

IEEE Standard for Requirements for Conduit and Cable Seals for Field Connected Wiring to Equipment in Petroleum and Chemical Industry Exposed to Pressures above Atmospheric (1.5 kPa, 0.22 psi)

IEEE Industry Applications Society

Sponsored by the
Petroleum and Chemical Industry Committee

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Sponsor

**Petroleum and Chemical Industry Committee
of the
IEEE Industry Applications Society**

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IEEE-SA Standards Board

Abstract: Provided in this document are specific requirements for field installed sealing between a pressurized system (stream) containing flammable or combustible process fluids which is connected directly or indirectly to an electrical system where a failure could allow the migration of process fluids directly into the electrical system. Not addressed in this document are the basic requirements for electrical safety and the effects of the loss of containment of the process system in terms of risk to the environment and/or personnel health and safety.

Keywords: high-pressure seal, IEEE 1673™, instrumentation sealing, process seal, secondary seal

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Introduction

This introduction is not part of IEEE Std 1673™-2015, IEEE Standard for Requirements for Conduit and Cable Seals for Field Connected Wiring to Equipment in Petroleum and Chemical Industry Exposed to Pressures above Atmospheric (1.5 kPa, 0.22 psi).

This document provides specific requirements for field installed sealing between a pressurized system (stream) containing flammable or combustible process fluids which is connected directly or indirectly to an electrical system where a failure could allow the migration of process fluids directly into the electrical system.

The basic requirements for electrical safety are not specifically addressed by this standard. The effects of the loss of containment of the process system in terms of risk to the environment and/or personnel health and safety are also not addressed by this document.

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1. Overview

1.1 Scope

This document provides specific requirements for field installed sealing between a pressurized system (stream) containing flammable or combustible process fluids which is connected directly or indirectly to an electrical system where a failure could allow the migration of process fluids directly into the electrical system.

The basic requirements for electrical safety are not specifically addressed by this standard. The effects of the loss of containment of the process system in terms of risk to the environment and/or personnel health and safety are also not addressed by this document.

1.2 Purpose

The purpose of this document is to provide construction and performance requirements for sealing devices that are designed to prevent flammable or combustible process fluids from entering the electrical wiring system and to prevent the propagation of an explosion through the cable or conduit system. While certain devices

incorporate a primary seal in their design, a redundant sealing method or secondary seal as defined in NFPA 70® NEC® (501.17, 505.26) and CSA® C22.1 (18-072) is required to provide a backup in the event of the failure of the primary seal. These seals are intended for field installation by qualified individuals.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

ANSI/ASME B1.20.1-1983 (R2001), Pipe threads, general purpose (inch)¹

ANSI/ISA 12.27.01, Requirements for Process Sealing Between Electrical Systems and Flammable or Combustible Process Fluids

ASME B31.3, ASME Code for Pressure Piping²

CSA C22.1®, Canadian Electrical Code®: Part 1³

CSA C22.2 No 18-M, Outlet Boxes, Conduit Boxes, and Fittings

CSA C22.2 No. 30, Explosion-Proof Enclosures for Use in Class I Hazardous Locations

ISO 965/1-1980, Metric Screw Threads⁴

ISO 965/3-1980, Metric Screw Threads

NFPA 70®, National Electrical Code®

UL 886, Standard for Safety for Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations⁵

3. Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.⁶

cable seal: A seal that is installed at a cable termination to prevent the release of an explosion from an explosion-proof enclosure and that minimizes the passage of gases or vapors at atmospheric pressure.

NOTE—These devices only minimize the passage of gas, but are not designed or intended to prevent it.⁷

¹ANSI publications are available from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

²ASME publications are available from the American Society of Mechanical Engineers, 3 Park Avenue, New York, NY 10016-5990, USA (<http://www.asme.org/>).

³CSA publications are available from the Canadian Standards Association, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, Canada, L4W 5N6 (<http://www.csa.ca/>).

⁴ISO publications are available from the ISO Central Secretariat, 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland (<http://www.iso.org/>). ISO publications are also available in the United States from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

⁵UL standards are available from Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112, USA (<http://www.global.ihs.com/>).

⁶*IEEE Standards Dictionary Online* subscription is available at: <http://ieeexplore.ieee.org/xpls/dictionary.jsp>.

⁷Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

conduit seal: A seal that is installed in a conduit to prevent the passage of an explosion from one portion of the conduit system to another and that minimizes the passages of gases or vapors at atmospheric pressure.

NOTE—These devices only minimize the passage of gas but are not designed or intended to prevent it.

dual seal device: Equipment which incorporates, along any single potential leakage path, a primary process seal and one or more secondary process seals such that the failure of two or more independent seals is required to allow migration of process fluids from their designed containment into the external electrical system.

field installed secondary seal: A secondary seal intended to be installed between unspecified process connected equipment and the premises wiring system that will only come into contact with process fluids in excess of pressures above 1.5 kilopascals (0.22 psi) in the event of the failure of a primary process seal. This includes secondary process seals of the containment and venting types.

maximum allowable working pressure (MAWP): The pressure at which a device can be subjected to without exceeding the maximum allowable stress of the material.

primary process seal: A process seal that is directly in contact with process fluids under conditions of normal operation.

process connected equipment: Electrical equipment that contains a process seal and is intended for connection to an external system that contains process fluids.

process fluid: A liquid or vapor that is used in, or is a byproduct of, an industrial process.

process seal: A device to prevent the migration of process fluids from the designed containment into the external electrical system.

secondary process seal—containment type: A seal that will only come into contact with process fluids in excess of pressures above 1.5 kilopascals (0.22 psi) only in the event of the failure of a primary process seal. This type of device is designed to contain the process pressure at a predetermined level and may provide a means of signaling that containment by the primary seal has been lost. Containment type means the seal must hold the pressure in the enclosure (materials cannot be released to the atmosphere) and may allow for an indication the primary seal has failed.

secondary process seal—venting type: A seal that will only come into contact with process fluids in excess of pressures above 1.5 kilopascals (0.22 psi) only in the event of the failure of a primary process seal. This type of device is not designed to contain the pressure of the process system. This device will vent the pressure and may provide a means of signaling that containment by the primary seal has been lost. “Venting” meaning the seal is intended to be connected to a box that fails below the maximum allowable working pressure (MAWP) of the seal, thereby relieving the pressure.

single seal device: A device that incorporates, along any single potential leakage path, a single sealing structure such that a failure of the seal may result in the migration of process fluids from their designed containment into the external electrical system.

4. General requirements

4.1 Basis for requirements

The manufacturer’s field installed secondary process seal specifications shall be determined to comply with the provisions of this document. Manufacturer specifications for field installed secondary process seals shall include but are not limited to the following:

- a) Operational temperature range
- b) Operational pressure range
- c) Materials of construction
- d) Maximum working pressure

NOTE—It is assumed for the purposes of this document that installers will follow standard engineering practice and adhere to industry standards for the selection, installation, and operation of devices that contain process seals. For example: The selection of a thermowell for use in a flowing process fluid would normally adhere to the requirements found in ASME/PTC 19.3.

4.2 Threads

Threaded portions of the fitting shall conform with one or more of the following standards: CSA C22.2 No 18-M, UL 886, ANSI/ASME B1.20.1-1983 (R2001), or ISO 965/1-1980, and ISO 965/3-1980.⁸

4.3 Materials

The manufacturer of the process seal shall make available the information necessary to determine if the materials critical to the process sealing of the device are compatible with process fluids under their conditions of use, as compatibility may vary at different temperature and pressure levels.

5. Type verifications and type tests for field installed secondary process seal other than containment type

Secondary seal shall also satisfy the following tests.

5.1 Heat/cold cycling test

Place sample unit in an environmental chamber, then

- a) Beginning at room temperature, bring the temperature of the sample to $T_{\max} + 10$ °C. The excursion time shall not be less than 30 min.
- b) Maintain the temperature (at $T_{\max} + 10$ °C) for at least 1 h.
- c) Cool the sample to $T_{\min} - 5$ °C. The excursion time shall not be less than 60 min.
- d) Maintain the temperature (at $T_{\min} - 5$ °C) for at least 1 h.
- e) Raise the temperature of the environmental chamber to room ambient. The excursion time shall not be less than 30 min.
- f) Repeat this heat/cold cycle for 50 times.
- g) Upon completion of the 50 cycles, there shall be no signs of degradation.

5.2 Gas tightness test

After the heat/cold cycling test (Test 1 above), the sample shall be subjected to the following test.

⁸Information on references can be found in [Clause 2](#).

- a) The sample shall be connected to a supply of either nitrogen or air, and be immersed to a depth of 25 mm in soapy water.
- b) The test pressure shall be two (2) times the MAWP of the gas (medium).
- c) The test pressure shall be held for a period of not less than 30 min.
- d) The test pressure shall be applied to the high-pressure side of the sample.
- e) There shall be no bubbles emerging through the sample.

5.3 Over pressure test

After the gas tightness test (Test 2), and where the sample unit was not previously certified or being modified from the original certified potting procedure or criteria, the sample shall be subjected to the following test:

- a) The sample shall be subjected to a test pressure of
 - 1) Four (4) times the MAWP, or
 - 2) One and one half (1.5) times the MAWP of the specific size, material, and grade of pipe tested to ASME B31.3 to which the seal is intended to be connected.
- b) The test pressure shall be held for a period of not less than 1 minute.
- c) If the device can be installed bi-directionally, the test pressure shall be applied to both sides (ends) of the sample independently.
- d) There shall be no evidence of rupture or deformation of any portion of the device sample.

NOTE 1—Devices that are intended to rupture as part of their design will be investigated to help ensure that the MAWP will not be transferred to the conduit or cable system.

NOTE 2—Where extremely high MAWPs are involved, the four times pressure test in 5.3a)i. may not be practical.

The 1.5 times the MAWP of the pipe to which the seal is attached in 5.3a)ii provides an acceptable margin of safety. This test method is intended for specific applications only and not for general certification purposes.

6. Additional type verification and type tests for field installed secondary process seal: venting type

6.1 Venting pressure determination: secondary process seals

Venting type shall be shown by test to be compatible with the conditions that would be present upon failure of the primary seal. An evaluation or test shall be conducted to determine the worst case pressure rise. That pressure shall be applied to the secondary seal until the vent is activated.

This test shall take into account the pressure and flow capacity of the worst case primary seal failure and the pressure and flow capacity of the venting mechanism. The venting pressure may be arrived at through theoretical means. In cases where rupture of an external wall of the equipment enclosure is relied upon for venting, this test shall verify the burst pressure of the enclosure.

NOTE—In most cases, primary seal failure is assumed to be a slow leak and the venting pressure is the same as the pressure at which the vent opens. The manufacturer of the process seal shall specify the worst case primary seal failure.

7. Type verifications and type tests for field installed secondary process seal: containment type

Secondary sealing devices intended to contain the full process pressure in the event of a failure of the primary seal shall meet the requirements for dual seal devices contained in ANSI/ISA 12.27.01.

8. Verification of annunciation effectiveness where provided

If the device incorporates an annunciation system, the annunciation shall be verified by applying pressure to the device. The device will be tested at the manufacturer's stated minimum and maximum ratings of the device. Annunciation methods may be audible, electronic, or visual.

9. Marking and documentation

9.1 Marking

The manufacturer shall mark the product with the following:

- Field installable secondary seal
- Venting or containment type
- Process temperature range
- Working pressure range
- Hazardous area classification rating

9.2 Documentation

The manufacturer shall include the following information in the product instructions:

- Information necessary for the determination of chemical compatibility of process wetted materials that form part of a primary seal
- Instructions for installation and use of primary seal failure annunciation (if applicable)
- Instructions necessary for proper maintenance of seals, vents, drains, and annunciations (as applicable)

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