



Member of the FM Global Group

Approval Standard for Chimney and Flue Liner Materials

Class Number 4929

November 2007

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 liner materials used in industrial chimneys and flues primarily found in the power generation industry but also extends to other industries such as mining. The purpose of these materials is to prevent damage to the underlying materials of construction when exposed to highly corrosive, high temperature environments.
- 1.1.2 Products that receive Approval recognition have been evaluated to provide assurance that the materials used as corrosive liners will limit flame propagation when ignited from unexpected sources.
- 1.1.3 Approval criteria may include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a follow-up program.

1.2 Scope

- 1.2.1 This standard sets performance requirements for industrial chimney and flue liner materials under simulated laboratory conditions by assessing the ability of a chimney or flue liner material to limit any flame spread that is caused by the unexpected ignition of these liner materials to a point just beyond their ignition zone without the use of sprinklers.
- 1.2.2 This standard is not intended to determine the suitability for all end use conditions of a product. Conditions under which chimney or flue liner materials are used vary widely. It is the responsibility of the manufacturer and chimney or flue owner to determine the suitability of the products for the intended location.
- 1.2.3 This standard does not examine the chimney or flue liner materials ability to:
 - resist corrosion to the liners caused by the products of combustion being exhausted from the chimney or flue
 - provide adequate corrosion protection to the underlining materials of construction
 - resist shrinkage or cracking
 - other performance requirements not specifically addressed

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 FM Approvals and other organizations. The advice of manufacturers, users, trade associations and loss control specialists was also considered.
- 1.3.2 Meeting these requirements qualifies a product as an FM Approved chimney or flue liner material. Requirements prohibit component substitution without prior authorization by FM Approvals.
- 1.3.3 The requirements of this standard reflect tests and practices used to examine characteristics of industrial chimney or flue liner materials for the purpose of obtaining Approval. These requirements are intended primarily as guides and strict conformity is not always mandatory. Chimney and flue liner materials 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, chimney or flue liner materials that meet all the requirements identified in this standard may not be FM Approved if other conditions that 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' 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 and Master Agreement
- satisfactory re-examination of production samples for continued conformity to requirements; and
- satisfactory Facilities and Procedures Audits (F&PAs) 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 that were 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 *January 1, 2008* 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 10-02, “Standard for Use of the International System of Units (SI): The Modern Metric System.”

1.8 Applicable Documents

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

FM Approvals/FM Global

FM Global Property Loss Prevention Data Sheet 1-13, *Chimneys* (April 2007)

ANSI/FM Approvals 4910, *Cleanroom Materials Flammability Test Protocol* (June 2004)

ASTM International

ASTM E-2058-06, Standard Test Methods for Measurement of Synthetic Polymer Material Flammability Using a Fire Propagation Apparatus.

1.9 Definitions

For purposes of this standard, the following terms apply:

Chimney – a structure used to carry gaseous products of combustion to the atmosphere

Flue – a channel in a chimney used for conveying products of combustion to the atmosphere

Liner – the operational element of a chimney, designed to resist chemical and physical actions of combustion gases and to protect the shaft from them.

Shaft – the structural element of a chimney designed to resist wind and temperature differentials and to shield the liner

2 GENERAL INFORMATION

2.1 Product Information

2.1.1 Industrial chimneys are used to carry highly corrosive products of combustion to the atmosphere. They are often from 100 ft to 500 ft (30 m to 150 m) or more in height and have large diameters. The shafts of the chimneys are made from a variety of materials including bricks, concrete, steel and to some extent, fiberglass reinforced plastic. Because of the corrosive nature of the products of combustion being vented through the chimneys or flues, the inside surfaces are often lined with a separate corrosion resistant liner material.

2.1.2 Some of these liner materials can become damaged from an extended exposure to a highly corrosive and high temperature environment. Liner materials can also be a fire hazard in and of themselves if they are somehow ignited. In order to provide protection, chimneys and flues can be equipped with sprinklers at various distances within the chimney or flue however, this type of installation is often difficult and expensive, especially for very tall or very large diameter chimneys. This can become a challenge if the liner material has a rapid flame spread. By meeting the requirements of this standard, these materials will exhibit an ability to resist flame spread beyond their ignition zones, or just beyond their ignition zones, without the need for sprinkler protection.

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, anticipated marking format, installation and any maintenance procedures;
- 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 an Approval examination, the manufacturer shall submit samples for examination and testing. Production of these samples shall be witnessed by a representative of FM Approvals.

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. 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.

3 GENERAL REQUIREMENTS

3.1 Review of Documentation

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 Approval investigation shall define the limits of the Approval.

3.2 Physical or Structural Features

Physical and structural features, including but not limited to material type, grade and thickness, shall be shown on controlled detailed drawings.

3.3 Markings

3.3.1 The packaging, and where practicable, the product itself, shall bear the manufacturer's name, product trade name and the Approval mark of FM Approvals (see Appendix B).

3.3.2 Labels or markings denoting Approval shall be applied by the manufacturer only within and on the premises of manufacturing locations that are under the FM Approvals Facilities and Procedures Audit Program. The only exception to this shall be when a nameplate is provided as described in Paragraph 3.3.6.

3.3.3 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.

3.3.4 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.

3.3.5 All markings shall be legible and durable.

3.3.6 In cases where it is not practicable to mark the individual products with the FM Approval Mark, upon completion of an installation, the manufacturer shall attach a permanent, corrosion resistant nameplate to the exterior of the chimney. At a minimum, the nameplate shall bear the manufacturer's name, product trade name, year of construction and the Approval Mark of FM Approvals. In cases where the product has not been installed the entire length of the chimney, the approximate elevation(s) where the product has been installed shall be noted.

3.4 Manufacturer's Installation Instructions

The manufacturer shall provide the user with

- instructions for the installation, maintenance and operation of the product;
- facilities for repair of the product and supply replacement parts; and
- 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.

3.5 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 Chimney and Flue Liner Parallel Panel Fire Test

4.1.1 Requirement

In order to qualify as an FM Approved Chimney or Flue Liner material, they shall be tested in accordance with the Chimney and Flue Liner Parallel Panel Fire Test (Appendix C). This test method consists of installing two (2) parallel panels that have been sheathed with the liner material and exposing them to a fire hazard typical of that normally found within an industrial chimney or flue.

4.1.2 Test/Verification

One (1) pair of panels at both the minimum and maximum thicknesses shall be tested per the Chimney and Flue Liner Parallel Panel Fire Test (Appendix C). The exposure fire shall be provided using a sand burner. The duration of the test shall be thirty (30) minutes. For details on the conduct of the test and the conditions of acceptance, see Appendix C.

4.2 Chimney and Flue Liner Screening Test

As a tool in screening various liner materials, small scale samples shall be permitted to be tested using the FM Global Research Fire Propagation Apparatus. A description of the test apparatus and test procedure is contained in ASTM E 2058. Samples that obtain a Fire Propagation Index ≤ 6 would be considered as viable candidates for further larger scale testing as a chimney or flue liner material.

5 OPERATIONS REQUIREMENTS

A Quality Control Program is required to assure that subsequent Chimney and Flue Liner Materials produced by the manufacturer shall present the same quality and reliability as the specific sample(s) 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 Facilities and Procedures Audit (F&PA).
- 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 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 Facilities and Procedures Audit (F&PA)

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 at or provided 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

AREA:	in^2 - "square inches"; $(\text{mm}^2$ - "square millimeters") $\text{mm}^2 = \text{in}^2 \times 6.4516 \times 10^2$ ft^2 - "square feet"; $(\text{m}^2$ - "square meters") $\text{m}^2 = \text{ft}^2 \times 0.0929$
HEAT FLUX:	Btu/ft^2 - hr - "British thermal unit per square foot hour" $(\text{kW}/\text{m}^2$ - "kilowatts per square meter") $(\text{kW}/\text{m}^2 = \text{Btu}/\text{ft}^2$ - hr $\times 0.0032)$
LENGTH:	in - "inches"; $(\text{mm}$ - "millimeters") $\text{mm} = \text{in.} \times 25.4$ ft - "feet"; $(\text{m}$ - "meters") $\text{m} = \text{ft} \times 0.3048$
MASS:	lb - "pounds"; $(\text{kg}$ - "kilograms") $\text{kg} = \text{lb} \times 0.454$
POWER	KW - "kilowatt" $(\text{j}/\text{sec}$ - "joules per second") $\text{j}/\text{sec} = \text{KW} \times 1000$
TEMPERATURE:	$^{\circ}\text{F}$ - "degrees Fahrenheit"; $(^{\circ}\text{C}$ - "degrees Celsius") $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 0.556$
VELOCITY:	ft/sec - "feet per second"; $(\text{m}/\text{sec}$ - "meters per second") $\text{m}/\text{sec} = \text{ft}/\text{sec} \times 0.3048$ miles/hr - "miles per hour"; $(\text{km}/\text{hr}$ - "kilometers per hour") $\text{km}/\text{hr} = \text{miles}/\text{hr} \times 1.61$
VOLUME:	ft^3 - "cubic feet"; $(\text{m}^3$ - "cubic meters") $\text{m}^3 = \text{ft}^3 \times 0.028$

APPENDIX B

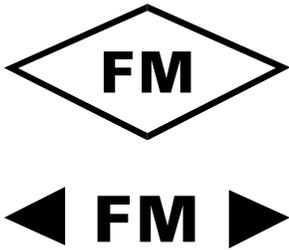
FM Approvals Certification Marks

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.

APPENDIX C

Chimney and Flue Liner Parallel Panel Fire Test

C-1 Introduction

- C-1.1 This test method is intended to evaluate the ability of a chimney or flue liner material to resist flame spread slightly beyond the ignition zone of the material.

C-2 Test Apparatus and Arrangement

- C-2.1 The Chimney and Flue Liner Parallel Panel Fire Test shall be performed under the FM Global Research Fire Products Collector (FPC). This unit is a 5 MW Heat Release Rate (HRR) Calorimeter. See Figure C-1 for details.

C-2.1.1 The FPC consists of a collection cone of Type 304 stainless steel that is 20 ft (6.096 m) in diameter at its lowest point which is 26 ft (7.925 m) above the concrete floor of the laboratory. Attached to the top of the cone is a 5 ft (1.524 m) diameter stainless steel elbow and duct which eventually connects into the exhaust system. The instrumentation station is located in the horizontal section of the duct and is located 39 ft 3 in. (12.01 m) from the centerline of the cone. The flow of air through the FPC is controlled by a variable damper capable of maintaining a constant mass flow of combustion air.

- C-2.2 The test apparatus shall consist of a large open air room. Two (2) panels shall be installed vertically to form the two (2) sides of the apparatus. The other two (2) sides and the top shall remain open to the room's atmosphere. Each vertical panel shall be 16 ft \pm 1/2 in. (4.9 m \pm 13 mm) high by 3 ft 6 in \pm 1/2 in. (1.1 m \pm 13 mm) wide. The outer layer of each panel shall be rigid plywood backing of minimum 1/2 in. (13 mm) thickness. Attached to the plywood backing shall be a minimum 1 in. (25 mm) thick calcium silicate (Marinite) insulation board. A 10 gage steel plate shall be attached to the insulation board. The vertical panels shall be placed such that the inside surfaces are flush with the edges of the burner resulting in the inside surfaces 1 ft 9 in \pm 1/2 in. (0.53 m \pm 13 mm) apart from each other. The bottom edge of the vertical panels shall be level with the top surface of the heat source. To ensure that the vertical panels maintain a separation distance of 1 ft 9 in \pm 1/2 in. (0.53 m \pm 13 mm) throughout the test, threaded rods shall be permitted to be installed to connect the panels together at the top along each long edge of the assembly. See Figure C-2 for details.

C-2.2.1 The heat source shall be a nominal 1 ft 9 in wide \times 1 ft high by 3 ft 6 in long (0.53 x 0.3 \times 1.1 m) propane sand burner having a surface area of 6.1 ft² (0.58 m²). The panels shall be placed such that their lowest edge is at the top of the sand burner. Any gaps between the test specimen and the sand burner shall be filled with Kaowool or other non-combustible material to keep the fire source from getting to the back side of the test specimen.

C-2.2.2 The propane flowmeter shall be adjusted such that the corresponding heat release rate is 360 kW.

C-3 Test Specimen

- C-3.1 A sufficient quantity of material shall be provided in order to construct two (2) panels that are each 3 ft 6 in wide \times 16 ft (1.1 m \times 4.9 m) tall \times the thickness desired for Approval. If the Approval is to extend to a range of product thicknesses, both the minimum and maximum thickness of the product shall be tested.

- C-3.2 The test specimens shall be installed using the manufacturer's written installation instructions. Any panels that utilize an adhesive for attaching the product to the chimney shall be tested using the appropriate substrate and adhesive. Products that are not adhered to the substrate shall be mechanically fastened to a steel plate substrate using the minimum size and spacing of fasteners for which Approval is desired.
- C-3.2.1 In the case of mechanical fasteners, additional fasteners may be placed along the bottom edge of the panel where the panel abuts the sand burner to help prevent flames from getting behind the test specimen and spreading up the back side of the test specimen.
- C-3.3 All seams and joints where the test specimen butts up to adjacent multiple sections shall be sealed, filled, caulked or mortared with the material intended to be used in actual installations.

C-4 Test Procedure

- C-4.1 Prior to moving the panels into position, the sand burner shall be calibrated to ensure that the 360 kW (± 10 kW) heat release rate is attained. The mass flow rate of the propane needed to meet this heat release rate shall be recorded.
- C-4.2 Once the test specimens have been installed on the panels and the panels have been moved into place, the test shall start with the ignition of the propane sand burner. The propane gas flow shall be adjusted to provide a heat release rate of 360 kW (± 10 kW). This shall be done by monitoring the mass flow rate obtained in C-4.1. This heat release rate shall be attained within five (5) minutes from the ignition of the propane.
- C-4.3 The test shall be conducted for a period of thirty (30) minutes. If at any time during the test flaming is noted above the top of the panels, propane flow to the sand burner shall cease and the test shall be terminated. The test shall also be terminated if the panels do not stay intact for any reason during the fire test.
- C-4.4 A video camera shall be placed parallel to the short dimension of the panels such that the height of the flame can be recorded throughout the duration of the test.
- C-4.5 Observations shall be taken during the test. The observations shall include notes on the visual height of the flame and any other events of note.

C-5 Performance Requirements

- C-5.1 Upon completion of the test, the test specimen shall be examined. The test specimen shall maintain its structural integrity without any fasteners or pieces of the test specimen becoming dislodged. Peeling, curling, bowing or deflection of the test specimen shall not be considered as a failure of its structural integrity as long as no through openings develop between the back of the test specimen and the vertical portion of the test apparatus when looking along the short dimension of the panel.
- C-5.2 No structural damage or visual flame damage shall extend more than 1 ft 6 in. (0.5 m) beyond the maximum sustained visual flame height from the ignition source. Visual flame damage shall be permitted to extend to the extremities of the panel along the 3 ft 6 in. (1.1 m) width dimension.
- C-5.3 The maximum chemical heat release rate, as measured by instrumentation located at the calorimetry station located in the exhaust duct of the FPC (see Figure C-1), shall not exceed 200 kW above the source fire of 360 kW.

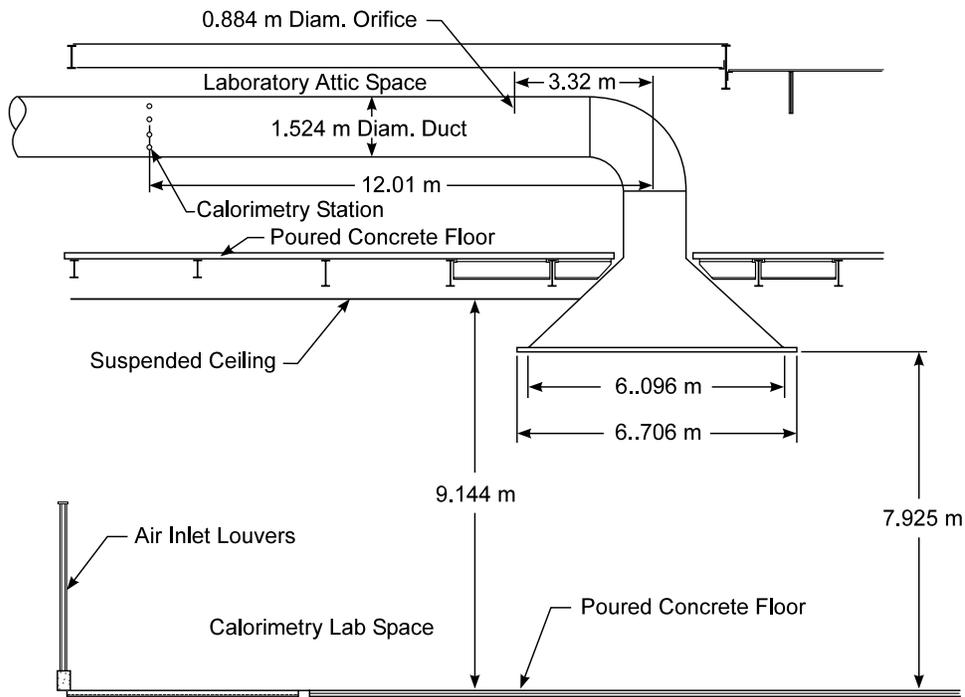


Figure C-1
Diagram of the 5 MW Fire Products Collector

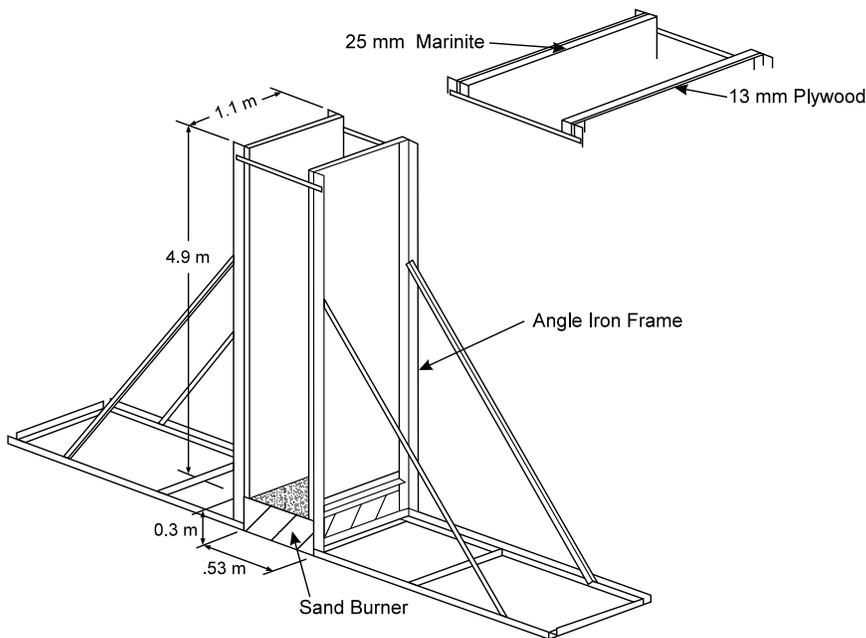


Figure C-2
Schematic of Parallel Panel Test Apparatus

