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Examination Standard for Lightweight Insulating Concrete for Use in Class 1 and Noncombustible Roof Constructions

Class Number 4454

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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 classification of lightweight insulating concrete when used in roof deck constructions. certified lightweight insulating concretes are those that meet the criteria of this standard for combustibility and wind resistance.

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 performance requirements for lightweight insulating concrete when used in roof deck constructions. This standard examines the ability of lightweight insulating concrete to limit fire spread and resist wind forces.

1.2.2 In addition to the requirements specified in this standard, the components above the lightweight insulating concrete (e.g. roof covers, base sheets, fasteners) shall meet the requirements of the Examination Standard 4470—Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Systems for use in Class 1 and Noncombustible Roof Deck Construction.

1.2.3 This standard is intended to verify that the product as described will meet the stated conditions of performance and quality, useful to determine the suitability for end-use conditions of these products.

1.2.4 The requirements of this standard shall be used to measure and describe the performance of lightweight insulating concrete in response to exposure from fire and wind, under controlled laboratory conditions. The results of these controlled exposures shall not be used to describe or appraise actual exposure conditions, since such conditions vary widely.

1.2.5 The certification program includes fire, wind uplift, corrosion, and other tests as noted. A complete review of construction and application specifications shall be conducted to assure, as far as possible, a practical and reliable installation. Inspection of the product manufacturing facility and of at least one field installation, at the discretion of the certification agency, shall be conducted to assure conformance with the required tests and specifications.

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 loss control specialists was also considered.

1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of lightweight insulating concrete for the purpose of obtaining certification.

1.4 Basis for Certification

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 is made to evaluate the manufacturer's ability to consistently produce the components of 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.

1.4.3 An examination of the procedures employed in supplying the material components and sufficient mixing and installation instructions to the field site, where the actual certified product is fabricated, to ensure the finished product meets the requirements for certification.

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.

ANSI/FM 4474 – American National Standard for Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies using Static Positive and/or Negative Differential Pressures.

AWS D1.3 - Structural Welding Code – Sheet Steel

FM 4470, Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for use in Class 1 and Noncombustible Roof Deck Construction

1.9 Terms and Definitions

For purposes of this standard, the following terms apply:

Cementitious Wood Fiber –A factory fabricated roof deck consisting of wood fibers and cementitious binder. It is supplied in 2 in. (50 mm) minimum thickness with tongue and groove sides and end joints.

Fastener- A mechanical securement device used alone or in conjunction with a stress distributor to secure various components of a roof assembly.

Lightweight Insulating Concrete -A type of insulation comprised of portland cement, lightweight aggregate or preformed foam or hybrid combination of these. It may be applied with or without the use of expanded polystyrene (EPS) board encapsulated within the lightweight insulating concrete.

Mechanically Fastened – Describes roof covers or base sheets that have been attached to the substrate at defined intervals using fasteners with or without stress distributors.

Roof Assembly — An assembly (including the structural deck) of interacting roof components designed to weatherproof and, normally, to insulate a building's top surface.

Roof System —A system of interacting roof components designed to weatherproof and, normally, to insulate a building's top surface. The roof system does not include the structural deck.

Steel Roof Deck – Corrugated metal with a thickness greater or equal to 22 gauge (0.7595 mm) used as a structural component to support a roof system.

Steel Form Deck – Corrugated metal with a thickness less than 22 gauge (0.7595 mm) used as a structural component to support a roof system.

Structural Concrete Roof Deck – Structural concrete decks are generally monolithic, cast in place decks or precast concrete plank. These decks have a minimum compressive strength of 2500 psi (17.2 mPa) and a density of approximately 150 lb/ft^3 (2400 kg/m^3). Roof assemblies on structural concrete are considered noncombustible.

Structure - The building framework to which the roof deck is fastened.

Weld - A type of securement whereby metal or plastic products are joined together through heat or solvent fusion.

Wind Uplift—Wind-induced forces on a roof assembly or components in a roof assembly. Wind uplift generally includes a negative pressure component caused by wind being deflected around and across the surfaces of a building and a positive pressure component from air flow beneath the roof deck.

2 GENERAL INFORMATION

2.1 Product Information

Lightweight insulating concrete is utilized to support finished roofing materials and other roof loads experienced throughout the life of the structure. The roof system is utilized to provide weatherproofing to the structure and contents. Lightweight insulating concrete is placed above steel roof deck, steel form deck, structural concrete, existing roofs in recover construction or cementitious wood fiber panels. The lightweight insulating concrete must demonstrate the ability to limit fire spread along the underside of the deck and resist anticipated wind forces. Modes of failures observed in testing and in field applications include adhesive failure between the various components within the roof assembly, cohesive failure of an individual component, separation of the steel roof deck or steel form deck from the structural framework, and separation of the roof system from the lightweight insulating concrete.

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, piping and electrical schematics, nameplate format, brochures, sales literature, spec. sheets, installation, operation and maintenance procedures, etc... ; 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.
- The mix design, including minimum compressive strength and finished product density, for the lightweight insulating concrete and the formulation and specifications for each component of the lightweight insulating concrete shall be submitted to the certification agency for review and be kept on file at the certification agency on a confidential basis. The manufacturer shall also provide any mix design or chemicals necessary to compensate for weather extremes (hot and/or cold weather adjustments).

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, 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; and
- 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 and Operation 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.

3.4 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

At the discretion of the certification agency, a representative of the certification agency shall witness production of and place their mark on components of and/or ingredients for the lightweight insulating concrete roof deck components to be evaluated.

3.6 Welding

Welding of the steel roof deck or steel form deck to the supporting members, if used, shall be by puddle welds (arc spot welds) in accordance with AWS D1.3. Qualified welders shall follow a qualified welding procedure. Welders and the welding procedure shall be qualified in accordance with AWS D1.3. Weld washers are required for steel form deck.

3.7 Roof Deck Spans

The roof deck spans shall be limited to a maximum of that meeting the wind uplift test requirements.

3.8 Other Requirements

Wind forces in the building perimeter and corners are up to 1.7 and 2.6 times greater, respectively, than wind forces in the field of the roof. When a steel roof deck or steel form deck is utilized, the securement of the deck to the supporting structure in these areas shall be enhanced by increasing the number of fasteners/welds as listed in the certified roof field spacing per FM Global Property Loss Prevention Data Sheet 1-29. When a mechanically fastened base sheet is utilized, the securement of the base sheet to the lightweight insulating concrete in these areas shall be enhanced per FM Global Property Loss Prevention Data Sheet 1-29.

4 PERFORMANCE REQUIREMENTS

In order to be certified, each lightweight insulating concrete shall satisfy the following performance criteria necessary to reduce the potential for fire spread, corrosion resistance and to obtain satisfactory wind uplift performance.

4.1 Combustibility – From Below Roof Assembly

4.1.1 Requirement

The Blank

The blank test sample consists of nothing more than the furnace cover. The cover is made from a noncombustible refractory concrete.

Class 1 Sample

The Class 1 sample shall consist of 18 ga. wide rib steel deck, 1 in (25 mm) thick wood fiber and a steel cover. The steel cover is placed over the wood fiber and the entire assembly is then placed in the furnace opening.

Samples for Testing

The test specimen is to be built by those suitably qualified in the construction of the type of assembly being tested and in accordance with the drawings or written description provided by the project engineer.

Construction of the test samples shall be done by certification agency personnel with the assistance of, and under the guidance of, the test sponsor. As an alternative, the test sponsor or contractor personnel shall be permitted to construct the assembly under the guidance of the test sponsor and witnessed by certification agency personnel.

Unless specified otherwise in the work request, the test sample shall consist of the following:

The steel deck shall be installed in two (2) pieces with the ribs running parallel to the long dimension of the opening. The piece of steel deck located at the front of the opening shall be four (4) ribs in width. The piece of steel located towards the rear of the opening shall be five (5) ribs in width. Need wood deck assembly as well.

When constructing the test sample, care shall be taken to ensure that each layer of the sample (steel deck, insulation, cover boards, base, ply and top sheets) be installed such that the joints between adjacent layers are staggered to the extent possible or oriented perpendicular to the layer below it.

Upon completion of the construction, each sample shall be clearly marked showing the Project ID and a sample number for identification purposes. Additional information shall be permitted to be shown.

4.1.2 Test/Verification

Standard Test Procedures

The test is conducted, and data recorded for a period of not less than 30 minutes.

The test shall be permitted to be terminated prior to the 30 minutes at the discretion of the test sponsor or engineer in charge of the project.
During the test, a technician shall be stationed in the test lab to monitor the test sample. Mud shall be placed around the edge of the sample and at any location where the sample is venting.

Upon completion of the test, the furnace shall be shut down.

Blank Test Procedures

One (1) blank test shall be conducted each week that a calorimeter test is scheduled for testing prior to conducting the calorimeter test. If the results of the test are satisfactory, no other blank tests need to be conducted. However additional blank tests can be conducted at the discretion of the operator.

Upon completion of the test, the heptane system shall be shut off followed by the propane system.

Following the shut down of the heptane and propane systems, the blank shall be removed from the furnace. If additional blank tests are to be conducted that day, a fan shall be placed in the furnace opening in an effort to reduce the temperatures in the furnace.

Subsequent blank tests, if conducted, shall not start until the cool down temperature has been reached. These subsequent tests shall be conducted using the same fuel flow rates but due to the nature of the apparatus, the target temperatures will not be attainable. In these cases, the operator shall compare the results to historical data obtained from previous and similar tests.

Class 1 Test Procedures

The Class 1 test procedures shall be identical to the standard test procedures except that a Class 1 sample shall be used.

The Class 1 test shall be conducted at a period not to exceed ninety (90) days. Tests shall be permitted to be run on a more frequent basis at the discretion of the operator. The results of the Class 1 test shall be as shown in Table 6.5.2.

Table 6.5.2

Maximum Average Rate of Fuel Contribution
for Various Time Intervals
[All rates are shown in BTU/ft²/min (kW/m²)]

Time Interval	3 min	5 min	10 min	Average
Class I Standard	410 (77.6)	390 (73.8)	360 (68.1)	285 (53.9)
Class 1 Test Results*	385 (72.9)	365 (69.0)	335 (63.4)	260 (49.2)

*Note: All rates shall have a tolerance of ±25 (±4.7).

If any of the Class 1 test results are not within tolerance, the operator shall bring this to the attention of the certification agency team manager for resolution.

4.1.3 Acceptance Criteria

The lightweight insulating concrete when subjected to fire exposure from below shall not exhibit fuel contribution rates in excess of the values in Table 1.

Additionally, there shall be no dropping of flaming particles into the furnace or uncontrolled flaming on the exterior surface of the sample.

Table 1

Time Interval min	***Max Fuel Contribution Rate Btu/ft²/Min (kW/m²)***	
3	410	(77.6)
5	390	(73.8)
10	360	(68.1)
Avg. (30 min)	285	(54.0)

4.2 Wind Resistance – Field of Roof

4.2.1 Requirement

The lightweight insulating concrete shall demonstrate its ability to withstand wind uplift forces. The roof assembly shall withstand the appropriate minimum uplift pressure shown in Table 2 for a minimum of 60 seconds without disengagement, separation, or failure of any component.

Table 2

Windstorm Classification	***Minimum Uplift Pressure Psf (kPa)***
Class 1-60	60 (2.9)
Class 1-75	75 (3.6)
Class 1-90	90 (4.3)
Class 1-105	105 (5.0)
Class 1-120	120 (5.7)
Class 1-135	135 (6.5)
Class 1-150	150 (7.2)
Class 1-165	165 (7.9)
Class 1-180	180 (8.6)
Etc.	

4.2.2 Tests/Verification

The test shall be conducted in accordance with ANSI/FM 4474 test procedures using alternate test methods 1 or 2: 12 x 24 ft Wind Uplift Tests for Single Ply and Multi Ply Roof Coverings, or 2 x 2 ft Wind Uplift Pull Test for Adhered Multi Ply Roof Coverings or Fully Adhered Single Ply Roof Coverings over structural concrete deck.

4.3 Wind Uplift Resistance – Component Substitutions or Modifications

4.3.1 Requirement

The roof assembly utilizing lightweight insulating concrete shall be tested to establish a base line performance for future modifications or component substitutions. When a modification or component

substitution to the certified assembly is desired the wind uplift performance of the modified assembly shall be equal to or better than the certified assembly.

4.3.2 Tests/Verification

The test shall be conducted in accordance with the following ANSI/FM 4474 test procedures: 12 x 24 ft Wind Uplift Tests for Single Ply and Multi Ply Roof Coverings, 2 x 2 ft Wind Uplift Pull Test for Fully Adhered Roof Coverings, or 5 x 9 ft Wind Uplift Tests for Single Ply and Multi Ply Roof Coverings.

4.4 Corrosion Resistance

4.4.1 Requirement

Through visual inspection, the amount of red rust is determined. Staining is not considered red rust. A sample passes the corrosion test when no specimen has a corrosion area of greater than 15%. Any sign of coating blistering, peeling, or cracking is cause for failure.

4.4.2 Test/Verification

Nylon line and/or glass rods can be used to arrange the specimens in the cabinet. Arrange the specimens in the cabinet in a such a way that no part of any specimen is within ¾ in. of another, 4 in. of the walls or lid, or 7-7/8 in. of the surface of water in the base of the chamber. Also, arrange the specimens so that the moisture which may condense on them or their supports will not fall on other specimens placed at lower levels.

Document the appropriate steps on the corrosion test form.

The cycle will run for 8 hours. The chamber is automatically purged at the end of each cycle.

Immediately after the 8 hours, wash the specimens by gently swishing the mounted specimens in a tank of distilled water heated to 100°F +/- 5°F.

Arrange the specimens back in the cabinet to air dry overnight with the lid open.

Repeat for a total of 15 cycles.

4.4.3 Acceptance Criteria

The analysis is run by an engineer.

Analysis is performed upon the completion of the 15 cycles.

Document the analysis on the corrosion analysis form.

Consult a total of 5 engineers. Through visual inspection, determine the amount of red rust and average the results. Staining is not considered red rust. A sample passes the corrosion test when no specimen has a corrosion area of greater than 15%. Any sign of coating blistering, peeling, or cracking is cause for failure. Each consulted engineer must also pass or fail the specimen based on the preceding criteria.

Exception: For fasteners which are embedded in the LWIC layer, the portion of the fastener embedded in the LWIC is exempt from this requirement.

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.
- on-site handling and installation procedures
- density of installed material
- compressive strength of installed material

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 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 Manufacturer's Responsibilities

5.4.1 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

ASCE 7- Minimum Design Loads for Buildings and Other Structures.

ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM G 87 - Standard Practice for Conducting Moist SO2 Tests

DIN 50018 - Testing in a Structural Atmosphere in the Presence of Sulphur Dioxide

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

FM Global Property Loss Prevention Data Sheet 1-29, Roof Deck Securement and Above-Deck Roof Components