Approval Standard for Class 1 Exterior Wall Systems

Class Number 4881

November 2016

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.

TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 Purpose 1
1.2 Scope 1
1.3 Basis for Requirements 1
1.4 Basis for Approval 2
1.5 Basis for Continued Approval 2
1.6 Effective Date 2
1.7 System of Units 3
1.8 Applicable Documents 3
1.9 Definitions 4
2 GENERAL INFORMATION 6
2.1 Product Information 6
2.2 Wind Zone Category 6
2.3 Wind Pressure Rating 6
2.4 Hail Resistance Rating 7
2.5 Approval Application Requirements 7
2.6 Approval Examination Requirements 8
3 GENERAL REQUIREMENTS 8
3.1 Markings 8
3.2 Installation Instructions 8
3.3 Drawings and Specifications 9
3.4 Fasteners, Clips, and Other Accessories 9
4 PERFORMANCE REQUIREMENTS 9
4.1 Wind Pressure Rating 10
4.2 Windborne Debris (Zone TCM Only) 11
4.3 Hail Resistance Rating 12
4.4 Small Scale Tests 12
4.5 Additional Tests 13
5 OPERATIONS REQUIREMENTS 13
5.1 Demonstrated Quality Control Program 13
5.2 Drawing and Change Control 14
5.3 Surveillance Audit 14
5.4 Installation Inspections 14
5.5 Manufacturer's Responsibilities 14
APPENDIX A: CONVERSION OF MEASUREMENT UNITS 16

1 INTRODUCTION

1.1 Purpose

1.1.1 This standard states Approval requirements for exterior wall systems which are subjected to natural hazards and weather conditions (e.g. wind, hail, and windblown debris).

1.1.2 All exterior wall systems shall be FM Approved with a Class 1 fire rating. Therefore, FM Approval of Class 4880, *Approval Standard for Class 1 Fire Rating of Building Panels or Interior Finish Materials*, is a prerequisite for all exterior wall systems.

1.2 Scope

1.2.1 This standard sets the performance requirements for exterior wall panel systems that are exposed to natural hazards such as wind, hail, and windborne debris. Exterior wall panel systems include, but are not limited to, wall panels constructed of metal, plastic, mineral wool, composite, or glass fiber.

1.2.2 Exterior wall panels systems shall be FM Approved with specific installation requirements and ratings including a:

- wind zone category,
- wind pressure rating, and
- hail resistance rating.

1.2.3 Exterior wall systems shall be FM Approved with specific building installation requirements, including, but not limited to:

- the support thickness and yield strength of the supports,
- the support spacing use in the building construction, and
- the fasteners, fastening accessories, and fastening scheme of the panels to the supports.

1.2.4 Any component which may be used in the installation of an exterior wall panel system such as fasteners, clips, or any other accessories, are considered part of the scope of the product and must be evaluated as part of the system. At the discretion of FM Approvals, any component that may affect the test performance must be included in the test sample construction.

1.2.5 Since environmental conditions can vary by location, this standard is not intended to determine the suitability of the use of a product at a particular location.

1.2.6 This standard shall not be used to qualify metal composite materials (MCM), cavity walls, fenestration products such as doors, windows and storm shutters, exterior insulated finish systems (EIFS), or other exterior wall coating systems.

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 national and international organizations. The advice of manufacturers, users, trade associations and loss control specialists was also considered.

1.3.2 Meeting the requirements qualifies the wall assembly as an FM Approved exterior wall system. 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 exterior wall systems for the purpose of obtaining Approval. Exterior wall systems 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, exterior wall systems 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 are performed to evaluate:

- the suitability of the product for its intended end use as an exterior wall system;
- the performance of the product as required by FM Approvals; and, as far as practical;
- the durability and reliability of the product when used as an FM Approved exterior wall system.

1.4.2 An examination of the manufacturing facilities for completed assemblies and components and audit of quality control procedures are made to evaluate the manufacturer's ability to consistently produce the products which are examined and tested, and the marking procedures used to identify the products. These examinations are conducted at a minimum frequency of annually as part of FM Approvals' Surveillance Audit Program.

1.5 Basis for Continued Approval

Continued Approval is based upon:

- production or availability of the product as currently Approved;
- the continued use of acceptable quality control procedures;
- satisfactory field experience;
- compliance with the terms stipulated in the Approval Report and Master Agreement;
- re-examination of production samples for continued conformity to requirements; and
- satisfactory examinations conducted at least annually as part of FM Approvals' Surveillance Audit 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.

Exterior wall systems FM Approved prior to the effective date of this standard, and which were FM Approved with a wind pressure ratio of 1.4 or 2.0, are still Approved and do not require a re-examination. However, the outward pressure (-P) shall meet the minimum and/or maximum pressure ratings list in Section 2.3 for the listed Wind Zone.

The effective date of this standard is upon publication for compliance with all requirements with the

exception of the Marking Requirements. The effective date of compliance of the Marking Requirements is March 1, 2017.

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, "American National Standard for Metric Practice."

1.8 Applicable Documents

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

1.8.1 *American Society for Testing and Materials (ASTM) International*

ASTM E 330-02, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

ASTM E 1233-00, Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors by Cyclic Static Air Pressure Differential

ASTM E 1886-13a, Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials

ASTM E 1996-03, Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Windborne Debris in Hurricanes

1.8.2 *FM Approvals, 1151 Boston-Providence Turnpike, Norwood Massachusetts 02062*

Approval Standard 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

Approval Standard 4471, Class 1 Panel Roofs

Approval Standard 4880, Class 1 Fire Rating of Building Panels or Interior Finish Materials

Specification Test Standard 4473, Specification Test Standard for Impact Resistance Testing of Rigid Roofing Materials by Impacting with Freezer Ice Balls

Test Procedure Class 4881: Fastener Withdrawal Test

Test Procedure Class 4881: Delamination Test

Test Procedure Class 4881: Hail Resistance Rating

Test Procedure Class 4881: Pull Though Test

Test Procedure Class 4881: Windborne Debris Test

Test Procedure Class 4881: Wind Load Rating Test

1.8.3 *FM Global Research, 1151 Boston-Providence Turnpike, Norwood Massachusetts 02062*

FM Global Property Loss Prevention Data Sheet 1-28, Design Wind Loads

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

FM Global Property Loss Prevention Data Sheet 1-34, Hail Damage

1.8.4 *Building Codes*

Florida Building Code 5th Edition (2014), Test Protocols for High-Velocity Hurricane Zones

Testing Application Standard (TAS) 201-94, Impact Test Procedures

Testing Application Standard (TAS) 202-94, Criteria for Testing Impact and Non-Impact Resistant Building Envelope Components Using Uniform Static Air Pressures

Testing Application Standard (TAS) 203-94, Criteria for Testing Products to Cyclic Wind Pressure Loading

1.8.5 *International Building Code*

SSTD 12-99, Standard for Determining Impact Resistance for Windborne Debris

1.9 Definitions

For purposes of this standard, the following terms apply:

Exterior Wall Panel System
An assembly or construction of materials and/or components which form the outer protective layer of a building structure. An exterior wall system typically consists of, but are not limited to, supports, wall panels, fasteners, and a fastener scheme.

Inward Pressure (+P)
A condition created on the windward side of a building measured in force pounds per unit area (pounds per square foot, PSF). It is caused by wind forces and places forces toward the wall. It is also known as positive pressure. The positive sign (+P) is used to signify the inward pressure of the wind pressure rating of an exterior wall panel system.

Moderate Hail (MH) Rating
A moderate hail rating is given to an exterior wall panel that is capable of withstanding the simulation of moderate hail in the Hail Resistance Rating Test. The simulation of moderate hail is created by projecting ice balls with a nominal 1.5 in. (38 mm) diameter with a minimum kinetic energy of 7.8 ft-lbs (10.4 J) at an exterior wall panel.

Outward Pressure (-P)
A condition created on the leeward side of a building measured in force pounds per unit area (pounds per square foot, PSF). It is caused by wind forces and places forces away from the wall. It is also known as negative pressure. The negative sign (-P) is used to signify the outward pressure of the wind pressure rating of an exterior wall panel system.

Wind Pressure Rating (+P/-P)

The maximum inward and outward pressures (+P/-P) successfully tested under the Wind Pressure Rating Test.

Severe Hail (SH) Rating

A severe hail rating is given to an exterior wall panel that is capable of withstanding the simulation of severe hail in the Hail Resistance Rating Test. The simulation of severe hail is created by projecting ice balls with a nominal 1.75 in. (44 mm) diameter with a minimum kinetic energy of 14.9 ft-lbs (20.3 J) at an exterior wall panel.

Supports

The horizontal and/or vertical steel framing of a building structure that a wall panel is directly secured or fastened too. Supports are also known as girts, studs, sheeting rails, etc.

Tropical Storm

A storm in which wind rotates about a center of low atmospheric pressure, clockwise in the southern hemisphere and counterclockwise in the northern hemisphere. Tropical storms include but are not limited to, hurricanes, typhoons, and tropical cyclones.

Very Severe Hail (VSH) Rating

A very severe hail rating is given to an exterior wall panel that is capable of withstanding the simulation of very severe hail in the Hail Resistance Rating Test. The simulation of very severe hail is created by projecting ice balls with a nominal 2 in. (50.8 mm) diameter with a minimum kinetic energy of 53 ft-lbs (71.8 J) at an exterior wall panel.

Windborne Debris

Objects and pieces of broken materials that have become airborne projectiles due to the high winds caused by tropical storms.

Zone Tropical Cyclone (TC)

An area prone to tropical storms. External wall systems with a TC Zone shall have a minimum wind pressure rating of +45/-45 based on an associated wind speed of 95 mph which this area may experience.

Zone Non- Tropical Cyclone (NTC)

An area that is not prone to tropical storms. External wall systems with a NTC Zone shall have a minimum wind pressure rating of +40/-40 based on an associated wind speed of 85 mph which this area may experience. Also, an NTC Zone shall not exceed a wind pressure rating of +75/-75, higher ratings require successful performance requirements for a TC Zone.

Zone Tropical Cyclone Missile (TCM)

An area prone to tropical storms that could product windborne debris. External wall systems with a TCM Zone shall have a minimum wind pressure rating of +60/-60 based on an associated wind speed of 110 mph which this area may experience.

2 GENERAL INFORMATION

2.1 Product Information

The desired wind zone category, wind rating, and hail ratings shall be selected by the panel manufacturer of an exterior wall system prior to performance testing. Since weather conditions can vary widely throughout the world, desired ratings should be based, in part, on the geographical location where an exterior wall system shall be constructed, and its surroundings as well as the historical meteorological events that have occurred and are likely to occur in the future.

Exterior wall systems that meet the requirements of this Approval Standard shall maintain the integrity of the building structure for the Approved wind zone category and design ratings. However, during a weather event wall systems may unexpectedly experience conditions which exceed the Approved ratings. All systems should be examined after each storm for damage that could adversely affect its performance in future storms, and repairs should be made as soon as possible to any damaged areas.

2.2 Wind Zone Category

There are three different wind zone categories;

- Non-Tropical Cyclone (NTC)
- Tropical Cyclone (TC)
- Tropical Cyclone Missile (TCM)

Each zone has different performance requirements and wind pressure rating limitations that are applicable to the weather conditions which the zone would typically experience. The performance requirements for each zone are detailed in Section 4, and the wind pressure rating limitations are detailed in Section 2.3.

The FM Global Property Loss Prevention Data Sheet 1-28 shall be used to determine which zone applies to a particular geographic location.

2.3 Wind Pressure Rating

The wind pressure rating of an exterior wall system shall be the maximum inward and outward pressures (+P/-P) successfully tested under the Wind Pressure Rating Test. The positive sign (+P) is used to signify the inward pressure or the applied force which is pushing the wall assembly against the supports. The negative sign (-P) is used to signify the outward pressure or the applied force pulling the wall assembly away from the supports.

Wind pressures on a building can vary and are based on multiple factors including, but not limited to, wind speeds and terrain at the geographic location of the building, and the building geometry such as building height, width, and the roof slope. Due to these variable factors, the desired rating shall be selected by the wall panel manufacturer and shall be within the minimum and maximum ratings allowed for the desired wind zone category shown in Table 2.3.1. The rating shall be given in increments of 5 lbs/ft^2 (0.25 kPa).

Table 2.3.1 Minimum and Maximum Wind Pressure Ratings per Wind Zone Category

Wind Zone Category	Minimum Wind Pressure Rating* +P/-P (lbs/ft^2)	Wind Speeds (3-Second Gusts) Associated with Minimum Pressure Rating*	Maximum Wind Pressure Rating +P/-P (lbs/ft^2)
NTC	+40/-40	85 mph (38 m/s)	+75/-75
TC	+45/-45	95 mph (42 m/s)	None
TCM	+60/-60	110 mph (49 m/s)	None

*The minimum wind pressure rating is based on the associated wind speed of that zone and other critical factors including the least critical building geometries and surrounding terrain. Higher pressure ratings may be desired for specific geographic locations with higher wind speeds and/or more critical terrains and/or more critical building geometries.

FM Global Property Loss Prevention Data Sheet 1-28 shall be used to determine the wind pressure rating(s) needed for a geographic location and building geometry(ies).

2.4 Hail Resistance Rating

All FM Approved exterior wall assemblies shall have a Hail Resistance Rating of either Moderate (MH), Severe (SH), or Very Severe (VSH). The rating evaluated for Approval shall be selected by the wall panel manufacturer.

FM Global Loss Prevention Data Sheet 1-34 shall be used to determine the hail resistance rating needed for a particular geographic location.

2.5 Approval Application Requirements

To apply for an Approval examination the manufacturer, or its authorized representative, should submit a request to information@fmapprovals.com.

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 (including supports, fasteners, fastener spacing, etc.), complete set of manufacturing drawings, anticipated marking format, brochures, sales literature, spec. sheets, installation, operation and maintenance procedures;
- the number and location of manufacturing facilities; and
- desired zone category, hail rating, and pressure rating.

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.

2.6 Approval Examination Requirements

In order to qualify as a Class 1 exterior wall panel the Approval examination shall include:

- Completion of the prerequisite, FM Approval of Class 4880, *Approval Standard for Class 1 Fire Rating of Building Panels or Interior Finish Materials.*
- review of the product and assembly component(s) and/or specification(s),
- performance requirements which are based on the desired ratings,
- an examination of the manufacturing facilities, critical supplier / subcontractor locations and review of the quality assurance procedures as part of the Surveillance Audit Program, and
- a complete review of installation specifications and, at the sole discretion of FM Approvals, inspection of one or more field installations shall be conducted to assure, as far as possible, the practicality and reliability of product installation.

3 GENERAL REQUIREMENTS

3.1 Markings

3.1.1 Markings on the product or, if not possible, on its packaging or label accompanying the product, shall include the following information:

- name and address of the manufacturer or marking traceable to the manufacturer,
- date of manufacture or code traceable to date of manufacture or lot identification,
- model number or product identification,
- the FM Approval mark as detailed below, and
- "Must be installed in accordance with the Approved installation provided with the panels"

For FM Approved products, the Approval Mark 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.

3.1.2 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.

3.2 Manufacturer's Installation Instructions

3.2.1 The manufacturer shall supply all necessary instructions and other assistance to the installer to ensure proper installation in accordance with the Approved wall assembly. Printed instructions shall be provided by the manufacturer to demonstrate proper installation procedures.

3.2.2 As part of the Approval examination, and at the discretion of FM Approvals, at least one inspection of a field installation during and/or after completion may be required. In some cases, a continued program of inspections shall be necessary to assess the application procedures or changes within the application techniques.

3.2.3 The manufacturer shall supply written information to the installer detailing the specific installation requirements as contained in FM Global Property Loss Prevention Data Sheets and other pertinent FM Global or FM Approvals standards.

3.3 Drawings and Specifications

3.3.1 The manufacturer shall provide FM Approvals with complete system drawings, including; supports, fasteners, fastener spacing, etc. Further, the manufacturer shall notify FM Approvals of any change in the manufacturing procedures or components used in the assembly prior to general sale and distribution.

3.4 Fasteners, Clips, and Other Accessories

3.4.1 All fasteners, clips, stress plates, and/or other accessories used in the installation of an exterior wall assembly shall be evaluated in conjunction with the exterior wall assembly.

3.4.2 With the exception of generic fastening accessories such as, but not limited to, nuts, bolts and rivets, all fasteners, clips, and stress plates used in an external wall system assembly shall require an examination of the manufacturing facility(ies) and/or the quality control facility(ies), audit of quality assurance procedures, and the Surveillance Audit Program.

3.4.3 At the discretion of FM Approvals, other accessories that may affect the test performance shall require an examination of the manufacturing facility(ies), audit of quality assurance procedures, and a Surveillance Audit Program.

3.4.4 FM Approved shall be granted to a wall fastener if all the requirements of the Wind Pressure Rating Testing and the Small Scale Testing (if applicable) are satisfied.

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 in accordance with ISO/IEC 17025.

4 PERFORMANCE REQUIREMENTS

Performance requirements are based on desired FM Approval ratings. Not all tests listed under this section are applicable to every rating. The requirements for each rating covered by this Standard are detailed in each section.

Tests of alternate constructions may be waived if considered less critical than those which were previously tested.

Confirming tests may be required, at the sole discretion of FM Approvals, depending on design features and results of any foregoing tests.

Following a test failure, a re-test of an identical or similar assembly shall be at the sole discretion of FM Approvals and with a technical justification of the conditions or reasons for the failure. When a test assembly or sample fails to meet the Approval acceptance criteria for a given classification/rating, two successful test assemblies or samples of the same construction shall meet the Approval acceptance criteria to qualify for the given classification/rating. Any test assembly or sample that fails more than three times is no longer considered a candidate for FM Approval.

4.1 Wind Pressure Rating

4.1.1 Requirement:

The desired pressure rating and zone category shall be selected by the wall panel manufacturer prior to the Wind Pressure Rating Test. The desired pressure rating (+P/-P) shall be within the minimum and maximum allowed for that particular zone category, as detailed in Table 2.31 and the rating shall be given in increments of 5 lbs/ft^2 (0.25 kPa).

An exterior wall assembly sample shall consist of the installation of wall panels on supports. The components and their utilization during the assembly shall set requirements and/or limitations for all FM Approved installations of the exterior wall system. These requirements and/or limitations include, but are not limited too;

- supports (strength and thickness)
- fasteners, clips, stress plates, and/or other accessories, and
- spacing of supports, fasteners, clips, stress plates, and/or other accessories.

All exterior wall systems shall be subjected to the static pressure sequence, shown in Table 4.1.1.1, and a cyclic pressure sequence for the targeted zone category. The cyclic pressure sequence for Zone Non-Tropical Cyclone (NTC) is shown in Table 4.1.1.2. The cyclic pressure sequence for Zone Tropical Cyclone (TC) and Tropical Cyclone Missile (TCM) is shown in Table 4.1.1.3.

Table 4.1.1.1 Static Pressure Sequence for all Zone Categories (NTC, TC, and TCM)

Loading Sequence	Pressure Direction	Static Pressure Based on Pressure (P)	Duration of Pressure
1	Inward	0.5(P)	1 minute
2	Inward	1.0(P)	1 minute
3	Outward	0.5(P)	1 minute
4	Outward	1.0(P)	1 minute

Table 4.1.1.2. Cyclic Pressure Sequence for Zone NTC

Loading Sequence	Pressure Direction	Air Pressure Cycles Based on Pressure (P)	No. of Air Pressure Cycles
1	Inward	0.0P – 0.6P	12
2	Inward	0.0P – 0.8P	1
3	Inward	0.0P – 0.6P	12
4	Inward	0.0P – 0.8P	1
5	Inward	0.0P – 0.6P	12
6	Inward	0.0P – 0.8P	1
7	Inward	0.0P – 0.6P	12
8	Inward	0.0P – 0.8P	1
9	Inward	0.0P – 0.6P	12
10	Inward	0.0P – 0.8P	1
11	Inward	0.0P – 1.0P	1
12	Outward	0.0P – 0.6P	12
13	Outward	0.0P – 0.8P	1
14	Outward	0.0P – 0.6P	12
15	Outward	0.0P – 0.8P	1
16	Outward	0.0P – 0.6P	12

Loading Sequence	Pressure Direction	Air Pressure Cycles Based on Pressure (P)	No. of Air Pressure Cycles
17	Outward	0.0P – 0.8P	1
18	Outward	0.0P – 0.6P	12
19	Outward	0.0P – 0.8P	1
20	Outward	0.0P – 0.6P	12
21	Outward	0.0P – 0.8P	1
22	Outward	0.0P – 1.0P	1
Repeat 1 though 22 an additional seven (7) times			

Table 4.1.1.3. Cyclic Pressure Sequence for Zone TC and TCM

Loading Sequence	Pressure Direction	Air Cycles Pressure Based on Pressure (P)	No. of Air Pressure Cycles
1	Inward	0.2P – 0.5P	3500
2	Inward	0.0P – 0.6P	300
3	Inward	0.5P – 0.8P	600
4	Inward	0.3P – 1.0P	100
5	Outward	0.3P – 1.0P	50
6	Outward	0.5P – 0.8P	1050
7	Outward	0.0P – 0.6P	50
8	Outward	0.2P – 0.5P	3350

There shall be no signs of failure during or after the static and cyclic pressures sequences on an exterior wall system assembly at the targeted pressure rating (+P/-P). Signs of failure include, but are not limited to;

- fastener(s) pulled out of the support,
- fastener(s) pulled through the wall panel,
- the facer delaminated from the core, and/or
- joint(s) slipped or broke and did not returning to the original location after pressure had been released.

4.1.2 Test/Verification:

Wind Load Rating Test, Test Procedure Class 4881: *Wind Load Rating Test*

4.2 Windborne Debris (Zone TCM Only)

4.2.1 Requirement:

Three (3) wall assembly samples shall be tested for windborne debris with the same assembly (supports, fasteners, etc.) and pressure rating (+P/-P) as successfully tested under Section 4.1. The samples shall be untested, meaning they cannot be the same sample(s) utilized for the Wind Pressure Rating Test (Section 4.1).

A wooden missile, a nominal 1.5 x 3.5 in by 8 ft (2.4 m) long weighing a nominal 9 lbs (4 kg) and traveling at a nominal speed of 50 ft/sec (15.25 m/s), which is approximately 35 miles per hour (56 km/hr), shall be used to simulate windborne debris.

Each of the three (3) wall assembly samples shall be able to withstand a series of impacts by the missile followed by the cyclic pressure sequence for Tropical Cyclone Missile (TCM) shown in Table 4.1.1.3.

For each of the three wall assembly samples;

- The missile shall not penetrate through all layers (if multiple) of the wall sample assembly at any of the impacted locations;
- During the cyclic pressure sequence the samples shall not develop any openings more than 5 in. (125 mm) in length or 1/16 in (1.6 mm) in width, through which air can pass, at any of the impacted locations; and
- There shall be no signs of failure during or after the cyclic pressures sequence on the exterior wall system assembly. Signs of failure include, but are not limited to;
    - fastener(s) pulled out of the support,
    - fastener(s) pulled through the wall panel,
    - facer(s) delaminated from the core, and/or
    - joint(s) slipped or broke and did not returning to the original location after pressure had been released.

4.2.2 Test/Verification:

Windborne Debris Test, Test Procedure Class 4881: *Windborne Debris Test*

4.3 Hail Resistance Rating

4.3.1 Requirement

The desired hail resistance rating of Moderate (MH), Severe (SH), or Very Severe (VSH) shall be selected by the wall panel manufacturer prior to the Hail Resistance Test.

The wall test sample shall show no signs of cracking or splitting after a series of impacts from ice balls. The size and kinetic energy for which the ice ball impacts the wall sample shall be based on the desired hail rating as shown in Table 4.3.1.1.

Table 4.3.1.1. Ice Ball Criteria for Hail Ratings

Hail Resistance Rating	Nominal Ice Ball Diameter in (mm)	Minimum Kinetic Energy ft-lbs (J)
Moderate (MH)	1.5 (38)	7.8 (10.4)
Severe (SH)	1.75 (44)	14.9 (20.3)
Very Severe (VSH)	2 (50.8)	53 (71.8)

Alternatively, this test can be waived if Hail Damage Resistance has been conducted under Class 4471 or Class 4470.

4.3.2 Test/Verification:

Hail Resistance Rating, Test Procedure Class 4881: *Hail Resistance Rating*

4.4 Small Scale Tests (Optional)

4.4.1 Requirement

At the discretion of FM Approvals, small scale testing shall be used for comparing exterior wall components which are utilized in a complete exterior wall assembly. The purpose of these tests is to either;

- identify critical components to include in Wind Pressure Rating Testing and Windborne Debris Testing (if applicable), and/or
- extend FM Approval to components which are alternate to those tested in the Wind Pressure

Rating Testing and Windborne Debris Testing (if applicable).

Alternate components shall be accepted with equivalent or superior test performance.

4.4.2 Verification/Test

Delamination Test Procedure Class 4881: *Delamination Test,* or
Pull Though Test Procedure Class 4881: *Pull Though Test,* or
Fastener Withdrawal Test Procedure Class 4881: *Fastener Withdrawal Test*

4.5 Additional Tests

Additional tests may be required, at the discretion of FM Approvals, depending on design features and results of any foregoing tests.

5 OPERATIONS REQUIREMENTS

A quality assurance program is required to assure that building panels, interior finish materials, identified components, and/or other critical components of building panels or interior finish materials produced by the manufacturer shall present the same quality and reliability as the specific product construction 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 of the FM Approved product is verified by the Surveillance Audit Program.
- Quality of performance is determined by field performance and by periodic re examination and testing.

5.1 Demonstrated Quality Control Program

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

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

5.1.2 Documentation/Manual

There should be an authoritative collection of procedures/policies. It should provide an accurate

description of the quality management system while serving as a permanent reference for implementation and maintenance of that system. The system should require that sufficient records are maintained to demonstrate achievement of the required quality and verify operation of the quality system.

5.1.3 Records

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

5.2 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 Approved Products Revision Request Form, FM Approved Product or Address/Main Contact Change Report.
- Records of all revisions to all FM Approved products shall be maintained.

5.3 Surveillance Audit

5.3.1 An audit of the manufacturing facility is part of the Approval or Identified Component 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.

5.3.2 These audits shall be conducted periodically but at least annually by FM Approvals or its representatives.

5.3.3 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 or Specification Test Report for Identified Components. Manufacture of products bearing the Approval Mark or "FM Specification Tested: Identified Component" mark is not permitted at any other location without prior written authorization by FM Approvals.

5.4 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.

5.5 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: CONVERSION OF MEASUREMENT UNITS

AREA:

in^2 - "square inches"; (mm^2 - "square millimeters")
$mm^2 = in^2 \times 6.4516 \times 10^2$

ft^2 – ''square feet''; (m^2 - ''square meters'')
$m^2 = ft^2 \times 0.0929$

ENERGY:

ft-lbs – ''foot pounds''; (J – ''joules'')
J = ft-lbs × 1.36

FORCE:

lbf – ''pound-force''; (N – ''Newtons'')
N = lbf × 4.448

LENGTH:

in - ''inches''; (mm - ''millimeters'')
mm = in. × 25.4

ft - ''feet''; (m - ''meters'')
m = ft × 0.3048

MASS:

lb - ''pounds''; (kg - ''kilograms'')
kg = lb × 0.454

PRESSURE:

lbs/ft^2 – ''pounds per square foot, PSF''; (kPa – ''kilopascals'')
$kPa = lbs/ft^2 \times 0.04788$

bar – ''bar''; (kPa – ''kilopascals'')
bar = kPa × 0.01
$bar = lbs/in^2 \times 0.0004788$

TEMPERATURE:

°F - "degrees Fahrenheit"; (°C - "degrees Celsius")
°C = (°F - 32) × 0.556

VELOCITY:

ft/sec – ''feet per second''; (m/sec – ''meters per second'')
m/sec = ft/sec × 0.3048

miles/hr – ''miles per hour''; (km/hr – ''kilometers per hour'')
km/hr = miles/hr × 1.61

VOLUME:

ft^3 – ''cubic feet''; (m^3 – ''cubic meters'')
$m^3 = ft^3 \times 0.028$