Designation: E2957 – 17

An American National Standard

Standard Test Method for Resistance to Wildfire Penetration of Eaves, Soffits and Other Projections [1]

This standard is issued under the fixed designation E2957; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This fire-test-response standard prescribes a method for qualitatively assessing the resistance to fire penetration of eave overhangs and other projections, such as the soffits of roof eaves and cantilevered floor projections, when exposed to direct flame impingement from a simulated external wildfire exposure, such as encountered in a "Wildland Urban Interface" scenario. This test method provides data suitable for comparing the relative performance of materials, which are used as the exposed underside surfaces of eave overhangs and other projections.

1.2 This test method measures the ability of eave overhangs and other projections to resist fire penetration from the exterior into the wall cavity or unexposed side of the test specimen under the conditions of exposure.

1.3 This test method is applicable to eave overhangs and other projections such as the soffits of roof eaves and cantilevered floor projections intended for use with either combustible or noncombustible building envelopes.

1.4 Limitations of the test method are listed in Section 5.

1.5 The values stated in metric units are to be regarded as the standard. Values in parentheses are for information only.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This standard is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled laboratory conditions, but does not by itself incorporate all factors required for fire hazard or fire risk assessment of the materials, products or assemblies under actual fire conditions.*

1.8 *Fire testing is inherently hazardous. Adequate safeguards for personnel and property shall be employed in conducting these tests.*

1.9 *The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (including those in tables and figures) shall not be considered as requirements of the standard.*

1.10 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C1396 Specification for Gypsum Board

D2898 Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing

D4442 Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials

D4444 Test Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters

D6662 Specification for Polyolefin-Based Plastic Lumber Decking Boards

D7032 Specification for Establishing Performance Ratings for Wood-Plastic Composite and Plastic Lumber Deck Boards, Stair Treads, Guards, and Handrails

E176 Terminology of Fire Standards

E631 Terminology of Building Constructions

E2707 Test Method for Determining Fire Penetration of Exterior Wall Assemblies Using a Direct Flame Impingement Exposure

E2912 Test Method for Fire Test of Non-Mechanical Fire Dampers Used in Vented Construction

E2886/E2886M Test Method for Evaluating the Ability of Exterior Vents to Resist the Entry of Embers and Direct Flame Impingement

[1] This test method is under the jurisdiction of ASTM Committee E05 on Fire Standards and is the direct responsibility of Subcommittee E05.14 on External Fire Exposures.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

2.2 *Other Standards:*
ISO 13943 Fire Safety—Vocabulary[3]
NFPA 286 Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth[4]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this standard, see Terminology E176, E631 and ISO 13943. In case of conflict between E176 and E631 or ISO 13943, the definitions given in Terminology E176 shall prevail. In case of conflict between E631 and ISO 13943, the definitions given in Terminology E631 shall prevail.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *building envelope, n*—the boundary or barrier separating different environmental conditions within a building and from the outside environment.

3.2.2 *eave, n*—a projecting edge of a roof that extends beyond the building envelope.

3.2.3 *glow, n*—visible light emitted by a solid undergoing combustion.

3.2.4 *holding fixture, n*—apparatus designed to hold the test specimen and a wall assembly, described in 7.3.

3.2.5 *projection, n*—an exterior outcrop of the building, such as a cantilevered room, that protrudes from or overhangs the building envelope.

3.2.5.1 *Discussion*—Examples include, but are not limited to, eaves, soffits, enclosed cantilevered balconies, and enclosed cantilevered room bump-outs.

3.2.6 *soffit, n*—the enclosed underside of any exterior overhanging section of a roof eave.

3.2.7 *sustained flaming, n*—flame on or over the surface of a test specimen that lasts longer than a period of 4 s.

3.2.8 *wall assembly, n*—framed vertical section simulating an exterior wall below an eave overhang or projection used in the evaluation of test specimen.

3.2.8.1 *Discussion*—Paragraph 7.2 describes the wall assembly used in this test method.

4. Summary of Test Method

4.1 This test method provides for the direct flame exposure of eave overhang and other projections.

4.2 This test method employs a gas burner to produce a diffusion flame in contact with the test specimen.

4.3 The flame source is centered left to right and below the test specimen.

4.4 The gas burner produces a prescribed net rate of heat output during the flame exposure period, after which the flame exposure is terminated.

4.5 The test method monitors the fire characteristics and the ability of the test specimen to resist fire penetration during the flame exposure period and a subsequent observation period.

4.6 Observations are made for the appearance of sustained flaming and glow on the unexposed side during the 10-min flame exposure period and a subsequent 30-min observation period.

5. Significance and Use

5.1 The test method described herein monitors the fire characteristics and the ability of eave overhangs and other projections to resist exterior fire penetration from underneath under the specified fire exposure conditions.

5.2 Representative joints and other characteristics of the eave overhang or projection shall be included in the test specimen when these details are representative of the end-use construction.

5.3 The test method does not apply to vents or perforated materials used to enclose or cap eaves, soffits, and other projections.

NOTE 1—Test Methods E2912 and E2886/E2886M are methods used to test vents or perforated materials to resist direct flame impingement and flame penetration into the building.

5.4 The test method is devised for eave overhangs and other projections independent of the materials covering the building envelope.

NOTE 2—Heat contribution from burning materials covering the building envelope beyond the prescribed fire exposure is not considered in this test method.

5.5 The test method does not necessarily represent the expected performance of eave overhang and projections under all actual fire conditions, but it does provide a basis for comparing eave overhang and projections materials when subjected to the test procedure described herein.

5.6 In this procedure, the test specimen is subjected to specific laboratory fire test conditions. If different test conditions are substituted or the anticipated end-use conditions are changed, it is not known whether it is possible by use of this test to predict changes in the performance characteristics measured. Therefore, the results are strictly valid only for the fire test conditions and construction tested.

5.7 The test method does not provide any basis for determining the fire resistance characteristics of eave overhangs or projections when exposed to a fire originating in the building.

5.8 The test method does not address interior or exterior flame spread.

6. Safety Precautions

6.1 The test procedure involves high temperatures and combustion processes. Therefore, the potential exists for burns, ignition of extraneous objects or clothing, and for inhalation of combustion products.

7. Apparatus

7.1 Unless otherwise noted, dimensions in the following descriptions shall be followed with a tolerance of ±13 mm (0.5 in.).

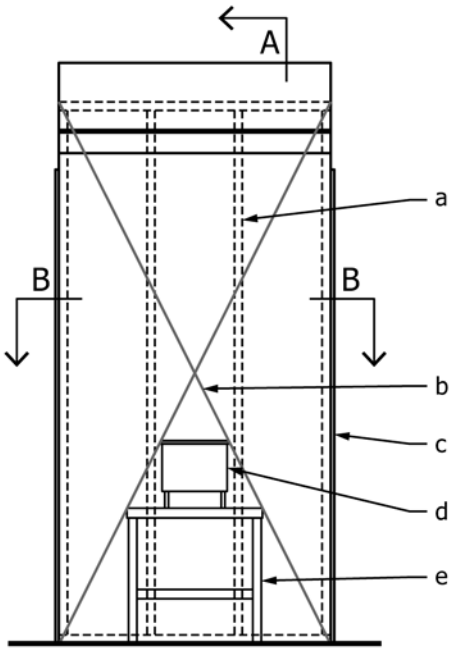
[3] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, http://www.iso.org.

[4] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.

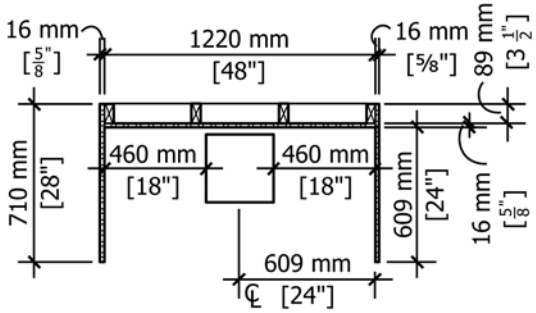
7.2 *Wall Assembly*—Framed assembly made up of standard 38 by 89 by 2440 mm (2 by 4 in. by 8 ft) standard wood wall studs (metal studs optional) at 406 mm (16 in.) o.c. overlaid with 16 mm (⅝ in.) Type "X" gypsum board complying with Specification C1396, or a noncombustible board material of nominal thickness of 12 mm (½ in.) or greater.

7.2.1 The wall assembly dimensions shall be 1220 mm (4 ft) wide and 2440 mm (8 ft) high.

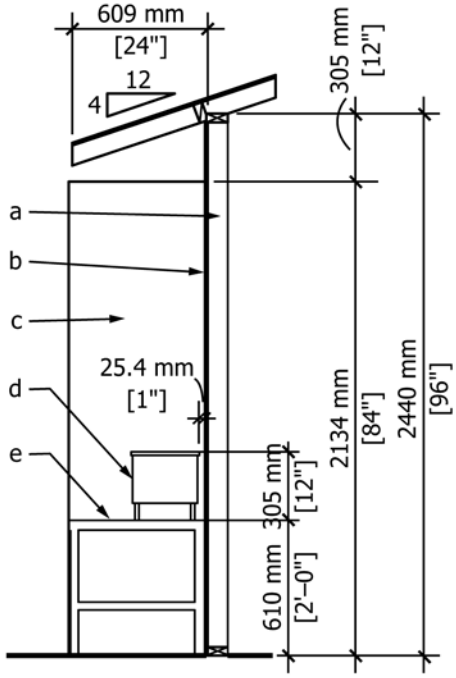
7.3 *Holding Fixture*—The assembly shown in Figs. 1 and 2 is designed to permit rapid installation and removal of the test specimen and the wall assembly, and to prevent edge penetration of fire at the margins of the wall assembly. The holding fixture includes a sturdy frame assembly to mount the test specimen and the wall assembly. The holding fixture permits a prefabricated wall assembly with an attached test specimen to be inserted from the rear and to seal in such a way that protects the wall assembly edges from fire. Side shields are situated near the vertical edges of the holding fixture and extend from the holding fixture's base to within 305 mm (12 in.) of the top of the wall assembly as shown in Figs. 1 and 2 to aid in minimizing extraneous drafts to the surface of the test specimen.



SECTION A
EAVE PLACEMENT



SECTION B–B



SECTION A–A

a. Wood studs 38 mm × 89 mm [1 1/2" × 3 1/2"] @ 406 mm [16"] o.c. (metal studs optional)

b. 16 mm [5/8"] type "X" gypsum board (optional 12.5 mm [½"]) 1220 mm × 2440 mm [48" × 96"], fastened to wall studs w/ #8 × 41.28 mm [1 5/8"] drywall screws @ 203 mm [8"] o.c. all edges and field

c. 16 mm [5/8"] type "X" gypsum board (optional 12.5 mm [½"]) 609 mm × 2134 mm [28" × 84"], clamped to frame

d. 305 mm × 305 mm [12" × 12"] gas diffusion burner

e. Metal stand

FIG. 1 Holding Fixture Loaded With Eave Test Specimen and Wall Assembly

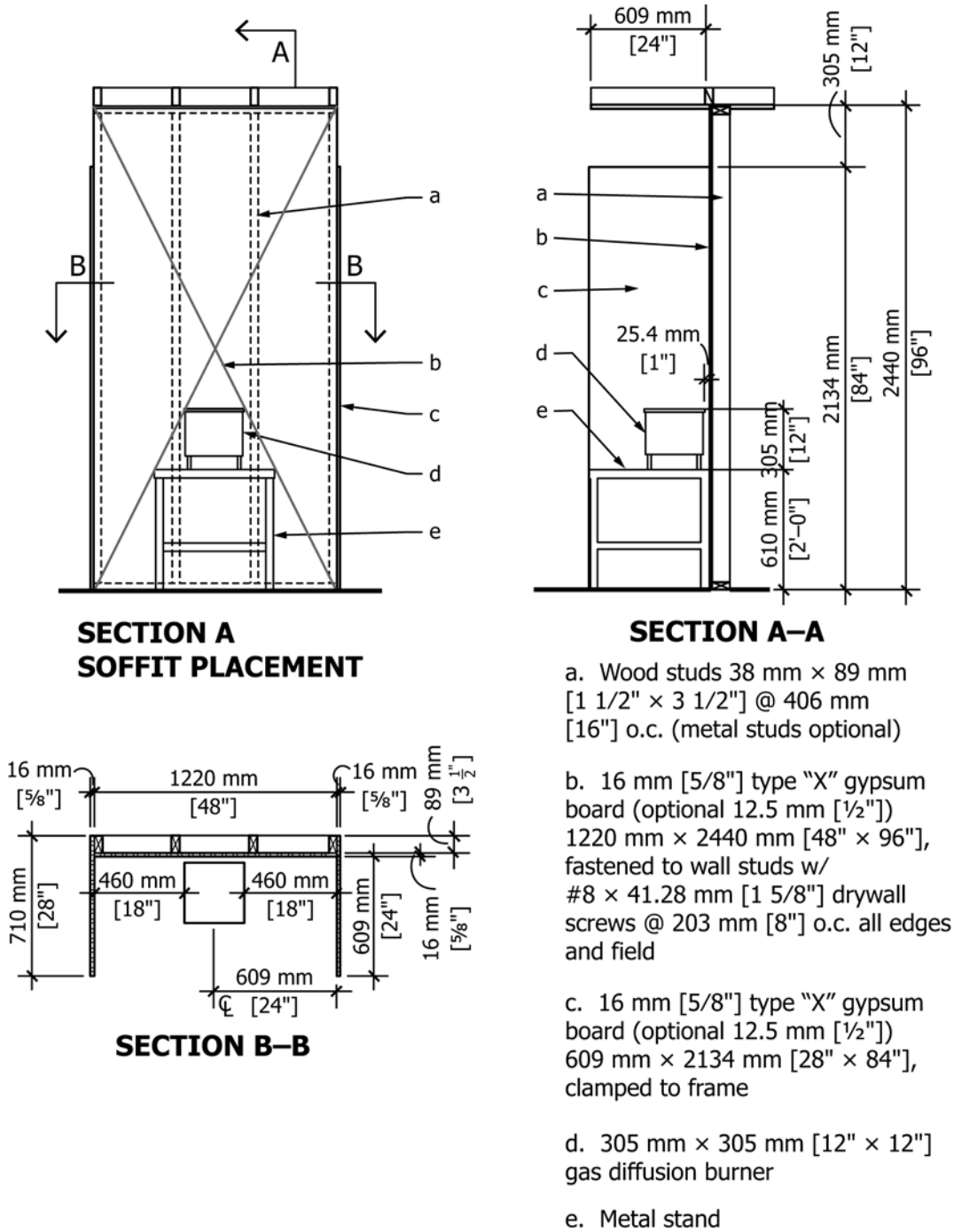


FIG. 2 Holding Fixture Loaded With Projection Test Specimen and Wall Assembly

7.3.1 The side shields shall consist of nominal 16 mm (⅝ in.) Type "X" gypsum board complying with Specification C1396 or a noncombustible board material of 12 mm (½ in.) nominal thickness or greater mounted on a sturdy frame.

7.3.2 The side shield dimensions shall be 609 mm (28 in.) wide and 2134 mm (84 in.) high.

NOTE 3—The holding fixture used in this test method is the same as the

Wall Assembly Holding Fixture described in Paragraph 7.2, Test Method E2707 except the simulated noncombustible soffit has been replaced with the test specimen under investigation.

8. Test Room

8.1 The ambient temperature in the test room shall be above 15 °C (60 °F) and the relative humidity shall be less than 75 %. The test room shall be draft-protected and equipped with an exhaust hood system for removal of products of combustion during testing.

8.2 Air velocities in the vicinity of the ignition source burner shall not exceed 0.5 m/s (1.64 ft/s) measured at a horizontal distance of 0.5 m (20 in.) from the edge of the wall assembly.

8.3 Air supply shall not be limited during the test.

9. Ignition Source and Calibration

9.1 *Ignition Source Burner:*

9.1.1 The ignition source shall be a gas diffusion burner with a porous top surface of a refractory material.

9.1.1.1 The gas diffusion burner shall have a nominal surface area 305 by 305 mm (12 by 12 in.), as shown in Fig. 3.

9.1.1.2 The gas diffusion burner shall be supported for a nominal height of 152 mm (6 in.) making the total height 305 ± 6 mm (12 ± 0.25 in.).

NOTE 4—The burner used for testing in this standard is the same as described in Section 4.1, NFPA 286.

9.1.2 The refractory material specified in 9.1.1 shall be a minimum 102 mm (4 in.) layer of white Ottawa sand used to provide the horizontal surface through which the gas is supplied.

9.2 *Burner Position:*

9.2.1 The gas diffusion burner enclosure shall be positioned so that it is centered relative to the width of the wall assembly.

9.2.2 The gas diffusion burner shall be located 25 ± 6 mm (1 ± 0.25 in.) from the wall assembly.

9.2.3 The distance from the base of the holding fixture in Figs. 1 and 2 to the top surface of the gas diffusion burner shall be 915 ± 6 mm (36 ± 0.25 in.). To obtain the required distance from the base of the holding fixture in Figs. 1 and 2 to the top surface of the gas diffusion burner, the nominal 305 mm (12 in.) tall burner shall be placed on top of a nominal 610 mm (24 in.) tall metal stand with a nominal top surface area of 610 by 610 mm (24 by 24 in). The metal stand is shown in Fig. 4.

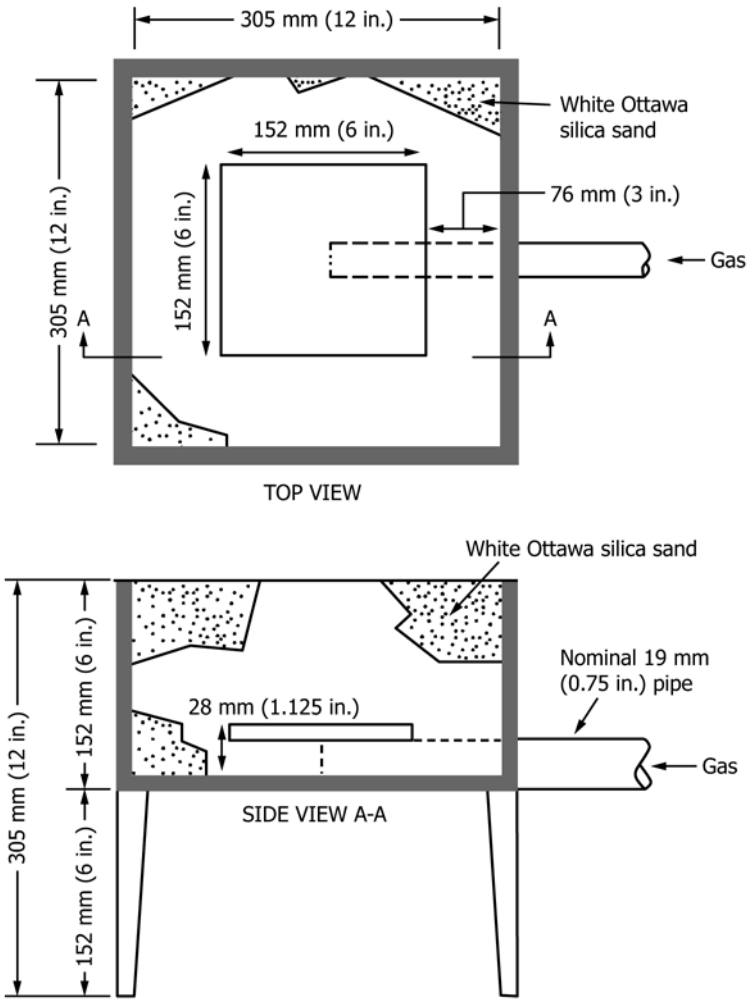
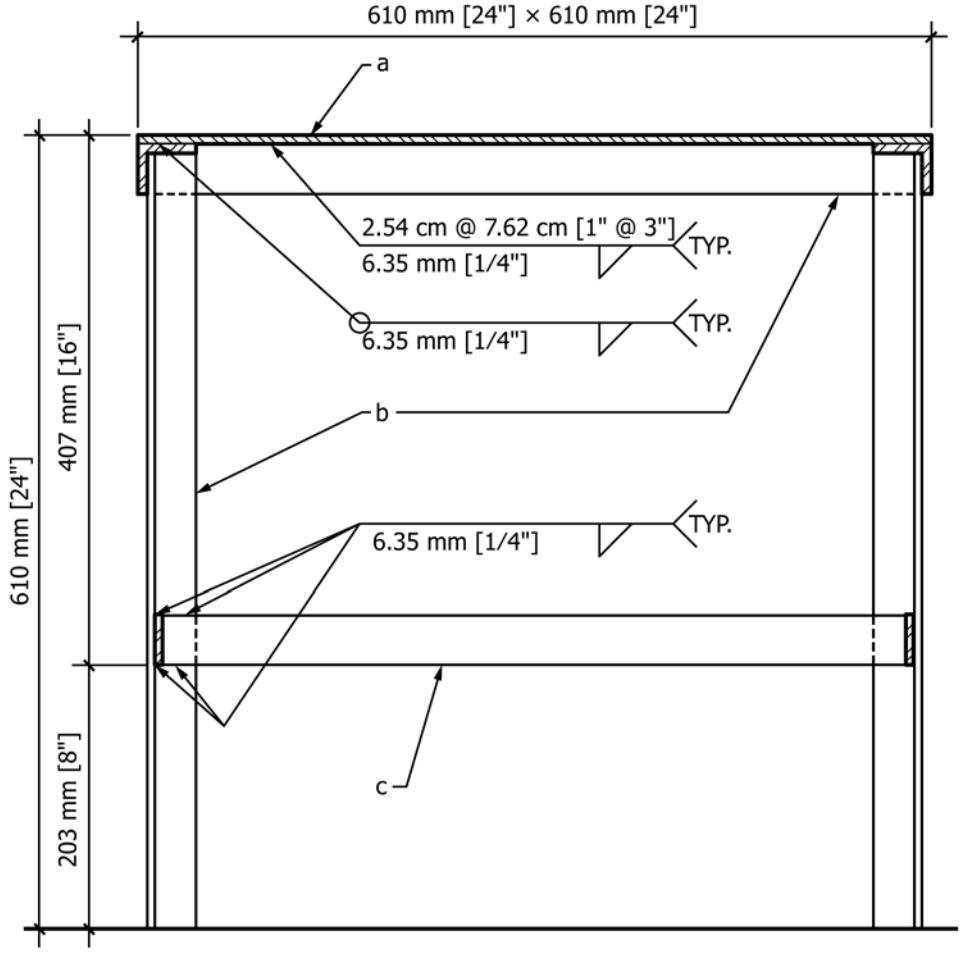


FIG. 3 Gas Diffusion Burner for Test



a. PL 6.35 mm [¼"], TYP.

b. L 3.81 cm × 3.81 cm × 6.35 mm [1 ½" × 1 ½" × ¼"], TYP.

c. PL 3.81 cm × 6.35 mm [1 ½" × ¼"], TYP.

FIG. 4 Metal Stand for Gas Diffusion Burner

9.3 The gas diffusion burner shall be supplied with minimum 99 % pure propane (often described by suppliers as CP or "chemically pure" grade) having a nominal heating value of 93.0 MJ/m^3 [22.2 kilocalories (thermochemical) per cubic meter or 2500 Btu (thermochemical) per cubic foot].

9.4 The propane shall be supplied to the gas diffusion burner through a metered control system.

9.5 The propane supply to the gas diffusion burner shall produce a net heat output of 300 ±15 kW (17,060 ± 853 BTU/min).

9.6 The gas diffusion burner shall be ignited by a pilot burner or a remotely controlled spark igniter.

9.7 Gas diffusion burner controls shall be provided for automatic gas supply shut-off if flameout occurs.

9.8 *Gas Diffusion Burner Calibration:*

9.8.1 The gas supply to the gas diffusion burner shall be the same as used for testing. The gas shall be metered and kept constant throughout the calibration test.

9.8.2 Place the gas diffusion burner in the configuration to be used for testing and obtain the heat release rate value prescribed in 9.5.

9.8.3 Take measurements at least once every 6 s and start 1 min prior to ignition of the gas diffusion burner. Determine the average heat output over a period of at least 1 min by the oxygen consumption method, or calculate the heat output from the gas mass flow and the net heat of combustion.

9.9 *Frequency of Calibration:*

9.9.1 Calibrate the gas diffusion burner for heat output prior to each day's use.

9.9.2 Any indication of off-limit condition such as unusual flame appearance or flame contour, excess turbulence, or unusual noise shall be cause for calibration prior to further use.

10. Preparation of Test Specimens

10.1 Unless otherwise noted, dimensions in the following descriptions, shall be followed with a tolerance of ±13 mm (0.5 in.).

10.2 *Construction of Test Specimen:*

10.2.1 The test specimen shall be 1220 mm (4 ft) wide. When applicable, normal roof framing, joints, and other typical features present in the end-use construction shall be present in the test specimen.

10.2.2 The test specimen shall extend out from the wall assembly a distance of 610 mm (24 in.) and be finished in a manner appropriate for exterior exposure as per accepted construction practices.

10.2.2.1 Testing of test specimens with an extension from the wall other than 610 mm (24 in.) is permitted. However, applicability of the results is limited to the extension tested or less, and shall be noted in the report.

10.2.3 The solid left and right vertical sides of the test specimen shall be finished with a noncombustible material to prevent unintended direct flame impingement of internal components.

10.3 *Accelerated Aging/Weathering and Conditioning of Test Specimens:*

10.3.1 When it is anticipated that a regulatory or other agency will require pre-test accelerated aging/weathering of the samples, the test sponsor shall have the option to conduct such weathering. Weathering shall be conducted as specified by the regulatory agency or applicable methods as specified for the test specimen.

10.3.1.1 Both weathered and unweathered test specimens shall be evaluated to assess the potential for the fire test response characteristics as measured in this test method to deteriorate due to accelerated aging/weathering of the eave overhang/projection materials.

10.3.1.2 Details of the weathering method used, or reference to a standard test method, shall be included in the report (see Appendix X2).

10.3.2 Five pieces of any cellulosic materials from the same stock from which the test specimen was constructed shall be tacked to the test specimen during construction in such a manner that they are easily removed and shall provide an overall moisture content average. These pieces shall be conditioned with the completed test specimen.

10.3.3 The completed test specimens are to be stored indoors at temperatures not lower than 16°C (60°F) nor higher than 32°C (90°F) for the period of time necessary to cure the test specimen components. This period is achieved when subsequent moisture content measurements obtained during a 24-h period show no change for the assembly components to come into equilibrium with a surrounding environment. Test specimens are to be stored so that each will be surrounded by freely circulating air. Relative humidity range is to be listed and be part of the testing documentation.

10.3.4 Just prior to testing the test specimen, but not more than 30 min before testing, the pieces of cellulosic materials prepared in 10.3.2 and 10.3.3 shall be tested for moisture content.

10.3.4.1 Make the moisture determination on two samples from each piece and report the average. For lumber and other wood-based materials, use Test Methods D4442. Alternatively, the moisture content for lumber and other wood-based materials is permitted to be measured using a moisture meter calibrated in accordance with Test Methods D4444.

10.3.4.2 For lumber used in the construction of the wall assembly and holding fixture, the moisture content shall not be more than 12 %. For plywood decks, the moisture content is to be not greater than 8 %. For other cellulosic materials, the moisture shall be within ranges specified by the test sponsor before the assembly is constructed. These specified ranges shall be typical for exposure at 25 ± 5°C (77 ± 9°F) and 55 ± 10 % relative humidity.

11. Procedure

11.1 Prior to testing, and without the test specimen or wall assembly in place, position the holding fixture at the desired test location under the collection hood and set the gas diffusion burner for the prescribed level of output.

11.2 Once the gas diffusion burner output is verified, mount the wall assembly and the test specimen into the holding fixture such that the test specimen connects to the wall assembly 1524 mm (5 ft) from the top of the gas diffusion burner, without affecting the distance between the wall assembly and the burner. Test configuration is shown in Figs. 1 and 2. Perform visual documentation during the installation period using color photographs or a video that would allow excerpting color photographs.

11.3 Seal the edges and ends of the test specimen and wall assembly with ceramic wool or comparable material to prevent flame penetration in these locations.

11.4 Simultaneously ignite the gas diffusion burner and start the timer marking the beginning of the test. Control the gas diffusion burner to a constant heat output as prescribed in 9.5. Control the hood duct flow to collect all products of combustion.

11.4.1 Flame exposure period: Apply the gas flame continuously for 10 min or until flame penetration of the test specimen through to the unexposed side occurs, whichever is shorter.

11.4.2 Observation period: After the gas flame has been extinguished, continue the test until all evidence of flame, glow, and smoke has disappeared, or until penetration occurs but not for more than an additional 30 min beyond the time at which the gas diffusion burner has been shut off.

11.5 *Observations*—Record the time and location should glow and sustained flaming occur on the unexposed sides of the test specimen.

11.5.1 At minimum, photographically document the exposed and unexposed sides of the test specimen at the following three time points:

11.5.1.1 Prior to ignition of the burner.

11.5.1.2 No more than 1 min after the conclusion of the flame exposure period.

11.5.1.3 No more than 1 min after the conclusion of the observation period.

NOTE 5—Full visual image recording of the test by video has been found to be useful to determine the time and location glow and sustained flaming occur on the unexposed side of the test specimen.

NOTE 6—Infrared temperature recording has been found to be useful to detect the increase of temperature on the unexposed side of the test specimen.

11.6 Perform the tests in triplicate and report as specified in Section 12.

12. Report

12.1 Report the following information:

12.1.1 Name and address of the testing laboratory,

12.1.2 Name and address of test sponsor,

12.1.3 Date of test and identification number and date of report,

12.1.4 Description of the test specimens including construction details, tested extension from the wall, the test sponsor's installation details and limitations as applicable,

12.1.5 Description of the test assembly including construction details and materials used,

12.1.6 Storage and conditioning of test specimens and wall assemblies,

12.1.7 Pre-test accelerated aging/weathering exposure, as applicable,

12.1.8 Moisture content of cellulosic elements of the test specimens and wall assembly materials at the time of testing,

12.1.9 Details of the calibration including heat release rate measurements, and

12.2 *Test Results*—The test results shall include:

12.2.1 A notation of the time and location of glow or sustained flaming on the unexposed side of the test specimens during the test along with the sequence number of the test specimen.

12.2.2 Observations of the burning characteristics of the test specimens during and after test exposure as detailed in 11.5.

13. Precision and Bias

13.1 *Precision and Bias*—No information is presented about either the precision or bias of Test Method E2957 for measuring flammability and fire penetration because the test result is non-quantitative.

14. Keywords

14.1 eave; fire penetration resistance; fire-test response characteristic; projection; soffit; wildland fire

APPENDIXES

(Nonmandatory Information)

X1. COMMENTARY

X1.1 Introduction

X1.1.1 This test method was developed in response to recommendations developed by the California Office of the State Fire Marshal (SFM) and the International Wildland-Urban Interface Code (IWUIC) regarding the enhancement of exterior fire protection of buildings in a wildland fire (exterior wildfire exposure). The SFM recommendations established performance criteria for a variety of materials to be used on the exterior of buildings. This test method is intended to address one component of an exterior wildfire exposure, that is, eaves and other projections exposed to direct flame impingement. The purpose of this standard is to provide a definitive set of procedures for the evaluation and measurement of the resistance to fire penetration of eaves and other projections.

X1.2 Eaves and Projections Test Method Development

X1.2.1 The major concern for eaves and other projections is ignition either directly (by radiation, convection, flame contact) or indirectly (combustion of materials near the base of the wall and the wall cladding), followed by penetration into the projection cavity (directly or indirectly through the eaves/projections, or through seams) and then into the building.

X1.2.2 For noncombustible cladding, the major concern is conductive heat transfer through the eave or projection cavity that can ignite rafters, joists, or other cavity materials. Also, for cladding materials having seams, there is a possibility of penetration via these joint openings.

X1.2.3 In an attempt to better understand the effects of flame impingement on an eave structure, a preliminary test method was developed by the Forest Products Fire Research Laboratory at the University of California (UC) at Berkeley, at the time managed and operated by the UC Forest Products Laboratory. Ignition by ornamental plants (or equivalent combustibles) and the exterior wall cladding was considered by the Berkeley researchers as the most probable source of flame impingement of eaves, and a number of tests were run to determine the likely intensity and duration of exposure from small to medium size plants. From these tests (and other sources of research), the decision was to use a 305 by 305 mm (12 by 12 in.) burner with a 600-kW heat output for a 10-min exposure. The exposure time was determined by field reports on the maximum length of time that a structure would be subjected to direct flames from a passing wildfire.

X1.2.4 The holding fixture (Figs. 1 and 2 in this standard) was designed to permit rapid installation and removal of 1.2-m (4-ft) wide eaves/projections and wall assemblies, and was designed to prevent penetration of fire at the test specimen edges. The side shields provide protection from ambient air currents and permit normal eddy currents to occur.

X1.2.5 Preliminary tests were performed on boxed-in eave configurations to obtain data on two common materials used in the construction of exterior wall systems: *(1)* nominal ¼ in. thick AC-grade plywood ("A" face facing the flames), and *(2)* nominal 1 by 4 clear grade Douglas-fir tongue and groove boards.

X1.2.6 The 10-min 600-kW exposure was used followed by an additional 60-min observation period. A single layer of newspaper was placed on the inside of the eave assembly, directly on top of the soffit material, for visual detection of burn-through.

X1.2.7 The two replications of the plywood soffit samples had burn-through at 1:30 and 2:00 min. Failure occurred at an open knot on the unexposed face of replication #1, and through a core gap in replication #2. In both cases, failure occurred within 150 mm (6 in.) of the back wall. The two replications of the Douglas-fir tongue-and-groove soffit failed at approximately 8:00 and 6:00 min. As was the case with the plywood, failure occurred near the back wall at the first or second joint from the wall.

X1.2.8 Material joints and defects (for example, knots) that reduced the effective thickness had a substantial adverse effect on relative performance acting as the point of failure.

X1.2.9 The length of the recommended observation period (60 min) after the 10-min burner exposure is considered important to ensure the detection of sustained smoldering combustion. In WUI fires, the persistence of smoldering combustion could lead to loss of structures long after they might be considered safe.

X1.2.10 Additional eave and soffit fire exposure research was conducted at Western Fire Center under the direction of the California State Fire Marshal. Numerous eave and soffit assemblies were tested using both flame and radiant exposures. The eave and soffit assemblies were supported on both combustible and noncombustible walls 2.4 m (8 ft) in height with flame exposures ranging from 300 to 600 kW. Fire exposures ranged from 10 to 15 min in duration. Two different gas diffusion burners were used in the study, a 914 mm (36 in.) line burner and a 305 mm (12 in.) square burner.

X1.2.11 Based on the research, it was determined a square gas diffusion burner producing 300 kW for 10 min and a noncombustible wall as support of the eaves/soffits would be a reasonable exposure level for testing. The established 300 kW level was double that for the California SFM exterior wall and window standards and was considered by the investigators to be reasonable to account for the heat release of ignitable siding that was noted in preliminary testing of wall cladding.

X1.2.12 Based on the UC Berkeley test method development program, the California SFM adopted the following Conditions of Acceptance:

X1.2.12.1 Absence of flame penetration of the eaves at any time.

X1.2.12.2 Absence of structural failure of the eaves subassembly at any time.

X1.2.12.3 Absence of sustained combustion of any kind at the conclusion of the 40-min test.

X1.3 Further Eaves and Projections Test Method Development

X1.3.1 Further testing was conducted at the University of California Cooperative Extension, Richmond California and Western Fire Center, in which the objective was to investigate the effect of eave/soffit designs and overhang width on the vulnerability of buildings subjected to radiant and direct flame contact exposures. The testing used a 1.5 m (5 ft) high wall assembly 3.7 m (12 ft) in length, testing both eave and soffit overhangs. The tested eave and soffit samples varied in overhang extension from 150 mm (6 in.), 460 mm (18 in.), and 915 mm (36 in.). All testing was run in triplicate in order to observe any variances in performance. A 0.9 m (3 ft) line burner was centered on the wall using a 160 kW exposure to drive a substantial flame onto the eave or soffit being tested. Additional testing was conducted at Western Fire Center on the same sized eave/soffit panels to 20 kW and 35 kW radiant exposures. This testing further validated the use of a 300 kW fuel source level and raising the top of the burner to within 1.5 m (5 ft) of the exposed eave or soffit to be tested. Results from the study were published in the Conference Proceedings of Fire & Materials 2011.[5] Subsequent analysis of the published time-to-flaming ignition data by Underwriters Laboratories did not indicate overhang extension to have a statistically significant (0.05 α) impact on the time to flaming ignition of the overhang.

X1.3.2 Wall cladding tests on a broad range of materials including plywood, OSB, vinyl and aluminum sidings conducted by Underwriters Laboratories using the same California SFM exterior wall standard as referred to in X1.2.10 resulted in heat release rates as great as 500 kW for the ignitable siding.

X1.3.3 Western Fire Center conducted a series of experiments examining flame impingement on the eaves at different burner elevations. They observed intermittent flame impingement when the burner was positioned at the elevation specified in California 12-7A-3 Horizontal Projection Underside whereas consistent flame impingement was observed when the burner top surface was elevated to 36 in. (915 mm).

[5] Quarles, S. L., Stacy, H., Simontacchi, J., and Loar, R., "Vulnerability of the Eave to Direct Flame Exposure and Radiant Exposures," *Conference Proceedings of Fire and Materials 2011*, 2011, pp. 493-506.

X2. ACCELERATED AGING/WEATHERING OF TEST MATERIAL

X2.1 The intent of the investigation will determine whether or not some form of accelerated aging/weathering of the test material prior to conducting the fire test is warranted. For product development research it may not be important or cost effective to subject a prototype test material to a treatment cycle before conducting a fire test. That decision is afforded the product development proponent. However, it is important to alert the user of this test method that test material exposure conditions are always important to consider.

X2.2 It is reasonable to assume that some form of accelerated aging/weathering cycle will be required by an AHJ or listing agency when it is important to evaluate the permanence of the fire retardant properties of the product. In this case the particular aging process will be defined by the intended end-use application and the materials content of the product being tested. Because this is a test method that can be used for a wide range of products or assemblies, or both, it is not reasonable to assume that all materials should be subjected to the same accelerated aging/weathering process, particularly when materials content can be dramatically different between product types. For example, Test Method D2898 has long been used as an accelerated weathering process with fire retardant treated lumber products where leaching of chemicals may be an issue. For a product comprised of 100 % plastic, where leaching may not be an issue, some other environmental stress may be appropriate.

X2.3 There are several different accelerated aging/weathering procedures available. The effectiveness of these procedures varies with changes in the composition of the substrate being aged. The following procedures, Practice D2898, Specification D6662, and Specification D7032 are currently available. Care should be taken in choosing the procedure that is most appropriate for the material under evaluation. Always check with the regulatory agency to verify which procedure they require prior to testing.

X2.4 The language has been worded so that accelerated aging/weathering is not required in all cases, but is required where such results are a condition of acceptance for a product to be used in a code regulated application. As such, the language provides the flexibility needed for the range of materials being used for exterior wall applications.

X3. CALIFORNIA SFM 12-7A-3 HORIZONTAL PROJECTION UNDERSIDE

X3.1 This standard is similar to California SFM 12-7A-3 Horizontal Projection Underside test requirement originally adopted into the 2007 California Building Code, Chapter 7A, with three exceptions – sample conditioning, burner position, and Conditions of Acceptance.

X3.1.1 *Sample Conditioning*—California SFM 12-7A-3 specifies “Prior to testing, all materials (lumber and soffit material) shall be conditioned to a constant weight or for a minimum of 30 days at 73 ± 4ºF (23 ± 2ºC) and 50 ± 5 % relative humidity, whichever occurs first. Constant weight shall be defined as occurring when the change in test material weight is less than or equal to 2 % in a 24-h period. Lumber moisture content shall be between 8 and 12 % (oven-dry basis) and sheathing shall not exceed 8 % (oven-dry basis).”

X3.1.2 *Burner*—The burner position specified in California SFM 12-7A-3 is centered with respect to the width of the wall assembly width and 0.75 in. (19 mm) from the wall. The distance from the bottom of the wall assembly to the top surface of the burner is specified as 12 in. (300 mm).

X3.1.3 *Conditions of Acceptance*—California SFM 12-7A-3 requires all three replicates to meet the Conditions of Acceptance, or should one of the replicates fail to meet the Conditions of Acceptance, three additional tests may be run. All of the additional tests must meet the Conditions of Acceptance as described in X1.2.11.