Design Registration Requirements for Application-Specific Pneumatic Test Procedures
AB–532

Edition 1, Revision 1 - Issued 2019-07-31

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FOREWORD

As provided for under Subsections 15(1)(j), 16(1)(g), 30(2) and 40(3) of the Pressure Equipment Safety Regulation, the Administrator in the pressure equipment discipline has established that this ABSA document AB-532 "*Design Registration Requirements for Application-Specific Pneumatic Test Procedures*" specifies information that must be submitted with design registration documents when

- an application-specific pneumatic test is to be conducted in Alberta on a new or repaired pressure vessel or pressure piping system, or
- the test procedure for pressure piping system is not within the scope of AB-522 "*Standard Pneumatic Test Procedure Requirements for Piping Systems.*"

1.0 INTRODUCTION

Pressure testing, in general, introduces hazards that must be identified and understood before such a test is undertaken. A pneumatic test is inherently more hazardous than a hydrostatic test of the same volume, pressure, and temperature. In the case of a failure, the sudden release of energy is catastrophic and the effects are comparable to those of an explosion. Appropriate safety precautions must be taken to manage the risk of a potential failure, taking into account the quantity of stored energy contained in a pneumatic test.

ABSA policy documents are living documents that are reviewed periodically to ensure that they align with current industry practices. We would welcome any suggestions you have to improve this document. Please provide your comments to:

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2.0 SCOPE

The requirements in this document apply to pneumatic testing of equipment when the test is conducted in Alberta, and such a test must be conducted by an organization that holds a certificate of authorization permit to construct or repair/alter the type of equipment to be subjected to the test.

Pneumatic testing of pressure equipment requiring a test pressure greater than 103 kPa (15 psi) must be conducted in accordance with an application-specific pneumatic test procedure that is registered with ABSA, unless it is conducted on a pressure piping system and the test meets the requirements of ABSA document AB-522 *Standard Pneumatic Test Procedure Requirements for Piping Systems.*

This document is intended to provide the minimum requirements for the registration of application-specific pneumatic test procedures that do not fall within the scope of AB-522.

The requirements established by this document are not intended to be understood as the only requirements to be considered when conducting a pneumatic test. This document does not absolve an organization conducting a pneumatic test from responsibility for compliance with other applicable laws, codes, and standards, with respect to safe execution of the test.

3.0 DEFINITIONS AND ACRONYMS

AB-31 - Design Registration Application form, an ABSA fill-in form, required for design registrations.

ABSA Safety Codes Officer (SCO) - means a safety codes officer, designated under the Act, in the pressure equipment discipline. [PESR 1(1)(ee)]

Alberta Quality Program (AQP) - a quality program that covers a defined scope such as piping fabrication, vessel fabrication, etc. for which a certificate of authorization permit has been issued per PESR Section 11.

ASME PCC-2 - Post Construction Committee document produced by an ASME ad hoc committee to identify generally accepted engineering standards for the inspection and maintenance of pressure equipment after it has been placed in service.

Certificate of Authorization Permit (CAP) - means a permit issued pursuant to section 44 of the Act authorizing a person to carry out the activities stated on the certificate of authorization permit [PESR 1(1)(g)].

CRN - is the acronym for Canadian Registration Number and means a design registration number issued by a pressure equipment jurisdiction in Canada per the requirements of CSA B51 Code. CRNs are issued for boiler, pressure vessel or fitting designs. A boiler, pressure vessel or fitting that is planned to be used in Alberta must have a CRN issued by ABSA.

Note: In addition to CRNs, there are other types of provincial design registrations in Alberta. Alberta provincial design registration numbers (not CRNs) are issued for pressure piping design registrations (PP numbers), special design registrations (ALDs), or welding procedures (WPs).

Chief Inspector - means a person who meets the requirements to be in charge of an owner's pressure equipment integrity assessment program.

Controlled Document – means a document that is controlled in a manner set forth in an acceptable quality management system, and identified by a document number and explicit revision number.

Design Pressure - means the pressure authorized on the design registration.

Equipment - for the purpose of this document, means a pressure vessel or pressure piping system, or a combination thereof, being subjected to a pneumatic test.

Hydrostatic Test - a pressure or tightness test where liquid, typically water, is the test medium.

Maximum Allowable Working Pressure (MAWP) - maximum allowable working pressure means the pressure authorized on the design registration or a lesser pressure as indicated on the manufacturer's data report. [PESR 1(1)(v)]

Maximum Working Pressure - is the maximum allowed pressure at which a hose can be operated, this is certified by the hose manufacturer.

Minimum Design Metal Temperature (MDMT) - *means* the minimum design metal temperature for which a pressure vessel was registered.

Owner - includes 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. [SCA 1(1)(v)]

PESR - means Pressure Equipment Safety Regulation, Alberta Regulation 49/2006.

Pneumatic Test – means a pressure or tightness test where a gas, generally nitrogen or air, is the test medium.

PRV - means a safety valve, relief valve, or safety relief valve.

Pressure Piping System - means pipes, tubes, conduits, fittings, gaskets, bolting and other components that make up a system for the conveyance of an expansible fluid under pressure and may also control the flow of that fluid. [PESR 1(1)(aa)]

Pressure Vessel - means a vessel used for containing, storing, distributing, processing or otherwise handling an expansible fluid under pressure. [PESR 1(1)(cc)]

Professional Engineer - as defined in the Pressure Equipment Safety Regulation, a person who is properly registered as a professional engineer and authorized to practice engineering in any province or territory of Canada or in any state of the United States.

Safe Distance - the minimum distance between all personnel and the equipment being tested.

4.0 REFERENCE PUBLICATIONS

- Pressure Equipment Safety Regulation (AR 49/2006)
- AB-518: "Pressure Piping Construction Requirements"
- AB-522: "Standard Pneumatic Test Procedure Requirements for Piping Systems"
- ASME PCC-2: "Repair of Pressure Equipment and Piping," Part 5
- ASME BPVC Section VIII-1: "Rules for Construction of Pressure Vessels"
- ASME B31.3: "Process Piping"
- API RP-580: "Risk-Based Inspection," Article 12
- ARPM IP-2: "Hose Handbook"

5.0 DESIGN REGISTRATION REQUIREMENTS FOR APPLICATION-SPECIFIC PNEUMATIC TEST PROCEDURES

5.1 GENERAL

Hydrostatic testing is the preferred method of pressure testing for pressure equipment. It presents a lower safety risk than pneumatic testing, due to the smaller amount of potential energy stored during the test. If it is not possible to perform a hydrostatic test then alternative testing may be considered. The organization responsible for the test must justify the use of a pneumatic test, and obtain acceptance from ABSA prior to the test.

Pneumatic testing of piping systems having a quantity of stored energy up to 1,677 kJ may be conducted under the provisions of this document, or in accordance with a standard pneumatic test procedure as permitted by AB-522.

This document establishes requirements applicable to the registration of application-specific pneumatic test procedures for pressure vessels and pressure piping systems when the test will involve stored potential energy more than 1,677 kJ.

It is acceptable to conduct a pneumatic test of a pressure piping system that includes a pressure vessel provided that:

- the vessel has been previously pressure tested,
- the vessel MAWP is greater than or equal to the piping design pressure,
- the test temperature is at least 17°C above the vessel MDMT, and
- the volume of the vessel is included in the stored energy calculations for the pneumatic test.

If the vessel doesn't meet the above criteria then the vessel shall be isolated from the piping, and its connections to the piping system replaced by adequately designed, fabricated, inspected, and tested piping components.

5.2 QUALITY SYSTEM REQUIREMENTS

PESR sections 11, 12, and 13 cover requirements for quality management systems and certificate of authorization permits. PESR sections 25 and 40 contain specific requirements for new construction and for repairs and alterations.

A pneumatic test to be conducted on a pressure piping system, whether or not a pressure vessel is included in the test, must be conducted within the scope of a

valid certificate of authorization permit associated with a quality management system that meets the requirements AB-518, "*Pressure Piping Construction Requirements."*

When a pneumatic test is to be conducted on a pressure vessel, the organization must conduct it within the scope of a valid certificate of authorization permit.

5.3 STORED ENERGY

The higher safety risks associated with pneumatic testing are due to the large amount of potential energy stored in the equipment during the test, and the potentially destructive effects of its sudden release.

The stored energy can be expressed in terms of the energy released by the detonation of an equivalent weight of TNT. In order to determine required safe distances, this equivalent weight of TNT must be calculated using the equations in ASME PCC-2, Part 5, Article 501, Mandatory Appendix 501-II.

Total test volume and absolute test pressure are two major variables used in calculation of the equivalent weight of TNT. The volume to be considered in the calculation is the total volume of the equipment to be subject to the pneumatic test, including the volume of any pressure vessels.

When calculating the stored energy of a piping system, a maximum volume shall not be based on a length of 8 pipe diameters as allowed in ASME PCC-2, Part 5, Article 501, Paragraph 501-6.2(e).

The pressure used in the calculation is in terms of absolute pressure rather than gauge pressure. The selected test pressure must be justified in accordance with the applicable code of construction.

5.4 SAFE DISTANCES

When conducting a pneumatic test, safe distances must be established for:

i) testing personnel,
ii) other personnel and occupied industrial buildings,
iii) other pressurized equipment, and
iv) public buildings, roads, and other occupied spaces.

Safe distances are to be calculated as follows:

5.4.1 Safe Distance Calculations

The safe distance shall be established using the equations in ASME PCC-2, Part 5, Article 501, Mandatory Appendix 501-III, modified as follows:

i) For personnel, whether or not they are involved in the test, for occupied industrial buildings, and for other pressurized equipment, the required safe distance shall be the greater of that given in 501-III-1(a) and that calculated in 501-III-1(b) using the default required value of R_{scaled} = 20 m/kg$^{1/3}$ (50 ft/lb$^{1/3}$) or greater. The value of R_{scaled} may not be reduced as permitted by Table 501-III-1-1 unless a barrier device is used which meets the requirements of section 5.4.2 below. Personal protective equipment used to justify a reduced value of R_{scaled} is considered an engineered barrier and must similarly meet the requirements of section 5.4.2.

ii) For public buildings, roads, and other occupied spaces, the safe distance shall be the greater of that given in 501-III-1(a), that calculated in 501-III-1(b), and that prescribed by Table 501-III-2-1. The default required value of R_{scaled} = 20 m/kg$^{1/3}$ (50 ft/lb$^{1/3}$) or greater shall be used, and may *not* be reduced by means of a barrier device or personal protective equipment.

5.4.2 Use of Engineered Barriers for Reduction of Safe Distances

The required safe distance for testing personnel, other personnel, and occupied industrial buildings as calculated above may be reduced if the following requirements are met:

i) A detailed hazard analysis shall be done in accordance with ASME PCC-2, Part 5, Article 501, Paragraph 501-6.2(g) and Mandatory Appendix 501-IV, using API RP-580 methodology. The hazard analysis report does not need to be submitted but it must be kept as a record in the event that a Safety Codes Officer requires it to be submitted for review and registration.

ii) A hazard analysis summary report shall be included in the submitted documentation. The summary report must be a controlled document that summarizes:
- the risk evaluation methodologies,
- the process used for the hazard analysis,
- the results and conclusions of the hazard analysis, and
- the personnel participating in the analysis, including their qualifications.

The hazard analysis summary report must be stamped by a Professional Engineer and must have the signature of the Owner's authorized representative or of the organization responsible for the test. Full details of the hazard analysis are not required to be included with the submission, but must be kept on file by the Owner or by the organization performing the test and must be made available for review as a part of the submission upon request.

iii) If devices are to be used which are intended to be capable of withstanding or deflecting a blast wave, such as engineered barriers, enclosures, or barricades, a report presenting the devices and guiding their use shall be included in the submission and shall meet the following requirements:
   - It shall be a controlled document. It shall be certified, stamped, and signed by a Professional Engineer; the preamble of the report must include a certifying statement such as:
     *"I, [*print full name]*, being experienced and competent in the design, fabrication, installation and usage of devices capable of withstanding the pressure blast wave associated with the accidental release of stored energy in pneumatically tested equipment, certify that to the best of my knowledge and belief, the device shown herein is safe to be used for the associated pneumatic test when used as indicated*."
   - It must provide complete technical details to identify the proposed device.
   - It must provide complete installation details.
   - It must specify modified safe distances.

The safe distances for public buildings, roads, and spaces prescribed by 5.4.1(ii) above cannot be reduced by means of a barrier device.

5.4.3 Test Equipment Configuration

The configuration of equipment for the test must be presented on a controlled document that includes the following:

- the position and location of the equipment to be tested,
- the location of the pressure source, test control center, and inlet and outlet piping,
- the location and required safe distance for testing personnel during pressurization, examination, and depressurization,
- the required safe distance for other personnel and occupied industrial buildings, and
- the required safe distance for occupied public buildings, roads, and spaces.

5.5 TEST MANIFOLD REQUIREMENTS

5.5.1 Test Manifold Design

The test manifold must meet the following requirements:

i) It shall be designed for at least the maximum intended pneumatic test pressure and registered as a Category 'H' fitting, or in the case of a pneumatic test of a pressure piping system, can be registered with the piping.
ii) It shall provide means for attachment of a pressure source for the test, and for discharge of test fluid after completion of the test.
iii) It shall provide calibrated pressure gauges as required to monitor the system pressure for the purpose of the test, and valves as required to isolate the system equipment from the pressure source.
iv) A It shall provide a pressure relief valve (PRV) capable of protecting the system equipment from overpressure during the pneumatic test, set at pressure not higher than the test pressure plus the lesser of 345 kPa (50 psi) or 10% of the test pressure. The relief valve shall be certified with a relief capacity at least as great as that of the pressure source at the test pressure.
v) It is not permitted to use a pressure regulator instead of a certified pressure relief valve.
vi) Test outlet discharge piping and relief valve discharge piping must be routed to a safe location.

Note 1: The designer may wish to make allowance for low-temperature service design of the manifold, with consideration that expansion of the test medium may induce an auto-freezing effect and the associated potential for brittle fracture.

Note 2: The use of rubber hoses in pressure equipment service presents additional hazards and caution is advised. Rubber hoses shall meet the requirements of ARPM IP-2 and CSA B51, Clause 8.1(c) for the design, materials, construction, installation, inspection, testing, and repair. Special consideration may need to be made prior to use of such hoses for pneumatic testing, including ensuring that the hose is suitable for use with the intended test fluid, and ensuring that hoses have not been subjected to wear or damage in storage or handling. Special examination or testing of the hoses before use may be warranted.

5.5.2 Test Manifold Documentation

Test configuration details must be provided with the submission in the form of a controlled document, including:

i) an indication of the test manifold CRN, or a statement that it was registered with plant piping along with a copy of the P&ID showing the manifold portion of the piping,

ii) an indication of the type of pressure source to be used for the test, along with its maximum volumetric flow rate capacity over the allowable range of test pressures, and
iii) the relief valve set pressure, along with an indication of its minimum rated capacity over the allowable range of test pressures.

5.6 TEST PROCEDURE REQUIREMENTS

To ensure the safe completion of the pneumatic test, it must be conducted in accordance with a registered application-specific pneumatic test procedure. The procedure must:

i) be presented on a controlled document,
ii) identify the person in charge of conducting the test and their responsibilities,
iii) identify additional required test personnel and their responsibilities, and
iv) identify all tasks to be performed by testing personnel in a step-by-step format including pre-test checks, activities associated with pressurization and depressurization of the equipment, and completion of required documentation and sign-offs,
v) identify the required step increments for pressure increase and decrease,
vi) include details as to how the test pressure is monitored,
vii) identify the type, extent, and locations of required examinations,
viii) include provisions for all activities relating to required repair work, and
ix) refer to specific supporting documentation, including safe distance calculations, inlet/outlet piping documentation, etc., by document number.

Note: All assembled connections such as flanged and threaded joints, bolted closures and covers, and other components that can be separated from the tested system must be checked prior to pressurization to ensure that:

- the assembled components are in good working condition,
- required fasteners are present and in good condition, and
- the connection is appropriately secured.

5.7 TEST PROCEDURE SUBMISSION REQUIREMENTS

Application-specific pneumatic test procedures must be submitted to ABSA's Design Survey department for registration prior to conducting the test. The registration documentation must include:

i) a completed AB-31 Application Form,
ii) a brief cover letter explaining the scope of the submission,
iii) a description of the technical justification for conducting a pneumatic test,
iv) in the case of a pneumatic test on a pressure piping system, a letter from the Owner accepting the use of pneumatic testing,

v) in the case of a pneumatic test to be conducted at a location not under care and control of the organization conducting the test, a letter from the organization which has care and control of that property,
vi) the required test pressure and the basis (code reference) and calculations used to establish it,
vii) justification for the allowable range of test temperature,
viii) the test procedure, as defined above in section 5.6,
ix) the stored energy calculations, as detailed above in section 5.3,
x) the safe distance calculations and details of the test equipment configuration, as described above in section 5.4,
xi) the hazard analysis summary report and other reports described in sections 5.4.2(ii) and 5.4.2(iii) above, if engineered barriers or personal protective equipment are used for the reduction of required safe distances, and
xii) in the case of pneumatic testing of pressure piping, a copy of the line list showing all lines subject to the pneumatic test, and a plot plan or diagram that shows the physical layout of all lines subject to the test.

5.8 PRECAUTIONS

i. Designs shall include reaction forces and moments created by the operation of pressure relief valves.
ii. Adequate anchoring shall be provided for equipment to be tested,
iii. Calibrated pressure gauges shall be used during the test,
iv. Valves shall be used to isolate the system equipment from the pressure source.

Notwithstanding the requirements listed in this document, the SCO responsible for the review of the submission may require additional information as necessary to ascertain that the proposed test procedure is safe.

6.0 REVISION LOG

Edition #	Revision #	Date	Description
1st Edition issued 2016-10-24			
1	1	2019-07-31	Updated definitions, and several revisions in the text.