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From: Dennis Anderson/UL
Contributors: Jeff Baker/WESTlab, Steve Fronek/Wausau Windows & Wall

Subject: General Information for Comparison of Condensation Resistance Ratings

This document is to help the NFRC Membership understand the differences and similarities of the three current condensation resistance ratings in preparation to review the NFRC 500 and NFRC 501 ballots that intend to align the three rating methods with the introduction of a new Condensation Index (CI) rating by the NFRC.

One important note regarding the test methods referenced below is that no matter the rating or index value, the specifications can only be used as guides to selecting fenestration systems and that there is no assurance that a selected system will not experience condensation. The rating is to help reduce the potential for condensation.

The three organizations and their respective test method are:


- CSA (Canadian Standards Association) - A440.2-14/A440.3-14, Fenestration energy performance/User Guide to CSA A440.2-14, Fenestration energy performance. The optional condensation rating within this method is titled the Temperature Index (I).

NFRC 500 is the only method above that is determined via simulation. The only instance when an NFRC 500 Condensation Resistance (CR) rating is determined via physical testing is if the product cannot be simulated.

AAMA 1503 and CSA A440 test methods are only determined via physical testing in a hot box.

The environment condition similarities of all three test methods is the interior & exterior air temperatures and interior boundary condition (natural convection):

Interior Air Temperature = 21 °C
Exterior Air Temperature = -18 °C

The boundary conditions (exterior wind speed) for the physical testing is assumed to be 30 W/m2-K (or 6.5 m/s wind speed) for the hot box tests. The laboratories are required to calibrate their exterior velocity fans to meet the 30 W/m2-K boundary condition +/- 10%. As noted above, physical testing (or hot box testing) is required for AAMA 1503 and CSA A440 testing.
The exterior boundary condition for NFRC 500 simulations is 26 W/m²-K (or 5.5 m/s wind speed). The difference in boundary conditions affected the interior surface temperature by 0.1 °C for a thermally-broken aluminum sliding glass door modeled in THERM.

The Test Methods:

**NFRC 500:**
The NFRC Condensation Resistance scale is 1 to 100, with a higher number representing more resistance to the formation of condensation. The Condensation Resistance rating is determined based on outside conditions of approximately -18°C (0°F) with a 6 m/s (15 mph) wind, and inside conditions of approximately 21°C (70°F) with relative humidities of 30%, 50%, and 70% taken into consideration. The Condensation Resistance rating is a value that considers the relative area under condensation at these three humidity levels, which are then normalized, and the degree to which the surface temperatures are below the dew point for the frame and for the glazing are considered. The Condensation Resistance rating specified in the NFRC rating is based on the lower of the frame, center-of-glazing, or edge-of-glazing values.

This standard is not meant to predict condensation. It is a tool for rating and comparing window products and their potential for condensation formation. Although the CR method specifies procedures for testing actual windows, if the product can be simulated, then only the simulation method portion of NFRC 500 shall be used for the rating.

**AAMA 1503:**
AAMA 1503 is a physical testing method only. The testing is conducted in a guarded hot box and the results obtained is a Condensation Resistance Factor (CRF). It is a scale of 1-100. The greater the CRF, the better the condensation resistance.

AAMA has developed an online calculator to estimate the CRF needed to prevent condensation at specific indoor relative humidity levels and outdoor temperatures. The webpage for this tool is: [https://aamanet.org/pages/crf-tool](https://aamanet.org/pages/crf-tool)

The CRF is determined by the lower of the CRF of the glass and frame. The CRF of the frame is calculated based on 14 pre-determined interior temperature locations (illustrated in the test method by product type), along a weighting factor to reduce the frame temperature by the average of four coldest "roving" temperatures. It is required to place 10 additional 'roving' thermocouples on the frame that the test technician must predict are the coldest points. Only four of those ten locations are used as the average roving temperature that is used as weighted factor against the 14 pre-determined frame temperatures.

The glass CRF is calculated based on the average glass temperature, combining the edge and center-of-glass thermocouples. There is not an average "edge" temperature versus "center-of-glass".

The frame and glass locations include the top and bottom of the product, so the average temperatures include a stratification effect of warmer surfaces along the head and colder along the bottom.
AAMA representative members that have attended and been significant contributors to the new NFRC CI approach have intended to look at AAMA 1503 for possible updates that may align with a harmonious approach to thermocouple placement on the frame and glass and the roving temperature weighting factor.

**CSA A440.2/.3**
The CSA A440.2/.3 condensation test is a physical testing method only with a scale of 1 to 100 that is called the Temperature Index (I).

The Temperature Index, like AAMA 1503, can be used to compare the expected performance of fenestration systems with respect to condensation resistance. The higher the Temperature Index of the fenestration system, the better the system is at resisting condensation.

The proposed NFRC CI simulation method was based on this CSA A440.2/.3 condensation test method due to its predication capabilities. As CSA A440.2/.3 cites on page 49 of the document, "For a particular application (i.e., for a given winter outside design temperature and indoor relative humidity), the Temperature Index can be used as a guide for selecting a suitable fenestration system."

The I value is determined by the placement of thermocouples along pre-determined locations illustrated in the test method. The number of frame thermocouples is determined by the operator type. No thermocouple is placed higher than ½ way up the frame except for horizontal sliding products (with one placed near the head) and vertical sliders (with 2 placed on the upper sash's bottom rail). Like AAMA 1503, the test technician must also place "roving" thermocouples on the frame at predicted coldest points but with only four.

Three glass temperatures are placed horizontally along a line of 50mm above the glass sightline of the sill/sash (three additional for the second glass lite for any horizontal or vertical slider as well as curtainwall). The average of the three glass temperatures is used for the glass temperature.

CSA representatives that have attended and been significant contributors to the new NFRC CI approach have agreed to re-evaluate the A440.2/.3 test method to change/add the glass surface placement of the thermocouples to align with the new NFRC 500 CI approach of 25mm (or 1") above the glass/frame junction. It is also CSA's intention that when the new NFRC CI value is approved, they may align with the NFRC and introduce a simulation method for condensation that is similar.

**Additional Information of other Future Test Methods**

**AAMA 515:**
This is not a published document but is a good reference to how the future is shaping to more condensation analysis of fenestration and building facades.

This standard is under development by AAMA and is a simulation method using THERM only to ascertain interior surface temperatures of fenestration but including the installed condition (with trim and substrates). This document will require the simulator to obtain the surface temperatures of interior frame and glass surfaces it will be required to report (or show on heat plots) the temperature of the glass at 25mm (1") above the glass-to-frame junction. This is equivalent to the newly proposed NFRC Condensation Index (CI).
AAMA 501.9
This is not yet a published document but again is a good reference to how condensation is a
concern in commercial construction. This is a method to assess interior surfaces for
condensation under project specification temperatures of mocked up specimens built in the
laboratory that best represents the actual construction of a façade for a given building project.

Therefore, this is a physical testing method only but one of the requirements is that the glass
surface temperature is only taken at the 25mm (1") location above the glass-to-frame junction.
Thus, illustrating the harmonious approach to NFRCs new CI value for evaluating the potential
for condensation.

A great source that may be interesting for condensation comparisons was a document
developed and published by AAMA titled, AAMA CRS-15, A Comparison of Condensation
Rating Systems for Fenestration. The link to the AAMA website store to purchase this
document is: https://pubstore.aamanet.org/pubstore/ProductResults.asp
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<td>CRF Unit-less ratio from average of glass or frame</td>
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Procedures in Grey are proposed and in DRAFT mode