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Examination Standard for Explosion Venting Systems Including Fasteners and Latches for Damage Limiting Construction

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Foreword

This standard is intended to verify that the products and services described will meet stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of this standard is to present the criteria for examination of various types of products and services.

Examination in accordance with this standard shall demonstrate compliance and verify that quality control in manufacturing shall ensure a consistent and reliable product.

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1 INTRODUCTION

1.1 Purpose

1.1.1 This standard states testing and certification requirements for explosion venting systems including fasteners and latches for damage limiting construction.

1.1.2 Accidental explosions in confined areas generally result in over-pressure situations where the actual pressures far exceed the design strength of the enclosure. This condition will result in significant damage to the enclosure which may be a room in a larger building or a separate standalone building. To mitigate the potential damage caused by accidental explosions, some form of damage limiting construction (DLC) is needed. Explosion venting panels are used as an element of DLC. A common DLC design would combine venting panels with reinforced walls.

1.1.3 One type of DLC works by designing certain parts of the structure (generally the roof or walls) as pressure resistant and other areas (generally external walls as pressure relieving. This pressure relieving area results in a weak point (usually a wall panel or panels) on the exterior of the enclosure that will fail at a pressure below the design strength of the pressure resistant elements of the enclosure. The net effect of this design is the products of the explosion (i.e., excess pressure and flame) are directed out of the protected enclosure to a predefined location through the vent panel while the remainder of the enclosure remains intact.

1.1.4 One of the most common methods of securing the pressure relieving panels to an enclosure is with explosion venting fasteners. Under normal conditions, the explosion venting fasteners secure the wall panels to the structure and are able to withstand typical loadings such as wind. These fasteners allow the panels to remain in place but are designed to fail when a specific force per fastener is exceeded such as would be the case during an explosion.

1.1.5 In addition to large enclosures like buildings or rooms having a need for explosion venting, there are many pieces of equipment (e.g., industrial ovens) that have the potential for an internal explosion as well. There is also a need to limit damage to this equipment by providing DLC. Commonly access doors can be used for explosion venting by providing latches specifically designed to release the door during an explosion. These fasteners/latches may have different operating methods, but they perform the same essential function – to secure a panel or door in place under normal conditions and release at a predetermined load that will allow venting of the enclosure.

1.1.6 Testing and certification criteria may include performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a surveillance program.

1.2 Scope

1.2.1 This standard sets the performance requirements for explosion venting systems. These systems are typically used on the exterior walls of enclosures (e.g., cut-off rooms, buildings and pre-fabricated standalone storage buildings) that have been identified as having the potential for an explosion hazard. They shall be examined for their ability to remain in place under normal conditions but to fail at pre-determined pressure levels characteristically associated with explosions.

1.2.2 This standard is intended to be applicable to wall fasteners used to secure wall panels to buildings, latches normally found on ovens and adjustable magnetic release devices used on other types of pressure relieving systems.

1.2.3 This standard is intended to evaluate only those hazards investigated and is not intended to determine suitability for the end use of the product.

1.2.4 This standard does not apply to detonations, bulk auto-ignition of gases or unconfined deflagrations such as open air or vapor cloud explosions or flameless duct explosion venting devices.

1.2.5 This standard does not provide any guidelines on the placement of venting panels or determining the amount of venting area needed for a given occupancy or construction.

1.3 Basis for Requirements

1.3.1 The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, trade associations, jurisdictions and/or loss control specialists was also considered.

1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of explosion venting wall systems including fasteners and latches for DLC for the purpose of obtaining certification.

1.4 Basis for Certification

Certification is based upon satisfactory evaluation of the product and the manufacturer in the following major areas:

1.4.1 Examination and tests on production samples shall be performed to evaluate

- the suitability of the product;
- the performance of the product as specified by the manufacturer and required for certification;
- the durability and reliability of the product.

1.4.2 An examination of the manufacturing facilities and audit of quality control procedures may be made to evaluate the manufacturer's ability to consistently produce the product which is examined and tested, and the marking procedures used to identify the product. Subsequent surveillance may be required by the certification agency in accordance with the certification scheme to ensure ongoing compliance.

1.5 Basis for Continued Certification

The basis for continual certification may include the following based upon the certification scheme and requirements of the certification agency

- production or availability of the product as currently certified;
- the continued use of acceptable quality assurance procedures;
- compliance with the terms stipulated by the certification;
- satisfactory re-examination of production samples for continued conformity to requirements; and
- satisfactory surveillance audits conducted as part of the certification agency’s product surveillance program.

1.6 Effective Date

The effective date of this certification standard mandates that all products tested for certification after the effective date shall satisfy the requirements of this standard.

The effective date of this standard is eighteen (18) months after the publication date of the standard for compliance with all requirements.

1.7 System of Units

Units of measurement used in this standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Conversion of U.S. customary units is in accordance with ANSI/IEEE/ASTM SI 10.

1.8 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the cited edition applies.

ANSI/IEEE/ASTM SI 10, *American National Standard for Metric Practice*

1.9 Terms and Definitions

For purposes of this standard, the following terms apply:

Damage Limiting Construction – a combination of pressure relieving (venting) and pressure resisting exterior construction which is intended to mitigate over-pressure damage to a building or enclosure in case of a vapor-air deflagration. The design of relieving and resisting features must be engineered to account for fuel, surface area of the enclosure, vent area and structural loads imposed by the deflagration.

Deflagration –a rapid combustion reaction in which the flame front moves through the unreacted medium (ignitable gas and air or combustible dust and air) at a velocity less than the speed of sound in that medium.

Detonation – an extremely rapid combustion reaction in which the flame front moves through the unreacted medium (see deflagration) at a velocity greater than the speed of sound in that medium.

Explosion – a sudden, rapid release of energy that produces potentially damaging pressures.

Fastener – a mechanical device used to hold or secure one or more objects in a definite position with respect to one another until intentionally loosened.

Latch – a fastener for a door or panel that has a bar that fits into a notch or slot and is lifted by a lever or handle.

Pressure Relieving – lightweight, exterior wall panel construction secured with special fasteners and designed to barely resist design wind loads and easily release during a deflagration.

Pressure Resistant – a type of construction that utilizes internal wall and if applicable, floor construction, which can resist overpressures caused by a deflagration (considering the type of fuel, surface area of the enclosure and vent area provided) so as to protect the adjacent occupancy and structures.

Static Breaking Strength – the average value at which the fasteners are considered to have failed.

Washer – a disc with a hole through the center that is used with a threaded fastener to ensure tightness of a joint.

2 GENERAL INFORMATION

2.1 Product Information

2.1.1 It is important to note that damage limiting construction and/or venting does not prevent deflagrations but that they can be an effective means to minimize the damage that can result from a deflagration.

2.1.2 Damage limiting construction relief panels shall be of lightweight construction and shall release at a minimum internal pressure of 20 lbs/ft^2 (0.96 kPa) and a maximum internal pressure of 40 lbs/ft^2 (1.92 kPa). They shall be designed to relieve at the lowest possible pressure that will provide adequate resistance to any applied wind loading to which it may be subjected.

2.1.3 Explosion venting systems generally use specially designed mechanical fasteners and/or washers as a means of securing the venting panel to the structure. Other methods, such as magnets, are also an acceptable method. When used, these alternate means shall also be subjected to the tests described in this standard in order to become certified.

2.1.4 Most explosion venting systems and fasteners are designed to fail during an over-pressure situation in tension and the tests contained in this examination standard are designed with that in mind. In cases where the fasteners are designed to fail in shear or by some other method, the tests shall be modified accordingly such that the fastener is subjected to the appropriate mode of failure.

2.2 Certification Application Requirements

The manufacturer shall provide the following preliminary information with any request for certification consideration:

- a complete list of all models, types, sizes, and options for the products or services being submitted for certification consideration;
- general assembly drawings, complete set of manufacturing drawings, materials list, sales literature and installation procedures as applicable;
- the number and location of manufacturing facilities; and;

All documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level. All documents shall be provided in English or with English translation.

2.3 Requirements for Samples for Examination

2.3.1 Following authorization of a certification examination, the manufacturer shall submit samples for examination and testing based on the following:

- Sample requirements to be determined by the certification agency.

2.3.2 Requirements for samples may vary depending on design features, results of prior or similar testing (if applicable), and results of any foregoing tests.

2.3.3 The manufacturer shall submit samples representative of production.

2.3.4 It is the manufacturer's responsibility to provide any necessary test fixtures, such as those which may be required to evaluate the explosion venting systems.

3 GENERAL REQUIREMENTS

3.1 General Information

3.1.1 The requirements of this standard shall be used to measure and describe the performance of explosion venting systems including fasteners and latches to loadings that simulate expected over-pressure situations likely to be encountered.

3.1.2 All venting panels shall be either hinged or tethered at the top, bottom or along the side but never along more than one edge. It is recommended that tethers be fabricated from steel cable and have sufficient slack to allow for panel movement. If hinges are used instead of tethers, they shall be made from corrosion resistant material.

3.1.3 The release pressure of systems or individual components shall be such that they can withstand anticipated wind loads.

3.1.4 All release devices shall be designed to release at an internal pressure between 20 lbs/ft^2 to 40 lbs/ft^2 (0.96 – 1.92 kPa).

3.2 Markings

3.2.1 Marking on the product or, if not possible due to size, on its packaging or label accompanying the product, shall include the following information:

- name and address of the manufacturer or marking traceable to the manufacturer;
- date of manufacture or code traceable to date of manufacture or lot identification;
- model number or designation and applicable ratings, as appropriate.

When hazard warnings are needed, the markings should be universally recognizable.

3.2.2 The model or type identification shall correspond with the manufacturer's catalog designation and shall uniquely identify the certification agency’s mark of conformity.

3.2.3 The certification agency’s mark of conformity shall be displayed visibly and permanently on the product and/or packaging as appropriate and in accordance with the requirements of the certification agency. The manufacturer shall exercise control of this mark as specified by the certification agency and the certification scheme.

3.2.4 All markings shall be legible and durable.

3.3 Manufacturer’s Installation Instructions

3.3.1 The manufacturer shall:

- prepare instructions for the installation, maintenance, and operation of the product;
- provide facilities for repair of the product and supply replacement parts, if applicable; and
- provide services to ensure proper installation, inspection, or maintenance for products of such nature that it would not be reasonable to expect the average user to be able to provide such installation, inspection, or maintenance.

3.3.2 The manufacturer shall provide the user with instructions for the installation and guidelines on the use of the product and will address, as appropriate:

- that the manufacturer shall be consulted to determine the number of fasteners, latches or other devices needed on a particular size panel or that this should be determined by a registered structural or civil engineer;

- information on the need for any pilot holes, oversized holes, spacers or other items needed for proper installation;
- that no obstructions should be placed in the path of the pressure relieving panels. This includes pipes, ducts, and conduit that may run along the outside wall, yard storage and adjacent structures and equipment;
- that pipes, ducts and conduit located on the interior side of the pressure relieving wall panels shall not be connected to or supported by the pressure relieving panels.

3.4 Calibration

3.4.1 Each piece of equipment used to verify the test parameters shall be calibrated within an interval determined on the basis of stability, purpose, and usage. A copy of the calibration certificate for each piece of test equipment is required. The certificate shall indicate that the calibration was performed against working standards whose calibration is certified and traceable to an acceptable reference standard and certified by an ISO/IEC 17025 accredited calibration laboratory. The test equipment shall be clearly identified by label or sticker showing the last date of the calibration and the next due date. A copy of the service provider's accreditation certificate as an ISO/IEC 17025 accredited calibration laboratory should be available.

3.4.2 When the inspection equipment and/or environment is not suitable for labels or stickers, other methods such as etching of control numbers on the measuring device are allowed, provided documentation is maintained on the calibration status of thus equipment.

4 PERFORMANCE REQUIREMENTS

4.1 Static Tests – Explosion Venting Fasteners and/or Systems, Including Oven Latches

4.1.1 Requirement

All explosion venting systems submitted for certification shall be subjected to a static test in order to determine the system(s) and fastener(s) static breaking strength.

4.1.2 Test/Verification

4.1.2.1 Five (5) tests shall be conducted on each fastener and/or panel combination and or oven latch for each design load for which certification is desired. The testing shall be conducted as follows:

Static tension or shear tests (whichever operating principle applies) are performed on the explosion venting fasteners or oven latches using a tensile testing machine operated at a machine speed of 2 in. (50 mm) per minute. Five tests are performed on each type and/or size of test specimen. Averaging the test results of the five tests will establish the static breaking strength of the test specimen.

4.1.2.2 The specimen shall be considered to meet the test criteria if:

- the static breaking strength of the five (5) samples does not exceed the average by more than 15%;
- all fasteners, washers and other items used to secure the panel do not disengage, fracture or tear the test assembly;
- the static breaking strength shall not exceed twice the load at which permanent deformation is first observed.

4.2 Small Scale Dynamic Tests - Explosion Venting Fasteners and/or Systems

4.2.1 Requirement

In cases where the characteristics of the explosion venting system(s) and/or fastener(s) are not suitable to be tested using the static test from 4.1, the system(s) and/or fastener(s) shall be subjected to the small-scale dynamic test for explosion venting systems in order to determine the breaking strength shall be conducted as follows in 4.2.2.

4.2.2 Test/Verification

4.2.2.1 Five (5) tests shall be conducted on each fastener and/or panel combination for each design load for which certification is desired. The testing shall be conducted as follows:

The test chamber which consists of a cylindrical tank that is 6 in (150 mm) in diameter and 8 in (200 mm) in depth with one open end. A circular vent panel is attached to the open end of the test chamber with a hinge at the bottom and a single test specimen at the top. The test chamber has a pressure transducer, and it is connected to a supply of compressed air.

The compressor shall be turned increasing the pressure in the chamber until the test sample completely deploys. Adjust the rate of pressure rise such that failure occurs at 0.1 seconds ± 0.05 seconds. The pressure at which the fastener completely deploys shall be recorded.

Because of the presence of the hinge, the breaking strength on the fastener or system shall be calculated using the following equation:

$F_{fastener} = P_{max} \times A_{eff} \times (L_{center} / L_{fastener})$

Where

$F_{fastener}$ = breaking strength on the fastener or system, lbs
P_{max} = the maximum pressure observed during the test, lbs/in²
A_{eff} = the effective vent area exposed to Pmax, in2
L_{center} = the distance from the hinge to the center of the panel, in

4.2.2.2 $L_{fastener}$ = the distance from the hinge to the fastener. The specimen shall be considered to meet the test criteria if:

- the breaking strength of the five (5) samples does not exceed the average by more than 15%;
- all fasteners, washers and other items used to secure the panel do not disengage, fracture or tear the test assembly.

5 MANUFACTURER'S REQUIREMENTS

A quality assurance program is required to assure that subsequent explosion venting systems including fasteners and other components produced by the manufacturer shall present the same quality and reliability as the specific products examined. Design quality, conformance to design, and performance are the areas of primary concern.

- Design quality is determined during the examination and tests and is documented in the certification report.
- Continued conformance to this standard is verified by the certifier's surveillance program.
- Quality of performance is determined by field performance and by periodic re-examination and testing.

5.1 Demonstrated Quality Control Program

5.1.1 The manufacturer shall demonstrate a quality assurance program which specifies controls for at least the following areas:

- existence of corporate quality assurance guidelines;
- incoming quality assurance, including testing;
- in-process quality assurance, including testing;
- final inspection and tests;
- equipment calibration;
- drawing and change control;
- packaging and shipping; and
- handling and disposition of non-conforming materials.

5.1.2 Documentation/Manual

There should be an authoritative collection of procedures/policies. It should provide an accurate description of the quality management system while serving as a permanent reference for implementation and maintenance of that system. The system should require that sufficient records are maintained to demonstrate achievement of the required quality and verify operation of the quality system.

5.1.3 Records

To assure adequate traceability of materials and products, the manufacturer shall maintain a record of all quality assurance tests performed, for a minimum period of two years from the date of manufacture.

5.1.4 Drawing and Change Control

- The manufacturer shall establish a system of product configuration control that shall allow no unauthorized changes to the product. Changes to critical documents, identified in the certification report, may be required to be reported to, and authorized by, the certification agency prior to implementation for production.
- Records of all revisions to all certified products shall be maintained.

5.2 Surveillance Audit

5.2.1 An audit of the manufacturing facility may be part of the certification agencies surveillance requirements to verify implementation of the quality assurance program. Its purpose is to determine that the manufacturer's equipment, procedures, and quality program are maintained to ensure a uniform product consistent with that which was tested and certified.

5.2.2 Certified products or services shall be produced or provided at, or provided from, location(s) disclosed as part of the certification examination. Manufacture of products bearing a certification mark is not permitted at any other location prior to disclosure to the certification agency.

5.3 Installation Inspections

Field inspections may be conducted to review an installation. The inspections are conducted to assess ease of application, and conformance to written specifications. When more than one application technique is used, one or all may be inspected at the discretion of the certification agency.

5.4 Product Modifications

The manufacturer shall notify the certification agency of changes in product construction, components, raw materials, physical characteristics, coatings, component formulation or quality assurance procedures prior to implementation.

6 Bibliography

ISO/IEC 17025, *General Requirements for the Competence of Testing and Calibration Laboratories.*