CSA Group Safety Standards for Oil and Gas Pipeline Systems: A Life-Cycle Approach

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CSA Group
Over 250 expert volunteer committee members

Membership includes a balanced matrix of:
- suppliers,
- fabricators,
- transmission users,
- distribution users, general interest groups, and
- regulators at the federal and provincial levels

There are 10 Technical Subcommittees (TSCs) with various working groups under each of these TSCs

TC and TSC representatives participate internationally at ISO TC67/SC2
This Standard covers the design, construction, operation, and maintenance of oil and gas industry pipeline systems that convey:

a) liquid hydrocarbons, including crude oil, multiphase fluids, condensate, liquid petroleum products, natural gas liquids, and liquefied petroleum gas;

b) oilfield water;

c) oilfield steam;

d) carbon dioxide used in oilfield enhanced recovery schemes; or

e) gas.
The scope of the standard includes:

a) oil industry fluids, piping and equipment in offshore pipelines, onshore pipelines, tank farms, pump stations, pressure-regulating stations, and measuring stations;

b) oil pump stations, pipeline tank farms, and pipeline terminals;

c) pipe-type storage vessels;

d) for carbon dioxide pipeline systems, piping and equipment in onshore pipelines, pressure-regulating stations, and measuring stations;

e) for gas industry fluids, piping and equipment in offshore pipelines, onshore pipelines, compressor stations, measuring stations, and pressure-regulating stations;

f) gas compressor stations; and

g) gas storage lines and pipe-type and bottle-type gas storage vessels.
Oil Industry Pipeline Systems Scope
Gas Industry Pipeline Systems Scope

Offshore pipeline

Ordinary high water mark

Onshore gas well, including any wellsite production facilities

Gas-gathering facilities, line heaters, or field dehydration facilities

Compressor station

Gas processing plant

Measuring and/or pressure-regulating station

Compressor station

Pipe-type or bottle-type holder

Measuring and/or pressure-regulating station

Gas distribution system (See Figure 12.1)

Underground formation
Gas Distribution Scope

- Onshore gas well
- Transmission line
- Distribution or service line
- Customer’s pressure-regulation and overpressure protection equipment
- Customer’s meter (Piping beyond the outlet of customer’s meter set assembly is covered by CAN/CSA-B149.1)
- Distribution regulator station
- Measuring and/or odorizing and/or pressure-regulating station

Gas manufacturing plant
The standard consists of 17 Clauses and 15 Annexes:

Clause 1: Scope
Clause 2: References and Definitions
Clause 3: Safety and Loss Management Systems
Clause 4: Design
Clause 5: Materials
Clause 6: Installation
Clause 7: Joining
Clause 8: Pressure Testing
Clause 9: Corrosion Control
Clause 10: Operating, maintenance, and upgrading
Clause 11: Offshore steel pipelines
Clause 12: Gas Distribution Systems
Clause 13: Reinforced composite, thermoplastic-lined, and polyethylene pipelines
Clause 14: Oilfield steam distribution pipelines
### Structure of the Standard

The standard consists of 17 Clauses and 15 Annexes:

**Clause 15:** Aluminum piping  
**Clause 16:** Sour service pipelines  
**Clause 17:** Composite-reinforced steel pipelines

**Annex A:** Safety and Loss Management System  
**Annex B:** Guidelines for risk assessment of pipelines  
**Annex C:** Limit states design  
**Annex D:** Guidelines for in-line inspection of piping for corrosion imperfections  
**Annex E:** Recommended practice for liquid hydrocarbon pipeline system leak detection  
**Annex F:** Slurry pipeline systems  
**Annex G:** Precautions to avoid explosions of gas-air mixtures  
**Annex H:** Pipeline failure records
The standard consists of 17 Clauses and 15 Annexes:

Annex I: Oilfield steam distribution pipelines — Alternate provisions
Annex J: Recommended practice for determining the acceptability of imperfections in fusion welds using engineering critical assessment
Annex K: Standards of acceptability for circumferential pipe butt welds based upon fracture mechanics principles
Annex L: Alternative or supplementary test methods for coating property and characteristics evaluation
Annex M: Guidance for system control, monitoring, and protection of liquid pipelines
Annex N: Guidelines for pipeline system integrity management programs
Annex O: Reliability-based design and assessment (RBDA) of onshore non-sour service natural gas transmission pipelines
Key Changes to 2015 edition

• Updates and revisions of the requirements for Safety and Loss Management Systems, Integrity Management Programs and Engineering Assessments process
• Expansion of Annex M to address system control, monitoring and protection for all hydrocarbon pipelines
• Clarification of requirements for steam distribution pipelines and high temperature pipelines
• Clarification of the “sour service” requirements for gas -free pipeline systems for crude oil, crude of blends, and low vapour pressure condensate
• New Annex to provide guidance on the development of qualification of welding procedure specifications
• Addition of reference to new standard CSA Z245.30 Field Applied Coatings for Steel Pipe
In Canada, federal and provincial pipeline regulations incorporate the Z662 Standard by reference, thus giving it the force of law.

Z662 is referenced by oil and gas pipeline and facility regulators, such as:

- the National Energy Board (for pipelines crossing provincial or international borders), and
- the provinces of British Columbia, Alberta, Saskatchewan, Manitoba, Quebec, Ontario, New Brunswick and Nova Scotia.

The timing of regulatory adoption following publication varies between regulators.

Regulators may choose to reference Z662 as published or with modifications through regulations.
• Canadian regulators verify compliance with Z662 throughout the pipeline lifecycle
  – From construction through operation, maintenance, and end-of-life (deactivation, decommissioning or abandonment)

• Compliance is assured through audits of the operators’ procedures, manuals and programs

• The frequency of inspections and audits vary and fall under three categories:
  – baseline,
  – random, and
  – risk-driven

• Regulators also collaborate with industry stakeholders to work towards better industry performance through pipeline workshops, safety forums, and the CSA Standards Development process
Natural Gas Pipelines

Liquid Pipelines

Close to 400,000 km of pipelines operate solely within Alberta and are regulated by the Alberta Energy Regulator (AER).

Alberta’s pipelines are mostly 168 mm (or 6 inches) outside diameter and smaller that transport raw production from well to central facility and then to a central delivery point.

These are commonly referred to as “gathering pipelines.”

About 900 different pipeline companies operate pipelines in Alberta.

AER works with the oil and gas pipeline industry to continually improve pipeline safety and reliability.

AER requires pipeline operators to report all pipeline incidents, including breaks, test failures, and external contact to the pipeline regardless of whether an actual leak occurs.
• Ontario has in the order of 100,000 km of distribution pipelines

• Ontario Ministry of Energy reviews large scale pipeline projects to ensure that they meet the highest environmental and safety standards as well as benefit Ontario’s economy

• The Ontario Energy Board advises the Minister of Energy, and approves natural gas rates, pipeline construction and geological formations that are suitable to store natural gas

• Ontario’s Technical Standards and Safety Authority (TSSA) regulates the transportation, storage, handling and use of fuels including natural gas, propane, butane, hydrogen, digester gas, landfill gas, fuel oil, gasoline, and diesel

• TSSA adopts Z662 with additional requirements added in their regulations
• In jurisdictions where adopted by the regulator, pipeline operators must comply CSA Z662
• Regulators proactively inspect and audit operations to identify non-compliances
• Table 5.3 of Z662 requires all steel pipe and components to be compliant with either CSA’s respective standards (Z245.12, Steel Flanges, Z245.1, Steel Pipe, Z245.11, Steel Fittings, and Z245.15, Steel Valves) or other equivalent standards
• Components are self-declared by the manufacturers for compliance with relevant standards (CSA or otherwise)
• CSA Group is developing an Attestation Program for pipeline components

• Third-party (CSA) involvement in pipeline component certification (attestation at first stage) will improve pipeline safety

• With ever-rising environmental awareness and resistance against pipelines the program will add credibility and improve public relations

• Currently examining the relevant CSA standard’s requirements towards manufacturing of pipeline components
Pipeline Integrity Management – Z662

- CSA Z662 makes it **mandatory** for operator companies to have a Pipeline Integrity Management program
  - Ensures integrity management is considered from a complete life cycle perspective
- Provides integrity requirements for existing pipeline systems
- Engineering assessments are required
- Conditions to be considered include
  - Mechanical damage
  - Corrosion
  - Stress corrosion cracking
  - Coating damage
Pipeline Integrity Management – Z662

Evolution of Integrity Management requirements:

• Lessons learned from pipeline incidents
  – Inadequate inspections
  – Failure to correct anomalies
  – Inadequate personnel training
  – Safety issues such as adequacy of internal corrosion programs

• CSA reacted with Annex N: *Guidelines for pipeline integrity management programs* (2005)

• Resulted in a changed approach to pipeline safety
  – Moved from a reactive approach ("failure to failure") to a proactive approach with a "no failure" philosophy
Records Requirements for Pipelines

• San Bruno Pipeline Failure (September 2010)
  – Material records may have been incomplete/incorrect
  – This information used to calculate maximum operating pressure

✓ Z662 proactively establishes records requirements

• Z662 also provides requirements for:
  ✓ Failure Investigations
  ✓ Operating and Maintenance Procedures
  ✓ Inspection

• Regulatory bodies responded with safety bulletins
  – (e.g. BC Oil & Gas Commission Safety Advisory reminded operators that records of materials must be developed and maintained as per Clause 5.7.1 of CSA Z662)
Safety and Loss Management – Z662

- Safety and integrity are primary concerns for all stakeholders
- Companies must have a management system to design, construct, operate, and maintain pipelines
- Regulators require companies to
  - develop and implement integrity management programs to identify, manage, monitor, and address any potential hazards associated with each individual pipeline.
  - monitor their pipelines through testing and inspection to ensure the integrity of the lines is maintained.

CSA Z662-11 Clause 3.1.1
Operating companies shall develop, implement, and maintain a documented safety and loss management system for the pipeline system that provides for the protection of people, the environment, and property.
Risk Management – Z662

- Risk management is part of a Safety and Loss Management System
- Annex A states that the operating company shall develop and implement a risk management process that identifies, assesses, and manages the hazards and associated risks for activities under its control

The risk management process should include the following general approach:

(a) define boundaries within which hazards are identified;
(b) identify all activities and facilities within the defined boundaries;
(c) identify potential hazards, focusing on the potential source of harm;
(d) assess and evaluate risks based on the combination of the probability and consequence of a hazardous event occurring;
(e) develop control measures that focus on reducing or eliminating the probability or consequence of an incident, or both, to an acceptable level;
(f) monitor control methods to ensure that the actions taken are effective and continue to be effective; and
(g) conduct a regular review of the risk management cycle to ensure that corrective and preventive actions are employed and that improvements to the risk management process are implemented as required.
Annex B – Guidelines for risk assessment of pipelines

This Annex provides guidelines on the application of risk assessment to pipelines. These guidelines are intended to

(a) identify the role of risk assessment within the context of an overall risk management process;

(b) set out standard terminology that is consistent with existing Canadian standards in the field of risk management;

(c) identify in general terms the components of the risk assessment process, the associated data requirements, and the requirements for documentation and records; and

(d) where applicable, provide reference to methodological guidelines for risk assessment.
Proposed new requirement for Z662-15 will make it mandatory to have a risk management process in place:

3.4 Risk management
The operational controls required by Clause 3.1.2(f)(i) shall be in the form of a risk management process that identifies, assesses, and manages the hazards and associated risks for the life cycle of the pipeline system. The risk management process shall include the following:
(a) risk acceptance criteria;
(b) risk assessment, including hazard identification, risk analysis, and risk evaluation;
(c) risk control;
(d) risk monitoring and review;
(e) communication; and
(f) documentation.

Notes:
(1) CAN/CSA-ISO 31000 sets out principles and guidelines for risk management.
(2) Annex B provides guidance on performing pipeline system risk assessments.
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Thank You!

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