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**INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS**
**UNIFORM EVALUATION SERVICES**

**EVALUATION CRITERIA FOR**

# Standing Seam Metal Roof-Mounted Rail-Type Snow Retention Systems

**EC 029 - 2018**
**(November 2018)**

## 1.0 INTRODUCTION

**1.1 Purpose:** The purpose of this evaluation criteria is to establish requirements for roof-mounted rail(fence)-type snow retention systems for standing seam metal roofs to be independently reviewed and recognized in an evaluation report issued by a certification body. This criteria provides for recognition under the 2018, 2015, 2012, 2009 and 2006 *International Building Code*® (IBC®) and the 2018, 2015, 2012, 2009 and 2006 *International Residential Code*® (IRC®). The basis for recognition is contained in 2018 and 2015 IBC Section 1709.1; 2012, 2009, and 2006 IBC Section 1708.1; IRC Section R301.1.3; and IBC Section 104.11 and IRC Section R104.11.

**1.2 Scope:**

**1.2.1** This Evaluation Criteria establishes the testing requirements and procedures, the documentation required for review, and analysis methods used to determine allowable loads for roof-mounted snow retention systems for recognition in an evaluation report issued by an approved certification body accredited in accordance with ISO/IEC 17065.

**1.2.2** This criteria is intended for use to evaluate the design of rail-type snow retention systems connected to standing seam metal roof covering panels using seam clamps to resist in-plane, down-slope snow loads. Uplift, sideways, or prying loads such as those that may be imposed by the attachment of solar panels, fall restraint systems, or similar roof mounted equipment are not considered in this document.

**1.3 Definitions:**

**1.3.1 Roof-mounted Snow Retention Systems:** Snow retention systems, also known as snow-guard systems, are composed of multiple individual snow guards or continuous snow guard assemblies designed to restrain quantities of snow and ice from sliding down the slope of the roof. These systems include primary snow guard elements, clips, cross-members, seam clamps, and/or brackets.

**1.3.2 Snow guard:** Snow guards are individual devices or assemblies designed to retard or restrain the movement of snow or ice.

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**1.3.3 Seam Clamps:** Seam clamps are devices that connect to standing seams of metal roof panels to provide attachment points for roof mounted systems. Seam clamps are designed to clamp securely onto the standing seams without penetrating the metal of the roof panel so that the roof remains water tight. Snow loads on the snow guards are transferred through the seam clamps to the roof panels.

**1.3.4 Cross-members:** Structural members (rods, bars or other shapes) installed perpendicular to the expected direction of sliding snow to provide a barrier against snow and ice movement. Cross-members are primary components of Rail- or fence-type snow retention systems.

**1.3.5 Snow Clip:** Components mounted to cross-members to increase the effectiveness of the snow retention system by retarding movement of snow or ice beneath the cross-member.

**1.3.6 Rail-Type Snow Retention System:** A snow retention system composed of rail- or fence-type cross-members and brackets. Snow clips also may be incorporated into the cross-members to increase the overall snow retention effectiveness.

**1.3.7 Brackets:** Devices used in some snow retention systems to connect one or more cross-members to metal roof standing seam clamps.

**1.3.8 Metal Roof Standing Seam System:** A roofing system composed of shaped metal panels interconnected via raised edges that are bent and folded together forming a vertical standing seam. The panels may be fastened to the building structure with attachment clips that are integrated into the standing seam leaving few or no exposed fasteners.

**1.3.9 Snow retention system design load ($RS_{DL}$):** The component of the maximum seasonal weight of the snow acting in the direction of sliding snow down the slope of the roof. $RS_{DL}$ is determined by the following equation:

$$RS_{DL} = W_{Smax} \cdot \sin(s_r°)$$

$W_{Smax}$ = maximum seasonal weight of snow on a roof

$s_r°$ = angle of the roof in degrees

The quantity and weight of snow restrained by the snow retention system shall be determined by a qualified design professional. Design shall be based on the ground snow load for the location of the building and other factors influencing snow and ice build-up and weight contained in ASCE 7. These factors may include wind exposure and thermal factors, applicable warm and cold roof factors, roof slope, unbalanced loads, aerodynamic shading, snow surcharge, and drifting and shielding action. Additional information concerning standard practices for design of snow retention systems can be found by consulting the Metal Construction Association.

Note: Due to the probability of water and ice on the roof surface, the force of friction acting to restrain the snow from sliding from the roof is assumed to be zero.

## 2.0 REFERENCED STANDARDS

**2.1** The following standards, referenced in this criteria, shall be applied consistently with the provisions of the applicable edition of the code(s) noted herein unless otherwise approved by the certification body:

| | |
|---|---|
| 2006, 2009, 2012, 2015, 2018 IBC | International Building Code® |
| 2006, 2009, 2012, 2015, 2018 IRC | International Residential Code® |
| ASTM A370 | Standard Test Methods and Definitions for Mechanical Testing of Steel Products |
| ASTM E4 | Standard Practices for Force Verification of Testing Machines |
| ASTM E575 | Standard Practice for Reporting Data from Structural Tests of Building Constructions, Elements, Connections, and Assemblies |
| ASTM A90 | Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings |
| ASTM A924 | Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| ASTM E8 | Standard Test Methods for Tension Testing of Metallic Materials |
| ISO/IEC 17011-2004 | Conformity assessment- General requirements for accreditation bodies accrediting conformity assessment bodies |
| ISO/IEC 17025-2005 | General requirements for competence of testing and calibration laboratories |
| ISO/IEC 17065-2012 | Conformity assessment -- Requirements for bodies certifying products, processes and services |
| ASCE 7-16 | Minimum Design Loads and Associated Criteria for Buildings and Other Structures |

## 3.0 BASIC INFORMATION

The following information shall be provided for review and evaluation:

**3.1 Product Description:** Complete information pertaining to components, including dimensional drawings, material specifications, and the manufacturing processes. Materials shall comply with an appropriate recognized national standard(s).

**3.2 Installation and Use Instructions:** Complete information pertaining to product installation and use. The same installation instructions published for use in the field for product installation, shall be observed by the laboratory for specimen preparation before testing.

**3.3 Packaging and Identification:** Method(s) of packaging and product identification, which shall include, at minimum, the manufacturer's or report holder's name and address, product name and identification number, mark of the certification body, and the evaluation report number.

**3.4 Justifying Documentation:** Complete justification for the product's acceptability for the stated use in accordance with the applicable codes, standards, related criteria, including this criteria, and reports of testing and analysis prescribed therein and otherwise appropriate to justify recognition and approval.

**3.4.1 Testing Laboratories:** Testing laboratories shall be accredited for the applicable testing procedures in accordance with ISO/IEC 17025 by a recognized accreditation

body conforming to ISO/IEC 17011. Testing at a non-accredited laboratory shall be permitted, provided the testing is conducted under the supervision of an accredited laboratory, the testing complies with all of the requirements of the applicable standards, the product specimens comply with the minimum criteria for acceptance, and the supervising laboratory issues the test report.

**3.4.2 Test Reports:** Test reports shall include all of the applicable information required by this criteria, the applicable test standard and ASTM E575, as appropriate.

**3.4.3 Product Sampling:** Sampling of the components of the roof-mounted rail-type snow retention systems for tests under this criteria shall be conducted at the manufacturing locations by an accredited testing laboratory or inspection agency. Alternatively, the specimens may be submitted to the laboratory by the manufacturer, provided the manufacturer attests that the submitted samples are representative of normal production and of the product being evaluated. The accredited testing laboratory or accredited inspection agency shall compare the samples taken to the normal product specifications and shall conclude that the products comply.

## 4.0 TEST AND PERFORMANCE REQUIREMENTS

### 4.1 Seam Clamp - Load Test Procedures and Analysis

**4.1.1** The following information shall be provided for the standing-seam metal roof panels and components:

(a) The uncoated base-metal thickness. The base-metal thickness may be calculated by converting the zinc or 55% AlZn coating weight to a zinc or 55% AlZn coating thickness and subtracting it from the overall measured thickness. The coating weight shall be determined in accordance with ASTM A90 or ASTM A924 for zinc and A792 for 55% AlZn.

(b) Specified minimum yield strength and a minimum tensile strength. Verification of strength values shall be in accordance with ASTM E8 as specified in ASTM A370. The tensile strength of the steel used in testing shall be within 10 percent of the minimum material strength specified in the approved quality documentation.

(c) Detailed scaled drawings of the roof panels and side joint (standing seam) to be used to verify the dimensions of the standing seam in the test setup. These details shall be included in the test report.

**4.1.2** The test setup shall consist of the following:

(a) The test setup shall include the seam clamps corresponding to the roof-mounted snow retention system, installed in accordance with the manufacturer's published instructions. The clamps shall be attached to a metal roof standing seam having identifiable configurations representative of field conditions.

(b) The number of specimens (setups) tested shall comply with the requirements of Section 4.1.4 of this criteria.

(c) Holding strength of seam clamps is dependent on setscrew installation torque. Each clamp setscrew shall be torqued to a maximum of 93 percent of the minimum torque indicated by the installation instructions and the values shall be recorded. Gouging or breaching of the corrosion-protective coating shall be avoided as shown in Figure 1 of this criteria.

(d) A testing machine complying with the requirements of ASTM E4 that is capable of operating at a constant rate of motion, or constant rate of loading, shall be used. The rate of loading shall be controlled, or a constant rate of motion or rate of loading shall be maintained. The applied loads shall be recorded to a precision of one percent of the anticipated ultimate load.

(e) Devices used to measure the components of the retention system shall be calibrated in accordance with ASTM E4. The devices used to measure longitudinal displacement of the clamp relative to the top of the seam shall provide a precision of ±0.03 inch (0.8 mm). The devices used to measure the thickness of the metal roofing material shall be accurate to within ±0.0005 inch (0.01 mm). The devices used to measure fastener dimensions shall provide a precision of ±0.005 inch (0.1 mm).

(f) A test apparatus as shown in Figure 2 of this criteria shall be used to investigate the holding strength of the seam clamps to the standing seam. The apparatus shall consist of a minimum $^{1}/_{8}$-inch-thick (3.175 mm) steel plate measuring approximately 20 inches by 30 inches (508 mm by 762 mm). The plate shall be reinforced as necessary with steel angle, tube or channel to prevent its buckling, warping or twisting when under tension loads parallel but offset from its surface. The test fixture shall be securely anchored to the test table along the 20-inch (508 mm) dimension, and sufficiently braced to the table to prevent excessive deflection during the test.

(g) The roof panel test specimen shall consist of a minimum 30-inch (762 mm) long section of a manufacturer-specific panel side joint (standing seam) and adjacent tributary area of two adjoining metal roof panels. Each manufacturer-specific roof panel configuration, material, and thickness sought for recognition in an evaluation report shall be tested. Any intermediate ribs that may be used as attachment points shall also be tested. The total width of the specimen shall be minimum 12 inches (305 mm) and maximum 20 inches (508 mm). The panel standing seam shall be mated as prescribed by the roof panel manufacturer in a typical installation, exclusive of any attachment clips. If the panel standing seam is normally machine seamed on site, the provider shall furnish the roof panels in a seamed condition, using the same type seaming machinery, methods, tools, and equipment as would be used in actual field assemblies.

(h) The test specimen shall be attached to the test apparatus so that the panel standing seam lies parallel to the direction of the test load.

(i) The test specimen shall be fastened to the plate using fasteners installed adjacent to the panel standing seam, in sufficient quantity and spacing to prevent movement of the panels during the test.

(j) A metallic scale with 1-millimeter increments shall be located at each clamp on the test panel standing seam to measure movement of the clamp or travel along the longitudinal direction of the standing seam.

**4.1.3** The test procedure shall comply with the following:

(a) Test loads shall be applied in the direction of the intended load of the clamp and shall be applied to simulate the load path associated with the cross-member and its attachment to the clamp. The test load path shall be applied to induce maximum torsion of the setscrew connection in the seam clamp attached to the standing seam. For a single cross-member system, the test load shall be applied where the seam clamp supports the single cross-member. For a multiple cross-member system, the test load shall be applied where the seam clamp (or bracket portion) supports the upper most cross-member.

(b) An initial load, or preload, is permitted to be applied to seat the seam clamps attached to the standing seam of the test roof panel. This preload shall not exceed 10 percent of the expected average ultimate load and is removed before loading the specimen to failure.

(c) The test load shall be applied at a uniform rate between 0.10 and 0.25 inch (2.54 to 6.5 mm) per minute until failure or ultimate load. Loads shall be recorded to a precision of ±1 percent of the ultimate load during application of test loads.

**4.1.4** Evaluation of test data shall comply with the following:

Test results shall be evaluated on a basis of the average value from the test data from not fewer than three identical specimens, provided the deviation of any individual test result from the average value obtained from all tests does not exceed 15 percent. If deviation from the average value exceeds 15 percent, more tests of the same kind shall be performed until the deviation of any individual test result from the average value obtained from all tests does not exceed 15 percent, or until at least three additional tests have been done. No test result shall be eliminated unless a rationale for its exclusion is given.

Allowable loads shall be determined from the lesser of the values in accordance with Section 5.0 of this criteria. Allowable loads shall be determined by taking the average ultimate load of the tests divided by a safety factor of 2.0, provided that each test is within 15 percent of the average. The safety factor shall be adjusted appropriately for variations in results exceeding this percentage.

Fastener loads for screws and bolts shall not exceed published allowable load values recognized in national standards referenced by the codes or recognized in a current and approved evaluation report.

**4.1.5 Failure modes:** The following shall indicate that the peak load for a given test specimen has been reached:

A. Dis-engagement of clamp from panel seam
B. Clamp displacement of more than 8 millimeters (0.315 inch)
C. Breakage or fracturing of clamp or fasteners
D. Stripping or other failure of any related fasteners
E. Fracturing of any area of panel seam
F. Buckling or any other structural or severe cosmetic damage to panel seam

**4.2 Cross-member - Calculations:** The strength and stiffness of the snow retention system cross-members shall be determined by analysis in accordance with the applicable code. The analysis shall be based on the sectional and material properties of the cross-members and shall account for material durability. Allowable loads shall not permit permanent deformation or permanent deflection of the cross-members. Analysis shall reflect the worst-case support conditions of the cross-members including multiple span, simple span, and cantilevers, as appropriate.

**4.2.1 Cross-member, Bracket, and Component Testing:** When the strength and stiffness of the snow-guard system cannot be determined by calculation, testing of the system shall be required. A testing plan documenting all material elements and each snow-guard retention system configuration shall be submitted to the evaluation agency for approval prior to testing. If a splice is to be used to join adjacent cross-members, testing shall be performed with the splice placed mid-span of the cross-member. Testing shall reflect the worst case support conditions of the cross-members including multiple span, simple span, and cantilevers, as appropriate. Brackets that hold cross-members in place shall be pull tested with an apparatus that represents cross-members transferring load into the bracket. A minimum of three replicate specimens shall be tested for each combination of variables that affect the performance of the system.

## 5.0 DETERMINATION OF ALLOWABLE LOADS

**5.1** Roof-mounted snow retention systems attached to metal standing seam roof panels shall be rated for allowable direct snow load capacity parallel to the plane of the roof and perpendicular to the expected direction of sliding snow. The allowable load for the systems shall be based on the allowable load for the weakest element in the system as follows:

(a) Allowable load determined for the cross-member based on analysis described in Section 4.2 of this criteria or testing in accordance with Section 4.2.1 of this criteria.

(b) Allowable load determined for any bracket in the system based on test results described in Section 4.1.3 of this criteria.

(c) Allowable load determined for the seam clamp based on testing and analysis in accordance with Sections 4.1.2 and 4.1.4 of this criteria, with the clamp attached to specific standing seem roof systems.

**5.2** Load duration factor adjustments are not permitted to be used to determine the capacity of the snow retention system.

**5.3** The material strength properties of the products used in testing shall not be greater than 110 percent of the minimum strength properties allowed for the manufactured product as specified in the manufacturer's quality management system.

## 6.0 QUALITY CONTROL

**6.1** Manufacturer's Quality Management System shall comply with the IAPMO UES minimum requirements for manufacturer' quality management systems (IAPMO ES-010).

**6.2** Inspections of manufacturing facilities by an approved certification or inspection agency is required for these products. The inspection agency shall be accredited in accordance with ISO/IEC 17020; the certification agency shall be accredited in accordance with ISO/IEC 17065.

## 7.0 EVALUATION REPORT RECOGNITION

**7.1** Evaluation reports shall include the general information required in Section 3.0 of this criteria and allowable loads in accordance with Section 5.0 of this criteria.

**7.2** The evaluation report shall state that:

**7.2.1** The roof-mounted snow retention system shall be structurally compatible with the standing seam metal roof. Compatibility shall be determined by an independent engineering review. The evaluation report shall specify the standing seam metal roof with which it is structurally compatible (justified by testing) by brand name, profile, thickness, material and coating. Galvanic compatibility shall be determined based on engineering judgement, the snow retention system and standing seam metal roof system manufacturers' recommendations, the building configuration, and in-service environmental conditions.

**7.2.2** Snow retention system components, including attachment fasteners, shall be fabricated from corrosion-resistant metals having a service life expectancy at least equivalent to the roof itself.

**7.2.3** Linear thermal expansion of the Snow Retention System shall be considered and accommodated by system design. Thermal cycling of the metal roof system shall not be impeded by Snow Retention System attachment.

**7.2.4** Seam clamp set screws shall be installed to the torque specified in the evaluation report using a calibrated torque installation device. The calibration certificate shall be available at the jobsite for review.

**7.2.5** Design snow load forces imposed on metal roof standing seam panels and their connections are assumed to be accounted for in the structural design and attachment of the roof panels. Snow retention systems shall not be used where the Roof Slope Factor, $C_S$, for unobstructed slippery surfaces is used in roof structure design in accordance with Section 7.4 of ASCE 7.

**7.2.6** The snow retention system shall be installed in accordance with the manufacturer's installation instructions.

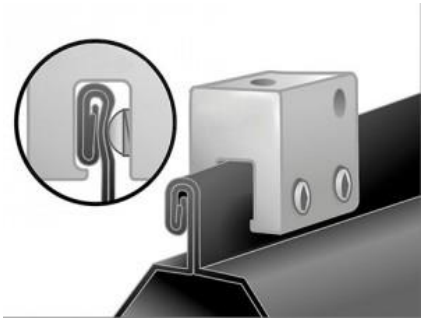

**Figure 1:** An example of round-point non-penetrating setscrews used to secure a snow-retention seam clamp to metal roof panels.

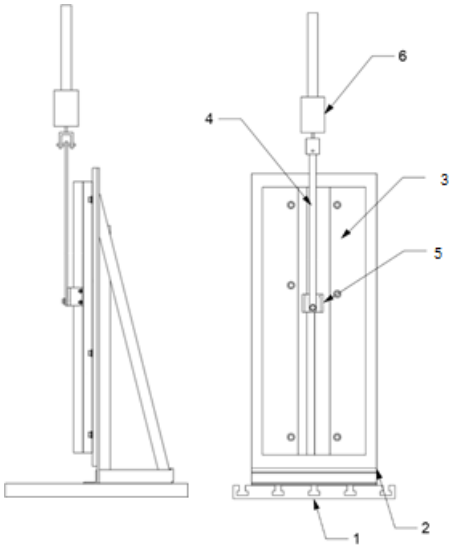


**FIGURE 2 — TEST APPURATUS**

**Where:**

1. Test bed
2. Test fixture
3. Two steel or aluminum roof panels joined with a specific side joint (standing seam) configuration. The standing seam shall be of a type and configuration intended for use with the roof-mounted rail-type snow retention system.
4. Load cell arm
5. Seam clamps from a roof-mounted rail-type snow retention system attached to the standing seam. The clamp shall be tested installed with the minimum end distance. For rail-type snow retention systems, the bracket shall be included in the test such that the load cell arm is located at the position of the top rail of the rail-type system (not shown in Figures 1 and 2).
6. Load cell