NFRC 500-2023[~~E0A2~~E0A3]

Procedure for Determining Fenestration Product Condensation Index Ratings

An American National Standard

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National Fenestration Rating Council®

FOREWORD

The National Fenestration Rating Council, Incorporated (NFRC) has developed and operates a uniform rating system for energy and energy-related performance of fenestration products. The Rating System determines the U-factor, Solar Heat Gain Coefficient (SHGC) and Visible Transmittance (VT) of a product, which are mandatory ratings for labeling NFRC certified products, are mandatory ratings for inclusion on label certificates, and are supplemented by procedures for voluntary ratings of products for Air Leakage (AL), and Condensation Resistance. Together, these rating procedures, as set forth in documents published by NFRC, are known as the NFRC Rating System.

The NFRC Rating System employs computer simulation and physical testing by NFRC-accredited laboratories to establish energy and related performance ratings for fenestration product types. The NFRC Rating System is reinforced by a certification program under which NFRC-licensed responsible parties claiming NFRC product certification shall label and certify fenestration products to indicate those energy and related performance ratings, provided the ratings are authorized for certification by an NFRC-licensed certification and Inspection Agency (IA).

The requirements of the rating, certification, and labeling program (Certification Program) are set forth in the most recent versions of the following as amended, updated, or interpreted from time to time:

- NFRC 700 Product Certification Program (PCP).
- NFRC 705 Component Modeling Approach (CMA), Product Certification Program (CMA-PCP).

Through the Certification Program and the most recent versions of its companion programs as amended, updated, or interpreted from time to time:

- The laboratory accreditation program (Accreditation Program), as set forth in the NFRC 701 Laboratory Accreditation Program (LAP).
- The IA licensing program (IA Program), as set forth in NFRC 702 Certification Agency Program (CAP).
- The CMA Approved Calculation Entity (ACE) licensing program (ACE Program), as set forth in the NFRC 708 Calculation Entity Approval Program (CEAP).

NFRC intends to ensure the integrity and uniformity of NFRC ratings, certification, and labeling by ensuring that responsible parties, testing and simulation laboratories, and IAs adhere to strict NFRC requirements.

In order to participate in the Certification Program, a Manufacturer/Responsible Party shall rate a product whose energy and energy-related performance characteristics are to be certified in accordance with mandatory NFRC rating procedures. At present, a Manufacturer/Responsible Party may elect to rate products for U-factor, SHGC, VT, AL, Condensation Resistance, or any other procedure adopted by NFRC, and to include those ratings on the NFRC temporary label affixed to its products, or on the NFRC Label Certificate. U-factor, SHGC and VT, AL, and Condensation Resistance rating reports shall be obtained from a laboratory that has been accredited by NFRC in accordance with the requirements of the NFRC 701.

The rating shall then be reviewed by an IA which has been licensed by NFRC in accordance with the requirements of the NFRC 702. NFRC-licensed IAs also review label format and content, conduct in-plant inspections for quality assurance in accordance with the requirements of the NFRC 702, and issue a product Certification Authorization Report (CAR), or approve for issuance an NFRC Label Certificate for site-built or CMA products and attachment products. The IA is also responsible for the investigation of potential violations (prohibited activities) as set forth in the NFRC 707 Compliance and Monitoring Program (CAMP).

Ratings for products that are labeled with the NFRC Temporary and Permanent Label, or products that are listed on an NFRC Label Certificate in accordance with NFRC requirements, are considered to be NFRC-certified. NFRC maintains a Certified Products Directory (CPD), listing product lines and individual products selected by the manufacturer/responsible party for which certification authorization has been granted.

NFRC manages the Rating System and regulates the Product Certification Program (PCP), Laboratory Accreditation Program (LAP) and Certification Agency Program (CAP) in accordance with the NFRC 700 (PCP), the NFRC 701 (LAP), the NFRC 702 (CAP), the NFRC 705 (CMA-PCP), and the NFRC 708 (CEAP) procedures, and conducts compliance activities under all these programs as well as the NFRC 707 (CAMP). NFRC continues to develop the Rating System and each of the programs.

NFRC owns all rights in and to each of the NFRC 700, NFRC 701, NFRC 702, NFRC 705, NFRC 707, NFRC 708 and each procedure, which is a component of the Rating System, as well as each of its registration marks, trade names, and other intellectual property.

The structure of the NFRC program and relationships among participants are shown in Figure 1, Figure 2, and Figure 3. For additional information on the roles of the IAs and laboratories and operation of the IA Program and Accreditation Program, see the NFRC 700 (PCP), NFRC 701 (LAP), and NFRC 702 (CAP) respectively.

Figure 1

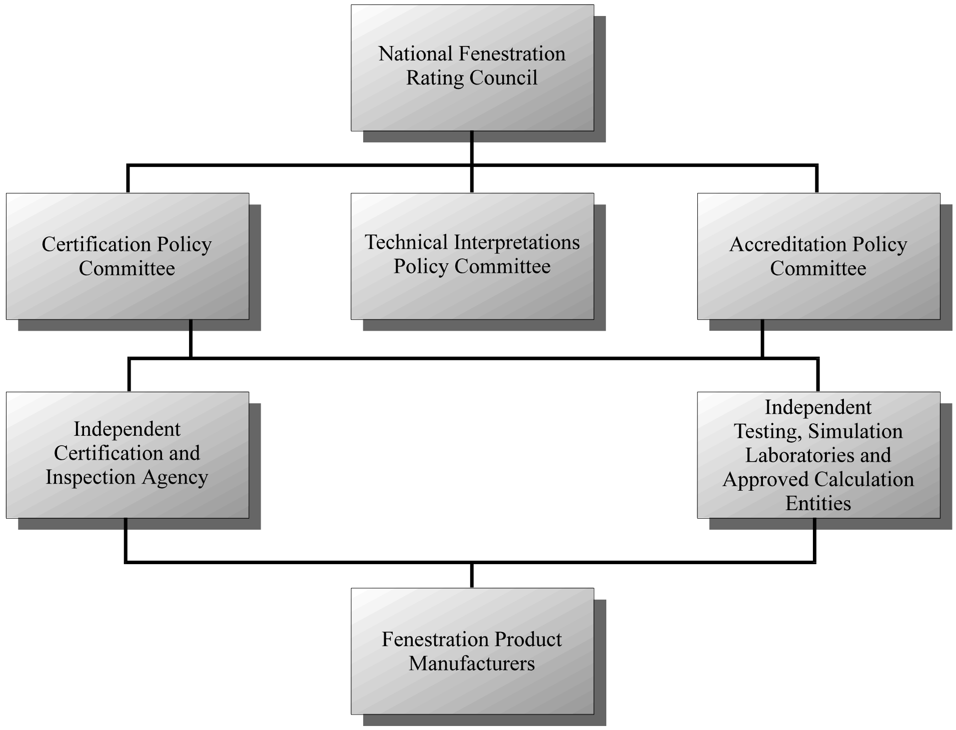


Figure 2

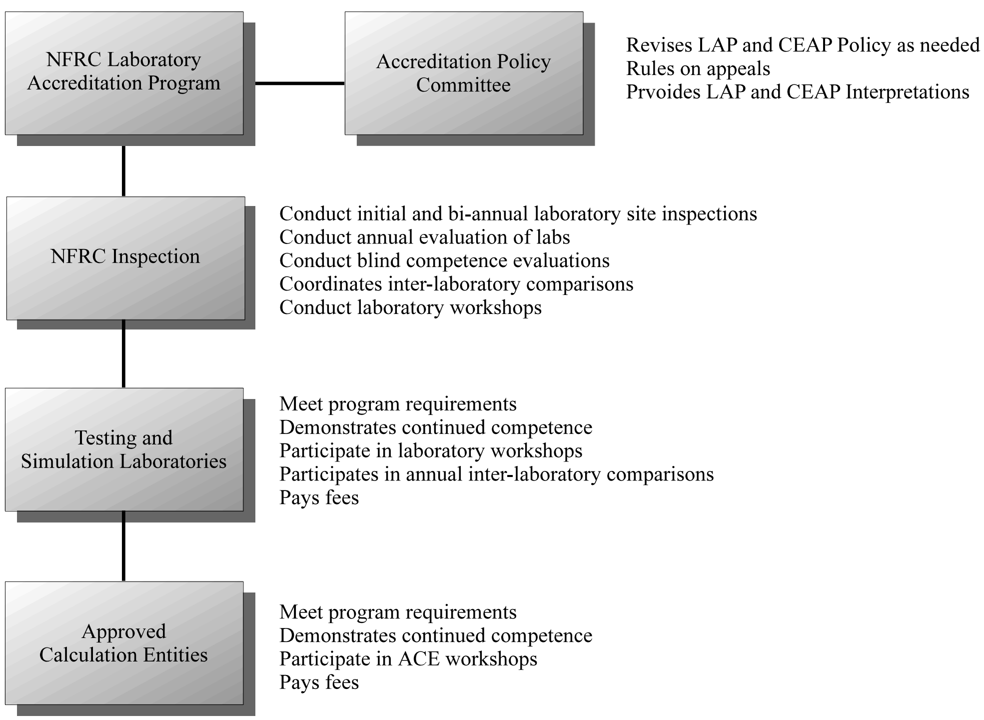
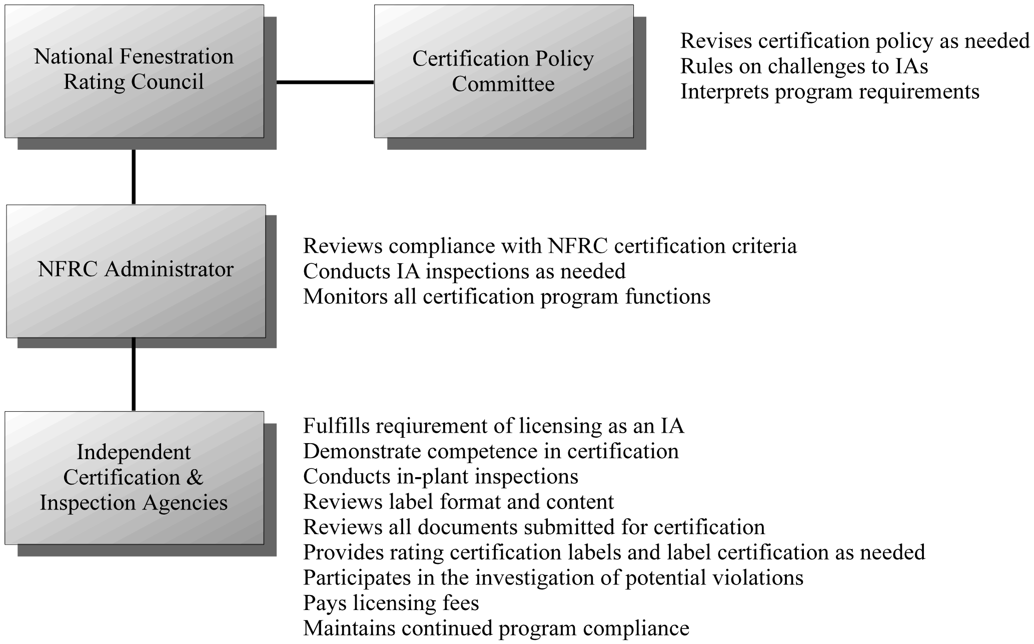


Figure 3



Questions on the use of this procedure should be addressed to:

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DISCLAIMER

NFRC certification is the authorized act of a Manufacturer/Responsible Party in: (a) labeling a fenestration or related attachment product with an NFRC Permanent Label and NFRC Temporary Label, or (b) generating a site built or CMA label certificate, either of which bears one or more energy performance ratings reported by NFRC-accredited simulation and testing laboratories and authorized for certification by an NFRC-licensed IA. Each of these participants acts independently to report, authorize certification, and certify the energy-related ratings of fenestration and related attachment products.

NFRC does not certify a product and certification does not constitute a warranty of NFRC regarding any characteristic of a fenestration or fenestration-related attachment product. Certification is not an endorsement of or recommendation for any product or product line or any attribute of a product or product line. NFRC is not a merchant in the business of selling fenestration products or fenestration-related products, and therefore cannot warrant products as to their merchantability or fitness for a particular use.

NFRC THEREFORE DISCLAIMS ANY AND ALL LIABILITY THAT MAY ARISE FROM OR IN CONNECTION WITH SERVICES PROVIDED BY, DECISIONS MADE BY OR REPORTS OR CERTIFICATIONS ISSUED OR GRANTED BY ANY NFRC-ACCREDITED LABORATORY, NFRC-LICENSED IA OR ANY PRODUCT MANUFACTURER/ RESPONSIBLE PARTY; RELIANCE ON ANY NFRC PRODUCT DESCRIPTION, SPECIFICATION, RATING, TEST OR CERTIFICATION, WHETHER APPEARING IN A REPORT, A PRODUCT CERTIFICATION AUTHORIZATION OR A PRINTED OR ELECTRONIC DIRECTORY, OR ON A LABEL, OR ON A LABEL CERTIFICATE; OR THE SALE OR USE OF ANY NFRC-RATED OR CERTIFIED PRODUCT OR PRODUCT LINE; INCLUDING BUT NOT LIMITED TO DAMAGES FOR PERSONAL OR OTHER INJURY, LOST PROFITS, LOST SAVINGS OR OTHER CONSEQUENTIAL OR INCIDENTAL DAMAGES.

NFRC program participants are required to indemnify NFRC from and against such liability.

This standard is maintained by the Continuous Maintenance Process.

Approval of ANSI/NFRC 500 as an American National Standard is maintained using the continuous maintenance process. Comments or proposals for revisions on any part of this standard may be submitted to National Fenestration Rating Council at any time. Written comments or proposals must be in writing and be submitted to the NFRC Accredited Standards Developer at standards@nfrc.org.

Any written comments or proposals submitted to NFRC as provided above shall be submitted by NFRC to its consensus body for consideration within a reasonable timeframe not to exceed one year. The submitter will be notified by NFRC of the expected time frame for consideration of the proposal or comments. NFRC shall apply for reaffirmation of this standard regardless any comment or proposals every three years.

Table of Contents

1. PREFACE

This edition of the NFRC Condensation Index procedure includes information from ASTM C 1199, ASTM E 1423, NFRC round robin testing data, and technical interpretations by NFRC. The Condensation Index procedure includes a Simulation Method and a Test Method.

The NFRC Simulation Method is presented in Section 4. The Simulation Method is based upon the NFRC-approved software tools and is to be used in conjunction with ANSI/NFRC 100, LEAFF Trendline Simulation Manual, and the THERM7 / WINDOW7 NFRC Simulation Manual.

The Test Method references NFRC 102 which contains many aspects of ASTM C 1199, as well as modifications adopted by NFRC.

The Test Method has been developed to be a supplement to the Simulation Method. Those products that cannot be simulated for Condensation Index shall use the test procedure to determine a Condensation Index rating. The Test Method replicates, as closely as possible, the Simulation Method for Condensation Index, but simulated and tested Condensation Index values may not be identical. The simulations are being validated with tested U-Factors, as obtained using the ANSI/NFRC 100 procedure and not with tested Condensation Index values.

This procedure may involve hazardous materials, operations and equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate health and safety practices and to determine the applicability of any regulatory limitations prior to use.

The values stated in metric (SI) units are to be regarded as the standard. The inch-pound (IP) units shown in parenthesis are for reference only.

2. SCOPE

2.1 Fenestration Products Covered by ANSI/NFRC 500

The following products and effects are within the scope of the ANSI/NFRC 500 and shall be permitted to be rated in accordance with this procedure.

A. This procedure provides a Condensation Index rating for windows, fully glazed doors, curtain wall systems, site-built products, sloped glazing systems, skylights, Dynamic Glazing Products, and other fenestration products.

i. Dynamic Glazing Products that utilize a shading system exposed to the interior or exterior air can only be rated for Condensation Index by using the test method specified in Section 5;

ii. Fenestration products containing fritted glazing, etched glazing, or sandblasted glazing shall be rated by computer simulation using clear glass properties~~.~~;

~~ii.~~iii. For glazing components that must be physically tested for the center-of-glass U-factor (such as but not limited to translucent panels or glass blocks), the test method specified in Section 5 must be used to obtain a CI rating.

B. This procedure refers to the Condensation Index rating of a fenestration system installed in the absence of solar and air leakage effects.

C. The Condensation Index rating is determined for a single set of environmental conditions (See Section 4.1.B). The Condensation Index value is a comparative rating that indicates a product's ability to resist the formation of condensation. Since the Condensation Index rating is a comparative rating, it may not be appropriate for the determination of the actual occurrence of condensation under a given set of environmental conditions.

2.2 Fenestration Products and Effects Not Covered by ANSI/NFRC 500

The following products and effects are beyond the scope of ANSI/NFRC 500 and shall not be rated in accordance with this procedure.

A. Fenestration products with shading or diffusing systems other than those listed in Section 2.1;

B. Exterior glazing condensation or between glazing layer condensation;

C. Thermal performance changes of a fenestration product over the course of time, i.e., long term energy performance;

D. The impact of air leakage and degradation in performance of fenestration products; and

E. Condensation potential of products with attachments.

3. TERMINOLOGY

Condensation Index (CI):

A relative indicator of a fenestration product's ability to resist the formation of condensation at a specific set of environmental conditions. The higher the Condensation Index value the greater the resistance to the formation of condensation and the potential for condensation decreases.

Center-of-glazing Condensation Index (CI):

The Condensation Index for the central portion of the glazing (i.e., part of glazing where 1-D heat transfer effects dominate). The central glazing portion is the area outside the first 63.5 mm (2.5 in) of the sightline of any part of a primary sash, and/or frame, and/or divider; or any part of a primary door, and/or frame, and/or divider. The CIc also includes divider and edge-of-divider portions of the product.

Dew point temperature:

Temperature at which water vapor condenses to liquid water at a given relative humidity (RH).

Edge-of-glazing Condesation Index (CI_e):

The Condensation Index for the edge portion of the glazing (i.e., part of glazing where 2-D heat transfer effects dominate). The edge glazed portion is represented by a point on the glass that is 25mm (1.0 in) above the frame-to-glass junction, excluding any divider or edge of divider.

Frame Condensation Index (CI_f):

The Condensation Index for the frame portion of the fenestration product.

Frame-to-Glass Junction:

This is the point on the product where the glazing touches the fenestration product's frame, sash, door lite frame, gasket, and/or wet seal. This junction may be at or below the sightline (See sightline definition).

Product Condensation Index (CI):

The lower of the CI_f, CI_c, and CI_e.

Sightline:

The line formed by the highest opaque member (frame, sash, spacer, divider, or shading system) that is interior, exterior, or within the glazing system cavity of the fenestration cross-section and the glazing in a plane perpendicular to the surface. A change in sightline will result in a change in the projected frame dimension (PFD) between frame cross-sectional profiles of individual products within a product line (see Figure 4-4 of ANSI/NFRC 100).

4. SIMULATION METHOD FOR DETERMINING FENESTRATION PRODUCT CONDENSATION INDEX VALUES

4.1 Significance and Use

A. This simulation method shall consist of 2-D heat transfer simulation of the same cross-sections used for U-Factor determination as specified by ANSI/NFRC 100, or the latest applicable procedures.

B. Since both temperature and surface air film conditions affect results, this simulation method requires the use of standardized environmental conditions. The standardized NFRC simulation conditions for determining the Condensation Index are specified below.

   i. Interior ambient temperature of 21 ºC (69.8ºF).

   ii. Exterior ambient temperature of –18 ºC (-0.4ºF).

   iii. Wind speed of 5.5 m/s (12.3 mph)

   iv. Mean radiant temperature equal to the exterior ambient air temperature.

   Note 1: The environmental simulation conditions stipulated above are for the purpose of comparative ratings between products.

C. The Condensation Index of a specimen shall be determined at the sizes specified in Table 4-3 of ANSI/NFRC 100.

D. This simulation method shall be used to determine the Condensation Index, provided the simulations have been validated under ANSI/NFRC 100. If the product has been deemed a test only product under ANSI/NFRC 100, Section 5 shall be used to determine the Condensation Index.

E. The trendline approach may be used to obtain a calculated CI. In cases when the trendline approach was used to obtain a U-factor, then the LEAFF method shall be used to determine the condensation indices CI_f, CI_e, and CI_c from the products simulated in the U-factor trendline(s). The U-factor trendline(s) required a straight-line criteria, the two (2) endpoints and mid-point used in the U-factor trendline shall be used to obtain the temperatures to calculate CI_f, CI_e, and CI_c The Indices will be plotted on the U-factor graph for determining the product's total Condensation Index (CI) based on the lower of CI_f, CI_e, and CI_c.

When the trendline approach is not used, then the determination of total product CI shall be calculated for each individual option (or group leader if applicable) for the Condensation Indices of CI_f, CI_e, and CI_c, with the lower of the three indices as the total product's CI.

4.2 Simulation Method

4.2.1 Product Simulation Requirements

The fenestration system shall be simulated in accordance with NFRC-approved software tools that include a detailed gray-body diffuse radiation model and detailed convection modeling inside all glazing cavities.

4.2.2 Determination of Surface Segments

For each 2-D cross-section, identification of the frame, sash, and panel (where applicable) shall be used to obtain the coldest temperature along each of the surface segments. The coldest point segments shall be used to compute the Condensation Index rating calculations.

4.2.3 Condensation Index Rating

The Condensation Index (CI) shall be determined for the total fenestration product from the lower of the Condensation Index rating for the frame (CI_f), edge-of-glazing (CI_e) and center-of-glazing (CI_c). For opaque doors, panel-edge shall be substituted for edge-of-glazing. For the frame (CI_f) calculation, the coldest temperature from all applicable framing segments shall be used (examples of framing segments are the frame, sash, glazing bead, door slab panel, etc.).

4.3 Condensation Index Calculations

The following section defines the method of calculating the Condensation Index from simulation data.

A. Determination of the resistance of the fenestration product to the formation of condensation in any form, referred to as the

Condensation Index, shall be accomplished using the conditions listed in Section 4.1.B.

B. The Condensation Index shall be determined by calculating the applicable CI per Equation 4-1, Equation 4-2, and Equation 4-3 for each modeled option.

C. The Condensation Index, for fenestration products using the Commercial Trendline Approach (CTA), shall be determined using the models to calculate the U-factor trendline points per ANSI/NFRC 100 Section 5.12.5.2.A, calculating the applicable CI per Equation 4-1, Equation 4-2, and Equation 4-3, and use one or both of the following procedures:

i. CI trendlines shall be generated for every specific spacer system product type where a specific CI rating is required per 4.3.3.A through 4.3.3.D. When generating CI trendlines, product options which use the specific spacer system, defined in the trendline, shall be allowed to use the CI trendline to calculate total product results. All remaining spacer system options not defined in a CI trendline shall be allowed to be grouped by using a worst performing spacer system trendline to calculate total product results.

ii. CI trendlines shall be generated using default spacer(s) k_{eff} from ANSI/NFRC 100, Table 5-10 to obtain the CI rating per 4.3.3.A through 4.3.3.D. The spacer system class from Table 5-10 will define the CI trendline that will be used.

Glazing options using a room surface low-E cannot be included within the same CI trendlines as options without room surface low-E. Additional CI trendlines, using new trendline points (U_{c-min}, U_{c-mid}, U_{c-max}) for only the room surface options, shall be developed using the product groupings per ANSI/NFRC 100, section 5.12.5.1.

4.3.1 Determine Condensation Index of the Frame, CI_f

The coldest temperatures shall be determined from all of THERM model(s) from the fenestration system's frame, sash, door panel or door panel edge. The measurement shall be obtained by traversing the entire interior wetted surface beginning 13mm (0.5") from the frame-to-glazing junction or meeting point of the frame and gasket/sealant, whichever is greater. No measurement shall be taken at the frame-to-glazing junction or on any interior glazing seal, weatherstripping or air cavity. (See example in Figure 3-1 below).

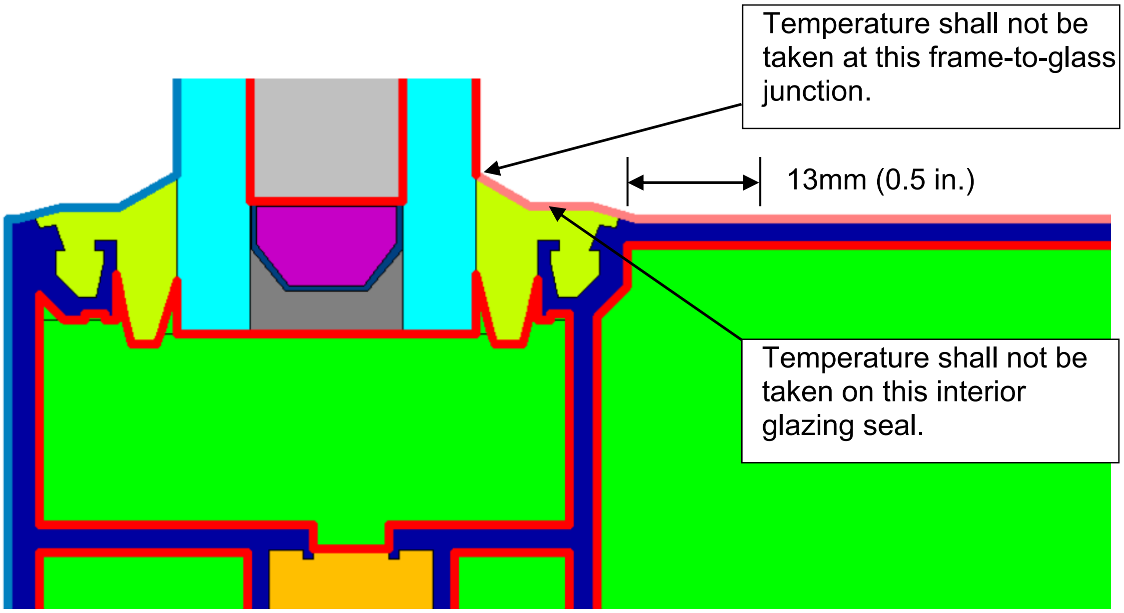


Figure 3-1

The CI of the frame shall be calculated per Equation 4-1.

$CI_f = ((T_{frame} - T_c) / (T_h - T_c)) \times 100;$ Equation 4-1

Where:

T_{frame} = Coldest Temperature from the surfaces of Frame, Sash, Panel or Panel Edge

T_c = Ambient Exterior Cold Air Temperature of -18 ºC

T_h = Ambient Interior Warm Air Temperature of 21 ºC

4.3.2 Determine Condensation Index of the Glazing Portion CI_c and CI_e.

The glazing Condensation Index shall be split into two components: the edge-of-glazing and the center-of-glazing

4.3.2.1 Center-of-Glazing (CI_c)

The center-of-glazing shall include the divider, and edge-of-divider when applicable. Glazing systems that contain true divided lites (TDL), simulated divided lites (SDL) or between glass dividers that require modeling (e.g. gap between divider and glass is less than 3 mm, or 1/8 in.), the divider and divider-edge coldest temperatures shall be obtained along the "Frame" and "Edge" U-factor surface tags of the THERM model(s). In the scenario that the glazing has only grids-between-glazing, the glass directly in front, or in same plane as the grid, is the "Frame" surface to obtaining the divider temperature.

The representative temperature to be used for the CI_c value shall be determined from the coldest temperature between Berkeley Lab WINDOW's COG result, divider frame THERM result, or divider-edge THERM result. That temperature shall be entered in Equation 4-2.

$CI_c = ((T_{cog} – T_c) / (T_h – T_c)) \times 100$; Equation 4-2

Where:

T_{cog} = Coldest temperature from Center-of-Glass , divider, divider-edge

T_c = Ambient Exterior Cold Air Temperature of -18 ºC

T_h = Ambient Interior Warm Air Temperature of 21 ºC

4.3.2.2 Edge-of-Glazing (CI_e)

Temperature of the edge-of-glazing (including edge-of-lite for doors) shall be determined on the glazing at a distance of 25mm (1 in.) from the frame-to-glass junction.

The CI of the edge-of-glazing shall be calculated per Equation 4-3. The final CI_e shall be the coldest temperature obtained from the THERM models.

$CI_e = ((T_e – T_c) / (T_h – T_c)) \times 100$; Equation 4-3

Where:

T_e = Coldest Temperature of all the glazing edges

T_c = Ambient Exterior Cold Air Temperature of -18 ºC

T_h = Ambient Interior Warm Air Temperature of 21 ºC

4.3.3 Determine Condensation Index of the Total Product, CI.

The total product's Condensation Index is the lower of the CI_f, CI_e, and CI_c values.

For product line options calculated per the trendline approach, the following shall be used

A. Develop a matrix of all individual product options according to the trendline category.

B. To ascertain the total fenestration product CI for all entries in the trendline matrix, three (3) y=mx+b equations shall be determined (one each for CI_f, CI_e, and CI_c) on the same graph as the three (3) points established for the U-factor (U_{cog} versus U_{total}) trendline(s). The three (3) CI y=mx+b equations determined shall be based on the U_{cog} versus each of the CI_f, CI_e, and CI_c values.

i. The “m” is the slope

ii. The “b” is the intercept

iii. The “x” is the individual product option’s center-of-glass U-factor(cog).

iv. The “y” represents CI_f, CI_e, and CI_c, respectively.

C. Apply “x" (or the U_{cog} value) to each of the following indices to obtain the CI_f, CI_e, and CI_c values for every individual product.

D. Total Product Condensation Index = Lower of the CI_f, CI_c, and CI_e

4.4 Adding Individual Product Options to Existing Trendlines

A. Addition of new individual product options where the U_{cog} is within an existing trendline’s endpoint range, shall be permitted to use the existing CI_f, CI_e, and CI_c trendlines.

B. Addition of new individual product options, where the U_{cog} falls outside an existing trendline’s endpoint range, shall not use the existing CI_f, CI_e, and CI_c trendlines and shall create new trendlines using the new three (3) U_{cog} point values established per section ANSI/NFRC 100, Section 5.11.4.1.

C. Addition of new spacer systems using the CTA, where the product k_{eff} is lower than established in the existing trendline(s) or is not grouped, shall not use existing CI_f, CI_e, and CI_c trendlines and shall create new trendlines, using the same three (3) U_{cog} point values established per ANSI/NFRC 100, Section 5.12.5.2.A and the new spacer system, to calculate the total product CI per 4.3.3, unless the trendlines were generated using default spacer systems, in which case the respective spacer system class trendline shall be used

4.5 Simulation Report

The simulation report shall include all requirements specified in the NFRC 701.07 and subsequent NFRC LAP Bulletins.

The report shall include the total product Condensation Index rating value, CI.

The following statement shall be included in the simulation report directly after the above results are reported:

The Condensation Index results obtained from this procedure are for controlled laboratory conditions and do not include the effects of air movement through the specimen, solar radiation, and the thermal bridging that may occur due to the specific design and construction of the fenestration system opening.

5. PHYSICAL TEST METHOD FOR DETERMINING FENESTRATION PRODUCT CONDENSATION INDEX VALUES

5.1 Significance and Use

A. This test method shall only be used when the product cannot have the Condensation Index simulated using the simulation method per Section 4 of this procedure.

B. This test method references the calibration and testing procedures as defined in the NFRC 102 and necessary additional temperature instrumentation required for the NFRC test procedure to measure the Condensation Index of fenestration systems in the vertical orientation only. Skylights are simulated at a 20º tilt and since no NFRC-accredited chamber exists to physically test products less than vertical, skylights shall not use Section 5 to determine Condensation Index.

C. Since both temperature and surface air film conditions affect results, this test method requires the use of standardized environmental conditions. The test conditions for the NFRC test procedure to measure Condensation Index shall be identical to those used in the NFRC 102.

D. This test method does not include procedures to measure the condensation potential due to either air movement through the test specimen or solar radiation effects.

E. The Condensation Index of a test specimen may be affected by its size and three-dimensional geometry. If the test specimen size is non-standard [± 12.7 mm (0.5 in)] in width and/or height from the model size referenced in Table 4-3 of ANSI/NFRC 100, then the text "non-standard size" shall be indicated in the final report as per Section 5.4.

5.2 Test Method

5.2.1 Test Specimen Testing Requirements

The fenestration system shall be tested in accordance with NFRC 102.

5.2.2 Temperature Measurement

The fenestration system shall be instrumented in accordance with Section 7 of NFRC 102.

A. All required air and surface temperature measurements specified in NFRC 102 shall be made.

B. Additional thermocouples for the CI rating shall be applied to the interior surface of the product as defined in Appendix B of this procedure by operator types.

   i. The attachment of thermocouples shall be performed using a nominal 25 mm wide by 100 mm long (4 in. by 1 in.) masking tape or aluminum foil tape, with a surface emittance as close as possible to the surface finish to which the thermocouple is to be applied.

   ii. Thermocouple tips located on the frame or sash shall not be closer than 13mm (0.5 in.) from the frame-to-glass junction surface. Glazing thermocouple tips shall not be greater than 2mm in length and shall be oriented parallel to the glazing sightline.

   iii. Three thermocouples shall be placed at the bottom of each glazing unit, at 25mm (1 in.) from the frame-to-glass junction, as shown in Appendix B.

C. For Dynamic Glazing Products that utilize a shading or diffusing system, thermocouples shall be applied to the most indoor glazing surface. They shall not be applied to any shade or blind component which may be present on the indoor side of the product.

5.3 Test Procedure Calculations

This section defines the method of calculating the Condensation Index from test data.

A. Determination of the Index of the fenestration product to the formation of condensation in any form, referred to as the Condensation Index, shall be accomplished using the conditions listed in Section 5.1.B.

B. The Condensation Index using this procedure shall be determined as follows.

i. Record interior surface temperature for each individual thermocouple location.

ii. Determine Condensation Index of the frame, CI_f, center-of-glazing, CI_c, and of the edge-of-glazing, CI_e, using Equation 5-1, Equation 5-2, and Equation 5-3:

5.3.1 Determine Condensation Index of the Frame, CI_f

The coldest temperature recorded from the attachment of thermocouples on the frame and sash (when applicable) shall be used to determine the CI_f. The CI of the frame shall be calculated per Equation 5-1.

$CI_f = ((T_{frame} - T_c) / (T_h – T_c)) \times 100$; Equation 5-1

Where:

T_{frame} = Coldest Temperature from the thermocouple on the surfaces of Frame, Sash, Panel or Panel Edge, ºC

T_c = Ambient Exterior Cold Air Temperature of -18 ºC

T_h = Ambient Interior Warm Air Temperature of 21 ºC

5.3.2 Determine Condensation Index of the Glazing Portion, CI_c and CI_e.

5.3.2.1 Center-of-Glazing

The center-of-glazing condensation resistance shall include the divider and edge-of-divider, and edge-of-lite (doorlite) areas, if applicable.

If test specimen does not contain dividers, the coldest temperature of the center-of-glazing determined from the thermocouples placed on the glazing center per Appendix B shall be used in Equation 5-2 for calculating the CI_c.

If the test specimen contains grids, the lowest temperature between the center-of-glazing, divider or divider-edge shall be centered in Equation 5-2 for calculating CI_c.

For fenestration products with dividers, thermocouples shall be placed on the divider and divider-edge.

The divider and divider-edge surfaces of the following divider types shall have the placement of thermocouples as follows:

- Dividers (a.k.a. Grids/Muntins) Between-the-Glass: Place thermocouple on glass directly in front, or in same plane, of the grid.
- Simulated Divided Lites (SDL) with dividers applied outside the glazing: Place thermocouples on any material outside the glazing and also on the divider-glass edge 25mm (1 in) from the frame-to-glass junction.
- True divided lites (TDL): Place thermocouples on any material outside the glazing and also on the divider-glass edge 25mm (1 in) from the frame-to-glass junction.

$CI_c = ((T_{cog} - T_c) / (T_h – T_c)) \times 100;$ Equation 5-2

Where:

T_{cog} = Center-of-Glass Temperature or divider or divider-edge temperature (lowest of the three), ºC

T_c = Ambient Exterior Cold Air Temperature of -18 ºC

T_h = Ambient Interior Warm Air Temperature of 21 ºC

5.3.2.2 Edge-of-Glazing

Temperature of the edge-of-glazing (including edge-of-lite for doors) shall be determined at a distance of 25mm (1 in.) from the sightline of the frame-to-glass junction.

The final CI_e shall be the coldest temperature of all the edge-of-glazings for a given individual product.

$CI_e = = ((T_e - T_c) / (T_h – T_c)) \times 100;$ Equation 5-3

Where:

T_e = Coldest Temperature of all the glazing edges, ºC

T_c = Ambient Exterior Cold Air Temperature of -18 ºC

T_h = Ambient Interior Warm Air Temperature of 21 ºC

5.3.3 Determine Condensation Index of the Total Product, CI.

Condensation Index = Lower of the CI_f, CI_c, and CI_e from Equations 5-1, 5-2, and 5-3.

5.4 Test Report

The report shall include all of the requirements specified in NFRC 102, NFRC 701.04 and subsequent NFRC LAP Bulletins. The test specimen size and design shall also be reported. If the test specimen size is non-standard [± 12.7 mm (0.5 in.)] in width and/or height from the model size referenced in Table 4-3 of ANSI/NFRC 100, then the text "non-standard size" shall be inserted immediately following the size everywhere the size is listed, both in the full report and in any summary.

The report shall include the total product Condensation Index rating value, CI; the frame Condensation Index, CI_f; the center-of-glazing Condensation Index, CI_c and the edge-of-glazing Condensation Index, CI_e, and if applicable the CI_{ep} in the case of an embossed or raised panel door. In addition, the report shall include, if applicable, information required in Section 10 of NFRC 102.

The following statement shall be included in the test report directly after the above results are reported:

> *The Condensation Index results obtained from this procedure are for controlled laboratory conditions and do not include the effects of air movement through the specimen, solar radiation, and the thermal bridging that may occur due to the specific design and construction of the fenestration system opening.*

6. REFERENCED DOCUMENTS

6.1 NFRC Documents

ANSI/NFRC 100	Procedures for Determining Fenestration Product U-Factors.
NFRC 102	Procedure for Measuring the Steady-State Thermal Transmittance of Fenestration Systems

THERM7 / WINDOW7 NFRC Simulation Manual

Linear Energy Analysis for Fenestration (LEAFF): Trendline Approach Component Based Calculation and Condensation Index Simulation Manual

6.2 ASTM Standards

C 1199	Standard Test Method for Measuring the Steady State Thermal Transmittance of Fenestration Systems Using Hot Box Methods
C 1363	Standard Method of Test for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus
E 1423	Standard Practice for Determining the Steady-State Thermal Transmittance of Fenestration Systems

6.3 CSA Standards

CSA A440.2:22/ CSA A440.3:22	*Fenestration energy performance/User Guide to CSA A440.2:22, Fenestration energy performance*

APPENDIX A BACKGROUND ON THE NFRC CONDENSATION INDEX RATING

Reducing or eliminating condensation is one of many fenestration product selection criteria, but an especially important one in cold climates. In addition to the aesthetic issue of reduced visibility or window view, condensation can cause damage to curtains, carpets and wall finishes, cause mold and wood rot, lift paint and plaster, and eventually result in damage to building materials. Water contact with insulating glass sealant may result in premature failure of the edge seals.

The formation of condensation on the interior surfaces of fenestration products is dependent on a number of factors including the outdoor temperature, and the relative humidity inside the building. As the outside temperature falls, the indoor surface temperature of the fenestration product may fall below the interior dew point temperature. The interior dew point temperature is a function of the relative humidity of the interior air; such that, the higher the relative humidity the higher the dew point temperature. This means that with the same fenestration product surface temperature conditions, condensation will occur sooner in a space with a higher indoor relative humidity. Measured winter relative humidity levels in buildings vary between 20 and 70 percent.

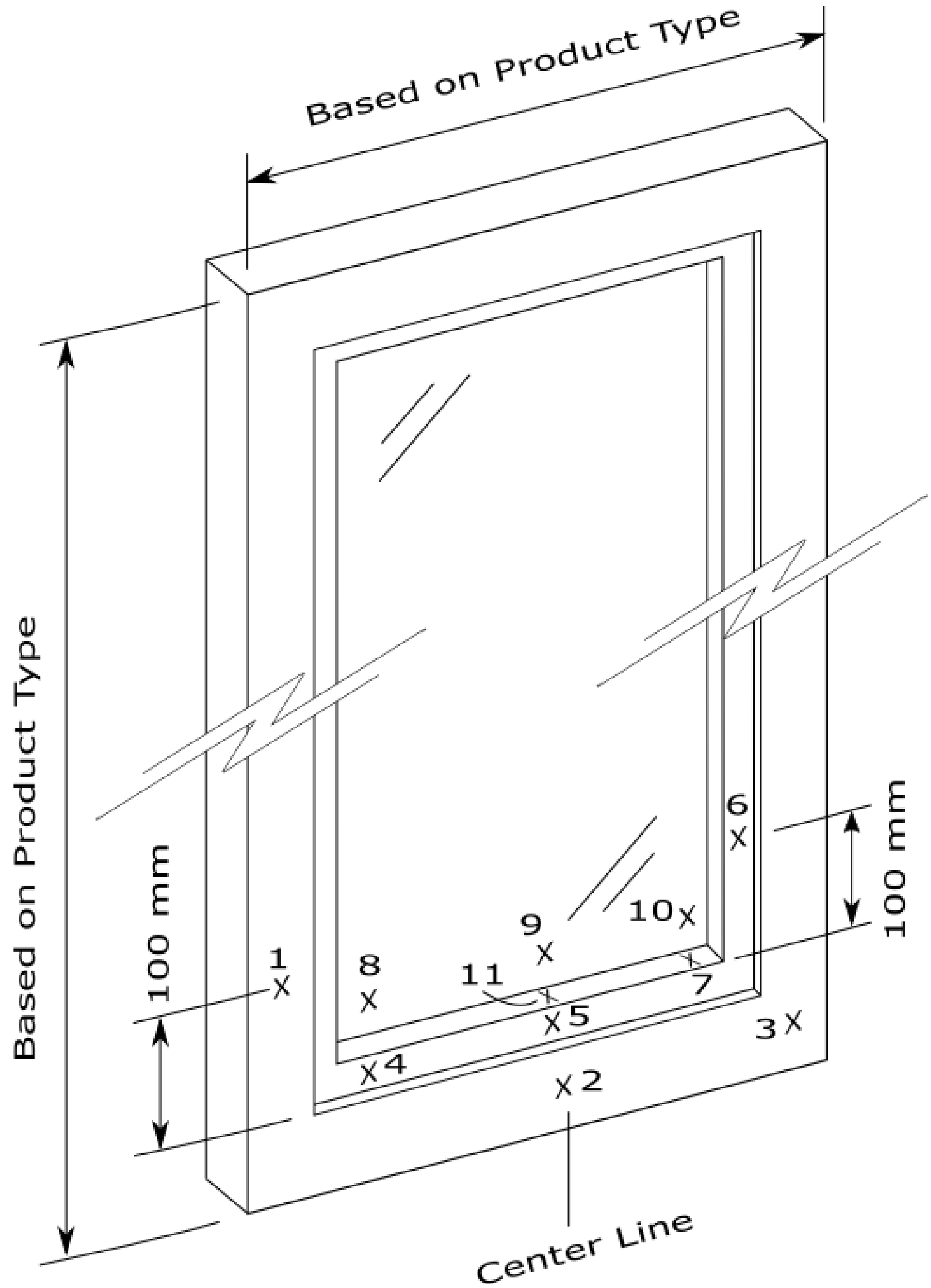
The NFRC Condensation Index scale is 1-100, with a higher number being better. The Condensation Index rating is determined using the coldest frame, sash, glazing, and glazing edge (or panel edge as applicable) temperatures based on outside conditions of -18 ºC (-0.4 ºF) with a 5.5 m/s (12.3 mph) wind and inside conditions of 21 ºC (69.8 ºF). . The Condensation Index rating is the lower of the frame, edge-of-glazing, center-of-glazing, and/or door panel edge values.

The Condensation Index rating is determined for very specific conditions. When installed in a building, there are numerous uncontrolled, site specific factors that may affect the condensation formation on the fenestration product, including installation details, site geometry, wind speed and direction, air circulation and fenestration product coverings, to name a few. In this procedure, the Condensation Index rating is meant to apply only to interior fenestration product surfaces under cold winter conditions. The procedure does not address the issue of condensation on the exterior fenestration product surface as can occur during seasons other than winter.

APPENDIX B PREDETERMINED TEMPERATURE MEASUREMENT LOCATIONS

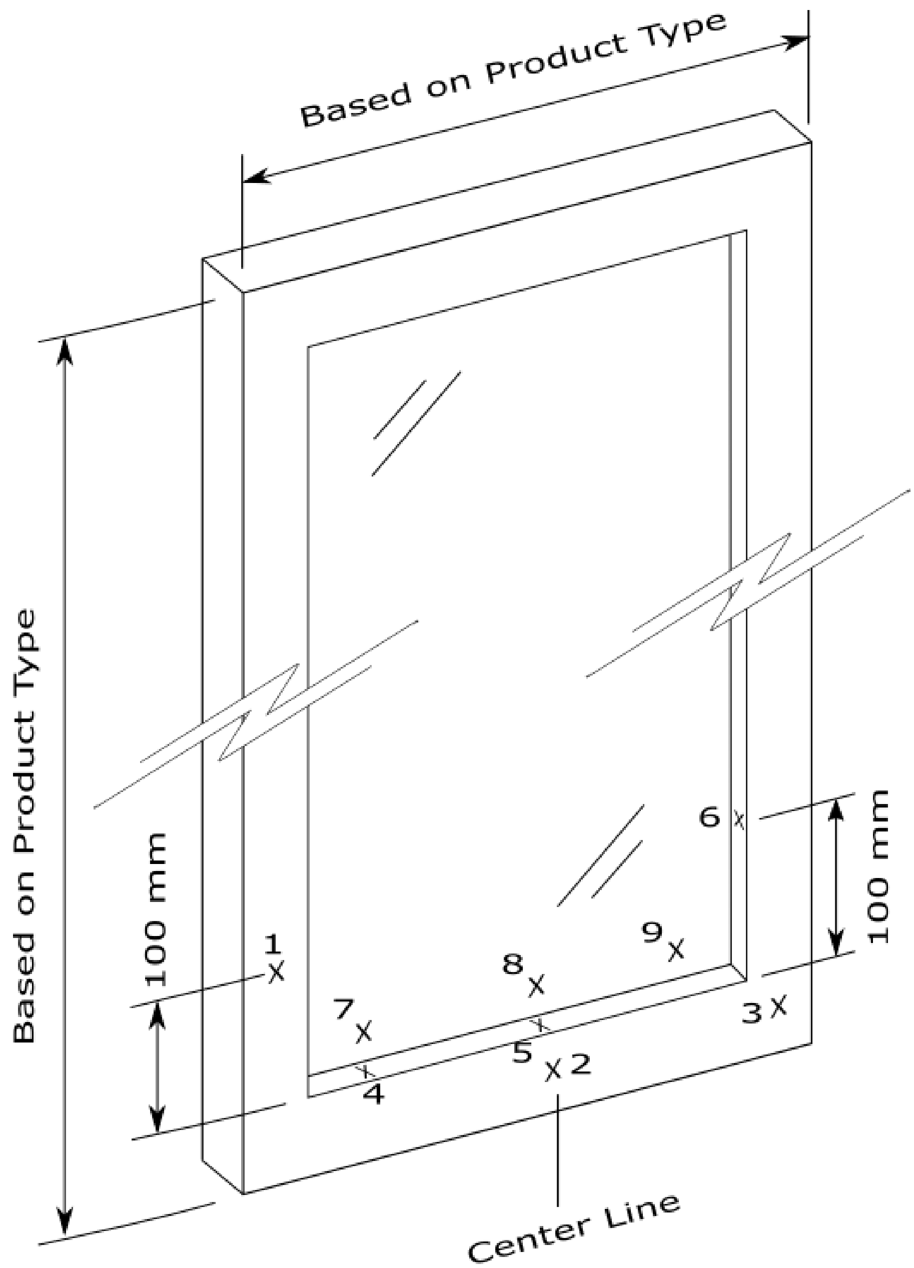
This appendix indicates the correct placement of thermocouples when testing for Condensation Index rating in accordance with Section 5. All thermocouples intended to measure center-of-glazing temperature shall be placed at the center-of-glazing of each unit in the fenestration product. All thermocouples intended to measure the edge-of-glazing temperature of the frame, sash, divider, or frame-lite shall be placed on the glazing at a distance of 25 mm (1 in.) from the frame-to-glass junction along the centerline of the fenestration product. All thermocouples intended to measure a door's panel-edge shall be placed at the thinnest section of the embossment or raised panel pattern but no greater than 13 mm (0.5 in.) from the panel edge. All thermocouples intended to measure frame, sash, divider frame and or door slab panel temperatures shall be placed along the centerline of the fenestration product profile at a location that will be representative of the area weighted average temperature of the frame segment represented by the thermocouple. There are many different kinds of fenestration products covered by this procedure, including many different frame materials and designs. The exact placement of frame thermocouples will require the operator to make some judgment in the position of the thermocouples. The following Figures (6-1 through 6-6) show the number of thermocouples required for the various operator types and required locations to aid the test operator.

Figure 6-1 Casement, Awning, and Dual Action Windows, plus Side-Hinged Doors Thermocouple Placement



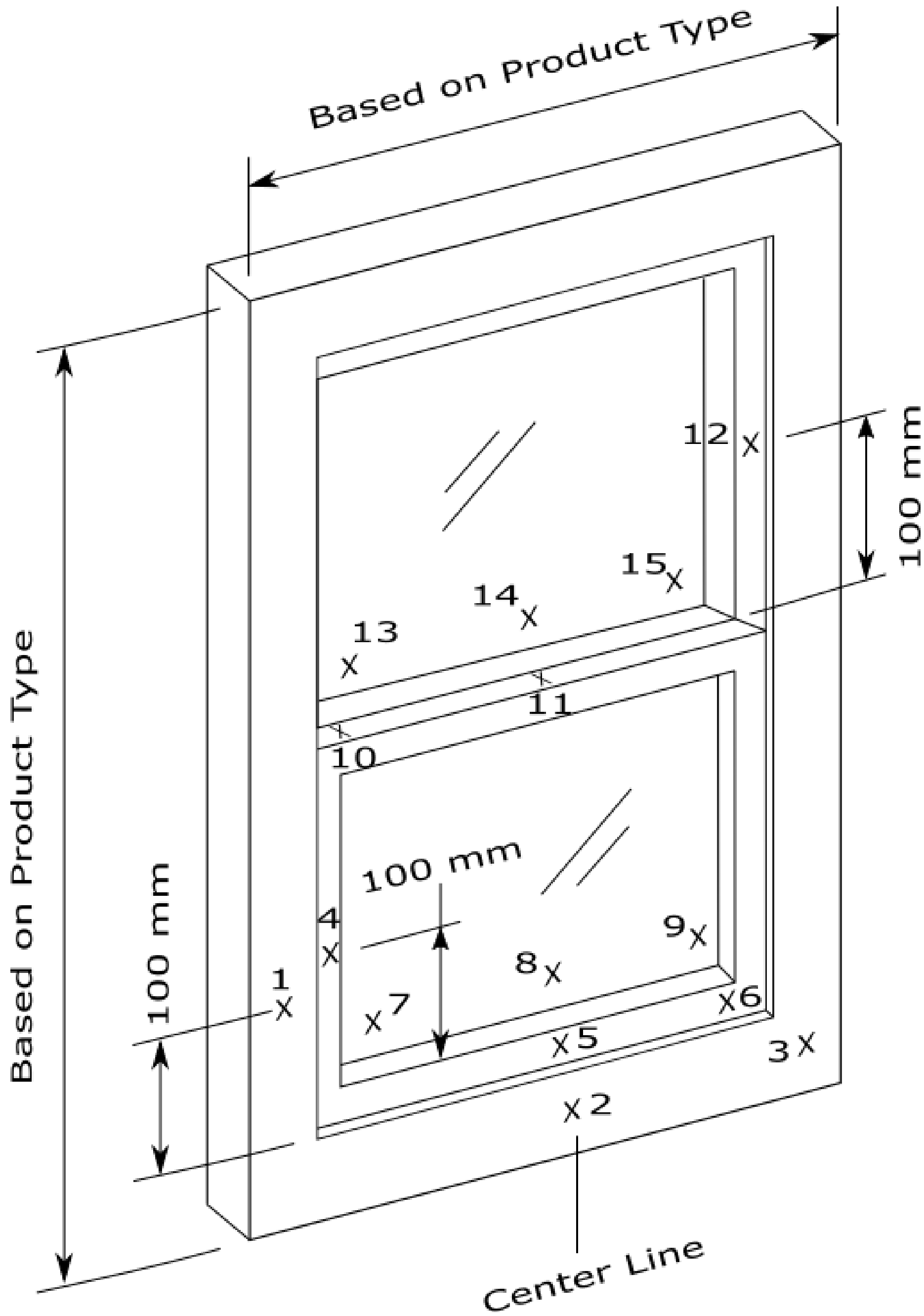
Notes:
1. Thermocouples on glass (#8, #9, and #10) are located 25mm (vertically and horizontally) from the frame-to-glass junction.
2. Thermocouple #7 and #11 shall not be applied on a gasket or weatherstrip.

Figure 6-2 Fixed Window, Sidelite, and Transom Thermocouple Placement



Notes:
1. Thermocouples on glass (#8, #9, and #10) are located 25mm (vertically and horizontally) from the frame-to-glass junction.
2. Thermocouples #4, #5, and #6 shall not be applied on a gasket or weatherstrip.

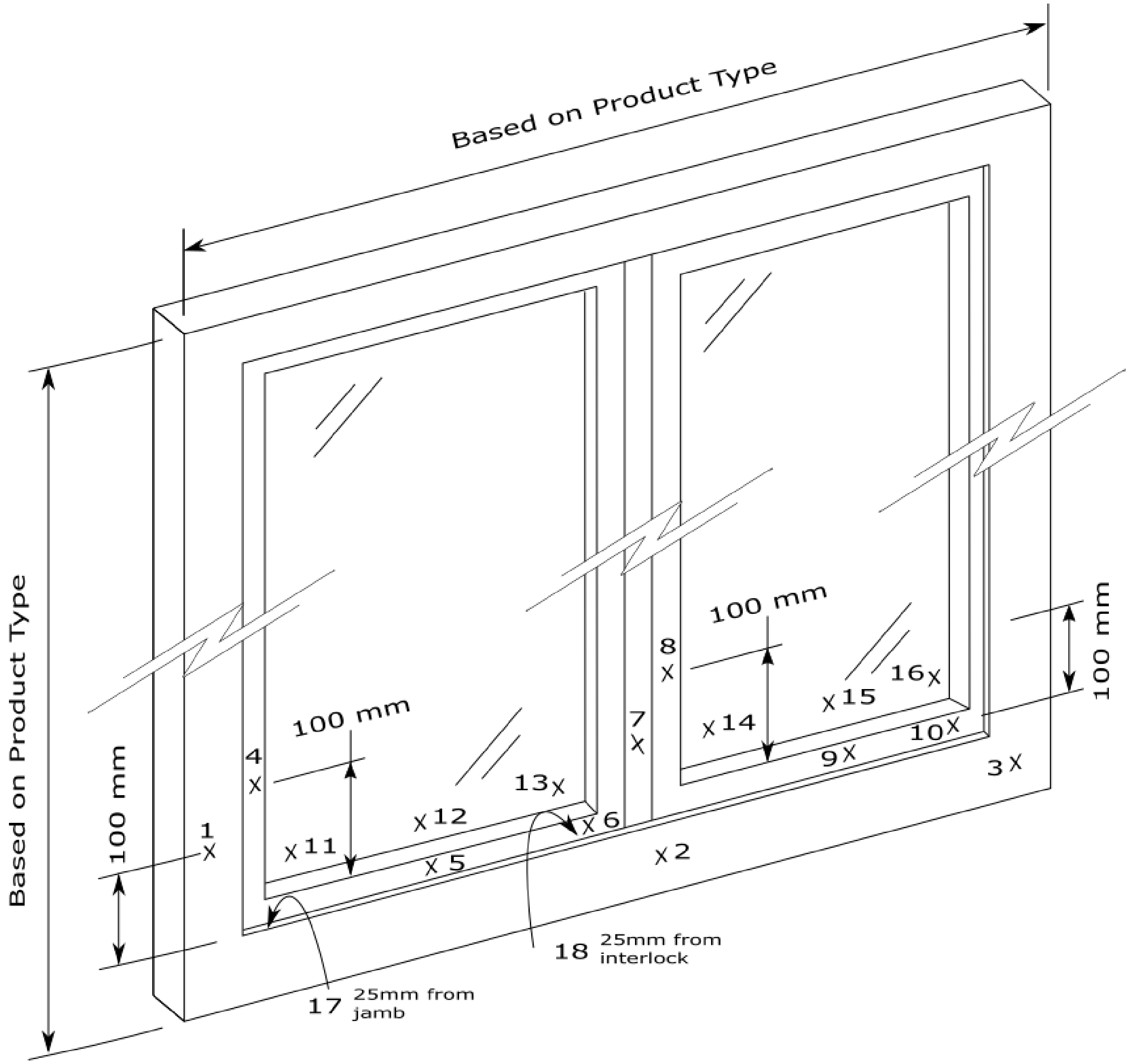
Figure 6-3 Vertical Sliding Window Thermocouple Placement



Notes:

1. Thermocouples on glass (#7, #8, #9, #13, #14, and #15) are located 25mm (vertically and horizontally) from the frame-to-glass junction.
2. Thermocouples #10 and / or #11 shall be placed no closer than 25mm from any locking hardware. If the surface for either #10 and/or #11 is not exposed or too thin to secure a thermocouple, then apply the thermocouple(s) as close as possible to that location.

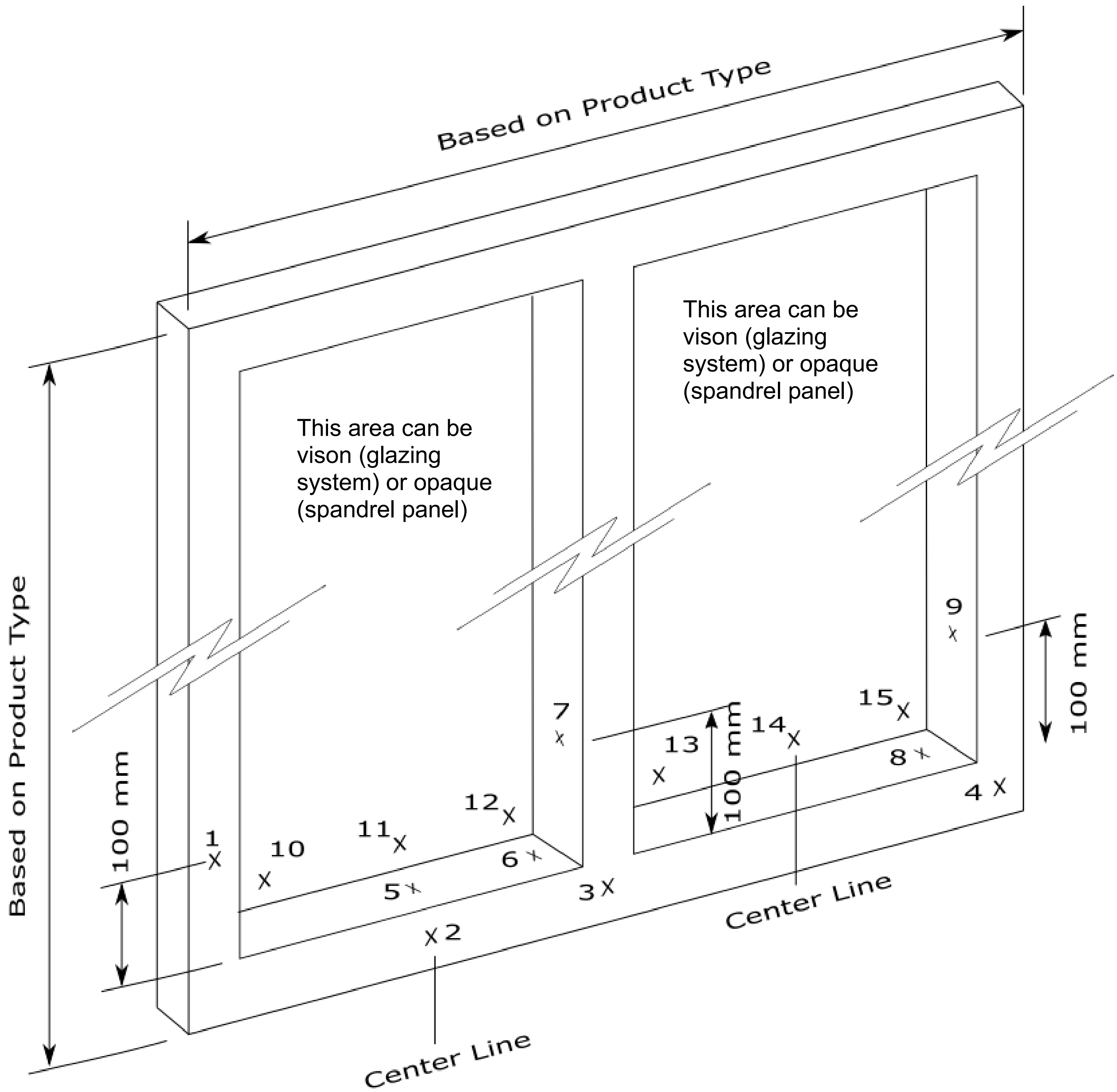
Figure 6-4 Horizontal Sliding Window and Sliding Glass Door Thermocouple Placement



Notes:

1. Thermocouples on glass (#11, #12, #13, #14, #15, and #16) are located 25mm (vertically and horizontally) from the frame-to-glass junction.
2. Thermocouples #17 and #18 shall be placed inside the track where the sash/panel slide.

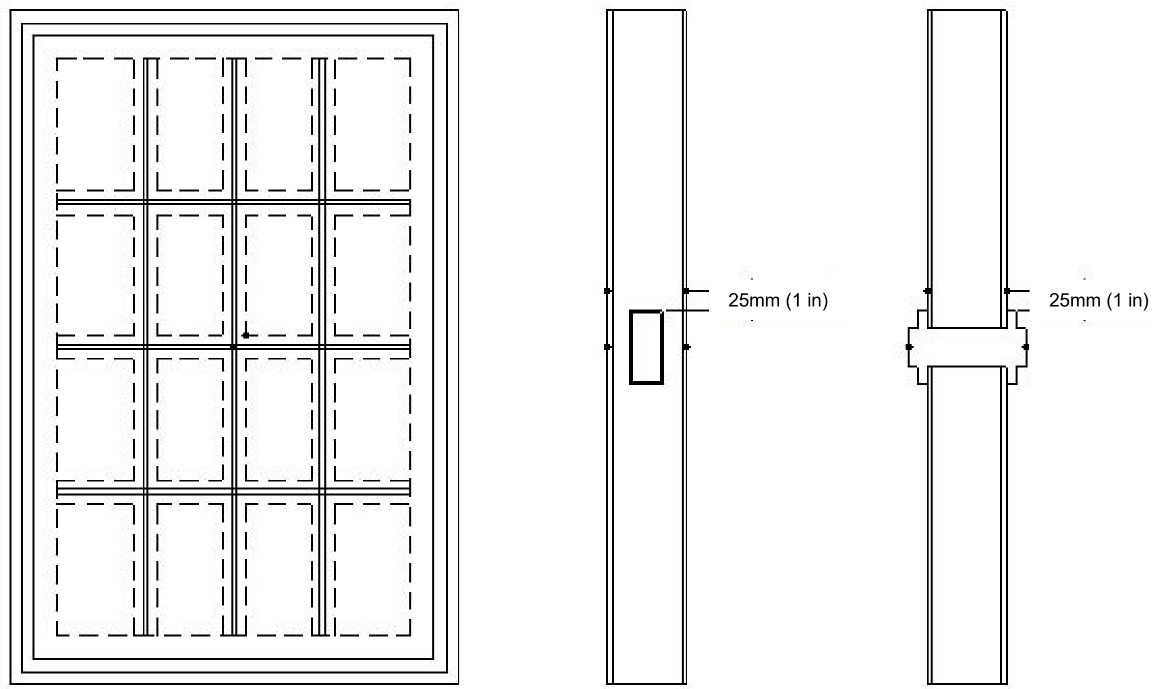
Figure 6-5 Glazed Wall Systems (Vision or Spandrel) Thermocouple Placement



Notes:

1. Thermocouples on glass or spandrel (#10, #11, #12, #13, #14, and #15) are located 25mm (vertically and horizontally) from the frame-to-glass junction.
2. Thermocouples on surfaces adjacent to the glass / spandrel (#5, #6, #7, #8, and #9) shall be placed in the middle, but no closer than 25 mm from the glass or spandrel.
3. For glazed wall systems with a spandrel infill that is flush with interior plane of the frame, then ignore #5, #6, #7, #8, and #9.

Figure 6-2 Divider Thermocouple Placement



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