An Overview of Recent Changes to the Single/Dual Process Seal Standards

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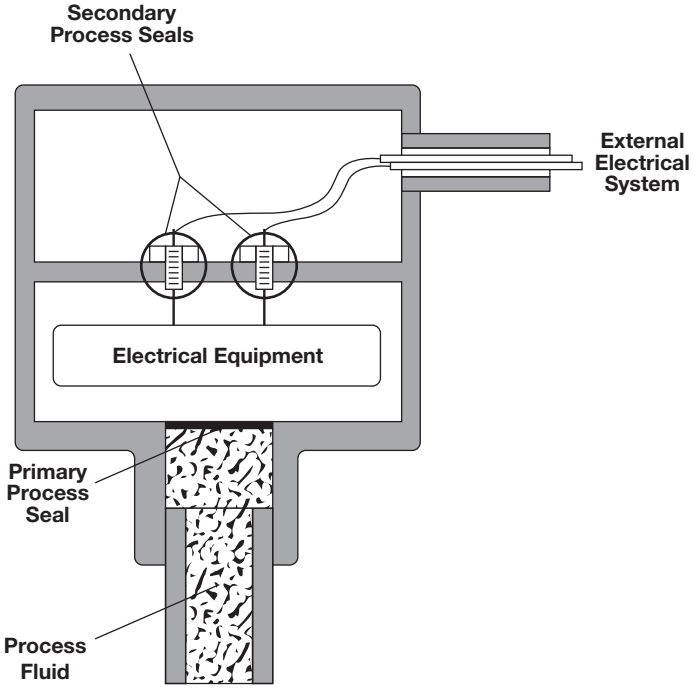
Two is better than one, right? Applying this old adage is often good guidance, but sometimes it's just not appropriate. Case in point—comparing single and dual process seals.

Overview

- Overview of the process sealing requirements as defined by the ANSI/ISA[1], NFPA/NEC[2], and the CEC[3]
- History and explanation of recent changes to the relevant codes and standards
- Guidelines for selecting process sealing based on the application and performance requirements



Background

Over the years, well-defined standards have been established to address the requirements for process sealing between an electrical system and process fluids, where a failure could allow the migration of the fluids into the electrical system. The primary audiences for these standards are the owner/operators of process facilities and installers of electrical equipment and instrumentation.

Definitions: Process Fluid and Seals

Generically, a process fluid is any liquid or vapor used in, or is a byproduct of, an industrial process. As defined in the standards, a process seal is a device that prevents the migration of a fluid from a designed containment into an external electrical system.

Process seals are often grouped into two categories of devices: single seal and dual seal[4]:

Single Seal: A device that incorporates a single sealing structure that is considered to have a negligible probability of failure when used in accordance with the manufacturer's specification.

Dual Seal: A device that 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 fluid from their designed containment into the external electrical system.

[1] ANSI, American National Standard Institute; ISA, Instrumentation, Systems, and Automation Society.
[2] NFPA, National Fire Protection Association; NEC, National Electric Code.
[3] CEC, Canadian Electric Code.
[4] ANSI/ISA-12.27.01-2003. *Requirements for Process Sealing Between Electrical Systems and Flammable or Combustible Process Fluids*. February 2, 2003.

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Brief History of Process Sealing Standards

Although they all have the same goal in mind, over the years ANSI ISA, NFPA/NEC, and the CEC have issued slightly different standards and code requirements for process sealing. More than 20 years ago, NEC required the use of primary and secondary seals, and specified that the secondary seals must be able to withstand conditions equal to or greater than the conditions that caused the primary seal to fail.

Independently, the CEC required that secondary seals must be provided between devices containing a primary seal and conduit/cable seal, where failure of a single component in the device containing the primary seal could allow passage of process fluids.

In 2003, ISA required that dual seal devices incorporate a method that indicated or annunciated a primary seal failure (e.g., visible leakage, an audible whistle, or other means of monitoring[5]).

In 2005 and again in 2008, the NEC[6] modified its requirements for process sealing to include the concept of dual seals consistent with the standards specified in ANSI ISA-12.27.01. The NEC still did not allow single seal devices. The NEC modifications required that either a device listed and marked as a dual seal was installed, or that the installer must add an external secondary seal (or other mitigation technique) to the system.

Reviewing All Seals

Some process facility owners/operators are replacing any equipment that has a non-compliant seal with a device that has a process seal that meets the ANSI ISA 12.27.01 standard. These changeovers may be directed by local legislation or inspired by more stringent safety practices. On a case-by-case basis, owners/operators should review their equipment with single-seal that are not covered by the new standards. Some of these applications will be acceptable as is; some should be changed in order to be compliant with ANSI ISA 12.27.01.

Here's an example. Consider a stainless steel thermowell isolating a temperature sensor from a process. A thermowell is considered a single seal device and covered by the standards. Since the thermowell is pressure-tight, solid container, it has negligible chance of a failure. It is a common and good engineering practice to use thermowells for safely separating electrical systems from a combustible media and does not need to be changed.

Alternatively, consider the same temperature sensor inserted directly into the process with a single o-ring forming a seal. Assume this process connection initially passes all standard agency testing. However, over time, the seal could age and weaken, thus allowing combustible gases to pass. This type of process seal has a significant chance of failure over time and should either be protected by a secondary seal or replaced with an approved single-seal device.

Recent Revisions to the Standards

The new NEC edition[7] has expanded its process sealing standards and added detail as to what will meet the requirements for installation of process connected equipment and the prevention of process material from getting into the conduit of equipment.

The 2011 update to the NFPA 70 process sealing methods have brought the current version of the NEC into alignment with CEC and ISA. A new clause (501.17) replaces clause 501.15(F)(3) relative to process seals. The key statement in this clause is in the last paragraph:

Process-connected electrical equipment that does not rely on a single process seal or is listed and marked "single seal" or "dual seal" shall not be required to be provided with an additional means of sealing.[8]

In summary, the NEC now allows devices to be marked as either single seal or dual seal per ANSI ISA-12.27.01. The NEC and CEC reference the testing standards as specified in the standard. A Nationally Recognized Testing Lab (NTRL) such as FM or CSA typically provides the certification for such devices.

[5] ANSI/ISA 12.27.01

[6] National Electrical Code. Clause 501.15(F)(3). 2008

[7] National Electrical Code. 2011 Edition

[8] National Electrical Code. Clause 501.17. 2011

Meeting Process Sealing Requirements

Single Seal Qualifications

To be certified and marked as "single seal," a device must pass the following controlled tests:

leakage and burst – must not show visible signs of leakage when subjected to over-pressure. The maximum pressure requirements and duration are different for different devices and are dependent on the maximum working pressure.

temperature cycling – must not fail when subjected to repeated changes in temperature.

fatigue cycling – must not fail when subjected to changes in pressure.

Dual Seal Qualifications

To be certified and marked as "dual seal," a device must pass the following controlled tests:

leakage and burst – same as those for the single deal device.

venting capacity – must account for the pressure and flow capacity of the worst-case primary seal failure. Pressure is applied until the required annunciation method (typically venting) has indicated the primary seal failure.

annunciation – must be verified by failing the primary seal and applying pressure to the device. The verification is carried out under the conditions deemed worst case for the manufacturer's rating of the device.

Single vs. Dual

In a dual seal device, the primary seal must pass the same leakage and burst tests as the single seal. However, this primary seal does not have to be subjected to temperature and fatigue cycling. Further, the secondary seal on a dual seal device is pressure tested to much lower pressures than a single seal device (150% of maximum venting pressure for one minute for a venting design or 150% of maximum rated working pressure for a non-venting device). Neither the primary nor secondary seal is required to be as robust as with a single seal device. In summary, the requirements for a single seal device are more stringent than the requirements for a dual seal device.

Installing to the Codes

The NEC and CEC are written for the installer of equipment, not necessarily for the equipment manufacturer. Therefore, mitigation techniques are provided by installers of equipment when a device is **not** listed and marked single seal or dual seal. Of course, installers prefer to comply with the standard without using any additional mitigation techniques—it is more cost effective and does **not** complicate the installation process. Therefore, it is easier for the installers to rely on the manufacturer to include features in their product that simplify the installation and make their product independently acceptable to the appropriate local codes.

Conclusion: One Over Two

The new NEC and CEC standards no longer require secondary means of sealing a process-connected electrical device when the device is marked "single seal" or "dual seal" per ANSI ISA-12.27.01. To gain a single or dual seal marking, the device must pass a strict series of tests. Single seals meet a higher performance level than dual seals.

Further, the recent experience and successful application of single seal devices seems to indicate that owners, operators, and installers are more concerned with meeting the required specification as simply as possible, rather than counting the number of seals used. This can lead one to the conclusion that two is not necessarily always better than one, especially when you're selecting process seals.

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