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*Providing compete construction specifications documentation, systems and performance descriptions, and risk and quality advisory services.*

Conspectus's Tech Tips received the national Communications Award from the Construction Specifications Institute.

**ABSTRACT**:
Condensation and frost on the inside surfaces of exterior glazed openings must be avoided. Temperature, humidity, fabrication, and installation, all contribute to success and failure. Learn what tools are available to help select glazing products for project design conditions?

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**KEYWORDS**:
Condensation, Relative Humidity, Design Temperature, Edge of Glass, Center of Glass, Testing, Simulation

**REFERENCES**:
AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections
ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings
NFRC 500 - Procedure for Determining Fenestration Product Condensation Resistance Values

# Fenestration Condensation

By David Stutzman, AIA, CSI, CCS, SCIP, LEED AP

## Brrrr, It's Cold!

Polar vortexes bring cold, very cold weather. Building envelopes are designed to accommodate most winter temperature conditions but not extremes.

The opaque walls are air-tight and thermally well insulated to resist the effects of the worst Mother Nature sends our way. Perhaps the HVAC system cannot keep up and we are a bit chilly as the interior temperature dips.

The building fenestration is different. These openings that are so important to admit natural light, provide views, and yes with operable windows, even provide ventilation. However, fenestration openings are thermal holes, breaching the otherwise highly efficient, well insulated envelope. Glazed openings may have U-values of 0.40, eight times greater than the 0.05 U-value of the R-20 insulated wall. (Lesser U-value means better thermal performance.).

Just like an iced water glass, cold fenestration has a propensity to sweat, allowing condensation to form on both the glass and frame. Condensation can stain surfaces and cause decay and corrosion, especially over time. Under the right conditions, condensation will promote mold growth, reducing the overall indoor air quality for building

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| Table 1 | | |
|---|---|---|
| Permitted Material | Fireblocking | Draftstopping |
| 2x lumber | 1 layer | N/A |
| 1x lumber | 2 layers | 1 layer |
| Plywood | 23/32 inch | 3/8 inch |
| Particleboard | 3/4 inch | 3/8 inch |
| Cement Millboard | 1/4 inch | N/A |
| Cement Fiberboard | N/A | Any thickness |
| Batts & Blankets | Mineral Wool<br>Mineral Fiber<br>Unfaced Fiberglass | Mineral Wool<br>Fiberglass |

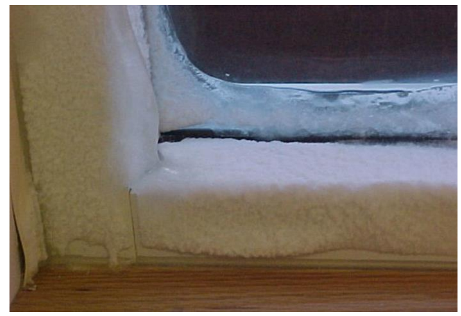

Photo: Courtesy of EFCO

Neither does ASHRAE 90.1. These documents prescribe U-values, solar heat gain coefficients, and air leakage requirements for glazed openings. These performance criteria are averaged over the entire assembly and reported as a single number. Averaged condensation performance can be misleading.

## Considerations

Condensation potential is highly dependent on individual assembly components, fabrication details, and installation details. Short-circuits across thermal isolation points in the system will contribute to localized condensation. When any point on a surface has a temperature less than the dew point of the surrounding air, condensation will occur at that point.

Condensation is also dependent on environmental conditions: interior temperature, exterior temperature, and indoor relative humidity (RH). Building HVAC systems are designed to control the temperature and for some occupancies like hospitals and museums, the relative humidity. In most buildings, the relative humidity is uncontrolled, so condensation predictions may be suspect.

The edge of glass (EOG) temperature may affect condensation performance too. Typical aluminum edge spacers help reduce the EOG temperature, increasing the probability of condensation.

Then there is the human factor. Those pesky building occupants that so easily thwart the best planned building systems. Pull the blinds; close the drapes; and place furniture over the air outlets. Then the real temperature conditions no longer match the design conditions. Fail to clean the clothes dryer vent; cook without running the exhaust hood, and the relative humidity will spike.

## Standards

Two standards exist to help predict fenestration condensation performance AAMA1503 and NFRC 500. No comparison can be made between these two standards because they report two different results.

AAMA 1503 reports condensation resistance factor (CRF). The CRF will be a dimensionless number between 30 and 80. CRF is a weighted value determined by physical testing. A single value is reported for the entire assembly including glass and frame. The greater the CRF, the better the condensation performance. Use the AAMA CRF tool to determine the recommended CRF for specific project design conditions. Input indoor and outdoor temperatures with indoor RH. The tool will report a minimum CRF value.

NFRC 500 reports condensation resistance (CR). CR is also a dimensionless number ranging from 1 to 100. The results are determined by computer simulation using 30, 50, and 70 percent RH interior conditions. The reported CR is the lowest value for all of the frame, center of glass (COG), and edge of glass locations. The greater the CR, the better the condensation resistance.

Both CRF and CR are meant for comparing the performance of different fenestration assemblies. Use only one measure to make comparisons. These are not to be taken as absolute performance measures. Both standards analyze fenestration assemblies of standard sizes, under laboratory conditions. The sizes vary by the fenestration operation and type - meaning window or glazed wall. The sizes in the two standards are not the same. Designing openings with smaller sizes and with more framing will reduce thermal and condensation performance because the best performing COG becomes a smaller percentage of the opening.

## Conclusion

Review reported performance data carefully. CRF and CR are reported for specific fenestration configurations and with specific glazing. Consider whether the proposed project glass has better COG and EOG thermal performance, or not. Also consider the proposed fenestration size. Smaller openings will have poorer thermal and condensation performance because of the increased frame and EOG percentage of the overall opening.

Consider replacing aluminum spacer with warm edge spacers to improve the EOG temperatures and overall thermal performance.

Check installation details carefully. Eliminate bridges between warm and cold surfaces. Window anchors are a common bridge. Be sure air cannot leak around the fenestration perimeter. Seal and insulate the perimeter. Consider using expanding foam sealant to completely fill the gaps and cracks between the frame and surrounding construction.

For critical applications, consider requiring THERM computer analysis of each unique fenestration condition to predict surface temperatures. Then compare those temperatures to the expected interior dew point.

Remember it is impossible to completely eliminate the probability of condensation Mother Nature will always prevail during the next unexpected cold snap.

For additional information see: CSI Specifying Practice Group presentation.

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