Examination Standard for Pipe and Duct Insulation

Class Number 4924

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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 materials which may be used as insulation on the exterior of noncombustible pipes or ducts. If such a material is sufficiently combustible, it may cause a spreading fire along the route of the pipe or duct which it insulates. Mechanical piping systems such as those in heating, ventilating, air conditioning, or refrigeration sometimes need to be insulated for maximum operational efficiency. This standard sets the performance requirements to accurately assess the ability of a material to resist this fire.

1.1.2 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 fire performance requirements for pipe and duct insulation including pre-insulated pipe and evaluates the potential for a horizontal spreading fire in parallel runs of insulated pipes or ducts within a pipe chase or plenum. To qualify for certification as a product of low fire hazard, not requiring automatic sprinkler protection of itself, the insulation material must perform satisfactorily in all tests as outlined in this standard. This standard is not intended to address certification of pre-insulated ducts, or fume and smoke exhaust ducts that have been certified in accordance with Examination Standard 4922.

1.2.1.1 Pipe and duct insulation that meet the fire performance requirements of paragraph 1.2.1 above, and are categorized for use in pharmaceutical manufacturing and storage area, food preparation and storage areas and similar occupancies or other occupancies that are highly susceptible to smoke damage shall also meet the requirements as outlined in paragraph 4.5 (Duct Insulation) or paragraph 4.6 (Pipe Insulation) of this standard. Pipe and duct insulation in this category produce somewhat higher levels of smoke (when compared to those materials which are evaluated for cleanrooms) but produce less smoke than materials evaluated for fire performance only.

1.2.1.2 Pipe and duct insulation that meet the fire performance requirements of paragraph 1.2.1 above, and are intended for use in cleanroom occupancies shall also meet the requirements of Examination Standard 4910, Cleanroom Materials Flammability Test Protocol. This test protocol evaluates the materials' fire propagation behavior and potential for smoke contamination using two indices: Fire Propagation Index (FPI) and Smoke Development Index (SDI).

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

1.2.3 The results of tests conducted under the controlled conditions required by this standard shall not be used to describe or appraise performance under actual fire conditions. Actual fire conditions may vary widely.

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 national and international 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 pipe and duct insulation for the purpose of becoming certified.

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*

ASTM E2058, *Standard Test Methods for Measurement of Synthetic Polymer Material Flammability Using a Fire Propagation Apparatus (FPA)*

ASTM D1622, *Standard Test Method for Apparent Density of Rigid Cellular Plastics*

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*

ISO 9705, *Fire Tests-Full Scale Room Test for Surface Products*

UBC Standard 26-3, *Room Fire Test Standard for Interior of Foam Plastics*

1.9 Terms and Definitions

For purposes of this standard, the following terms apply:

Critical Heat Flux (CHF) — the maximum heat flux at or below which there is no ignition.

Duct Insulation — thermal insulation applied to the exterior of non-combustible ducts that are used in heating, ventilation, and air conditioning (HVAC) systems.

Fire Propagation Index (FPI) — ratio of the one-third power of the radiative fraction of the chemical heat release rate per unit width of a sample to the ignition resistance of the sample, defined as the Thermal Response Parameter (TRP). It is an indicator of the propensity of the material to support fire propagation.

FSP_c - convective flame spread parameter — FSPc = (Qc/TRP*A) where Qc is the 5 second average peak convective heat release rate, TRP is the thermal response parameter determined from ignition tests per ASTM E2058, and A is the area of the combustion sample used to determine Qc

Pipe Insulation — thermal insulation applied to the exterior of non-combustible pipes

Pre-Insulated Pipe — Pre-insulated pipe systems normally include a carrier pipe, an outer jacket, and an insulation material between the pipe and jacket.

Smoke Development Index (SDI) — Smoke Yield (ys) multiplied by Fire Propagation Index (FPI). It is an indicator of the potential for smoke contamination during fire propagation.

Smoke Yield (ys) — ratio of the total mass of smoke released to the total mass of the material vaporized

Thermal Response Parameter (TRP) — indicator of the ignition resistance or the thermal inertia of a material.

Thermocouple — A thermoelectric device used to make accurate measurements of temperatures, especially high temperatures.

Thermoplastic — polymer that becomes pliable or moldable above a specific temperature, and returns to a solid state upon cooling.

Thermosetting Polymer — also known as a thermoset, is a polymer material that irreversibly cures. The cure may be done through heat, through a chemical reaction or irradiation. Once hardened, a thermoset resin cannot be reheated and melted back to a liquid form.

2 GENERAL INFORMATION

2.1 Product Information

2.1.1 The requirements of this standard shall be used to measure and describe the performance of pipe and duct insulation in response to exposure from fire under controlled laboratory conditions. The results of these controlled exposures shall not be used to describe or appraise actual exposure conditions, since such conditions may vary widely. The certification examination includes fire tests as noted. Inspection of the product manufacturing facility shall be conducted to assure conformance with the required tests and specifications.

2.1.2 Pipe and duct insulation comes in many forms including, but not limited to Flexible elastomeric foams (nitrile butadiene rubber [NBR] or ethylene propylene diene monomer (M-class) rubber [EPDM]), rigid foams (phenolic, polyurethane [PUR] or polyisocyanurate [PIR]), polyolefin foams, mineral wool, and fiberglass. In addition, these insulators may or may not be jacketed with metal foil and paper combinations or some other material. The type of jacket, if any, is dependent upon the specific application, the insulation manufacturer or both. In some cases, pre-insulated pipe systems are used which normally include a carrier pipe, an outer jacket, and an insulation material between the pipe and jacket.

2.1.3 Testing of tubular pipe insulations will be conducted in accordance with the Pipe Chase Test. Testing will be performed on the maximum insulation wall thickness, most critical facer (if applicable), maximum internal diameter and most critical system components (adhesives, tapes and accessories) at the density for which certification is sought. Overall outside diameter shall not exceed 18 in. (457 mm). Upon successful completion, certification will be extended to include thinner wall thicknesses and smaller internal diameters at the same density tested.

2.1.3.1 For certification of tubular pipe insulation exceeding an overall outside diameter of 18 in. (457 mm) the following is required:

- successful completion of testing as described in 2.1.3 above for tubular pipe insulation having less than overall outside diameter of 18 in (457 mm) and
- successful completion of testing as a flat sheet as described in 2.1.4 below.

2.1.4 Testing of flat sheet insulations will be conducted in accordance with UBC Standard No. 26-3 or ISO 9705 room test. Testing will be performed on the maximum insulation wall thickness, most critical facer (if applicable) and most critical system components (adhesives, tapes and accessories) at the density for which certification is sought. Upon successful completion, certification will be extended to include thinner wall thicknesses at the same density tested.

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, anticipated marking format, brochures, sales literature, specification sheets and installation; and
- the number and location of manufacturing facilities.

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 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;
- a representative of the certification agency shall inspect the manufacturing facility for, witness the production of, and place their mark on, each sample pipe or duct insulation to be evaluated.

2.3.2 Requirements for samples may vary depending on design features, results of prior or similar testing, 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 products for certification.

3 GENERAL REQUIREMENTS

3.1 Review of Documentation

3.1.1 During the initial investigation and prior to physical testing, the manufacturer's specifications and details shall be reviewed to assess the ease and practicality of installation and use. The certification examination results may further define the limits of the final certification.

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, size, rating, capacity, etc., 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

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.

3.4 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.

3.5 Observation of Test Sample Production

A representative of the certification agency shall inspect the manufacturing facility, witness the production of, and place an identification mark on, each pipe and duct insulation product to be evaluated.

3.6 Formulation Changes

3.6.1 Certification of formulation changes involving a single major ingredient (polymeric ingredients, flame retardant, fillers, plasticizers, blowing agents, etc.) of a previously certified pipe or duct insulation shall be based on a favorable comparison of the flammability characterization of the component produced from the modified formulation with the flammability characterization of the originally certified component.

3.6.2 Certification of formulation changes involving more than one major ingredient or a single major ingredient where flammability characterization of the modified formulation and previously certified components do not compare favorably shall be based on all the requirements of this standard.

4 PERFORMANCE REQUIREMENTS

In order to qualify for certification, the candidate product shall satisfy the following test requirements as described in paragraphs 4.1 thru 4.5 below. An optional smoke-sensitive occupancy rating may be attained as described in paragraphs 4.6 and 4.7 below.

4.1 Room Test

4.1.1 Requirement:

Duct insulation (sheets) covered by this standard shall be subjected to an ANSI FM 4880 Room Test or an ISO 9705 room test.

4.1.1.1 For both ANSI FM 4880 Room Test and ISO 9705 the extent of flame spread along the insulation is assessed as a:

- 0.25 in. (6.4 mm) char depth for Thermosetting Polymer material measured at least 1 ft (0.3 m) below the enclosure ceiling. For products with a thickness of less than 0.25 in. (6.4 mm), the char depth must be less than the material thickness.
- 0.50 in. (13 mm) melt depth for Thermoplastic material measured at least 1 ft (0.3 m) below the enclosure ceiling. For products with a thickness of less than 0.50 in. (13 mm), the melt depth must be less than the material thickness.

Note 1: If testing is conducted in accordance with ISO 9705 Room test an optional smoke-sensitive occupancy rating may also be attained. (See paragraph 4.6)

4.1.2 Test/Verification

ANSI FM 4880 Room Test, as described in Appendix C of ANSI FM 4880: Room Test or ISO 9705 - Fire Tests - Full-Scale Room Test for Surface Products.

4.2 Pipe Chase Test

4.2.1 Requirement:

Pipe insulation (tubes) and pre-insulated pipe covered by this standard shall be subjected to a Pipe Chase Test: The tube insulation shall (1) not support a self-propagating fire to the end of the 24 ft (7.3 m) horizontal segment of the insulated pipe within 10 minutes of ignition. This can be qualitatively assessed from visual observation during the fire test or as a ¼ in. (6.35 mm) char depth measured for at least 30% of the insulations outer diameter; (2) not exceed a temperature of 572°F (300°C) as measured by the thermocouple located along the centerline of the pipe chase, 0.5 in (13 mm) below the ceiling and adjacent to the open end of the Pipe Chase (TC 5); and (3) be considered acceptable if all flaming and glowing material, that has fallen from the horizontal segment of the test pipes during the 10 minute fire exposure, has extinguished within 10 seconds of hitting the floor.

4.2.2 Test/Verification:

The Pipe Chase Test is intended to evaluate the performance of cylindrical pipe insulation to resist a specified minimum exposure fire along unprotected insulated pipes. This is accomplished by quantifying the flame propagation along a series of parallel insulated pipes located within a three sided pipe chase. The exposure test shall be run for ten (10) minutes. A sufficient amount of pipe insulation (tubes) or pre-insulated pipe is required to cover three (3) pipes of 24 ft (7.3 m) long horizontal sections connected to a 3 ft (0.9 m) vertical section.

4.3 Surface Burning Characteristics of Pipe and Duct Insulation

4.3.1 Requirement:

For pipe and duct insulation, the flame spread and smoke developed shall be reported for the bare

insulating core at a thickness of 4 in. (100 mm) or the maximum insulating core thickness, whichever is less. A minimum of 3 tests shall be conducted[2].

4.3.2 Test/Verification:

ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials

Note 2: These tests are optional and conducted to satisfy building code requirements or for identification purposes. The certification agency place no limits on the values obtained.

4.4 Density of Insulating Core

4.4.1 Requirement:

For pipe and duct insulation, the density of the un-faced insulation shall be determined and reported[3].

4.4.2 Test/Verification:

ASTM C167, Standard Test Methods for Thickness and Density of Blanket or Preformed Block or Broad-Type Thermal Insulation or ASTM D1622, Standard Test Method for Apparent Density of Rigid Cellular Plastics.

Note 3: These tests are conducted for identification purposes including confirmation of test sample product density. The certification agency place no limits on the values obtained.

4.5 Flammability Characterization

4.5.1 Requirement:

For plastic or other combustible components of pipe and duct insulation covered by this standard, the chemical heat of combustion, kJ/g (ΔH_{ch}), critical heat flux for ignition, kW/m^2 (q''_c), thermal response parameter, kW/m^{2}s$^{-1/2}$ (TRP) and convective flame spread parameter, s$^{-1/2}$ (FSPc) shall be determined[4].

Note 4: These tests are conducted to establish a base from which requests for formulation revisions are evaluated. With respect to this standard, the certification agency places no limits on the values obtained.

4.5.2 Test/Verification

Flammability Characterization using a Fire Propagation Apparatus per ASTM E2058.

4.6 Optional Smoke-Sensitive Occupancy Rating (Duct Insulation)

4.6.1 Requirement:

Duct insulation (sheets) covered by this standard which are categorized for use in pharmaceutical manufacturing and storage areas, food preparation and storage areas and similar occupancies or other occupancies which are susceptible to smoke damage shall (1) meet the certification requirement as outlined in paragraphs 4.1, 4.3, 4.4 & 4.5 and (2)[5] not generate smoke in excess of 575 g (1.30 lb) during the 20 minute exposure fire plus an additional 2 minutes.

Note 5: Smoke generation rates as measured during ISO 9705 Room test.

4.6.2 Test/Verification:

Instrumentation installed to quantify the smoke generation rate in the gas flow exiting the apparatus during the International Standards Organization (ISO) 9705, International Standard, Fire Tests-Full Scale Room Test for Surface Products.

4.7 Optional Smoke-Sensitive Occupancy Rating (Pipe Insulation)

4.7.1 Requirement:

Pipe insulation (tubes) covered by this standard which are categorized for use in pharmaceutical manufacturing and storage areas, food preparation and storage areas and similar occupancies or other occupancies which are susceptible to smoke damage shall (1) meet the certification requirement as outlined in paragraphs 4.2, 4.3, 4.4 and 4.5 and (2) not generate smoke in excess of 110 g (0.24 lb) during the 10 minute exposure fire plus an additional 2 minutes.

4.7.2 Test/Verification:

Instrumentation installed to quantify the smoke generation rate in the gas flow exiting the apparatus during the pipe chase test.

5 MANUFACTURER'S REQUIREMENTS

5.1 Demonstrated Quality Control Program

5.1.1 A quality assurance program is required to assure that subsequent products 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 may be 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.

5.1.2 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.

5.1.3 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.

5.1.4 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.

5.1.5 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 agency's 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 Product Modifications

5.3.1 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*.

Ditch, Benjamin. *Development of a Fire Performance Test for Pipe and Duct Insulation, Examination Standard Class Number 4924, FM Global Technical Report, Project ID 0003033423, May 2011*

Tewarson, A. *Generation of Heat and Chemical Compounds in Fires, The SFPE Handbook of Fire Protections Engineering, 3rd Edition, Section 3 Chapter 4, pp. 3-82 to 3-161, 2002*