



Designation: E2140 – 01 (Reapproved 2023)

Standard Test Method for Water Penetration of Metal Roof Panel Systems by Static Water Pressure Head¹

This standard is issued under the fixed designation E2140; 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 laboratory test method covers the determination of the resistance to water penetration of exterior metal roof panel system sideseams, endlaps, and roof plane penetrations when a specified static water pressure head is applied to the outside face of the roof panel.

NOTE 1—This test method is intended to evaluate water-barrier (not water-shedding) roof system joints and details. These systems are also referred to as hydrostatic roof systems.

1.2 This test method is limited to specimens in which the sideseams and attachments are clearly visible and in which the source of leakage is readily observable.

1.3 This test method excludes performance at roof perimeter conditions.

1.4 This test method is suitable for evaluating leakage at roof plane penetrations such as fasteners, curbs, pipes, and expansion joints under a static water pressure head.

1.5 The proper use of this test method requires a knowledge of the principles of water pressure.

1.6 The text of this standard includes notes and footnotes excluding tables and figures, which provide explanatory material. These notes and footnotes shall not be considered as requirements of the standard.

1.7 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.8 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements, see Section 7.

¹ This test method is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.57 on Performance of Metal Roof Systems.

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1.9 *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

E631 Terminology of Building Constructions

E1646 Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference

3. Terminology

3.1 *Definitions*—For definitions of general terms relating to building construction used in this method, see Terminology E631.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *composite roof systems*—roof systems consisting of an exterior metal skin and other components. Factory assembled composite panels consist of an exterior metal skin, insulation, and interior metal skin. Field assembled composite systems consist of exterior metal skins, underlayment, and a structural roof deck.

3.2.2 *panel endlap*—the connection between two in-line metal panels across the width of the panels.

3.2.3 *panel sideseam*—the connection between two adjacent metal panels along the length of the panels.

3.2.4 *specimen*—the entire assembled unit submitted for test as described in Section 8.

3.2.5 *water leakage*—penetration of water through the plane of the innermost face of the test specimen during the test period.

3.2.6 *water pressure head*—the distance from the surface of the water to the lowest point or cell of the metal panel specimen, measured at the locations shown in Fig. 1.

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.

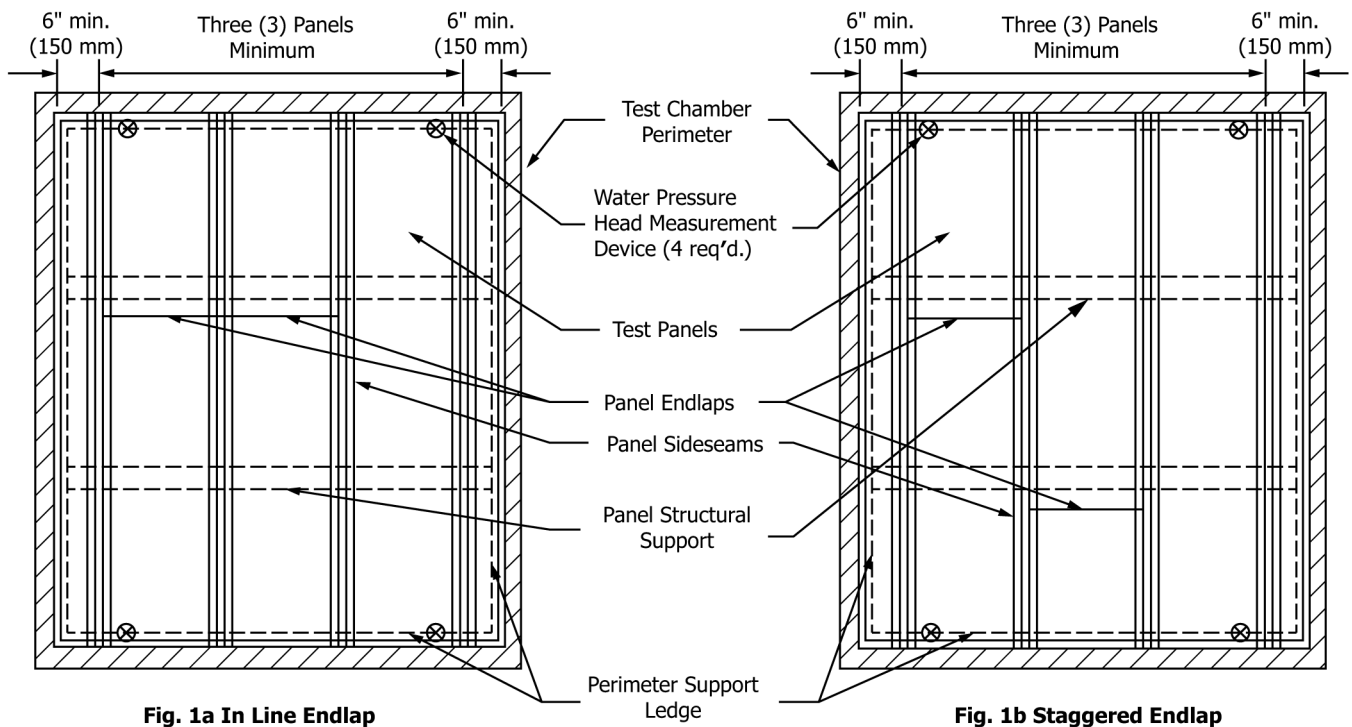


Fig. 1a In Line Endlap

Fig. 1b Staggered Endlap

FIG. 1 Plan of Typical Three-Span Test Specimen Mounted in Chamber

4. Summary of Test Method

4.1 The test consists of sealing and fixing a test specimen to a horizontal support frame, locating vertical water dams around the perimeter of the test specimen, applying a specified static water head to the outside face of the test specimen and observing for water leakage on the underside of the test specimen.

5. Significance and Use

5.1 This test method is a standard procedure for determining water leakage through metal roof panel system sideseams, endlaps, and roof plane penetrations when the roof system is subjected to a specified static water pressure head.

NOTE 2—In applying the results of tests by this method, note that the performance of a roof or its components or both, is in part a function of proper installation and adjustment. In service, the performance will also depend on the integrity of the supporting construction, roof slope, and on the resistance of components to deterioration by various causes: corrosive atmosphere, aging, ice, vibration, thermal cycling, etc. It is difficult to simulate the identical complex wetting, aging, and other variable conditions that can be encountered in service, including wind-blown ponded water; the effects of temperature and age on sealant performance; differential pressure across the joints due to wind, snow, and ice accumulation; densification and migration; and abrasions within the joint components which may occur during thermal cycling and other weather events. Some joint conditions are more sensitive than others to these factors.

5.2 This test method will evaluate the resistance of roof panels, sideseams, endlaps, and roof plane penetrations to water submersion. It will not evaluate panel resistance to wind driven rain.

NOTE 3—See Test Method E1646 for a test which evaluates resistance to wind driven rain.

5.3 This test method is not a structural adequacy test.

5.4 This test method is applicable to single skin metal panels, the exterior skin of factory assembled composite panels, and the exterior skin of field assembled composite systems as long as means can be provided to distinguish leakage through the exterior panel sideseams/endlaps and perimeter leakage.

6. Apparatus

6.1 This description of apparatus is general in nature and any arrangement of equipment capable of performing the test procedure within the allowable tolerances is permitted.

NOTE 4—One such alternate test apparatus arrangement consists of perimeter seals erected on top of the test specimen.

6.2 *Test Chamber*—(See Figs. 1 and 2). A well-sealed chamber or box with either an opening, a removable mounting panel or one open face in which or against which the specimen is installed and sealed. The test chamber shall be maintained in a horizontal position.

6.2.1 The test chamber shall be provided with a horizontal perimeter support ledge to which test specimens may be attached and sealed.

6.2.2 The test specimen shall be anchored to the test chamber perimeter to adequately resist imposed test loads without leakage or failure.

6.2.3 The test chamber shall be provided with a vertical water dam around the perimeter of the chamber. Water dam shall be well sealed and of sufficient height to maintain the required water pressure head.

6.2.4 A means of viewing all areas under the roof panel specimen shall be provided to facilitate observations for water

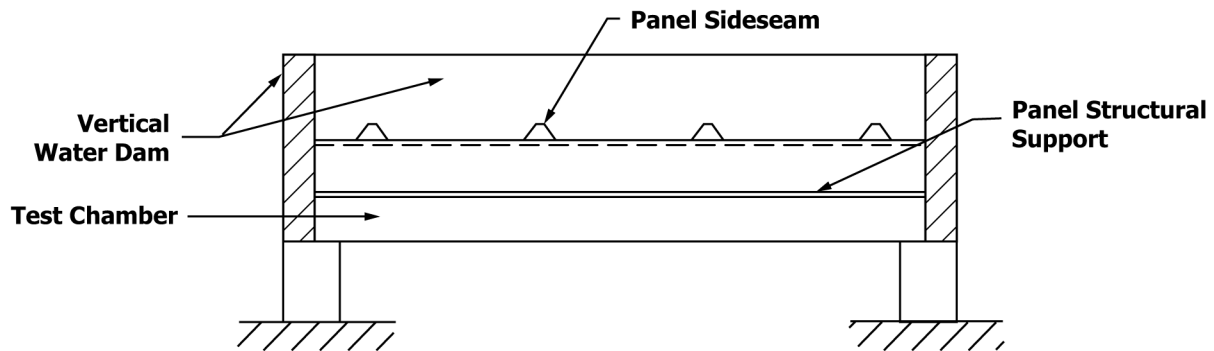


FIG. 2 Section Through Typical Test Specimen Mounted in Chamber

leakage. It is important to isolate perimeter leakage from leakage in areas under evaluation. For factory assembled components, this may be accomplished by omitting any sealant from joints of the interior metal skin.

6.3 *Water Pressure Head Measurement Device*—A calibrated scale capable of measuring the water pressure head within a tolerance of ± 0.1 in. (3 mm).

6.3.1 Four water pressure head measurement devices shall be used, and shall be located as shown in Fig. 1. Each device shall be located directly over a perimeter support ledge, and not more than 1.0 in. (25 mm) from the base of the sidelap.

7. Safety Precautions

7.1 Adequate precautions shall be taken to protect personnel from test chamber or test specimen failure during loading.

8. Test Specimens

8.1 Roof test specimens shall be of sufficient size to determine the performance of all typical parts of the roof system.

8.2 For roofs constructed with prefabricated or preformed units or panels, the specimen width shall not be less than three typical units plus supporting elements at each side.

8.3 The specimen shall include at least four side seams and at least two panel endlaps in adjacent panels in accordance with manufacturer's standard details. The center line of the panel side seams must be at least 6 in. (150 mm) from the perimeter of the test assembly as shown in Fig. 1.

8.4 The test specimen shall be installed as a multiple-span condition, unless the panel is used only in single-span applications. If two spans are used, they shall be unequal, with the shorter being 75 % of the longer. If three or more spans are used, they shall be equal in length. One span of the test specimen shall not be less than the maximum span to be used in a roof application.

8.5 All parts of the roof test specimen shall be full size, using the same materials, details, seals, and methods of construction and anchorage in accordance with manufacturer's standard written or illustrated instructions, or both. Specimen attachments and seals at test chamber perimeters are exempt from this requirement. Composite systems tested shall utilize a substrate of the same stiffness to be used in the field assembly.

8.6 The specimen perimeter shall be well sealed and structurally attached to the test apparatus perimeter to isolate leakage through the test specimen from leakage through the perimeter. For composite roof systems, remove internal or secondary seals and disrupt all possible channels that may carry leakage to the perimeter of the test specimen. The substrate of field assembled composite roof systems shall be made discontinuous so that any leakage through the external skin is readily identified as such.

8.7 Structural panel supports shall be the same size and shape as specified in manufacturers standard written or illustrated instructions, or both. Structural supports shall be designed to support test loads.

8.8 Roof insulation shall not be included unless it is an integral part of the roof panel system.

9. Procedure

9.1 Remove any sealing material or construction that is not normally a part of the typical panel assembly.

NOTE 5—When full length brake-forming is available, the test panels at the side rails can be bent upward to form effective side seals.

NOTE 6—Non hardening mastic compounds or pressure sensitive tapes can be used effectively to seal the test panel assembly to test chamber.

NOTE 7—The perimeter seals between test panel specimen and test chamber do not have to duplicate actual building perimeter details.

9.2 Load the test specimen to approximately 3 in. (75 mm) of water pressure head. Maintain water level for a minimum of 5 min.

NOTE 8—The use of room-temperature water is recommended to avoid condensation which may interfere with the observations of water leakage.

9.2.1 Examine perimeter seals and repair as necessary. Restore water pressure head to approximately 3 in. (75 mm) if required and maintain for a minimum of 5 min.

NOTE 9—A small amount of perimeter seal leakage is permitted provided that it does not impede the determination of water leakage on the inside face of the roof panel specimen.

9.3 Increase the water pressure head to 6 in. (150 mm).

9.3.1 Maintain the 6 in. (150 mm) ± 0.2 in. (5 mm) water pressure head for a period of 6 h.

9.3.2 Record the water pressure head and observe for water leakage on the inside face of the roof panel specimen 1 h after