



Member of the FM Global Group

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

Class Number 4440

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Foreword

The FM Approvals certification mark is intended to verify that the products and services described will meet FM Approvals' stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of Approval Standards is to present the criteria for FM Approval of various types of products and services, as guidance for FM Approvals personnel, manufacturers, users and authorities having jurisdiction.

Products submitted for certification by FM Approvals shall demonstrate that they meet the intent of the Approval Standard, and that quality control in manufacturing shall ensure a consistently uniform and reliable product. Approval Standards strive to be performance-oriented. They are intended to facilitate technological development.

For examining equipment, materials and services, Approval Standards:

- a) must be useful to the ends of property conservation by preventing, limiting or not causing damage under the conditions stated by the Approval listing; and
- b) must be readily identifiable.

Continuance of Approval and listing depends on compliance with the Approval Agreement, satisfactory performance in the field, on successful re-examinations of equipment, materials, and services as appropriate, and on periodic follow-up audits of the manufacturing facility.

FM Approvals LLC reserves the right in its sole judgment to change or revise its standards, criteria, methods, or procedures.

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1. INTRODUCTION

1.1 Purpose

- 1.1.1 This standard states Approval 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 stand alone 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 damage limiting construction .A common DLC design would combine venting panels with reinforced walls.
- 1.1.3 One style of damage limiting construction 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 reliving 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 due to potential explosion hazards, 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 damage limiting construction. 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 Approval criteria shall include, but are not limited to, performance requirements, marking requirements, an examination of manufacturing facility(ies), an audit of quality assurance procedures, and a follow-up 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 stand alone storage buildings) that have been identified as having the potential for a room/building 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. For recommendations on this type of information, refer to the latest edition of FM Global Property Loss Prevention Data Sheet 1-44, Damage Limiting 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 for damage limiting construction for the purpose of obtaining Approval. Explosion venting wall systems and fasteners having characteristics not anticipated by this standard may be FM Approved if performance equal, or superior, to that required by this Standard is demonstrated, or if the intent of the standard is met. Alternatively, explosion venting wall systems including fasteners which meet all of the requirements identified in this Standard may not be FM Approved if other conditions which adversely affect performance exist or if the intent of this standard is not met.

1.4 Basis for Approval

Approval 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 by FM Approvals; and as far as practical,
 - the durability and reliability of the product.
- 1.4.2 An examination of the manufacturing facilities and audit of quality control procedures is 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. These examinations may be repeated as part of FM Approvals' product follow-up program.

1.5 Basis for Continued Approval

Continued Approval is based upon:

- production or availability of the product as currently FM Approved;
- the continued use of acceptable quality assurance procedures;
- satisfactory field experience;
- compliance with the terms stipulated in the Approval report;
- satisfactory re-examination of production samples for continued conformity to requirements; and

- satisfactory Surveillance Audits conducted as part of FM Approvals' product follow-up program.

Also, as a condition of retaining Approval, manufacturers may not change a product or service without prior authorization by FM Approvals.

1.6 Effective Date

The effective date of an Approval standard mandates that all products tested for Approval after the effective date shall satisfy the requirements of that standard. Products FM Approved under a previous edition shall comply with the new version by the effective date or else forfeit Approval.

The effective date of this Standard is December 31, 2014 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. Appendix A lists the selected units and conversions to SI units for measures appearing in this standard. Conversion of U.S. customary units is in accordance with the American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)/American Society for Testing Materials (ASTM) SI 10, *Standard for Use of the International System of Units (SI): The Modern Metric System*.

1.8 Applicable Documents

The following standards, test methods, and practices are referenced in this standard:

FM Global Data Sheets

FM Global Property Loss Prevention Data Sheet 1-44, Damage Limiting Construction.

1.9 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/ft² (0.96 kPa) and a maximum internal pressure of 40 lbs/ft² (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 Approved.
- 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 Approval 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 Approval Application Requirements

To apply for an Approval examination, the manufacturer, or its authorized representative, should submit a request to:

Materials-Director
FM Approvals
1151 Boston-Providence Turnpike PO Box 9102
Norwood, MA 02062 U.S.A.

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

- A complete list of all models, types, sizes, and options for the products or services being submitted for Approval 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 an Approval examination, the project engineer will inform the manufacturer of the number and type of samples that shall be submitted for examination and testing.

2.3.2 The manufacturer shall submit samples representative of production. FM Approvals, at their sole discretion, shall reserve the right to witness production of test samples and/or any components or raw materials that are deemed to be critical to the performance of the product. Any decision to use data generated using prototypes is at the discretion of FM Approvals.

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

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 DLC relief panels shall be of lightweight construction. They shall be permitted to be fabricated from single or multiple layers and can incorporate insulating materials for energy conservation. The maximum panel weight shall be 4 lbs/ft² (19.5 kg/m²).
- 3.1.4.1 For very fast burning fuels that fall into Table 5 of FM Global Property Loss Prevention Data Sheet 1-44, Damage Limiting Construction., the maximum weight shall not exceed 3 lbs/ft² (14.6 kg/m²).
- 3.1.4.2 When panels are used within a wall having an exterior fire exposure rating, the panel weight may be increased to 8 lbs/ft² (39.0 kg/m²). The increase in weight is permitted only when used with fuels governed by Table 2 or 3 of FM Global Property Loss Prevention Data Sheet 1-44, Damage Limiting Construction.,
- 3.1.5 All release devices shall be designed to release at an internal pressure between 20 lbs/ft² to 40 lbs/ft² (0.96 – 1.92 kPa).

3.2 Markings

3.2.1 Marking on the product 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.

3.2.2 The model or type identification shall correspond with the manufacturer's catalog designation and shall uniquely identify the product as FM Approved. The manufacturer shall not place this model or type identification on any other product unless covered by a separate agreement.

3.2.3 The Approval Mark (see Appendix B) shall be displayed visibly and permanently on the product and/or packaging as appropriate. The manufacturer shall not use this mark on any other product unless such product is covered by a separate report.

3.2.4 All markings shall be legible and durable.

3.3 Manufacturer's Installation Instructions

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

All examinations and tests performed in evaluation to this Standard shall use calibrated measuring instruments traceable and certified to acceptable national standards.

4. PERFORMANCE REQUIREMENTS

4.1 Static Tests – Explosion Venting Fasteners and/or Systems

4.1.1 Requirement

All explosion venting systems submitted for Approval 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 for each design load for which Approval is desired. The testing shall be conducted in accordance with the Static Test Procedure for Explosion Venting Fasteners and/or Systems. Including Oven Latches.

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 Static Test Procedure for Explosion Venting Systems, the system(s) and/or fastener(s) shall be subjected to the Small Scale Dynamic Test Procedure for Explosion Venting Systems in order to determine the breaking strength.

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 Approval is desired. The testing shall be conducted in accordance with the Small Scale Dynamic Test Procedure for Explosion Venting Systems.

4.2.2.2 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;

4.3 Static Tests – Oven Latches

4.3.1 Requirement

All oven latching systems submitted for Approval shall be subjected to a static test in order to determine the system(s) and latch(es) static breaking strength.

4.3.2 Test/Verification

4.3.2.1 Five (5) tests shall be conducted on each latch and/or system combination for each design load for which Approval is desired. The testing shall be conducted in accordance with the Static Test Procedure for Explosion Venting Fasteners and/or Systems Including Oven Latches. The same sample will be used for all five (5) tests.

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

- the static breaking strength of the five (5) tests does not vary from the average by more than 15%;
- all latches that secure the system 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.

5. OPERATIONS 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 Approval Report.
- Continued conformance to this Standard is verified by the Surveillance Audit.
- 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 Approval Report, must be reported to, and authorized by, FM Approvals prior to implementation for production.
- The manufacturer shall assign an appropriate person or group to be responsible for, and require that, proposed changes to FM Approved or Listed products be reported to FM Approvals before implementation. The manufacturer shall notify FM Approvals of changes in the product or of persons responsible for keeping FM Approvals advised by means of FM Approvals' Form 797, *FM Approved Product/ Specification-Tested Revision Report or Address/Main Contact Change Report*.
- Records of all revisions to all FM Approved products shall be maintained.

5.2 Surveillance Audit

- 5.2.1 An audit of the manufacturing facility is part of the Approval investigation 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 insure a uniform product consistent with that which was tested and FM Approved.
- 5.2.2 These audits shall be conducted periodically but at least annually by FM Approvals or its representatives.
- 5.2.3 FM Approved products or services shall be produced or provided at or from the location(s) audited by FM Approvals and as specified in the Approval Report. Manufacture of products bearing the Approval Mark is not permitted at any other location without prior written authorization by FM Approvals.

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 FM Approvals.

5.4 Manufacturer's Responsibilities

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

APPENDIX A: Units of Measurement

LENGTH: in. - "inches"; (mm - "millimeters")

$$\text{mm} = \text{in.} \times 25.4$$

ft - "feet"; (m - "meters")

$$\text{m} = \text{ft} \times 0.3048$$

AREA: in^2 - "square inches"; (mm^2 - "square millimeters")

$$\text{mm}^2 = \text{in}^2 \times 6.4516 \times 10^2$$

ft^2 - "square feet"; (m^2 - "square meters")

$$\text{m}^2 = \text{ft}^2 \times 0.0929$$

MASS: lb - "pounds"; (kg - "kilograms")

$$\text{kg} = \text{lb} \times 0.454$$

PRESSURE: psi - "pounds per square inch"; (bar - "bar")

$$\text{kPa} = \text{psi} \times 6.895$$

bar - "bar"; (kPa - "kilopascals")

$$\text{bar} = \text{kPa} \times 0.01$$

$$\text{bar} = \text{psi} \times 0.06895$$

TEMPERATURE: °F - "degrees Fahrenheit"; (°C - "degrees Celsius")

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 0.556$$

APPENDIX B: FM APPROVALS CERTIFICATION MARKS

FM Approvals certifications marks are to be used only in conjunction with products or services that have been Approved by FM Approvals and in adherence with usage guidelines.



FM APPROVED mark:

Authorized by FM Approvals as a certification mark for any product that has been FM Approved. There is no minimum size requirement for the mark, but it must be large enough to be readily identifiable. The mark should be produced in black on a light background, or in reverse on a dark background.



Cast-On FM Approvals marks:

Where reproduction of the FM Approved mark described above is impossible because of production restrictions, use these modified versions of the FM Approved mark. There is no minimum size requirement for the mark, but it must be large enough to be readily identifiable.



FM Approved Mark with “C” only:

Authorized by FM Approvals as a certification mark for any product that has been evaluated by FM Approvals in accordance with Canadian codes and standards. There is no minimum size requirement for the mark, but it must be large enough to be readily identifiable. The mark should be produced in black on a light background, or in reverse on a dark background.



FM Approved mark with “C” and “US”:

Authorized by FM Approvals as a certification mark for any product that has been evaluated by FM Approvals in accordance with US and Canadian codes and standards. There is no minimum size requirement for the mark, but it must be large enough to be readily identifiable. The mark should be produced in black on a light background, or in reverse on a dark background.

FM Approvals Certification Marks

USAGE GUIDELINES

All FM Approvals certification marks are the sole property of FM Approvals LLC (“FM Approvals”) and are registered or the subject of applications for registration in the United States and many other countries. They are for use only according to these guidelines.

FM Approvals certification marks may be used only on FM Approved products and related product packaging, in advertising material, catalogs and news releases. Use of FM Approvals certification marks on such material is not a substitute for use of the complete FM Approvals certification mark on FM Approved products and/or product packaging.

No FM Approvals certification mark or aspect thereof may be incorporated as part of a business name, Internet domain name, or brand name/trademark for products/product lines. This includes both design aspects (the FM Approvals “diamond,” etc.) and word aspects (“FM,” “Approved,” etc.). The use of any FM Approvals certification mark as a trademark is strictly prohibited.

The Approval Standard number or class number may not be incorporated as part of a business name, Internet domain name, or brand name/trademark for products/product lines. For example, a company may not say “ABC Company’s 4100 Fire Door is FM Approved”; the proper terminology is, “ABC Company’s Fire Door is FM Approved per Approval Standard 4100.”

FM Approvals certification marks, except for the FM Approvals Quality System Registration mark, may not be used on business stationery/cards/signage because this could mischaracterize the relationship with FM Approvals. Additionally, these items should not reference any FM Approvals certification mark.

Products or services may not be marketed under any mark or name similar to “FM Global,” “FM Approvals” or any of the FM Approvals certification marks. Further, products or services may not be marketed to imply a relationship beyond the scope of any Approval made by FM Approvals.

When an FM Approvals certification mark is used in advertising material or on product packaging, all material must reflect the specific circumstances under which the product was FM Approved. The material must clearly differentiate between products that are FM Approved and those that are not, and may not, in any way, imply a more substantial relationship with FM Approvals.

A company may not reference the intent to submit a product for Approval or the expectation that a company will have a certain product FM Approved in the future. For example, a company may not state, “Approval by FM Approvals pending” or “Approval by FM Approvals applied for.”

FM Approvals certification marks should not be preceded or followed by a qualifier that indicates a degree of certification or acceptability. For example, “exceeds,” “first” or “only” may not be used to qualify any FM Approvals certification mark.

Only original artwork issued by FM Approvals should be used. The FM Approvals certification marks should not be altered in any way other than to resize the artwork proportionately. Unacceptable uses of the marks include, but are not limited to, adding/deleting wording or artwork, reducing the artwork to an illegible size, animation or distortion.

The text of the FM Approvals certification marks may not be translated into any language other than English.

FM Approvals certification marks must appear in a size and location that is readily identifiable, but less prominent than the name of the owner of the certification or the manufacturer/seller/distributor of the certified products.