

**ENGINEERING STANDARDS AND SPECIFICATIONS**

Rev.

5

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2.0

Section Name:

Pipelines

Sub-Section No.:

ESS 2.21

Section Name:

Hydrostatic Testing Procedures for Facilities

HYDROSTATIC TESTING PROCEDURES FOR FACILITIES

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
Rev.	Date	Revision Description	By	Chk'd	Appr.
1	10-11-11	New Specification.	LS		
2	10-11-17	Revised as per Pembina's mark-ups.	LS		
3	11-01-04	Revised as per Pembina's mark-ups.	LS		
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5	11-06-14	Updated Owner User Manual References	RB		



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1.0 **SCOPE**

This Specification is applicable to projects or works undertaken by Pembina Corporation facilities only.

The Specification prescribes the requirements for pressure testing of pipe spools and installed piping systems under the jurisdiction of the latest editions of ASME B31.3 and CSA Z662.

The following are excluded from the requirements of this Specification:

- a. Any package unit previously tested by the Manufacturer in accordance with the applicable codes.
- b. Atmospheric sewers and drains.
- c. Plumbing systems, which are tested in accordance with the applicable plumbing codes.
- d. Lines and systems open to the atmosphere provided it is Category "D" fluid.
- e. Instrument piping lead lines between the root valve at the process or utility line and the connected instrument and control piping used to connect air or hydraulically operated control apparatus.
- f. Boiler external piping under the jurisdiction of ASME B31.1.
- g. Liquid petroleum transportation pipelines systems under the jurisdiction of CSA Z662 or ASME B31.4.
- h. Gas transmission and distribution pipelines systems under the jurisdiction of CSA Z662 or ASME B31.8.

No deviation shall be made from this Specification without written authorization from Pembina's Technical Services Group.

2.0 **PURPOSE**

The purpose of this Specification is to prescribe the methods, tasks, scope, and criteria for testing pipe spools and installed piping systems for Pembina's facilities projects.

3.0 **RELATED SPECIFICATIONS**

- EG 3.10, Facility Piping Guidelines
- ESS 3.42, Piping Class Specifications

4.0 **STANDARDS, REGULATIONS & CODES**

Work shall be in accordance with the latest revision of all applicable Codes, Standards Specifications and Regulations listed below. The term “latest revision” shall be interpreted as the revisions including addenda of the publications effective on the date of purchase order or contract award. Except as modified by the requirements specified herein or the details of the drawings, all Work governed by this Specification shall comply with the applicable provisions of the referenced publications.

American Society of Mechanical Engineers (ASME)

- ASME B16.5 Pipe Flanges And Flanged Fittings
- ASME B16.21 Nonmetallic Flat Gaskets For Pipe Flanges
- ASME B16.34 Valves - Flanged, Threaded, And Welded End
- ASME B31.3 Process Piping

Canadian Standards Association (CSA)

- CSA B51 Boiler, Pressure Vessel and Pressure Piping Code
- CSA Z662 Oil and Gas Pipeline Systems

Regulations

- British Columbia Occupational Health & Safety
- BC Safety Authority
- Province of Alberta, Safety Codes Act
- Pressure Equipment Safety Regulation, Alberta Regulation, Latest Edition
- Pressure Equipment Exemption Order, Alberta Regulation, Latest Edition
- Occupational Health and Safety Act and Regulations, General Safety Regulation, Alberta Regulation, Latest Edition

Where fabrication criteria in this Specification are affected by city, provincial, or federal requirements, this Specification shall be modified as necessary to ensure compliance. When compliance with any code or standard by a local jurisdiction is mandatory, the requirements prescribed therein shall also be met.

5.0 **TERMS AND DEFINITIONS**

TERM

DEFINITION

Authorized Inspector / Inspector

Employee of an authorized agency, who is qualified and certified to perform API 570 (piping) & API 510 (pressure vessel) inspections.

Category D Fluid Service (ASME B31.3)

A fluid service in which all the following apply:

- The fluid handled is nonflammable and nontoxic.
- The design gauge pressure does not exceed 1034 kPa (150 psi).
- The design temperature is between – 29°C (-20°F)

TERM
DEFINITION

through 186°C (366°F).

Calculated Test Pressure

The test pressure determined in accordance with Section 8.3 of this Specification.

Closure Welds

The following is extract from ASME B31.3 Section 345.2.3 Paragraph c which states:

“(c) Closure Welds. The final weld connecting piping systems or components which have been successfully tested in accordance with para. 345 need not be leak tested provided the welds are examined in-process in accordance with para. 344.7 and passes with 100% radiographic examination in accordance with para. 344.5 or 100% ultrasonic examination in accordance with para. 344.6.”

Designated Engineer

Qualified Engineer designated by Pembina Corporation.

LVP

Low Vapour Pressure (LVP) sweet liquid.

Maximum Test Pressure

The highest allowable test pressure gage reading. (The pressure test rating of the weakest component in the test system.)

Minimum Design Metal Temperature (MDMT)

Design Minimum Temperature for which the material is normally suitable without impact testing other than that required by the governing material specification.

Minimum Test Pressure

The lowest allowable test pressure gage reading. (The calculated test pressure excluding the additional pressure resulting from the static head of the test fluid.)

System Test

A test that includes multiple sections of piping, having the same or different design pressures, but which are tested together at one time using a single test procedure and pressure.

Test Temperature

The minimum temperature occurring during the test period of the metal temperature of the piping being tested (including any vessels or equipment included in the test).

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6.0 GENERAL

6.1 Pressure Testing

All pressure testing shall be in accordance with pressure piping codes CSA B51 and ASME B31.3 or CSA Z662.

The test pressure for each line shall be specified in the piping line list.

6.2 Closure Weld

Field closure welds shall be examined in accordance with ASME B31.3 para. 345.2.3 (c) in lieu of pressure testing. A hydrotest waiver form shall be completed for all cases. For registered piping systems, examination of closure welds in lieu of pressure testing requires approval of the local jurisdiction, in accordance with Pembina's Owner User manual.

7.0 PRODUCTS

7.1 Pressure Test Blinds

Special length bolting and test gaskets may be required during testing, and shall be removed after test completion and replaced with standard line class bolts and new service gaskets.

A field procedure must be established and care taken to ensure the installation and removal of material which is specified for testing only.

Plate material, extra length bolts, and gaskets for testing shall be furnished by the field construction contractor unless dictated otherwise by contract requirements.

8.0 EXECUTION

8.1 Preparation

8.1.1 General

Subsequent to repairs and heat treatment and prior to initial operation, all installed piping shall be pressure tested except where otherwise qualified in this Specification.

The provincial local inspector shall be notified at least 48 hours in advance of pressure testing of piping under the jurisdiction of the provincial safety code for witnessing at his/her option.

The test shall be hydrostatic using water unless there is a possibility of damage due to freezing; or, if the operating fluid or piping material would be adversely affected by water, any other suitable liquid or additives may be used on approval by the Pembina Designated Engineer. Testing of ferritic piping, however, is limited to the temperature restrictions in this Specification.

If a flammable liquid is used, its flash point shall be no less than 49°C (120°F) and consideration shall be given to the test environment.

If testing with glycol-water mixture to prevent freezing, the safety, leak and disposal problem of the test fluid shall be considered.

8.1.2 Vessels, Equipment and Piping Components

The following equipment shall be excluded from all piping pressure tests:

- Vessels and tanks
- Heat exchangers
- Rotating machinery, such as pumps, compressors, and turbines
- Equipment and Supplier furnished piping specifically recommended by the Manufacturer not to be tested
- Expansion joints
- In-line process valves (where feasible)

8.1.3 Instruments

All in-line Instruments shall be either removed or blocked prior to hydrotesting to prevent damage during hydrotesting (e.g. meters).

Instrument take-off piping and sampling system piping, up to the first block valve, shall be tested with the piping to which it is connected.

Instrument lead lines, between the first block valve and the instruments to which they are connected, shall be pressure tested to the test pressure of the associated piping. Testing may be performed separately or at the same time as the piping is tested, but the instruments shall be disconnected.

8.2 Test Water

Clean water that will not corrode and/or damage the test system shall be used for hydrostatic tests. If municipal water is not available, supply water may be obtained from native water supply (e.g. dugout). Water containing silt or suspended material shall not be used, and a suitable filter with 40 mesh should be provided in the filling line. Pembina's Designated Engineer shall approve the proposed source of test water.

If water source is not potable, Pembina's Designated Engineer shall consider adding inhibitor to reduce risk of pitting or introduction of microbiologically induced corrosion (MIC). Pembina's Designated Engineer should also consider biodegradable inhibitor to allow fluid re-entry into the environment.

A mixture of glycol-water shall be used where the ambient temperature may reach less than 0°C (32°F) during testing or prior to dry-out.

8.3 Test Methods and Pressures

8.3.1 Hydrostatic Testing of Piping Designed for Internal Pressure (ASME B31.3)

Hydrostatic test pressure shall be determined per the applicable code, except as follows:

- Underground pressure piping in water service and employing non-welded girth joints (such as bell and spigot) shall be hydrostatically tested at 1.5 times the system design pressure. The test pressure shall be maintained for 2 hours while the leakage rate is measured and the joints are inspected for leakage.
- The minimum hydrostatic test pressure at any point in the system shall not be less than 1-1/2 times the design pressure.

8.3.2 Commodity Test for Category 'D' Fluid Service only (ASME B31.3)

A piping system used only for Category D Fluid Service, not previously hydrostatic tested in accordance with this Specification, may be tested at the normal operation conditions of the system during or prior to initial operation by examining for leaks at every joint.

8.3.3 Pressure Testing of Piping Design for Internal Pressure (CSA Z662)

Refer to CSA Z662 (Latest Edition), Section 8 "Pressure Testing" for facilities only in British Columbia. In addition, LVP piping in Alberta and British Columbia are tested according to CSA Z662.

8.4 Test Preparation – Field Procedure

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Joints, including welds, shall be left uninsulated and exposed for examination during the test, except that joints previously tested in accordance with this Specification may be insulated or covered. All joints that require a leak test shall not be primed and painted prior to leak testing.

Underground portions of piping systems may be tested and covered before testing aboveground portions.

Piping designed for vapour or gas shall be provided with additional temporary supports, if necessary to support the weight of the test liquid. Where required, temporary supports shall be specified in the pressure test documents.

Lines that are counterweight supported shall be temporarily blocked during testing in order to sustain the weight of the test fluid. Spring hangers that have been provided with stops for carrying the test load normally do not require additional temporary supports; if this is not the case, temporary support must be provided before filling the system.

Before testing, the following procedures shall be carried out:

- Verify that any required heat treatment has been performed and that all NDE requirements are complete.
- Piping systems shall have been completely checked for completeness.
- Piping systems shall be checked to ensure that the entire system can be completely drained after testing.
- Vents or other high point connections shall be opened to eliminate air from lines that are to receive a hydrostatic test.
- System shall be purged of air before hydrostatic test pressure is applied.
- Short pieces of piping that must be removed to permit installation of a blind or blank shall be tested separately.
- Flanged joints at which a blank is inserted to isolate other equipment during a test need not be tested after blank is removed.
- Lines containing check valves shall have the source of pressure located in the piping upstream of the check valve so that the pressure is applied under the seat. If this is not possible, remove or jack up the check valve closure mechanism or remove check valve completely, and provide necessary filler piece or blinds. Removed internals shall be bagged, and placed close to the valve they were removed from in order that inspectors may verify that the internals have been removed for the test.
- When conducting tests at freezing temperatures, the test shall not take more than 4 hours, and special precautions, such as using glycol/water mixture, shall be observed to avoid freezing damage. Follow precautions to minimize the risk of brittle fracture as noted in this Specification.

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- Systems that include expansion joints, which have been removed for pressure testing, shall be investigated to see that any required temporary restraints, anchors, or guides are installed or removed prior to test.
- When a pressure test is required to be maintained for a period of time during which the testing medium in the system would be subject to thermal expansion, provision shall be made for relief of any pressure greater than the maximum test pressure.
- With prior authorization from Pembina's Designated Engineer, piping or sections of piping to be tested may be isolated by closed valves provided the valve closure is suitable for the test pressure. Refer to Attachment A of this Specification.
- Drain and vent valves to be in open position and plugged during test to permit testing of valve packing.
- Bypass valves on gate valves provided with centre cavity pressure equalizing bypass shall be open during the test.

8.5 Hydrostatic Test Procedure

Piping systems shall be pressurized slowly and evenly to prevent vibrations. When the pressure has been raised to 1000 kPa, a leak check shall be done to check all valves and fittings. If leaks are found, system must be depressurized prior to fixing leaks.

In order to hydrostatic test as much piping as possible at one time, a systems test may be employed.

The minimum test pressure for a system test shall be such that each line in the system is subjected to a test pressure in accordance with Section 8.3 of this Specification.

The maximum system test pressure shall not exceed the pressure test rating of any piping component. Maximum test pressures for valves conforming to ASME B16.34 are given in Attachment A.

Systems or sections of systems to be tested may be isolated by closed valves, provided the valve body and seat are suitable for the test pressure. Refer to Attachment A of this Specification.

Where a suitable valve is not available, vessels, equipment, or other piping not included in the system pressure test shall be either disconnected from the system or isolated by blinds or other means during the test.

The normal location for the pressure test gauge is at grade near the pressure test pump. Readings may be made at higher points providing the gauge pressure reading and the static head [9.79 kPa/m (0.433 psi/ft) for water] between grade and

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the point of measurement do not exceed the maximum test pressure. Gauges shall be tagged with the date last calibrated, and this activity shall be recorded.

Hydrostatic test pressure shall be maintained for a sufficient length of time to visually determine whether there are any leaks, but no less than 10 minutes.

Gauges shall be a minimum 100 mm (4") diameter face and shall be graduated over a range of approximately double the intended test pressure but in no case shall the range be less than 1.5 times nor greater than 4 times that pressure.

At least two gauges shall be used per test. One gauge shall be located on the test head and one on the system being tested. Gauge must read within 5% of each other.

The use of NDE in lieu of the hydrotest for the final closure weld requires a hydrotest waiver as described in Section 6.2.

Test procedures and test schedules of lines or systems shall be reviewed by Pembina prior to the start of the test. Procedures shall include the following:

- Source of test fluid
- Disposition of test fluid
- Provisions to prevent the creation of significant negative pressure (vacuum) during draining of the test fluid, etc
- The specific lines to be included within a system test
- Provisions for temporary supports, vent, drain, fill connections, and gage locations.

All tests shall be witnessed and accepted by the Inspector. The test results shall be recorded and a copy shall be provided to Pembina Corporation.

8.5.1 Minimum Test Temperature

Hydrostatic test pressure shall be applied until the piping and its contents are at approximately the same temperature.

The minimum test temperature for hydrostatic pressure testing shall not be at metal temperatures below 2°C (35°F).

The system MDMT shall not be lower than the minimum design temperature specified in the applicable piping materials line class.

Note that for some materials, the MDMT depends on the material thickness. For example, the MDMT of ASTM A106 Grade B and A53 Grade B piping is defined by Curve B of Figure 323.3.3 of ASME B31.3 For A106 Grade B

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pipe with wall thickness of 12.5 mm (0.5 inches) or less, the MDMT is -29°C (-20°F) and minimum test temperature is therefore -20°C (-4°F).

For materials with unknown MDMT, consult Pembina's Designated Engineer.

8.6 Test Records

Records shall be made of each piping system test. In general, these records shall include the following information:

- Date of test
- Identification of piping system
- Test medium
- Test pressure
- Minimum ambient temperature
- Test medium temperature
- Certification by examiner
- Test duration
- Pipe standards or specifications for the test
- Pressure and temperature recording charts and logs
- Location and cause of leaks/failures
- Repair procedures used in the event that the pipe leaked or failed
- Test results
- Name of test operator
- Minimum metal temperature (if applicable)
- Test gauge calibration date

Forms, when completed, shall be retained in the Construction Contractor's QC file as a permanent record. A copy of each piping pressure test system record form shall be given to Pembina's Authorized Inspector.

Consult the Alberta Pressure Equipment Safety Regulation for the requirements on the submission and retention of piping pressure test records.

8.7 Test Completion

If leaks are found, their location shall be marked, the pressure shall be gradually released, and the piping shall be drained or vented. Appropriate repair or

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replacement shall be made. The affected piping shall be retested at the pressures originally specified for the test.

After completion of testing, all temporary blanks and blinds shall be removed, all operating blinds returned to proper position, and all lines and piping components (except those tested according to Section 8.4 of this Specification) shall be completely drained. Valves, valve internals, orifice plates, expansion joints, and short pieces of piping that have been removed shall be reinstalled with proper new gaskets in place. Valves that were closed during hydrotest shall be opened to ensure drainage of the bonnet cavity. Lines being drained after testing shall have all vents open. Piping systems downstream of check valves should be inspected to ensure complete drainage.

After lines have been drained, temporary supports shall be removed, and insulation and painting completed. Spring hangers provided with stops to carry the test load shall have these stops removed except those identified to be removed after system is charged.

8.7.1 General

Instruments which were removed or blocked out for test shall be reinstalled and blocks placed in the normal operating position.

Temporary bolting and gaskets used for pressure testing shall be removed and replaced with line class bolts and gaskets.

Check valves that were jacked open or the internals were removed for pressure testing shall be returned to their proper operating position.

Instruments and process lead lines that were subjected to the hydrostatic pressure test shall be blown out with dry air or nitrogen.

Vent and drain connections that were added solely for pressure testing shall be closed and seal welded as required. Drains shall have either the valve closed and plugged or, if the valve is removed, the connection plugged and seal welded as required.

Painting and insulation shall be completed after inspection of seal welded vents and drains.

Strainer screens shall be removed, cleaned, and reinstalled.

ATTACHMENT A

Table 1: Maximum Hydrostatic Test Pressure (kPag) for Valves

Flange Rating (Class)	Carbon Steel		Stainless Steel			
	Normal (1.1)		304 (2.1) 316 (2.2) 321 (2.4) 347, 348 (2.5)		304L, 316L (2.3)	
	Shell	Seat	Shell	Seat	Shell	Seat
150	3,000	1,960	2,900	1,900	2,400	1,590
300	7,700	5,110	7,500	4,960	6,300	4,140
600	15,400	10,210	14,900	9,930	12,500	8,270
900	2,300	15,320	22,400	14,890	18,700	12,410
1500	38,300	25,530	37,300	24,820	31,100	20,680
2500	63,900	42,550	62,100	41,370	51,800	34,470

Notes:

- The above chart provides the maximum allowable hydrotest pressures of NPS 2 through NPS 24 flanged and standard class weld end valves (shell test, with valve open and seat test, with valve closed). The above Shell test and Seat test pressures are based on ASME B16.34, Para. 2.5.3.
- If approved by Pembina's Designated Engineer, flanged valves manufactured according to API-600 and API-602 may be tested in accordance with the above chart. Carbon steel, Normal (1.1), Class 800 Threaded or Socketweld valves manufactured according to API-602 may be tested to 20500 kPag (shell test) or 13620 kPag (seat test).
- For valves not conforming to the above standards, the Manufacturers' recommended test pressure limits for both shell and seat shall be used.
- Maximum test pressures for valves over NPS 24 and piping components not covered by this chart shall be provided by the Construction Contractor as applicable to Pembina's for approval.

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ATTACHMENT B

CLOSURE WELDS (FIELD CLOSURE WELD CHECKLIST)

Job No.	Weld No.	
Unit No.		
CWP No.	Original	Repair No.
ISO or Drawing No.		
Insert Required?	Pipe Diameter	
WPS & Rev. No.	Nominal Joint Thickness	
	Material & Grade to Type & Grade	

REQUIREMENTS	FOR FIELD USE ONLY		
Purge Required Gas Type	Recorded Results		
Preheat Temp F Min	Welding Super. Release Date	AWS/Date	Other
Cleanlines, Fit-up and Release for welding			
Interpass Temp C Max			
VT-Root Pass			
VT-Filler Passes			
Final VT, Released for NDE			
PWHT Temp C			
Hold Time Hrs			
NON DESTRUCTIVE EXAMINATION			
Liquid Penetrate			
Magnetic Particle	NON DESTRUCTIVE EXAMINATION		
Radiography	Performed By:		
Other NDE	Subcontractor:		
FILLER MATERIAL			
Covered Bare	Accept	Reject	
	Accept	Reject	
Other	Accept	Reject	
Area Welding Specialist Review & Holding Point(s)	Actual Filler Material Used		
Supplement Sheet	Yes	No	
Completed By:			
	Remarks		
Area Welding Specialist			
Above "REQUIREMENTS" Certified Correct			
Area Welding Specialist	Welder's Name & Symbol		
Remarks:			
	Above "RESULTS" Certified Correct		
<i>(Note: This form is for general closure weld. It may be modified to suit each construction site specific use.)</i>			