filament winding tension and speed, curing times and temperatures, and autofrettage procedures, shall be specified.

Surface finish, thread details, acceptance criteria for ultrasonic scanning (or equivalent), and maximum lot sizes for batch tests shall also be specified.

5.5 Quality control program

The manufacturer shall specify methods and procedures in accordance with Clause 13 that will ensure that all production cylinders comply with the design. This information shall be submitted in a separate quality control manual.

Arrangements for an independent inspection agency shall also be documented.

5.6 Service life and in-service requalification requirements and rejection criteria

5.6.1 Service life

The manufacturer shall specify the maximum service life of cylinders manufactured to the design.

5.6.2 Retesting

The manufacturer shall specify any required retesting interval, the test method, and the retesting rejection criteria. For metal and metal-lined cylinders (Type 1, Type 2, and Type 3 designs), the frequency of retesting shall be based on the rate of crack growth associated with 750 cycles per year from 20 bar to working pressure. The retesting shall be performed at a frequency that will allow detection of a crack before it leads to a leak condition. Manufacturers may avoid the requirement to specify retesting requirements during the service life of the cylinder by using the 100% ultrasonic scanning examination or an equivalent non-destructive examination (which is a part of the production inspection) to ensure the absence of flaws that would otherwise lead to fatigue failure within the service life of the cylinder. The rejection criteria for ultrasonic scanning or its equivalent shall be calculated using fracture mechanics methods. The ability of the non-destructive inspection system to detect the specified minimum defect size shall be documented.

For all-composite cylinders (Type 4 designs), manufacturers shall provide data, as necessary, to justify an appropriate retesting period. This information shall include, but not be limited to,

a) production inspection methods for non-metallic liners, including non-destructive examination of any bonded or fused connections;
b) long-term compatibility of the liner material to natural gas vehicle (NGV) environments;
c) long-term integrity of the liner/metal boss connection; and
d) provision for conducting accelerated cylinder tests under NGV service conditions.

5.6.3 Reinspection

Visual reinspection of the external cylinder surfaces shall be the responsibility of the regulatory authorities; however, the manufacturer shall specify the rejection criteria for visual reinspections and the frequency of reinspection, if the minimum requirement specified in Clause 4.1.4.1 is not sufficient.

For Type 1 designs, the dimensions of allowable defects shall be defined by the fracture mechanics studies required for the design. For Type 2, Type 3, and Type 4 designs, the visual reinspection rejection criteria shall be based on the results of pressure-cycling tests performed on cylinders containing specified visible flaws. The manufacturer shall provide the results of these tests.

5.7 Design specification sheet

A summary of the documents providing the information required by Clause 5.1 shall be listed on a specification sheet for each cylinder design. The title, reference number, revision numbers, dates of

original issue, and version numbers of each document shall be given. All documents shall be signed or initialled by the issuer.

The design specification sheet shall be given a number, and revision numbers if applicable, that can be used to designate the cylinder design, and shall carry the signature of the engineer responsible for the design. Space shall be provided on the specification sheet for a stamp indicating registration of the design.

6 Requirements applicable to all cylinder types

6.1 General

The requirements specified in Clauses 6.2 to 6.17 shall be generally applicable to the cylinder types specified in Clauses 7 to 10. The design of cylinders shall take into account all relevant aspects necessary to ensure that every cylinder produced to the design is fit for its purpose for the specified service life.

6.2 Design

This Standard does not provide design formulas or specify permissible stresses or strains, but it does specify requirements on the adequacy of the design, which are established by appropriate calculations and demonstrated by the cylinders' capacity to consistently pass the design qualification, production, and batch tests specified in this Standard.

All designs shall ensure leak-before-break under feasible degradation of pressure parts during normal service. Leaks in metal cylinders or metal liners shall occur by the growth of a fatigue crack.

6.3 Materials

6.3.1 General

The materials used shall be suitable for the service conditions specified in Clause 4. The design shall not bring incompatible materials into contact with each other.

6.3.2 Steel (excluding stainless steels)

6.3.2.1 General

Steels shall be aluminum-killed and produced to predominantly fine-grain practice. The chemical composition of all steels shall be declared and shall be defined at least by

a) carbon, manganese, aluminum, and silicon contents in all cases; and
b) nickel, chromium, molybdenum, boron, and vanadium contents where these elements are alloying elements intentionally added.

6.3.2.2 Chemical analysis

The following limits shall not be exceeded in the cast analysis:

a) sulphur: 0.02%;
b) phosphorus: 0.02%; and
c) sulphur and phosphorus: 0.03%.

6.3.2.3 Tensile tests

Tensile testing shall be performed in accordance with Clause 14.1 to demonstrate compliance of the materials in accordance with Clause 5.3.3. The ultimate tensile strength of the steel shall not exceed 1200 MPa.

6.3.2.4 Impact test

The impact properties of the steel in the finished cylinder shall be determined in accordance with Clause 14.2. Impact values shall not be less than those in specified Table 1.

6.3.2.5 Sulphide stress cracking test

For natural gas and hydrogen blends service, if the upper limit of the specified hardness range for the steel exceeds 22 HRC (240 HB), the steel from a finished cylinder shall be tested in accordance with and meet the requirements of Clause 14.3.

6.3.2.6 Hydrogen compatibility

For hydrogen blends and hydrogen service, if the tensile strength of the steel exceeds the limits specified in ISO 9809-1, the compatibility of the steel with hydrogen at the intended working pressure shall be demonstrated using the test methods specified in ISO 11114-4.

6.3.3 Aluminum

6.3.3.1 General

Aluminum alloys shall be quoted according to the Aluminum Association practice for a given alloy system. The impurity limits for lead and bismuth in an aluminum alloy shall not exceed 0.01%.

6.3.3.2 Stress corrosion cracking tests

Aluminum alloys shall meet the requirements of the stress corrosion cracking tests performed in accordance with Clause 14.4.

6.3.3.3 Sustained load cracking tests

Aluminum alloys shall meet the requirements of the sustained load cracking tests performed in accordance with Clause 14.5.

6.3.3.4 Tensile tests

Tensile testing shall be performed in accordance with Clause 14.1 to demonstrate compliance of the materials in accordance with Clause 5.3.3.

6.3.4 Resins

The materials for impregnation shall be thermosetting or thermoplastic resins. Examples of suitable matrix materials include epoxy, modified epoxy, polyester and vinylester thermosetting plastics, and polyethylene and polyamide thermoplastic material. Resin materials shall be tested on a sample coupon representative of the composite overwrap in accordance with ASTM D2344/D2344M. Following a 24 h immersion in boiling water, the composite shall have a minimum shear strength of 13.8 MPa (2000 psi).

6.3.5 Fibres

The structural reinforcing filament material type shall be glass fibre, aramid fibre, or carbon fibre. If carbon-fibre reinforcement is used, the design shall incorporate means to prevent galvanic corrosion of the metal components of the cylinder.

The manufacturer shall keep on file the published specifications for composite materials used, the material manufacturer's recommendations for storage conditions and shelf life, and the material manufacturer's certification that each shipment conforms to the specification requirements. The fibre manufacturer shall certify that the fibre material properties conform to the manufacturer's specifications for the product.

6.3.6 Plastic liners

The polymeric material shall be compatible with the service conditions specified in Clause 4. In accordance with the method specified in ISO 306 (Vicat) or an equivalent method, the plastic softening temperature shall be at least 90 °C (194°F) and the melt temperature shall be at least 100 °C (212°F). The tensile yield strength and ultimate elongation shall be determined in accordance with ASTM D638. Tests shall be conducted to demonstrate the ductile properties of the plastic liner material at temperatures of less than –50 °C (–58°F).

6.4 Manufacture

The manufacturer shall specify manufacturing procedures in detail sufficient to ensure consistent products.

6.5 Test pressure

The minimum test pressure used in manufacturing shall be 1.5 times the working pressure.

6.6 Burst pressures and fibre stress ratios

For all types of cylinders, the minimum burst pressure shall be not less than 2.25 times the working pressure. For Type 2, Type 3, and Type 4 designs, the composite overwrap shall be designed for high reliability under sustained loading and cyclic loading. This reliability shall be achieved by meeting or exceeding the composite-reinforcement stress ratio values specified in Table 2, the stress ratio being the stress in the fibre at the specified minimum burst pressure divided by the stress in the fibre at working pressure.

6.7 Stress analysis

A stress analysis shall be performed to justify the minimum design wall thicknesses. It shall include a determination of the stresses in liners and fibres of composite design and shall be used with the fracture mechanics of metal cylinders and liners to establish inspection rejection criteria during production and to establish the retest or reinspection frequency and rejection criteria during service.

6.8 Inspection and testing

The manufacturer shall specify programs and procedures for

a) inspections, tests, and acceptance criteria at the time of manufacture; and
b) periodic in-service inspections, tests, and acceptance criteria.

6.9 Fire protection

The cylinder, its materials, pressure relief devices, and any added insulation or protective material shall be designed to collectively ensure adequate safety during the fire conditions specified in Clause 14.15. A

manufacturer may specify alternative pressure relief device locations for specific vehicle installations in order to optimize safety considerations.

Pressure relief devices shall be of a registered design that meets the requirements of CSA ANSI PRD 1 or CSA ANSI HPRD 1, as appropriate.

6.10 Openings

6.10.1 General

Openings shall be located in heads only. The centreline of openings shall coincide with the longitudinal axis of the container.

Threads shall be clean-cut, even, without surface discontinuities, and to gauge.

6.10.2 Tapered threads

Openings with tapered threads may be used only in steel cylinders or steel liners. Tapered threads shall comply with a recognized international or national standard.

6.10.3 Straight threads

Openings with straight threads shall comply with a recognized international or national standard.

6.11 Cylinder supports

The manufacturer shall provide cylinder supports or specify the means by which cylinders shall be supported.

Note: *The manufacturer should consider such factors as the undue stresses created in an overwrap by cylinder expansion against a metal support, the need to specify a gasket material to prevent support damage to cylinders, and the required properties of any gasket material. Type 2, Type 3, and Type 4 designs should be provided with shielding arrangements to protect the composite wrapping from mechanical damage.*

6.12 Exterior protective coatings

The exterior of cylinders shall be protected from environmental effects. Acceptable protection shall meet the requirements of Clause 14.21 and, if applicable, Clause 14.6.

6.13 Design qualification tests

For the approval of each cylinder type, the material, design, and manufacture shall be proved to be adequate for the cylinder's intended service by meeting the applicable requirements specified in Clause 6.3 and the design qualification tests summarized in Table 3, with all tests to be performed in accordance with the applicable test methods specified in Clause 14.

The tests shall be witnessed by the independent inspecting agency or a person acceptable to the regulatory authority. If more cylinders or liners are subjected to the tests than are required by this Standard, all results shall be documented.

6.14 Batch tests

The batch tests specified in this Standard for each cylinder type shall be conducted on cylinders or liners taken from each batch of finished cylinders or liners. Alternatively, heat-treated witness samples shown to be representative of finished cylinders or liners may be used. The batch tests for each cylinder type shall be as specified in Table 4. These tests shall be conducted in accordance with the requirements specified in Clauses 7 to 10 for the applicable cylinder type.

6.15 Production examinations and tests

6.15.1 General

Production examinations and tests shall be performed on all cylinders produced in a batch. Each cylinder shall be examined at all critical stages during manufacturing and after completion, as follows:

a) ultrasonic scanning of metal cylinders and liners in accordance with the method described in Clause B.4 or a demonstrated equivalent method to confirm that the maximum defect size does not exceed the size specified in the design;
b) verification that the critical dimensions and mass of the completed cylinder and of any liner and overwrapping are within design tolerances;
c) verification of compliance with the specified surface finish, with special attention to deep-drawn surfaces and folds or laps in the neck or shoulder of forged or spun end-closures or openings;
d) verification of coating quality (if required);
e) verification of markings;
f) hardness tests, or equivalent, of metal cylinders and liners in accordance with Clause 14.8, performed after the final heat treatment. The values thus determined shall be in the range specified for the design. Alternative methods shall be acceptable, provided that a well-defined correlation is established between the tensile strength and hardness of the materials; and
g) hydrostatic pressure proof test in accordance with Clause 14.11.

6.15.2 Maximum defect size

For Type 1, Type 2, and Type 3 designs, the maximum defect size at any location in the metal cylinder or metal liner that will not grow to a critical size within the specified service life shall be determined (see Clause 14.7.2). The critical defect size shall be defined as the limiting through-wall (cylinder or liner) thickness defect that would allow stored gas to be discharged without rupturing the cylinder. Defect sizes for the rejection criteria for ultrasonic scanning or its equivalent shall not exceed the maximum calculated allowable defect sizes. For Type 2 and Type 3 designs, the calculations shall assume that there will be no damage to the composite due to time-dependent mechanisms.

6.16 Design changes

A design change shall be defined as any change in the selection of structural materials or any dimensional change not attributable to normal manufacturing tolerances. Minor design changes may be qualified through a reduced testing program. The design changes specified in Table 5 shall require design qualification testing as specified in Table 5. When changes in diameter or pressure are made, the structural wall elements shall operate at the same or lower nominal stress levels as the original design (e.g., if the pressure or diameter increases, the wall thickness shall increase proportionally; if the pressure or diameter decreases, the wall thickness may be decreased proportionally).

6.17 Failure to meet test requirements

In the event of failure to meet test requirements, the cause of the test failure shall be identified. If there is evidence that the failure was caused by a fault in performing a test or an error of measurement, the identified cause shall be corrected and a further test shall be performed. If the result of this test is satisfactory, the first test shall be ignored. If a greater number of cylinders or liners are subjected to the tests than the number required by this Standard, all results shall be documented.

7 Type 1 metal cylinders

7.1 General

For a cylinder operating to the working pressure, the design shall identify the maximum size of an allowable defect at any point in the cylinder that will not grow to a critical size within the specified retesting period, or within the service life if a retest is not specified. Calculations for leak-before-break performance and allowable defect size shall be in accordance with the procedures specified in Clause 14.7.

7.2 Stress analysis

The stresses in the cylinder shall be calculated for 20 bar, working pressure, test pressure, and design burst pressure. The calculations shall employ suitable analytical techniques to establish stress distributions at the neck, transition regions, and cylindrical part of the shell.

7.3 Manufacturing and production tests

7.3.1 General

The ends of aluminum cylinders or liners shall not be closed by a forming process.

The base ends of steel cylinders or liners that have been closed by forming, except those cylinders or liners designed in accordance with ISO 9809-1, shall be subjected to non-destructive examination (NDE) or equivalent. Metal shall not be added in the process of closure at the end. Each cylinder or liner shall be examined before end-forming operations for thickness and surface finish.

After forming, the cylinders shall be heat treated to the hardness range specified for the design. There shall be no localized heat treatment.

When a neck ring, foot ring, or attachment for support is provided, it shall be of material compatible with that of the cylinder and securely attached by a method other than welding, brazing, or soldering.

7.3.2 Non-destructive examinations

Non-destructive examinations shall be carried out in accordance with a recognized ISO or equivalent national standard.

The following tests shall be carried out on each metal cylinder:

a) a hardness test in accordance with Clause 14.8. Alternatively, conductivity measurements may be used, provided that a well-defined correlation is established between the tensile strength and hardness of the material; and
b) an ultrasonic examination in accordance with the method specified in Clause B.4, or a demonstrated equivalent non-destructive method, to ensure that the maximum defect size does not exceed the size specified in the design as calculated in accordance with Clause 14.7.2.

7.3.3 Hydrostatic pressure proof test

Each finished cylinder shall be hydrostatically pressure tested in accordance with Clause 14.11. The manufacturer shall define the appropriate limit of permanent volumetric expansion for the test pressure used, but the permanent expansion shall not exceed 5% of the total volumetric expansion at test pressure. Cylinders not meeting the defined limit shall be rejected and either destroyed or used for batch test purposes.

7.4 Batch tests

7.4.1 Materials tests

The following shall be performed on a finished cylinder or on a coupon from the same heat treatment that is representative of a finished cylinder:

a) the dimensions shall be checked against the design;
b) one tensile test in accordance with Clause 14.1 shall be performed;
c) for steel cylinders, three impact tests in accordance with Clause 14.2 shall be performed; and
d) when a protective coating is a part of the design, coating batch tests in accordance with Clause 14.9 shall be performed and the protective coating shall meet the requirements of Clause 14.9.

All cylinders represented by a batch test in which the test cylinder fails to meet the specified materials requirements shall be rejected, except in cases where heat-treated cylinders fail to meet the requirements of mechanical tests, in which event the cause of the failure shall be determined. Two repeat sets of tests may then be carried out on two or more randomly selected cylinders of the same batch. If all repeated test pieces pass, the batch shall be acceptable, provided that each cylinder also meets the manufacturer's specification for hardness, non-destructive examination, and hydrostatic pressure testing. Otherwise, the batch shall be reheat treated and all required batch tests shall be repeated. Cylinders shall not be reheat treated more than once.

When the coating fails to meet the requirements of Clause 14.9, the entire batch shall be inspected to remove similarly defective cylinders. Defective cylinders may be stripped of their coating and recoated. The coating batch test shall then be repeated.

7.4.2 Burst test

One cylinder selected from each batch shall be hydrostatically pressurized to burst in accordance with the test procedure specified in Clause 14.12. The burst pressure shall meet or exceed the minimum required burst pressure; otherwise, the batch shall be rejected.

The container used for the cycle test specified in Clause 7.4.4 may be used for the burst test. If the burst pressure of the cycled container is less than the minimum required burst pressure, an additional burst test shall be conducted on another container selected from the batch. The burst pressure on the additional container shall meet or exceed the minimum required burst pressure; otherwise, the batch shall be rejected.

7.4.3 Periodic burst test

The first five sequential batches of a design family (i.e., with the same materials, processes, and stress levels, but allowing different sizes) shall be burst tested in accordance with Clause 14.12. If a cylinder from any batch fails to meet the minimum required burst pressure, the batch shall be rejected.

If five sequential batches pass the burst test, subsequent burst tests shall be performed on every tenth batch manufactured. If more than three months have passed since the first batch of cylinders was burst tested, a cylinder from the next batch of cylinders manufactured shall be burst tested.

If a cylinder fails to meet the minimum burst test requirement, the batch shall be rejected and a representative cylinder from each of the next ten batches shall be burst tested.

7.4.4 Pressure-cycling test

One cylinder shall be pressure-cycle tested, in accordance with Clause 14.13, for 750 cycles times the specified service life in years. If the cylinder fails to meet the minimum pressure-cycle requirement, the batch shall be rejected.

7.4.5 Periodic pressure-cycling test

The first five sequential batches of a design family (i.e., with the same materials, processes, and stress levels, but allowing different sizes) shall be tested to a minimum of 11 250 cycles at a rate not to exceed 10 cycles/min. If a cylinder from any batch fails to meet this requirement, the batch shall be rejected.

If five sequential batches pass the cycling test, subsequent pressure-cycling tests shall be performed on every tenth batch manufactured. If more than three months have passed since the last batch of cylinders was cycle tested, a cylinder from the next batch of cylinders manufactured shall be cycle tested.

If a cylinder fails to meet the minimum pressure-cycle requirement, the batch shall be rejected and a representative cylinder from each of the next ten batches shall be cycle tested to re-establish confidence.

7.5 Design qualification tests

7.5.1 General

Qualification testing shall be performed on finished cylinders that are representative of normal production and complete with identification marks. Selection, witnessing, and documentation of the results shall be in accordance with Clause 6.13.

7.5.2 Hydrostatic pressure burst test

Three representative cylinders shall be hydrostatically pressurized to failure in accordance with Clause 14.12. The cylinder burst pressures shall exceed the minimum burst pressure calculated in accordance with the stress analysis for the design and shall be at least 450 bar.

7.5.3 Ambient temperature pressure-cycling test

Three finished cylinders shall be pressure cycled to failure or to 2250 cycles times the specified service life in years at an ambient temperature in accordance with Clause 14.13. The cylinders shall not fail before reaching 750 cycles times the specified service life in years. Cylinders exceeding 750 cycles times the specified service life in years shall be allowed to fail by leakage but not by rupture. Cylinders that do not fail within 2250 cycles times the specified service life in years shall be destroyed, either by continuing the cycling until failure occurs or by hydrostatically pressuring to burst. The number of cycles to failure and the location of the failure initiation shall be recorded.

7.5.4 Bonfire tests

Tests shall be performed in accordance with and meet the requirements of Clause 14.15.

7.5.5 Penetration tests

Tests shall be performed in accordance with and meet the requirements of Clause 14.16.

7.5.6 Leak-before-break performance tests

Tests shall be performed in accordance with and meet the requirements of Clause 14.7.1.

8 Type 2 hoop-wrapped cylinders

8.1 General

During pressurization, the Type 2 cylinder behaves in such a way that the displacements of the composite overwrap and the metal liner are linearly superimposed. Because of different manufacturing techniques, this Standard does not provide a definitive method for design.

Calculation of the leak-before-break performance and the critical crack size for the non-destructive examination of the metal liner shall be in accordance with the procedures specified in Clause 14.7.

8.2 Design

8.2.1 Metal liner

The metal liner shall have a minimum burst pressure of 1.25 times the working pressure.

8.2.2 Composite overwrap

The tensile stress in the fibres shall meet the requirements of Clause 6.6.

8.2.3 Stress analysis

After pre-stress, the stresses in the composite and in the liner shall be calculated. The pressures used for these calculations shall be zero, 20 bar, working pressure, test pressure, and design burst pressure. The calculations shall employ suitable analytical techniques to take account of non-linear material behaviour of the liner and to establish stress distributions at the neck, transition regions, and cylindrical part of the liner.

For designs using autofrettage to provide pre-stress, the limits within which the autofrettage pressure needs to fall shall be calculated. For designs using controlled-tension winding to provide pre-stress, the temperature at which controlled-tension winding is performed, the tension required in each layer of composite, and the consequent pre-stress in the liner shall be calculated.

8.3 Manufacturing

8.3.1 General

The composite cylinder shall be fabricated from a liner overwrapped with circumferential continuous filament windings. Filament winding operations shall be computer or mechanically controlled. The filaments shall be applied under controlled tension to develop the design composite thickness. After winding is complete, thermosetting resins shall be cured by heating, using a predetermined and controlled time–temperature profile.

8.3.2 Liner

The manufacturing of a metal liner shall meet the requirements of Clause 7.3 for the appropriate type of liner construction. The weight of each liner without overwrap shall be documented.

8.3.3 Overwrap

8.3.3.1 General

The cylinders shall be fabricated in a filament-winding machine. During winding, the significant variables shall be documented in a winding record. These variables can include, but are not limited to,

a) band width;
b) fibre type, including sizing;
c) manner of impregnation;
d) number of rovings;
e) temperature of the liner;
f) temperature of the resin;
g) type of resin and composition;
h) winding speed; and
i) winding tension.

8.3.3.2 Curing of thermosetting resins

If a thermosetting resin is used, it shall be cured after filament winding. During curing, the curing cycle (i.e., the time–temperature history) shall be documented.

The curing temperature shall be controlled and not affect the material properties of the liner. The maximum curing temperature for cylinders with aluminum liners shall be 177 °C (350°F).

8.3.4 Autofrettage

Autofrettage, if used, shall be performed before the hydrostatic pressure test. The autofrettage pressure shall be within the limits established in accordance with Clause 8.2.3.

8.4 Production testing

8.4.1 Non-destructive examinations

Non-destructive examinations shall be performed in accordance with a recognized ISO or equivalent national standard.

The following tests shall be performed on each metal liner:

a) a hardness test in accordance with Clause 14.8, at the centre and domed end. Alternatively, conductivity measurements may be used, provided that a well-defined correlation is established between the tensile strength and hardness of the material; and
b) an ultrasonic examination in accordance with the method specified in Clause B.4, or a demonstrated equivalent non-destructive method, to ensure that the maximum defect size does not exceed the size specified in the design as calculated in accordance with Clause 14.7.2.

8.4.2 Hydrostatic pressure proof test

Each finished cylinder shall be hydrostatically pressure tested in accordance with Clause 14.11. The manufacturer shall define the appropriate limit of permanent volumetric expansion for the test pressure used, but the permanent expansion shall not exceed 5% of the total volumetric expansion at test pressure. Cylinders not meeting the defined rejection limit shall be rejected and either destroyed or used for batch test purposes.

8.5 Batch tests

8.5.1 Materials tests

Cylinder dimensions and liner mechanical properties shall meet the requirements of Clause 7.4.1.

8.5.2 Burst tests

Batch burst tests shall be performed in accordance with Clause 7.4.2 or 7.4.3.

8.5.3 Pressure-cycling tests

Batch pressure-cycling tests shall be performed in accordance with Clause 7.4.4 or 7.4.5.

8.6 Design qualification tests

8.6.1 General

Qualification testing shall be performed on finished cylinders that are representative of normal production and complete with identification marks. Selection, witnessing, and documentation of the results shall be in accordance with Clause 6.13.

8.6.2 Hydrostatic pressure burst test

8.6.2.1

One liner shall be hydrostatically pressurized to failure in accordance with Clause 14.12. The burst pressure shall exceed the minimum burst pressure specified for the liner design.

8.6.2.2

Three representative cylinders shall be hydrostatically pressurized to failure in accordance with Clause 14.12. The cylinder burst pressures shall exceed the specified minimum burst pressure established by the stress analysis for the design, in accordance with the requirements of Clause 6.6.

8.6.3 Ambient temperature pressure-cycling test

Two finished cylinders shall be pressure cycled to failure or to 2250 cycles times the specified service life in years at an ambient temperature in accordance with Clause 14.13. One of these cylinders shall be tested with the manufacturer’s specified mounting straps attached to the cylinder.

The cylinders shall not fail before reaching 750 cycles times the specified service life in years. Cylinders exceeding 750 cycles times the specified service life in years shall be allowed to fail by leakage and not by rupture; however, cylinders exceeding 2250 cycles times the specified service life in years shall be allowed to fail by rupture. Cylinders that do not fail within 2250 cycles times the specified service life in years shall be destroyed by continuing the cycling until failure occurs or hydrostatically pressurizing to burst. The number of cycles to failure and the location of the failure initiation shall be recorded.

8.6.4 Extreme-temperature pressure-cycling test

One cylinder shall be tested in accordance with and meet the requirements of Clause 14.14.

8.6.5 Bonfire test

Finished cylinders shall be tested in accordance with and meet the requirements of Clause 14.15.

8.6.6 Penetration test
One finished cylinder shall be tested in accordance with and meet the requirements of Clause 14.16.

8.6.7 Flaw tolerance tests
One finished cylinder shall be tested in accordance with and meet the requirements of Clause 14.17.

8.6.8 Accelerated stress rupture test
One finished cylinder shall be tested in accordance with and meet the requirements of Clause 14.18.

8.6.9 Environmental test
One finished cylinder shall be tested in accordance with and meet the requirements of Clause 14.21.

8.6.10 Leak-before-break performance tests
Three finished cylinders shall be tested in accordance with and meet the requirements of Clause 14.7.1.

9 Type 3 fully wrapped cylinders

9.1 General
During pressurization, the Type 3 cylinder behaves in such a way that the displacements of the composite overwrap and the liner are superimposed. Because of different manufacturing techniques, this Standard does not provide a definitive method for design.

Calculation of the leak-before-break performance and the critical crack size for the non-destructive examination of the metal liner shall be in accordance with the procedures specified in Clause 14.7.

9.2 Design requirements

9.2.1 Composite overwrap
The tensile stress in the fibres shall meet the requirements of Clause 6.6.

9.2.2 Stress analysis
The stresses in the tangential and longitudinal directions of the cylinder, in the composite and liner, shall be calculated for zero pressure, 20 bar, working pressure, test pressure, and design burst pressure. The limits within which autofrettage pressure needs to fall shall be calculated. The calculations shall employ suitable analytical techniques to take account of non-linear material behaviour of the liner and to establish stress distributions at the neck, transition regions, and cylindrical part of the liner.

9.3 Manufacturing
The manufacturing requirements specified in Clause 8.3 shall apply, except that the overwrap shall also include helically wound filaments.

9.4 Production tests
The production test requirements specified in Clause 8.4 shall apply.

9.5 Batch tests
Batch tests shall be performed in accordance with Clause 8.5.

9.6 Design qualification tests

9.6.1 General

Design qualification tests shall be performed in accordance with Clauses 8.6 and 9.6.2, except that the test specified in Clause 8.6.10 shall not apply.

9.6.2 Drop test

One or more finished cylinders shall be drop tested in accordance with Clause 14.19.

10 Type 4 all-composite cylinders

10.1 General

Because of the variety of possible cylinder designs, this Standard does not provide a definitive method for the design of cylinders with polymeric liners.

10.2 Design

10.2.1 General

Design calculations shall be used to justify design adequacy. The tensile stress in the fibres shall meet the requirements of Clause 6.6.

Only straight threads in accordance with Clause 6.10.3 shall be used on the metal end-bosses. Metal end-bosses with threaded openings shall be able to withstand a torque force of 500 N•m (370 ft•lb) without damaging the integrity of the connection to the non-metallic liner.

10.2.2 Stress analysis

The stresses in the tangential and longitudinal direction of the cylinder in the composite and in the liner shall be calculated. The pressures used for these calculations shall be zero, working pressure, test pressure, and design burst pressure. The calculations shall employ suitable analytical techniques to establish stress distributions throughout the cylinder.

10.3 Materials — Metal end-bosses

The metal end-bosses connected to the non-metallic liner shall be of a material compatible with the service conditions specified in Clause 4.

10.4 Manufacturing

10.4.1 General

The composite cylinder shall be fabricated from a liner overwrapped with circumferential and helical continuous filament windings. Filament winding operations shall be computer or mechanically controlled. The filaments shall be applied under controlled tension to develop the design composite thickness. After winding is complete, thermosetting resins shall be cured by heating, using a predetermined and controlled time–temperature profile.

10.4.2 Overwrap

The cylinders shall be fabricated in a filament-winding machine. During winding, the significant variables shall be documented in a winding record. These variables can include, but are not limited to,

a) band width;
b) fibre type, including sizing;
c) manner of impregnation;
d) number of rovings;
e) temperature of the liner;
f) temperature of the resin;
g) type of resin and composition;
h) winding speed; and
i) winding tension.

10.4.3 Curing of thermosetting resins

If a thermosetting resin is used, it shall be cured after filament winding. During curing, the curing cycle (i.e., the time–temperature history) shall be documented.

The curing temperature shall be controlled and not affect the material properties of the liner.

10.5 Production testing

10.5.1 Hydrostatic pressure proof test

Each finished cylinder shall be hydrostatically pressure tested in accordance with Clause 14.11. The pressure range over which the elastic expansion is measured shall be from not more than 10% of the working pressure to not less than the test pressure. Cylinders not meeting the defined rejection limit shall be rejected and destroyed.

10.5.2 Leak test

Each finished cylinder with fused liner joints or bonded bases shall be leak tested in accordance with and meet the requirements of Clause 14.10.

10.6 Batch tests

10.6.1 Materials tests

Cylinder dimensions and liner mechanical properties shall meet the requirements of Clause 7.4.1.

10.6.2 Burst tests

Batch burst tests shall be performed in accordance with Clause 7.4.2 or 7.4.3.

10.6.3 Pressure-cycling tests

Batch pressure-cycling tests shall be performed in accordance with Clause 7.4.4 or 7.4.5. Following the cycle test, the cylinder shall be leak tested in accordance with the method described in Clause 14.10 and meet the requirements of that clause.

10.7 Design qualification tests

10.7.1 General

Design qualification tests shall be performed in accordance with Clauses 8.6, 10.7.2, and 10.7.3, except that Clauses 8.6.2.1 and 8.6.10 shall not apply.

10.7.2 Permeation test

One cylinder shall be tested for permeation in accordance with and meet the requirements of Clause 14.20.

10.7.3 Gas cycling test

One cylinder shall be tested in accordance with and meet the requirements of Clause 14.22.

11 Marking

On each cylinder the manufacturer shall provide clear, permanent markings at least 6 mm (0.25 in) high. The markings shall take the form of labels incorporated into resin coatings, labels attached by adhesive, low-stress stamps used on the thickened ends of Type 1 and Type 2 designs, or a combination of these methods. Adhesive labels and their application shall meet the requirements of UL 969. Multiple labels shall be allowed, and all labels shall be located in such a way that they are not obscured by mounting brackets. Each cylinder complying with this Standard shall be marked with the following:

a) "**CNG ONLY**", "**CNG and HYDROGEN BLENDS ONLY**", or "**HYDROGEN ONLY**",* as applicable;
**The equivalent French wording is "GNC SEULEMENT", "GNC ET DE L'HYDROGÈNE UNIQUEMENT LES DÉGRADÉS", and "HYDROGÈNE SEULEMENT".*

b) **"DO NOT USE AFTER YYYY/MM**",* i.e., the year and month of expiry (the expiry date shall not exceed the specified service life);
**The equivalent French wording is "NE PAS UTILISER APRÈS AAAA/MM".*
Note: *The expiry date marking may be applied to the cylinder at the time of dispatch, provided that the cylinder has been stored in a dry location without internal pressure.*

c) manufacturer's identification;

d) cylinder identification (applicable part number and a serial number unique to the cylinder);

e) working pressure in bar (psi) at temperature in Celsius (Fahrenheit);

f) "CSA B51", along with cylinder type and a Canadian Registration Number (described in Clause 4.3 of Part 1 of this Standard); and

g) a statement on how to obtain information on qualified fire protection systems.

Note: *The following information may be provided on a separate label:*

a) *temperature range, e.g., –40 °C to 57 °C (–40 °F to 135°F);*

b) *nominal water capacity of the cylinder to two significant numbers, e.g., 60 L (2.1 ft³); and*

c) *date of original pressure test (year and month).*

The markings shall be placed in the sequence listed, but the specific arrangement may be varied to match the available space. An acceptable example of mandatory information is

CNG ONLY
DO NOT USE AFTER 2009/03
Manufacturer/Part Number/Serial Number 200 bar (2900 psi) 15 °C (59°F)
CSA B51 Type 2 (Canadian Registration Number)
Use only manufacturer-approved pressure relief device.

12 Preparation for dispatch

Before dispatch from the manufacturer's shop, every container shall be internally cleaned and dried, and every cylinder shall be inspected as required by the manufacturer. Cylinders not immediately closed by the fitting of a valve, and safety devices if applicable, shall have plugs that prevent entry of fluids and protect threads fitted to all openings. A corrosion inhibitor (e.g., oil-containing) shall be sprayed into all steel cylinders and liners before dispatch.

The statement of service required by Clause 5.2 and all necessary information to ensure proper installation and safe use of the cylinder shall be supplied to the purchaser.

13 Quality control

13.1 General

Quality control programs shall be established and operated to ensure that cylinders will be produced in accordance with the approved

a) design; and
b) written manufacturing procedures and inspection and test procedures that were used to produce the cylinders that passed the design qualification tests.

Quality control systems shall be approved and monitored by a nationally recognized agency or registrar, e.g., the National Board of Boiler and Pressure Vessel Inspectors, the American Gas Association Laboratories, Underwriters Laboratories, QMI-SAI Global, or the British Standards Institution.

13.2 Manufacturer's quality control system

The manufacturer's quality control system shall comply with the applicable requirements of ISO 9001 or an equivalent standard, except that if the design is developed by an organization other than the cylinder producer, the design organization shall have a quality control system that meets the requirements of ISO 9001 or an equivalent standard.

The quality control system shall cover all aspects of cylinder manufacture for which the manufacturer is responsible. If a quality control system other than ISO 9001 is adopted, the equivalency of the adopted quality control system to the ISO system in all respects shall be demonstrated to and approved by the regulatory authority.

13.3 Manufacturer's quality control system manual

The manufacturer's quality control system manual shall document all elements, requirements, and provisions of the quality control system adopted by the manufacturer. The system shall be described in a comprehensive and orderly manner in the form of written policies, procedures, and instructions that will permit a clear and consistent understanding of the manufacturer's intent with respect to quality control.

13.4 Audit of manufacturer's quality control system

13.4.1

A nationally recognized agency shall appoint an audit team to determine whether the manufacturer's system can be approved. The audit team shall have at least one member who is experienced in the relevant cylinder technology and at least one member who is a specialist in quality control.

13.4.2
The audit team shall assess the quality control system described in the manufacturer's manual and shall visit all facilities covered by the manual to determine whether an acceptable quality control system has been implemented. The audit shall include all elements covered by ISO 9001 (see Clause 13.2).

13.4.3
The manufacturer shall be notified of the audit team's assessment and given the opportunity to correct any deficiencies.

13.4.4
Audits shall be repeated every 3 years if the manufacturer wishes to maintain certification.

13.4.5
A nationally recognized agency or its agents shall carry out minor reviews of the manufacturer's quality control system every six months or, if considered necessary, shall make unexpected visits to the manufacturer's facilities.

13.4.6
For the purpose of auditing or monitoring the operation of the quality control system, the manufacturer shall allow the nationally recognized agency entrance to locations where cylinders are designed, produced, inspected, tested, stored, or shipped. The manufacturer shall also allow access to all quality control system documentation, including inspection reports, test data, calibration data, and personnel qualification reports.

13.5 Certification of the manufacturer
A nationally recognized agency shall provide appropriate certification to a manufacturer whose quality control system is approved. The certification shall indicate the type of cylinder it covers, any limitations that apply, and the date when it expires and a new audit is required.

13.6 Maintenance of the manufacturer's quality control system
A manufacturer with a certified quality control system shall

a) keep the approved system in use and enforce conformity with its provisions with respect to any cylinders made and shipped under this Standard;
b) inform the certifying agency of any intended changes to the quality control system and implement such changes only after the agency has evaluated them and determined that the system will still satisfy the requirements of this Standard after the changes have been made; and
c) make the documentation of the quality control system, including revisions and records of decisions or reports from the independent inspection agency, accessible to the certifying agency for a period equal to the service life of any approved cylinder produced under the quality control system.

13.7 Independent inspection agency's quality control system
The independent inspection agency's quality control system shall meet the applicable requirements of CAN/CSA-ISO 9001, ISO 9001, or an equivalent standard approved by the nationally recognized agency.

13.8 Third-party inspection of production

13.8.1
The manufacturer shall arrange for third-party inspection of cylinder production to the registered design, either by a nationally recognized authority or its independent inspection agency.

13.8.2
Cylinders may be produced under an approved quality control system that allows for reduced involvement on the part of the independent inspector. The independent inspector shall visit the plant regularly to monitor the ongoing implementation of the quality control system, review documentation, and co-sign report of manufacturing forms that have been prepared by the manufacturer's personnel. Independent inspectors shall note after their signature that they did not personally perform the inspections or witness the tests.

Note: *See Annex A.*

14 Test methods

14.1 Tensile tests — Steel and aluminum
Tensile tests shall be conducted in accordance with Clause 7.2 of ISO 9809-1 for steels or Clause 8.2.3 of ISO 7866 for aluminum, or using the test methods specified in ASTM E8.

14.2 Impact test — Steel cylinders and steel liners
The impact test on steel in the finished cylinder or liner shall be conducted in accordance with ISO 148-1 or ASTM E23. The impact test pieces shall be taken from the wall of the cylinder in the transverse direction. The notch plane orientation shall be in the centreline direction (i.e., perpendicular to the circumference and along the length), as shown in ASTM E399. Test pieces with a width of less than 5 mm (0.2 in) shall be taken from the longitudinal direction. The inside and outside cylinder surfaces of the test piece shall not be machined in the vicinity of the notch; if the wall thickness does not permit a final test piece width of 10 mm (0.4 in), the width shall be as near as practicable to the nominal thickness of the cylinder wall. Impact testing shall be conducted at –40 °C (–40°F).

14.3 Sulphide stress cracking test — Steel
The ultimate tensile strength of the steel from a finished container shall not exceed 1200 MPa (175 000 psi). If the upper limit of the specified ultimate tensile strength exceeds 950 MPa (138 000 psi), the steel shall be tested in accordance with the procedures specified in "Method A — NACE standard tensile test" of NACE TM0177. Tests shall be conducted on at least three tensile specimens with a gauge diameter of 3.81 mm (0.150 in) machined from the wall of a finished cylinder or liner. The specimens shall be placed under a constant tensile load equal to 60% of the specified minimum yield strength of the steel and immersed in a solution of distilled water buffered with 0.5% (wt/wt) sodium acetate trihydrate and adjusted to an initial pH of 4.0 using acetic acid. The solution shall be continuously saturated at room temperature and pressure with 0.414 kPa (0.06 psia) hydrogen sulphide (balance nitrogen). The tested specimens shall not fail within the 144 h duration of the test.

14.4 Stress corrosion cracking tests — Aluminum
Corrosion tests for aluminum alloys shall be conducted in accordance with and meet the requirements of Annex A of ISO 7866.

14.5 Sustained load cracking test — Aluminum

The resistance to sustained load cracking test shall be conducted in accordance with and meet the requirements of Annex B of ISO 7866.

14.6 Coating performance tests

Coatings shall be evaluated using the following test methods:

a) Adhesion testing shall be conducted in accordance with ASTM D3359, using Method A or B, as applicable. The coating shall exhibit an adhesion rating of 4A or 4B, as applicable.
b) Flexibility shall be in accordance with ASTM D522, using Test Method B with a 12.7 mm (0.5 in) mandrel at the specified thickness at –20 °C (–4°F). Samples for the flexibility test shall be prepared in accordance with ASTM D522. There shall not be any visually apparent cracks.
c) Impact resistance shall be in accordance with ASTM D2794. The coating at room temperature shall pass a forward impact test of 18 J (160 lbf).
d) Chemical resistance shall be in accordance with ASTM D1308. The tests shall be conducted using the open spot test method and 100 h exposure to a 30% sulphuric acid solution (battery acid with a specific gravity of 1.219) and 24 h exposure to a polyalkalene glycol (e.g., DOT 3 brake fluid). There shall be no evidence of lifting, blistering, or softening of the coating. The adhesion shall meet a rating of 3 when tested in accordance with ASTM D3359.
e) Minimum 1000 h exposure shall be in accordance with ASTM G154. There shall be no evidence of blistering. Adhesion shall attain a rating of 3 when tested in accordance with ASTM D3359. The maximum allowable gloss loss shall be 20%.
f) Minimum 500 h exposure shall be in accordance with ASTM B117. Undercutting shall not exceed 2 mm (0.079 in) at the scribe mark, there shall be no evidence of blistering, and adhesion shall attain a rating of 3 when tested in accordance with ASTM D3359.
g) Resistance to chipping at room temperature shall be in accordance with ASTM D3170. The coating shall have a rating of 7A or better, and there shall not be any exposure of the substrate.

14.7 Fracture performance tests

14.7.1 Leak-before-break performance test

For Type 1 and Type 2 designs, three finished cylinders shall be hydraulically pressure cycled at ambient temperature, between not more than 20 bar and not less than 1.5 times the working pressure, and at a rate not to exceed 10 cycles/min. All cylinders shall either fail by leakage or exceed three times the maximum number of filling cycles.

14.7.2 Determination of non-destructive examination defect size by flawed-cylinder cycling

For Type 1, Type 2, and Type 3 designs, three cylinders containing artificial defects that exceed the defect length and depth detection capability of the non-destructive examination method specified in Clause 6.15.2 shall be pressure cycled to failure in accordance with the test method specified in Clause 14.13. For Type 1 designs with a fatigue-sensitive site in the cylindrical part, external flaws shall be introduced on the sidewall. For Type 1 designs with a fatigue-sensitive site outside the sidewall, and for Type 2 and Type 3 designs, internal flaws shall be introduced. Internal flaws may be machined before the heat treatment and closing of the end of the cylinder.

The cylinders shall not leak or rupture in less than 750 cycles times the specified service life in years.

The allowable defect size for non-destructive examination shall be equal to or less than the artificial flaw size for the given location.

14.8 Brinell or Rockwell hardness test

A hardness test shall be conducted at the centre of each cylinder and liner in accordance with ISO 6506-1 or ISO 6508-1. The test shall be conducted after the final heat treatment, and the hardness values thus determined shall be in the range specified for the design.

14.9 Coating batch tests

14.9.1 Coating thickness

The thickness of the coating shall meet the requirements of the design when tested in accordance with one of the following test methods, as applicable:

a) ASTM D7091; or
b) ASTM D4138.

14.9.2 Coating adhesion

The coating adhesion strength shall be measured in accordance with ASTM D3359 and have a minimum rating of 4 when measured in accordance with Test Method A or B, as applicable. An equivalent national standard may be used in lieu of ASTM D3359.

14.10 Leak test

Type 4 designs shall be leak tested using the following procedure (or an appropriate alternative):

a) Cylinders shall be thoroughly dried and pressurized to 1.25 times the working pressure with inert gas and/or a detectable gas such as natural gas, hydrogen, or helium.
b) Cylinders shall be placed in an enclosure to permit detection of leaks.

A leak shall be cause for rejection.

14.11 Hydrostatic pressure proof test

14.11.1

Each cylinder shall be hydrostatically tested to at least 1.5 times the working pressure. The test pressure shall not exceed the autofrettage pressure.

14.11.2

Pressure shall be maintained for 30 s or longer to ensure complete expansion. If the test pressure cannot be maintained because of test apparatus failure, the test may be repeated at a pressure increased by 6.9 bar (100 psig). There shall be not more than two repeat tests.

14.11.3

The manufacturer shall define and record the appropriate limit of elastic and permanent volumetric expansion for the test pressure used. Cylinders not meeting the defined limit shall be destroyed.

14.12 Hydrostatic pressure burst test

14.12.1

The rate of pressurization shall not exceed 14 bar/s (200 psi/s) at pressures exceeding 80% of the design burst pressure. If the rate of pressurization at pressures exceeding 80% of the design burst pressure exceeds 3.5 bar/s (50 psi/s), either the cylinder shall be placed schematically between the pressure

source and the pressure measurement device or there shall be a 5 s hold at the minimum design burst pressure.

14.12.2

The minimum required (calculated) burst pressure shall be at least 2.25 times the working pressure or 450 bar, whichever is greater, and not less than the value necessary to meet the stress ratio requirements. The actual burst pressure shall be recorded. Rupture can occur in the cylindrical or dome region of the cylinder.

14.13 Ambient temperature pressure-cycling test

Pressure cycling shall be performed in accordance with the following procedure:

a) The cylinder to be tested shall be filled with a non-corrosive fluid such as oil, inhibited water, or glycol.
b) The pressure in the cylinder shall be cycled between not more than 20 bar and not less than 1.25 times the working pressure or 260 bar, whichever is greater, at a rate not to exceed 10 cycles/min. The cylinders shall not fail before reaching 750 cycles times the specified service life in years. Cylinders exceeding 750 cycles times the specified service life in years shall be allowed to fail by leakage and not by rupture; however, for Type 3 and Type 4 designs, cylinders exceeding 2250 cycles times the specified service life in years shall be allowed to fail by rupture. For Type 2, Type 3, and Type 4 designs, the fibres in the overwrap shall not be allowed to fail. Cylinders that do not fail within 2250 cycles times the specified service life in years shall be destroyed by continuing the cycling until failure occurs or hydrostatically pressurizing to burst.

Cylinder pressure during cycle testing shall be monitored by a transducer located after the cylinder, i.e., the cylinder shall be located between the pressure source and the transducer. Alternatively, it shall be demonstrated to the satisfaction of the independent inspection agency that the pressure measured at the maximum cycle pressure is the “true” pressure, i.e., there is no pressure drop between the cylinder and the pressure transducer. This can be achieved by incorporating a 1 s hold in the cycle at the maximum pressure and the minimum pressure. The pressure cycle rate during cycle testing shall not exceed the rate at which pressure verification was performed.

The number of cycles to failure and the location of the failure initiation shall be reported. A description of the failure initiation shall be included in the report.

14.14 Extreme-temperature pressure-cycling test

Finished cylinders with their composite wrapping free of protective coating shall be cycle tested without showing evidence of rupture, leakage, or fibre unravelling, as follows:

a) The cylinders shall be hydrostatically pressurized for 4000 cycles times the specified service life in years between not more than 20 bar and not less than 260 bar or 1.25 times the working pressure, at a temperature of 85 °C (185°F) or higher.
b) The cylinders shall be stabilized at zero pressure and ambient temperature.
c) The cylinders shall be pressurized from not more than 20 bar to not less than 80% of working pressure for 4000 cycles times the specified service life in years at –40 °C (–40°F) or a lower temperature.
d) The pressure cycling rate specified in Item a) shall not exceed 10 cycles/min. The pressure-cycling rate specified in Item c) shall not exceed 3 cycles/min unless a pressure transducer is installed directly within the cylinder. Adequate recording instrumentation shall be provided to ensure that the minimum temperature of the fluid is maintained during the low-temperature cycling.

14.15 Bonfire test

14.15.1 General

The bonfire test is designed to demonstrate that finished cylinders, complete with pressure relief devices specified in the design, will prevent the rupture of the cylinder when tested under the specified fire conditions.

Because cylinder rupture can occur, extreme caution shall be exercised during fire testing.

14.15.2 Cylinder set-up

The cylinder shall be placed in a horizontal position with its bottom approximately 100 mm (4 in) above the fire source. Metal shielding shall be used to prevent direct flame impingement on cylinder valves, fittings, and pressure relief devices. The metal shielding shall not be in direct contact with the specified fire protection system (pressure relief devices or cylinder valve).

Any failure during the testing of a valve, a fitting, or tubing that is not part of the intended protection system for the design shall invalidate the result.

14.15.3 Fire source

A uniform fire source 1.65 m (65 in) in length shall provide direct flame impingement on the cylinder surface across its entire diameter.

Any fuel may be used for the fire source, provided that it supplies uniform heat sufficient to maintain the specified test temperatures. Selection of a fuel should take into consideration air pollution concerns. The arrangement of the fire shall be recorded in sufficient detail to ensure that the rate of heat input to the cylinder is reproducible.

Any failure of or inconsistency in the fire source during a test shall invalidate the result.

14.15.4 Temperature and pressure measurements

Surface temperatures shall be monitored by at least three thermocouples fastened to the bottom of the cylinder and spaced not more than 0.75 m (29.5 in) apart.

Metal shielding shall be used to prevent direct flame impingement on the thermocouples.

Thermocouple temperatures and the cylinder pressure shall be recorded every 30 s during the test.

14.15.5 General test requirements

Cylinders used for natural gas or hydrogen blends service shall be pressurized with natural gas to working pressure and tested in the horizontal position.

Cylinders used for hydrogen service shall be pressurized with hydrogen to working pressure and tested in the horizontal position.

Immediately following ignition, the fire shall produce flame impingement on the surface of the cylinder along the 1.65 m (65 in) length of the fire source and across the cylinder diameter.

Within 5 min of ignition, the temperature of at least one thermocouple shall be at least 590 °C (1100°F). This minimum temperature shall be maintained until the end of the test.

14.15.6 Cylinders 1.65 m (65 in) in length or shorter

The centre of the cylinder shall be positioned over the centre of the fire source.

14.15.7 Cylinders longer than 1.65 m (65 in)

If the cylinder is fitted with a pressure relief device at one end, the fire source shall originate at the opposite end of the cylinder.

If the cylinder is fitted with pressure relief devices at both ends, or at more than one location along the length of the cylinder, the centre of the fire source shall be placed midway between the pressure relief devices that are separated by the greatest horizontal distance.

14.15.8 Acceptable result

The cylinder shall vent through a pressure-release device without bursting.

If venting occurs in less than 5 min, the fire test shall continue for at least 5 min to demonstrate that the minimum test temperature conditions have been achieved.

14.16 Penetration test

A cylinder pressurized to working pressure with compressed natural gas or compressed hydrogen, as appropriate, shall be impacted on the sidewall at an approximate angle of 90° by an armour-piercing bullet with a diameter of 7.62 mm (0.3 in) or greater, having a nominal velocity of 850 m/s (2789 ft/s), and fired from a distance no greater than 45 m (148 ft). The bullet may pass through the sidewall of the cylinder. The cylinder shall not rupture.

14.17 Flaw tolerance test

For Type 2, Type 3, and Type 4 designs only, one finished cylinder, complete with protective coating, shall have two flaws cut into the composite in the longitudinal direction. One flaw shall be a minimum of 25 mm (1 in) long and 1.25 mm (0.05 in) deep, and the other flaw shall be a minimum of 200 mm (8 in) long and 0.75 mm (0.03 in) deep.

The flawed cylinder shall then be pressure cycled from not more than 20 bar to not less than 1.25 times the working pressure for a number of cycles equivalent to 750 times the service life of the cylinder in years. The cylinder shall not leak or rupture within the first 3000 cycles, but may fail by leakage up to the maximum number of cycles. All cylinders that complete this test shall be destroyed.

14.18 Accelerated stress rupture test

For Type 2, Type 3, and Type 4 designs only, one cylinder free of protective coating shall be hydrostatically pressured to working pressure. The cylinder shall be held at this pressure and at a temperature of 85 °C (185°F) for 1000 h. The cylinder shall then be pressurized to burst in accordance with the procedure specified in Clause 14.12, except that the burst pressure shall exceed 80% of the minimum design burst pressure.

14.19 Drop test

One or more finished cylinders shall be drop tested at ambient temperature without internal pressurization or attached valves. The surface onto which the cylinders are dropped shall be a smooth and horizontal concrete pad or flooring. One cylinder shall be dropped in a horizontal position, with the bottom 1.83 m (72 in) above the surface onto which it is dropped. One cylinder shall be dropped vertically, on each end, from a height above the floor or pad sufficient to produce potential energy of 488 J (360 ft•lb), but the height of the lower end above the floor or pad shall not be greater than

1.83 m (72 in). One cylinder shall be dropped at a 45° angle onto its dome from a height such that the centre of gravity is at 1.83 m (72 in); however, if the lower end is closer to the ground than 0.6 m (24 in), the drop angle shall be changed to maintain a minimum height of 0.6 m (24 in) and a centre of gravity of 1.83 m (72 in). The cylinder shall be allowed to bounce on the concrete pad or flooring after the initial impact. No attempt shall be made to prevent this secondary impacting.

Following the drop impact, the cylinders shall be pressure cycled from not more than 20 bar (290 psi) to not less than 1.25 times the working pressure for 750 cycles times the specified service life in years. The cylinders shall not leak or rupture within the first 3000 cycles, but shall be allowed to fail by leakage during further pressure cycling. Cylinders completing the cycling test shall be destroyed.

14.20 Permeation test

The permeation test shall be required only for Type 4 designs. For natural gas service, one finished cylinder shall be filled with compressed natural gas to the working pressure, placed in an enclosed sealed cylinder at ambient temperature, and monitored for leakage for a time sufficient to establish a steady-state permeation rate. The permeation rate shall be less than 0.25 mL of natural gas per hour per litre of the water capacity of the cylinder.

For hydrogen blends or hydrogen service, one finished cylinder shall be filled with hydrogen to the working pressure, placed in an enclosed sealed cylinder at ambient temperature, and monitored for leakage for a time sufficient to establish a steady-state permeation rate. The permeation rate shall be less than 2 mL of hydrogen gas per hour per litre of the water capacity of the cylinder.

14.21 Environmental test

14.21.1 Test cylinder

One cylinder shall be tested, including coating if applicable.

Five distinct areas shall be marked on the upper section of the horizontal cylinder. Each shall be nominally 100 mm (4 in) in diameter. Each area shall be preconditioned with an impact from a pendulum impactor, followed by fluid exposure. To facilitate testing, the five areas need not be oriented along a single line, but they shall not overlap.

Although preconditioning and fluid exposure shall take place on the cylindrical section of the cylinder, all of the cylinder, including the domed ends, shall be as resistant to the exposure environments as the exposed areas.

14.21.2 Pendulum impact preconditioning

The impact body shall be made of steel and be in the shape of a pyramid with equilateral triangular faces and a square base. The summit and the edges shall be rounded to a radius of 3 mm (0.12 in). The centre of percussion of the pendulum shall coincide with the centre of gravity of the pyramid; its distance from the axis of rotation of the pendulum shall be 1 m (39 in). The total mass of the pendulum referred to its centre of percussion shall be 15 kg (33 lb). The energy of the pendulum at the moment of impact shall be not less than 30 N•m or as close to that value as possible.

During pendulum impact, the cylinder shall be held in position by the end-bosses or by the intended mounting brackets. Each of the five marked areas shall be preconditioned by an impact of the pendulum body summit at the centre of the area. The cylinder shall be unpressurized during preconditioning.

14.21.3 Environmental fluids for exposure

Each marked area shall be exposed to one of the following fluids:

a) sulphuric acid: 19% solution by volume in water;
b) sodium hydroxide: 25% solution by weight in water;
c) methanol/gasoline: 5% methanol and 95% gasoline concentration of M5 fuel meeting the requirements of ASTM D4814;
d) ammonium nitrate: 28% by weight in water; or
e) windshield washer fluid (50% by volume solution of methyl alcohol and water).

When exposed, the cylinder shall be oriented in such a way that the exposure areas are uppermost. A pad of glass wool approximately 0.5 mm (0.02 in) thick and between 90 and 100 mm (3.5 and 4 in) in diameter shall be placed on each exposure area. An amount of fluid sufficient to ensure that the pad is wetted evenly across its surface and through its thickness for the duration of the test, and to ensure that the concentration of the fluid is not changed significantly during the test, shall be applied to the glass wool.

14.21.4 Pressure cycle and pressure hold

Cylinders shall be hydraulically pressure cycled between 20 bar (290 psi) or less and 1.25 times the working pressure, for a total of 2250 pressure cycles. The maximum pressurization rate shall be 27.5 bar/s (399 psi/s). After pressure cycling, the container shall be pressurized to 1.25 times the working pressure and held at that pressure until the time of exposure to the environmental fluids has elapsed.

14.21.5 Acceptable result

The fuel cylinder shall not rupture or leak during the test. The cylinder shall be hydraulically pressurized to burst following the procedure specified in Clause 14.12.1. The cylinder shall have a burst pressure of at least 85% of the design minimum burst pressure.

14.22 Gas cycling test

One finished cylinder shall be pressure cycled, using compressed natural gas for natural gas service and compressed hydrogen for hydrogen blends and hydrogen service, from less than 20 bar (290 psi) to working pressure for 1000 cycles. Each cycle, consisting of the filling and venting of the cylinder, shall not exceed 1 h. The cylinder shall be leak tested in accordance with and meet the requirements of Clause 14.10. Following completion of the gas cycling, the cylinder shall be sectioned and the liner and liner/end-boss interface inspected for evidence of deterioration, e.g., fatigue cracking or electrostatic discharge.

Table 1
Impact values
(See Clause 6.3.2.4.)

Width of test piece, mm	Direction of test	Impact energy, J/cm²*
< 5	Longitudinal	60
5–7.5	Transverse	44
7.6–10	Transverse	50

* *Required average of three specimens. Not more than one specimen shall break at less than the average value required and no specimen shall break at less than 70% of the average value.*

Table 2
Stress ratios
(See Clause 6.6.)

Material	Type 2 hoop-wrapped	Type 3 fully wrapped	Type 4 all-composite
Aramid	2.25	3.0	3.0
Carbon	2.25	2.25	2.25
Glass	2.65	3.5	3.5

Table 3
Design qualification tests
(See Clause 6.13.)

		Cylinder type			
Test and clause reference		Type 1	Type 2	Type 3	Type 4
14.7.1	Leak-before-break cycle	X	X	—	—
14.12	Burst	X	X	X	X
14.13	Ambient temp. cycle	X	X	X	X
14.14	Extreme-temp. cycle	—	X	X	X
14.15	Bonfire	X	X	X	X
14.16	Penetration	X	X	X	X
14.17	Flaw tolerance	—	X	X	X
14.18	Stress rupture	—	X	X	X
14.19	Drop	—	—	X	X
14.20	Permeation	—	—	—	X
14.21	Environmental*	—	X	X	X

* *Required only when no protective coating is used.*

Table 4
Batch tests
(See Clause 6.14.)

Test and clause reference		Cylinder type			
		Type 1	**Type 2**	**Type 3**	**Type 4**
14.1	Tensile	X	X*	X*	—
14.2	Impact (steel)	X	X*	X*	—
14.9	Coating	X	X†	X†	X*
14.12	Burst	X	X	X	X
14.13	Ambient temp. cycle	X	X	X	X

* *Tests on liner material.*
† *Except where no protective coating is used.*

Table 5
Design change qualification tests
(See Clause 6.16.)

Design change	Test and clause reference										
	Sulphide stress cracking, 14.3	Burst, 14.12	Ambient temp. cycle, 14.13	Extreme-temp. cycle, 14.14	Bonfire, 14.15	Penetration, 14.16	Flaw tolerance, 14.17	Stress rupture, 14.18	Drop, 14.19	Permeation, 14.20	Environmental, 14.21/ Coating performance, 14.6
Manufacturer	—	X	X	—	—	—	—	X*	—	X†	—
Metal cylinder or liner material	X	X	X	X*	X	X	X*	X*	—	—	—
Non-metallic liner material	—	—	X	X	X	—	—	—	—	X	—
Fibre material	—	X	X	X	X	X	X	X	—	X†	—
Resin material	—	X	—	X	—	X	X	X	—	—	—
Diameter change ≤ 20%	—	X‡	X‡	—	—	—	—	—	—	—	—
Diameter change > 20%	—	X	X	—	X	X	X*	—	X	—	—
Length change ≤ 50%	—	X‡	—	—	X§	—	—	—	—	—	—
Length change > 50%	—	X**	X**	—	X§	—	—	—	X	—	—
Dome shape	—	X	X	—	—	—	—	—	—	X†	—
Opening size increase	—	X	X**	—	—	—	—	—	—	—	—
Coating change	—	—	—	—	—	—	—	—	—	—	X
Fire protection system	—	—	—	—	X	—	—	—	—	—	—
Change in manufacturing process	X	X	X	—	—	—	—	—	—	—	—
Working pressure change ≤ 20%	—	X‡	X‡	—	—	—	—	—	—	—	—

* *Test not required for metal (Type 1) designs.*
† *Test required only for all-composite (Type 4) designs.*
‡ *Only one unit required for qualification.*
§ *Test required only when length increases.*
** *Only one unit required for qualification for fully wrapped (Type 3) and all-composite (Type 4) designs.*

Annex A (informative)
Report forms

Note: *This Annex is not a mandatory part of this Standard.*

A.1

The following forms should be used:

a) report of manufacturing and certification of conformance, in the format shown in Figure A.1;
b) report of chemical analysis of material for metal containers, liners, or bosses, in a format of the manufacturer's choosing;
c) report of mechanical properties of material for metal containers and liners, in a format of the manufacturer's choosing; and
d) report of physical and mechanical properties of materials for non-metallic liners, in a format of the manufacturer's choosing.

Each form should be signed by representatives of the independent inspection authority and the manufacturer.

Figure A.1
Report of manufacturing and certification of conformance for compressed natural gas fuel cylinders
(See Clause A.1.)

REPORT OF MANUFACTURING AND CERTIFICATION OF CONFORMANCE FOR COMPRESSED NATURAL GAS FUEL CYLINDERS
RAPPORT DE FABRICATION ET CERTIFICAT DE CONFORMITÉ DES BOUTEILLES DE GAZ NATUREL COMPRIMÉS

Manufactured by/*Construit par* _____

Located at/*Adresse* _____

Canadian Registration Number/*Numéro d'enregistrement canadien* _____

Manufacturer's mark and number/*Marque et numéro du constructeur* _____

Serial numbers/*Numéros de série* _____ to/*à* _____ , inclusive

Container description/*Description du récipient* _____

Size/*Dimensions:* Diameter/*Diamètre* _____ mm Length/*Longueur* _____ mm

Marks stamped on shoulder or on labels of the cylinder are
Les marques estampées sur l'épaulement ou les étiquettes de la bouteille sont

a) "CNG ONLY"/*«GNC SEULEMENT»*
b) "DO NOT USE AFTER"/*«NE PAS UTILISER APRÈS»* _____ YYYY/MM/(*année/mois)*
c) Manufacturer's mark/*Marque du constructeur* _____
d) Serial or part number/*Numéro de série ou de pièce* _____
e) Working pressure in bar @ °C/*Pression de service en bars @* °C _____ bar @ _____ °C
f) CSA B51 cylinder type/*Type de bouteille CSA B51* _____ CRN/*NEC* _____
g) Fire protection/*Protection contre le feu* _____ type
h) Original test (month and year)/*Date de l'essai initial (mois année)** _____
i) Water capacity in L/*Capacité en eau en* L* _____ L
j) Test pressure in bar/*Pression d'essai en bars* _____ bar
k) Any special instructions/*Instructions spéciales* _____

*Not mandatory/*Pas obligatoire*

Each container was made in compliance with all of the requirements of CSA Standard B51, Part 2, and in accordance with the CRN specified above. Required reports of test results are attached.
La fabrication de chaque récipient est conforme à toutes les exigences de la norme CSA B51, Deuxième partie et au NEC susmentionné. Les rapports exigés à l'égard des résultats des essais sont en annexe.

I hereby certify that all of these test results proved satisfactory in every way and are in compliance with the requirements of CSA Standard B51, Part 2, and the CRN specified above.
Je certifie par la présente que ces résultats des essais sont satisfaisants de tous points de vue et qu'ils sont conformes aux exigences de la norme CSA B51, Deuxième partie, et au NEC susmentionné.

Comments/*Commentaires* _____

_____
(Authorized body or inspection agency/*Organisme autorisé ou organisme d'inspection)*

_____
(Inspector's signature/*Signature de l'inspecteur)*

_____
(Manufacturer's signature/*Signature du constructeur)*

Place/*Lieu* _____

Date _____

Annex B (informative)
Procedure for requalifying all-steel natural gas vehicle storage cylinders

Note: *This informative Annex has been written in normative language to facilitate its adoption where users of the Standard or regulatory authorities wish to adopt it formally as additional requirements to this Standard.*

B.1 Introduction

This Annex establishes the minimum requirements for requalifying cylinders that are designed or used under Part 2 or 3 of this Standard and have reached the end of the service period specified by their manufacturers.

The design life of an all-metal steel cylinder, which is based on the rate of fatigue crack growth in the cylinder wall, is determined by a variety of factors, including material properties, the number of pressure cycles, the wall stress associated with the pressure cycle amplitude, and the nature of the crack-initiating feature on the cylinder.

B.2 Cylinder types and service conditions

B.2.1 Cylinder types covered

The types of cylinders covered in this Annex are

a) steel vehicle cylinders that
   i) are designed for use as on-board fuel storage containers for vehicles powered by natural gas; and
   ii) are provincially registered in accordance with this Standard;
b) steel vehicle cylinders that
   i) are designed for use as on-board fuel storage containers for vehicles powered by natural gas;
   ii) meet the requirements of Part 2 of this Standard; and
   iii) are given a special permit by Transport Canada; and
c) steel ground storage cylinders that
   i) are designed for the transportation of dangerous goods; and
   ii) are
      1) registered with Transport Canada in accordance with CSA B339 to the TC-3AAM specification; or
      2) approved by the United States Department of Transportation (U.S. DOT) to the 3AA specification.

B.2.2 Service conditions

Part 2 of this Standard specifies the service conditions for cylinders that are used for the on-board storage of natural gas as a fuel for automotive vehicles and designed to comply with the requirements of Part 2. Part 3 of this Standard and CSA B108 specify the service conditions for cylinders used for the storage of gas at natural gas vehicle fuelling facilities as part of a cascade or buffer system. These Standards specify pressures for the most common working pressure used in Canada, i.e., the P30 (200 bar) operating system. Accommodation for higher-pressure systems shall be made in any requalification procedure; the procedure for accommodating higher pressures is described in Clause 1.3 of Part 2 of this Standard.

B.3 Visual inspection procedure

B.3.1 Original markings

The inspector (the person responsible for requalifying the cylinders) shall ensure that the original markings on the cylinder are clearly visible and unambiguous. If the markings do not include an identification of the manufacturer, the cylinder serial number, and the design registration number, the cylinder shall not be requalified under this procedure.

B.3.2 Visual damage

Before ultrasonic inspection, the cylinder shall be visually inspected in accordance with ISO 19078 for heat damage, dents, gouges, or severe external corrosion. A cylinder that fails the visual inspection shall be destroyed.

B.3.3 Cleaning

To ensure the accuracy of the ultrasonic inspection, any surface roughness that would interfere with that inspection shall be removed. All cylinders shall be drained of fluids.

B.4 Ultrasonic inspection

B.4.1 Introduction

Clause B.4 is based on the ultrasonic inspection techniques described in Annex B of ISO 9809-1. Other inspection techniques may be used if they have been demonstrated to be suitable for the detection of the reference notches.

B.4.2 General requirements

The ultrasonic testing equipment shall be capable of detecting, at a minimum, the reference standards specified in Clauses B.4.3.2 and B.4.5.2. The equipment shall be serviced regularly in accordance with the manufacturer's operating instructions to ensure that its accuracy is maintained. Inspection records and approval certificates for the equipment shall be maintained.

The testing equipment shall be operated by trained personnel and supervised by qualified and experienced personnel certified to Level 2 of CAN/CGSB-48.9712/ISO 9712.

The outer and inner surfaces of a cylinder that is to be tested ultrasonically shall be in a condition suitable for an accurate and reproducible test.

For flaw detection, the pulse echo system shall be used. For thickness measurement, the resonance method or the pulse echo system shall be used. Contact or immersion testing techniques shall be used. A coupling method that ensures adequate transmission of ultrasonic energy between the testing probe and the cylinder shall be used.

B.4.3 Flaw detection in the cylinder sidewall

B.4.3.1 Procedure

The cylinder to be inspected and the search unit shall have a rotating motion and translation relative to one another such that a helical scan of the cylinder will be described. The velocity of rotation and translation shall be constant within ±10%. The pitch of the helix shall be less than the width covered by the probe (at least 10% overlapping shall be guaranteed) and be related to the effective beam width in

a way that ensures 100% coverage at the velocity of rotation and translation used during the calibration procedure.

An alternative scanning method in which the scanning or relative movement of the probes and the work piece is longitudinal may be used for transverse defect detection. The sweeping motion shall ensure 100% surface coverage, with about 10% overlapping of the sweeps.

The cylinder wall shall be tested for longitudinal defects with the ultrasonic energy transmitted in both circumferential directions and for transverse defects in both longitudinal directions.

The effectiveness of the equipment shall be periodically checked by submitting a reference standard to the test procedure. At a minimum, this check shall be carried out at the beginning and end of each shift. If during this check the appropriate reference notch is not detected, all cylinders tested subsequent to the last acceptance check shall be retested after the equipment has been reset.

B.4.3.2 Sidewall reference standard

A reference standard of convenient length shall be prepared from a cylinder sidewall of similar diameter and wall thickness range, and made of material with the same acoustic characteristics and surface finish as the cylinder to be inspected. The reference standard shall be free from discontinuities that could interfere with the detection of the reference notches.

Reference notches, both longitudinal and transverse, shall be machined on the outer and inner sidewall surfaces of the standard. The notches shall be separated in such a way that each notch can be clearly identified.

The dimensions and shape of notches are crucially important for the adjustment of the equipment and shall meet the following requirements:

a) The length of a notch shall not be greater than 25 mm.
b) The width of a notch shall not be greater than 1 mm.
c) The depth of a notch shall be 5 ± 0.75% of the wall thickness over the full length of the notch. There may be runouts at each end.
d) A notch shall be sharp-edged at its intersection with the surface of the cylinder wall. The cross-section of a notch shall be rectangular except where spark-erosion machining methods are employed, in which case the bottom of the notch shall be rounded.
e) The shape and dimensions of a notch shall be demonstrated by an appropriate method.

B.4.3.3 Calibration of equipment

The equipment shall be adjusted to provide clearly identifiable indications from inner and outer reference notches in accordance with the sidewall reference standard specified in Clause B.4.3.2. The amplitude of the indications shall be as close to identical as possible. The indication of smallest amplitude shall be used as the rejection level and for the setting of visual, audible, recording, or sorting devices. The equipment shall be calibrated with the reference standard or probe, or both, moving in the same manner, direction, and speed as will be used during the inspection of the cylinder. All visual, audible, recording, and sorting devices shall operate satisfactorily at the test speed.

B.4.4 Wall thickness measurement

One hundred per cent of the cylindrical part shall be examined to ensure that the wall thickness is not less than the minimum design thickness and that the reduction in wall thickness is less than 5% of the typical wall thickness of the cylinder being examined. The sidewall reference standard specified in Clause B.4.3.2 shall be used to calibrate the thickness measurement.

B.4.5 Flaw detection in the cylinder ends

B.4.5.1 Procedure

The entire surface of the ends shall be examined using a 45° angle probe.

The scans shall be made as follows:

a) with the probe parallel to the longitudinal axis; and
b) with the probe at right angles to the longitudinal axis.

Each scan shall be carried out with the probe pointing in one direction and then repeated with the probe reversed. In addition, a scan shall be carried out at the root of the neck with the probe held at an angle of 45° to the longitudinal axis of the cylinder and then repeated with the probe turned to 90°. The scans shall be made using probes with maximum dimensions of 10 to 20 mm (0.4 to 0.8 in), the smaller probes being used to scan the root of the neck.

Scans shall begin or terminate at points 50 mm (2 in) along the parallel part of the cylinder. Each scan shall overlap the previous scan by 25%.

B.4.5.2 End reference standards

A reference standard of convenient length shall be prepared from a cylinder head end and a cylinder base end of similar diameter and wall thickness range, and made of material with the same acoustic characteristics and surface finish as the cylinder to be inspected. The reference standard shall be free from discontinuities that could interfere with the detection of the reference notches.

Reference notches, both longitudinal and transverse, shall be machined on the outer and inner surfaces of the standard head end and base end. The notches shall be separated in such a way that each notch can be clearly identified. At the head end, the notches shall be located in the neck curvature near the base of the threads. At the base end, the notches shall be located in the curved portion of the transition adjacent to the cylinder sidewall.

The dimensions and shape of notches are crucially important for the adjustment of the equipment and shall meet the following requirements:

a) The length of a notch shall not be greater than 25 mm.
b) The width of a notch shall not be greater than 1 mm.
c) The depth of a notch shall be 10 ± 0.75% of the wall thickness over the full length of the notch. There may be runouts at each end.
d) A notch shall be sharp-edged at its intersection with the surface of the cylinder wall. The cross-section of a notch shall be rectangular except where spark-erosion machining methods are employed, in which case the bottom of the notch shall be rounded.
e) The shape and dimensions of a notch shall be demonstrated by an appropriate method.

B.4.6 Assessment of results

B.4.6.1 General

If surface defects are removed by grinding, the cylinders shall also be subjected to ultrasonic defect detection and thickness measurement after the grinding. Cylinders continuing to show defects at points of minimum design thickness shall be deemed not to comply with the requirements of this procedure.

B.4.6.2 Acceptance criteria for steel vehicle cylinders

The following acceptance criteria shall apply:

a) The acceptance criterion for the sidewall of a cylinder design that meets the requirements of Part 2 of this Standard shall be as specified in Table B.1.
b) The acceptance criterion for the ends of a cylinder design that meets the requirements of Part 2 of this Standard shall be the absence of any defect indication that is equal to or greater than the end reference notches.

B.4.6.3 Acceptance criteria for steel storage cylinders

The following acceptance criteria shall apply:

a) The acceptance criterion for the sidewall of a storage cylinder that meets the TC-3AAM or U.S. DOT 3AA specification shall be as specified in Table B.2.
b) The acceptance criterion for the ends of a cylinder design that meets the TC-3AAM or U.S. DOT 3AA specification shall be the absence of any defect indication that is equal to or greater than the end reference notches.

B.4.6.4 Destruction of cylinders that fail the inspection

Cylinders that fail the sidewall or end inspection shall be destroyed.

B.5 Protective coating

B.5.1 Recoating

Cylinder designs registered to Part 2 of this Standard for vehicle use shall be recoated to meet the requirements of Clause 14.9. Stamping marks shall also be coated.

Cylinders used for dedicated ground storage service in accordance with Part 3 of this Standard shall be recoated with a coating system that is capable of protecting the cylinder for the duration of the requalification period. Stamping marks shall also be coated.

B.5.2 Visibility of markings

Requalifying agencies shall ensure that all markings are visible after a cylinder has been recoated and before the cylinder is shipped.

B.6 Stamping or labelling procedure

B.6.1 Unique marking

A requalified cylinder shall be marked with a unique marking that will identify the agency approved or recognized by the authority having jurisdiction over the cylinder designs covered by this procedure for the requalification of cylinders. This marking shall be registered with the authority having jurisdiction.

B.6.2 Length of requalification period

Cylinders that have been requalified shall be marked with a retest due date that is not more than 15 years from the date of inspection.

The service life of steel vehicle cylinders shall not exceed 30 years from the date of manufacture.

B.6.3 Use after requalification

If not previously marked, a requalified cylinder shall be marked CNG ONLY. The lettering shall be at least 6 mm (0.24 in) high.

B.6.4 Expiry Date — Steel vehicle cylinders

Steel vehicle cylinders that have been requalified shall be labelled with the words DO NOT USE AFTER followed by the year of expiry (at most, 15 years from the date of ultrasonic inspection or 30 years from the date of manufacture, whichever comes first). The lettering shall be at least 6 mm (0.24 in) high. The following is an example:

DO NOT USE AFTER 2023
(Inspector's stamp)

B.6.5 Expiry Date — Steel storage cylinders

Conventional transportation cylinders that have been requalified shall be marked with the letters UE followed by the year of inspection. Immediately underneath that marking shall be a marking consisting of the word DUE followed by a year that is not more than 15 years from the date of ultrasonic inspection. The lettering shall be at least 6 mm (0.24 in) high. The following is an example:

UE 2008
DUE 2023
(Inspector's stamp)

B.7 Storage and shipment procedure

For a cylinder where the valve has been removed, the internal surfaces of the cylinder shall be sprayed with a vapour-phase corrosion inhibitor (or equivalent). The cylinder shall then be sealed to atmosphere for storage or transport.

B.8 Documentation

A record of the inspection and stamping shall be made for each requalified cylinder. An example of an acceptable form is provided in Figure B.1. Records shall be kept for at least 15 years by the agency identified in Clause B.6.1. One copy of the completed form for each cylinder shall be provided to the cylinder owner.

B.9 Quality control system

The quality control system for the inspection of cylinders used by the agency identified in Clause B.6.1 shall comply with the requirements of Clause 13.

Table B.1
Acceptance criteria for steel vehicle cylinders
(See Clause B.4.6.2.)

Crack depth (*D*) expressed as a % of wall thickness	Permissible crack length, mm
$D \leq 4\%$	No limit
$4\% < D \leq 5\%$	8 or less
$5\% < D \leq 7\%$	6 or less
$7\% < D \leq 10\%$	5 or less
$10\% < D \leq 15\%$	4 or less
$D > 15\%$	Not acceptable

Table B.2
Acceptance criteria for steel storage cylinders
(See Clause B.4.6.3.)

Crack depth (*D*) expressed as a % of wall thickness	Permissible crack length, mm
$D \leq 4\%$	No limit
$4\% < D \leq 5\%$	36 or less
$5\% < D \leq 6\%$	26 or less
$6\% < D \leq 7\%$	22 or less
$7\% < D \leq 8\%$	18 or less
$8\% < D \leq 9\%$	14 or less
$9\% < D \leq 10\%$	12 or less
$D > 10\%$	Not acceptable

Figure B.1
Sample form for requalified cylinders
(See Clause B.8.)

Cylinder owner *Propriétaire de la bouteille*	Cylinder manufacturer *Fabricant de la bouteille*	Serial no. *N° de série*	Date of manufacture *Date de fabrication*	Retest date *Date de reprise des essais*	Results *Résultats*			Inspector *Inspecteur*	Comments *Commentaires*
					Sidewall *Paroi*	Neck *Goulot*	Base *Base*		

Inspector *Inspecteur* _____ Date *Date* _____ Requalification agency *Agence de requalification* _____

National Standard of Canada

B51-19, Part 3

Compressed natural gas and hydrogen refuelling station pressure piping systems and ground storage vessels

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B51-19, Part 3
Compressed natural gas and hydrogen refuelling station pressure piping systems and ground storage vessels

1 Scope

1.1

1.1.1
The pressure piping systems covered in Part 3 of this Standard are systems used in compressed natural gas (CNG) and hydrogen refuelling stations

a) between the termination of the utility's piping, usually at the meter, and the inlet to the compressor assembly if the design pressure exceeds 414 kPa (60 psi); and
b) from the inlet to the compressor assembly through to the dispenser nozzle, except for the mechanical parts of the compressor and any subsystems designed for 414 kPa (60 psi) or less.

1.1.2
The ground storage vessels covered in Part 3 of this Standard are pressure vessels that are installed at CNG and hydrogen refuelling stations and intended to store CNG or hydrogen at pressure for delivery to vehicle fuel tanks.

1.2
Where a clause in Part 3 of this Standard is at variance with codes or standards referenced in Part 3 of this Standard, the requirements of Part 3 of this Standard govern.

1.3
In this Standard, "shall" is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the standard; "should" is used to express a recommendation or that which is advised but not required; and "may" is used to express an option or that which is permissible within the limits of the standard.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

1.4
The values given in SI units are the units of record for the purposes of this Standard. The values given in parentheses are for information and comparison only.

2 Reference publications

Part 3 of this Standard refers to the following publications, and where such reference is made, it shall be to the edition listed below, including all amendments published thereto.

CSA Group

CSA/ANSI NGV 4.1-2018
Natural gas vehicle (NGV) dispensing systems

12.6-04 (R2014)
Vehicle refuelling appliances

B108-18
Natural gas refuelling stations installation code

B149.1-15
Natural gas and propane installation code

B339-18
Cylinders, spheres, and tubes for the transportation of dangerous goods

B340-18
Selection and use of cylinders, spheres, tubes, and other containers for the transportation of dangerous goods, Class 2

CAN/CSA-Z662-15
Oil and gas pipeline systems

ASME (The American Society of Mechanical Engineers)

Boiler and Pressure Vessel Code (2017)
Section V — Nondestructive Examination
Section VIII — Rules for Construction of Pressure Vessels — Division 1
Section VIII — Rules for Construction of Pressure Vessels — Division 2 — Alternative Rules
Section X — Fiber-Reinforced Plastic Pressure Vessels

B31.1-2018
Power Piping

B31.3-2016
Process Piping

ASTM International

A105/A105M-18
Standard Specification for Carbon Steel Forgings for Piping Applications

A106/A106M-18
Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

A182/A182M-18
Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service

A213/A213M-18a
Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes

A216/A216M-18
Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service

A312/A312M-17
Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes

A333/A333M-16
Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service and Other Applications with Required Notch Toughness

A334/A334M-04a (R2016)
Standard Specification for Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service

A350/A350M-18
Standard Specification for Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components

A352/A352M-18
Standard Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service

CGA (Compressed Gas Association)

G-5.4-2012
Standard for Hydrogen Piping Systems at User Locations

3 Definition

The following definition shall apply in Part 3 of this Standard:

Design pressure — the maximum pressure for the adopted temperatures and cycling conditions for which a system is designed.

4 General requirements

4.1 General

Pressure piping systems and ground storage vessels shall comply with Clause 4 of Part 1 of this Standard, except when the requirements of Clause 4 of Part 1 of this Standard are modified by Part 3 of this Standard. Pressure vessels shall be designed in accordance with

a) Part 2 of this Standard;
b) CSA B339;
c) Section VIII, Division 1 or 2, of the ASME Code; or
d) Section X of the ASME Code.

Note: *See ASME B31.1 and ASME B31.3 for piping system design and construction details.*

4.2 Gas quality

Pressure piping systems and ground storage vessels shall be designed for safe operation with

a) natural gas composed mainly of methane but also with other constituents in amounts not exceeding the limits specified in Clause 4.5 of Part 2 of this Standard; and
b) the hydrogen gas compositions specified in Clause 4.5 of Part 2 of this Standard.

4.3 Registration

For every refuelling station installation, a site-specific drawing and bill of material for the pressure piping system shall be submitted for registration. Information on the following shall be included in the submission:

a) the pressure piping code of construction;
b) the design pressure and temperature of systems and subsystems;
c) material specifications (as permitted by the code of construction);
d) registered fittings;
e) registered vessels;
f) pre-registered piping sub-assemblies (i.e., shop-built assemblies or buried piping); and
g) registered temperature-compensated dispensed-pressure control systems.

Each item shall be clearly identified and all Canadian Registration Numbers shall be shown.

4.4 Inspection

4.4.1

Final inspections at the site shall include, but not be limited to, the following:

a) a review of a registered copy of the site-specific drawing of the pressure piping system;
b) a review of partial data reports substantiating the shop inspection and the witnessing of shop tests that have been carried out on pre-registered shop-fabricated piping sub-assemblies;
c) a review of partial data reports substantiating previous field inspections and/or witnessing field tests of buried pipe sub-assemblies;
d) a review of the storage vessel manufacturer’s data reports;
e) witnessing of hydrostatic or pneumatic pressure tests in accordance with the requirements of the pressure piping code of construction for any items not previously tested in accordance with an acceptable partial data report;
f) witnessing of a leak test, at operating pressure, of mechanical joints between previously tested sub-assemblies;
g) a review of the temperature-compensated dispensed-pressure control system registration; and

h) a check that the temperature-compensated dispensed pressure is adjusted properly and that arrangements for subsequent control have been made.

4.4.2
A piping systems installation and test data report covering the pressure piping system at the site shall be completed and signed by the designer or installer of the system and countersigned by the authorized inspector.

In addition to ensuring that the pressure piping system and ground storage vessels comply with this Standard, owners and operators of CNG and hydrogen refuelling stations shall ensure that their stations comply with the applicable requirements of CSA B108 and CSA B149.1, and are inspected with respect to those requirements by the regulatory authority.

5 Compressed natural gas and hydrogen refuelling station pressure piping systems

5.1 Design

5.1.1
The design temperature range shall be, at a minimum, –20 to +65 °C (–4 to +149°F) for buried piping and –40 to +65 °C (–40 to +149°F) for above-ground installations, unless the system is in a temperature-controlled enclosure.

5.1.2
The minimum wall thickness of piping and tubing shall be determined in accordance with the requirements of ASME B31.1, ASME B31.3, or an alternative code acceptable to the regulatory authority.

5.1.3
ASME standard fittings shall be rated for a pressure equal to or greater than the design pressure.

5.1.4
Non-standard fittings shall be capable of withstanding a proof test of at least four times the design pressure.

5.1.5
The design of all piping systems, fittings, and vessels shall be registered as required by Clause 4 of Part 1 of this Standard.

5.2 Materials

5.2.1
Piping and tubing for CNG stations shall be seamless and meet the following specifications or alternatives approved by the regulatory authority:

a) ASTM A106/A106M, Grade B: seamless carbon-steel pipe (when the pipe is not buried, impact testing shall be performed as required by Section VIII, Division 1, of the ASME Code);

b) ASTM A213/A213M: alloy-steel tubes, austenitic grades only;
c) ASTM A312/A312M: austenitic stainless steel pipe;
d) ASTM A333/A333M, Grade 6: steel pipe for low-temperature service; and
e) ASTM A334/A334M, Grade 6: steel tubes for low-temperature service.

Note: *When alloy-steel tubes are subject to vibration or differential expansion, only the "bright annealed" austenitic grade should be used.*

5.2.2

Piping and tubing for hydrogen stations shall conform to CGA G-5.4.

5.2.3

Flanges, fittings, valve bodies, and other piping component material for CNG stations shall meet the following specifications or alternatives approved by the regulatory authority:

a) ASTM A105/A105M: carbon-steel forgings (when the forgings are not buried, impact testing shall be performed as required by Section VIII, Division 1, of the ASME Code);
b) ASTM A182/A182M: forged or rolled alloy-steel pipe flanges, fittings, valves, etc., austenitic grades only;
c) ASTM A216/A216M, Grade WCC: carbon-steel castings;
d) ASTM A350/A350M, Grade LF2: carbon-steel forgings requiring notch toughness testing;
e) ASTM A352/A352M, Grade LCC: carbon-steel castings for low-temperature service; and
f) non-ferrous materials suitable for the service and meeting an appropriate ASME or ASTM specification.

5.2.4

Flanges, fittings, valve bodies, and other piping component material for hydrogen stations shall conform to CGA G-5.4.

5.3 Installation and welding

5.3.1

Above-ground piping and tubing shall be

a) connected by welding, threading, compression fittings, or flanges, but flared connections shall not be used;
b) protected against external corrosion by a suitable coating and against other damage from external sources; and
c) supported and anchored as required by CAN/CSA-Z662.

5.3.2

Buried piping shall be connected only by welding and coated, cathodically protected, and monitored in accordance with CAN/CSA-Z662.

5.4 Non-destructive examination

5.4.1

Except for joints in interstage compressor piping, butt-welded joints shall be examined radiographically over their full length in accordance with procedures specified in Section V of the ASME Code. The acceptance criteria of ASME B31.1 or ASME B31.3 shall be met.

5.4.2
Butt-welded joints in interstage compressor piping shall be examined radiographically, as required by the inspector.

5.4.3
Socket-welded joints shall be examined visually. Weld size and surface finish acceptability shall be determined by the inspector.

5.5 Pressure tests

5.5.1
Pressure testing shall be conducted in accordance with the ASME Code, ASME B31.1, or ASME B31.3, except as required or permitted by Clauses 5.5.2 to 5.5.5.

5.5.2
Except as permitted by Clause 5.5.3, all joints shall be hydrostatically tested to not less than 1.5 times the system design pressure or pneumatically tested to not less than 1.2 times the system design pressure.

5.5.3
Flanged, threaded, or compression-type joints made in the field to connect shop-fabricated, shop-tested sub-assemblies may be leak tested at the operating pressure of the system.

5.5.4

5.5.4.1
Where the entire system is accessible for inspection, the test pressure shall be held for 30 min or longer if necessary to inspect for leakage. When a pneumatic test is conducted, all joints shall be examined for leakage with a suitable leak-detecting solution.

5.5.4.2
If part of a system has been buried or is otherwise inaccessible for inspection, the test pressure shall be held for 24 h and a recording chart shall be used.

5.5.4.3
Any evidence of leakage shall be considered unacceptable.

5.5.5

5.5.5.1
Shop pressure tests for piping sub-assemblies required by this Standard shall be witnessed by an authorized inspector, as required by Clause 4.8.1 of Part 1 of this Standard.

5.5.5.2
Pressure tests of field installations required by this Standard shall be witnessed by an authorized inspector, as required by Clause 4.8.1 of Part 1 of this Standard, or by an inspector required by the authority having jurisdiction.

5.6 Overpressure protection

5.6.1
A safety valve shall be installed on the compressor outlet and set to open at or below the design pressure of the downstream system. The valve discharge capacity shall be sufficient to limit accumulation to 110% of the system design pressure.

5.6.2
Where ground storage vessels can be isolated from the safety valve required by Clause 5.6.1, a protective device as required by the vessel code of construction shall be provided for each group of connected containers.

5.6.3
The pressure of CNG or hydrogen at the point where it is dispensed to cylinders that are mounted permanently on vehicles and used to store natural gas or hydrogen at ambient temperatures for use as a fuel in the vehicles shall be limited by a system that will automatically regulate the dispensed pressure to the filling limits specified in Clause 4.2 of Part 2 of this Standard. The system shall meet the requirements of CSA/ANSI NGV 4.1 or CSA 12.6, and shall be designed and installed to fail safe if a malfunction or valve leakage should occur and to prevent unauthorized adjustments. Adjustments, repairs, and/or servicing shall be carried out by an organization that meets the requirements of Clause 4.9.2 of Part 1 of this Standard.

6 Compressed natural gas and hydrogen refuelling station ground storage vessels

6.1 Design

6.1.1
Ground storage vessels shall meet the requirements of the standards referenced in Clause 6.1.2.

“Design pressure”, “working pressure”, and “service pressure”, which are defined terms that are used in various standards and codes and stamped or labelled on vessels, shall be defined in accordance with the standard under which the vessel was produced.

6.1.2
Ground storage vessels may be located in the refuelling station piping system downstream of the compressor and upstream of the overfill protection required by Clause 5.6.3, or in the piping system downstream of the overfill protection required by Clause 5.6.3. Overpressure and temperature protection shall be provided in accordance with the vessel code of design.

Vessels made to the following shall be acceptable for ground storage applications:
a) Part 2 of this Standard;
b) CSA B339, provided that the vessels are selected, manufactured, and requalified in accordance with CSA B339 and CSA B340;
c) Section VIII, Division 1 or 2, of the ASME Code; or
d) Section X of the ASME Code.

6.2 Use of cylinders

Cylinders shall not be used for longer than their maximum design life. In addition, a composite cylinder shall not be used beyond the manufacturer's expiry date or for longer than 20 years from the date of its manufacture, whichever is earlier, at which time the vessel shall be removed from service and destroyed.

6.3 Requalification of steel ground storage containers

Steel ground storage containers may be requalified for further service in accordance with the procedure described in Annex B of Part 2 of this Standard.

6.4 Natural gas storage installations

Natural gas storage installations shall meet the requirements of CSA B108.

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