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Progress Report:

DEVELOPMENT OF UPDATED FRAME GROUPING RULES

Report prepared for: NFRC Project Monitoring Task Group

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Executive Summary

The research project is divided into three tasks:

1. Review, documentation and cataloguing of existing frame grouping rules,
2. Collection and cataloguing of major framing types and options in fenestration products,
3. Development of new and updated frame grouping rules

Task (subtask) completed so far:

In task 1 current NFRC frame grouping rules were reviewed. The conclusion drawn based on the Component modeling approach being applicable to all the building types except single family houses and multi family structures of three stories or fewer above grade, which will deploy the standard punched opening products, was that all of the current NFRC frame grouping rules will be applicable to the CMA procedures as well. As part of the project some of these rules will be further modified to expand the number of variations covered under the current rules. As a part of the exercise, the rules are documented and assigned to the category of building types these rules may be applicable to. The summary of the existing rules along with some proposed modifications are listed in section 1.1. These rules will be modified as the project progresses and more information on frame profile becomes available,

In Task 2, to identify the listing of all major product types, including the listing and categories of prevalent existing framing cross sections and relevant manufacturers a list of manufacturer from NFRC was requested. Both punched opening and glazing façade manufacturers and products are considered for this project. The list developed based on NFRC website information did not list several non-residential manufactures of importance and therefore the list was extended based on the other available information and search made on the website. A letter requesting the participation from the manufacturer was mailed to this extended list of manufactures. The content of the letter and list of manufacturers is given in Appendix A.

Meanwhile Carli, Inc. has obtained the catalogs from the major manufacture like KAWNEER, TRACO, GRAHAM, Arch Aluminum & Glass, Champion Window and Door and Crystalite. The product types from these catalogs are being studied and categorized for potential frame grouping options. The main emphasis is being given on Curtain Walls, Custom windows, Glazed wall/sloped glazing, Store Front and commercial Skylights as stated in the proposal. It is planned to analyze 3 major framing systems in each category.

Proposed Strategy to complete the tasks:

Based on our own findings and recommended frame grouping rules from the manufactures, a new set of frame grouping rules will be developed and sent to PMTG as recommendations for adoption. Preliminary study suggest that potential parameters for analysis are: Projected frame dimension (PFD), emissivity (external BC and internal frame cavity), Glazing inset related to exterior, frame thermal performance, variation in frame width and/or frame height (frame cavity web addition causing cavity split), frame material thickness, changes in internal frame cavities and monotonous changes in the same parameter. An example eligible for framing systems grouping is shown below.

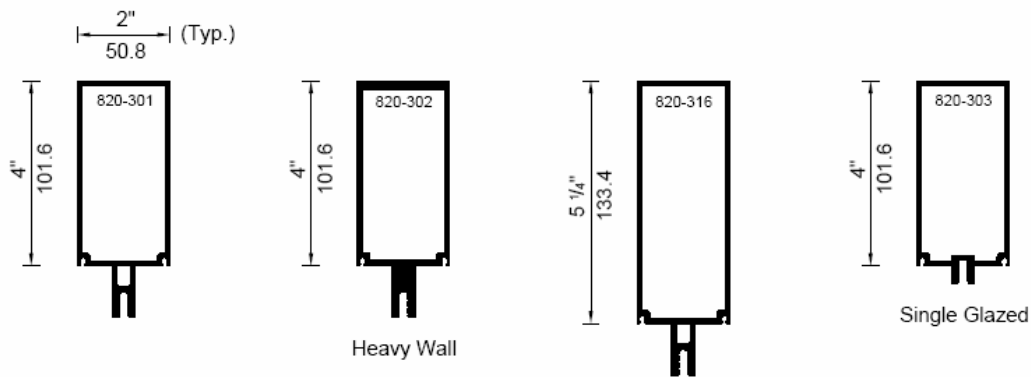


Figure 1: Example of framing systems eligible for grouping

One of the subtasks of this project is to recommend the generic frame systems for each of the product types. Strategy is to review listing in current NFRC database to determine the worst case U factors based on framing and operator type. These identified product information will then be acquired from the manufacturer for further study. Based on the information and analysis a default frame U factor for best and worst cases in each category will be developed and recommended as generic system. PFD may play a major role in the thermal performance of a framing system, and therefore, based on non-residential product type study based on catalogue review, default PFD's will also be recommended for each of the generic frame systems. We are also researching the literature for any existing study in this area.

Based on the information received so far, the following variations will be considered for determining the frame grouping rule. This rules based on analysis performed on Product size (600 x 1500, 1200x1500 and 2000 x 2000 mm) and Frame material (AL, AL-TB, Wood, Vinyl, and Fiberglass will help manufacturer to determine the group leader without performing simulations based on clear trends.

	Variations
1	Glass Location /Position
2	Material Thickness
3	Change in length (X direction)
4	Change in PFD
5	Emissivity (0.2, 0.8, 0.9)
6	Internal cavity - variations
7	
8	

Based on the recommendations from PMTG, the list of variations given in table above will be finalized. The methodology is explained here with the help of an example.

This example shows the effect of change in length in X direction. The cross section length was varied by 25mm, 50mm, 75mm, 125mm and 175 mm along the X-axis as shown in Figure below for the variation of 25 mm and 175 mm .

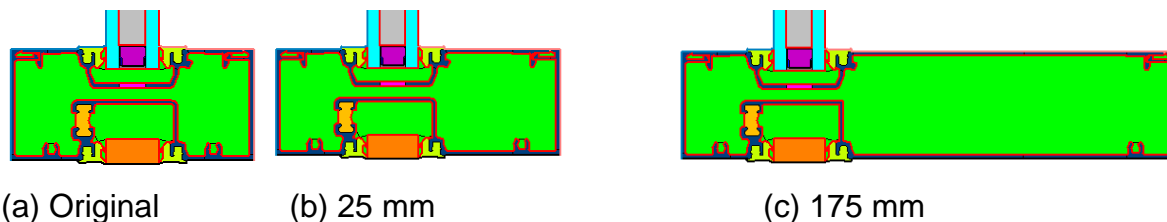


Figure 2: Variation of length in X-Axis

A glazing system (clr-Arg-lowE) with c-o-g U factor of 1.37 W/m²K (0.24 Btu/hr-ft²F) was considered for the analysis. The calculations were performed for 3 product sizes of 600 mm x 1500 mm, 1200mm x 1500m and 2000mm and 200mm, representing casement, fixed and curtain wall products. The analysis was done for Aluminum and Thermally Improved Aluminum product type with emissivity of 0.8 (Anodized Aluminum) and 0.2 (Mill Finish Aluminum).

The U factor results are shown in Figure 3- 6.

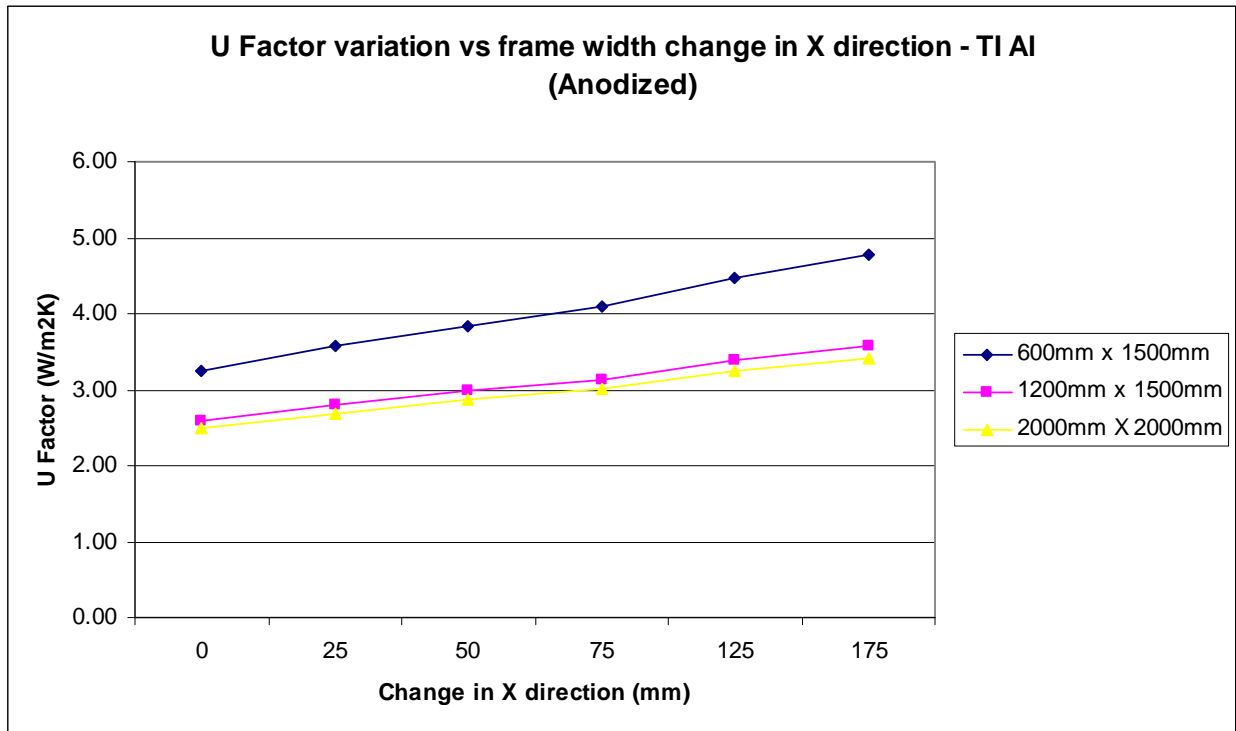


Figure 3: U factor variation with change in X direction for Thermally Improved Anodized Aluminum window

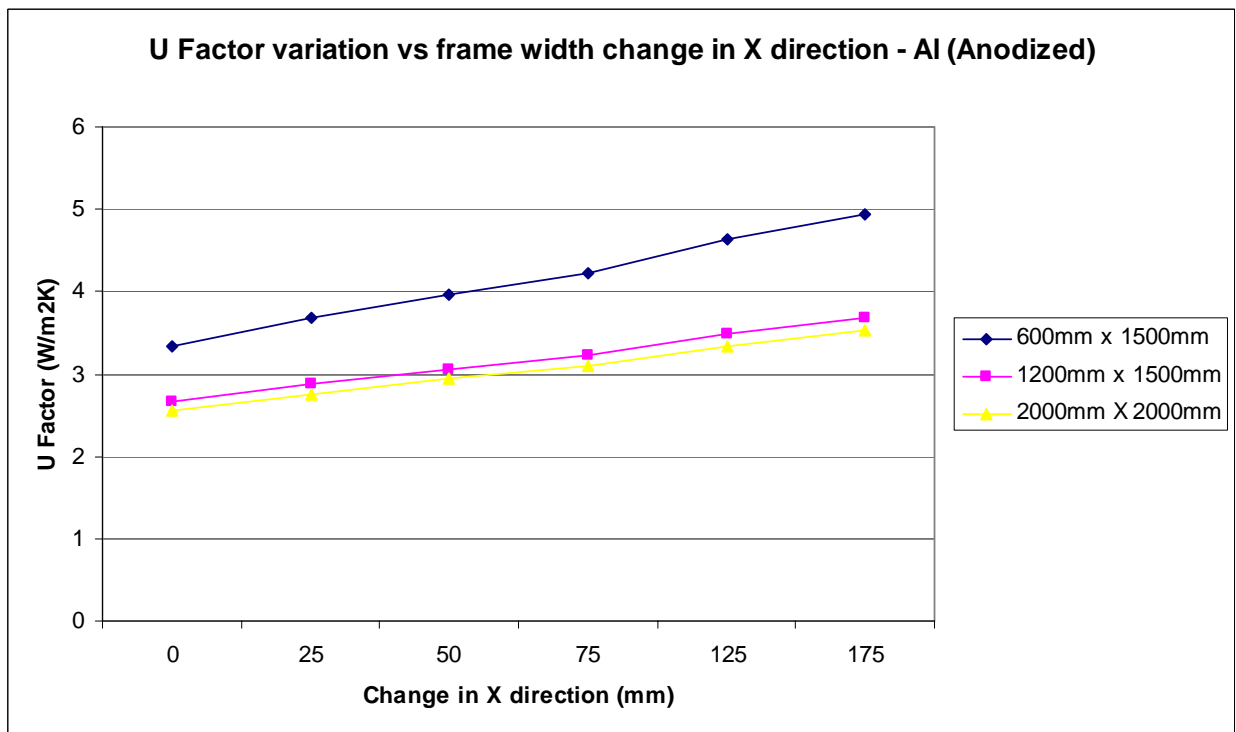


Figure 4: U factor variation with change in X direction for Anodized Aluminum window

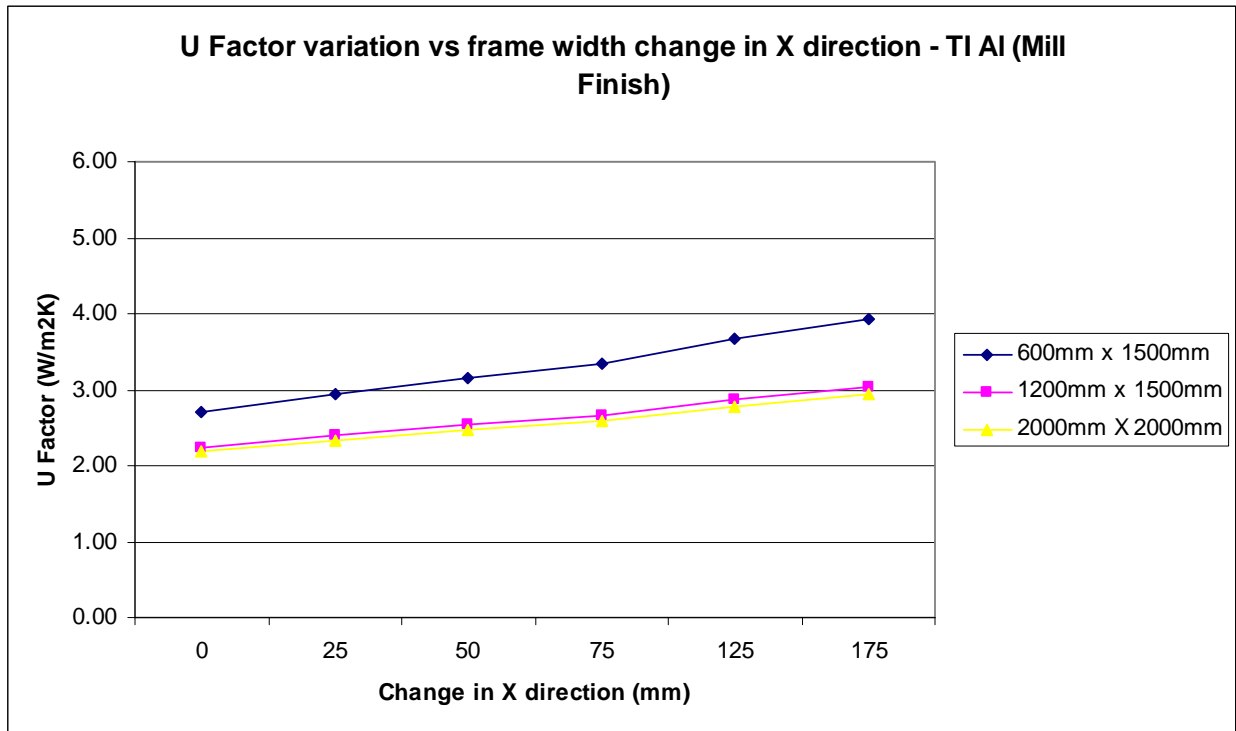
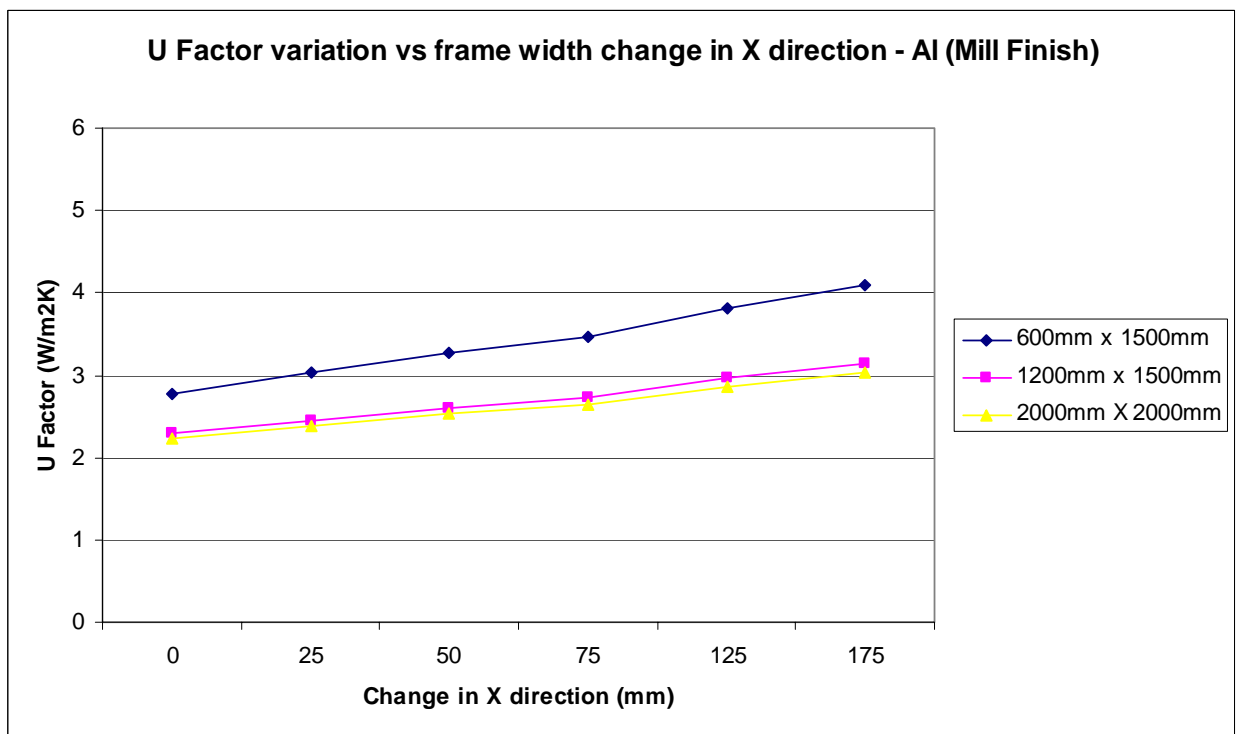


Figure 5: U factor variation with change in X direction for Thermally Improved Mill Finished Aluminum window



It is evident from Figure 3-6 that U factor increases as the length along X-axis increases. The manufacture can take the product with highest length in X-direction as a group leader without simulating the product.

Note: We are looking for guidance on the directions we are planning to move. Once we get approval from PMTG, we can go ahead and complete the task envisioned here. The accompanying spreadsheet shows the variations to be considered along with the parameter values..

1.1 Current Frame grouping rules and their applicability to CMA

1. Changes to accommodate glazing unit variations. Limited to changes of geometry, number or material type to stops, beads, adhesives or gaskets designed to retain the glazing. Changes to frame and sash profiles are allowed to accommodate glazing unit variations. This provision does not allow for interior and exterior glazed products to be in the same product line. [\[Applicable to all product types\]](#)
2. Frame/sash modifications made to accommodate operating hardware and reinforcement for the purpose of addressing higher/lower loads and stresses. Limited to changes that do not change the exterior perimeter shape of the assembled cross section. [\[Applicable to high rise residential, motels\]](#)
3. Frame or sash changes where one component is replaced by another component of the same physical shape with a thermal conductivity that does not differ by more than ten times the thermal conductivity of the original material. [\[Applicable to high rise residential, motels\]](#)
4. Interior/exterior appendages added to the main web of the frame that is not exposed after product installation, i.e., nailing fins. [\[Applicable to high rise residential, motels\]](#)
5. Changes to the frame profiles to allow for different installations. Limited to the following:
 - i. Any changes to interior/exterior appendages added to the main web of the frame that are removable or not exposed after product installation, i.e., nailing fins
 - ii. Changes in the width (dimension perpendicular to the plane of the glazing) of the main frame or main frame components to allow for installation in different wall thicknesses.
 - iii. Products manufactured in both in-swing and out-swing options.
6. Any sightline changes due to:
 - i. Lengthening or shortening existing walls.
 - ii. Components added or replaced for equal and unequal lite configuration options or;
 - iii. For the installation of an Outside Air Ventilator Assembly (OAVA).
 - iv. Changes to the frame profiles to allow for different installations including pocket or sloped sill configuration options and sill height modifications. [\[Applicable to all the products\]](#)

7. Minor revisions made to the profiles for aesthetic purposes. Limited to changes in the size and shape of snap beads, stops, jamb extensions, dividers (including simulated and true divider lites), exterior trim caps on curtain walls, window walls and sloped glazing. Decorative elements such as grooves or beads formed in or applied to the frame or sash are also allowed. [\[Applicable to all the products\]](#)
8. Any changes to the exterior beyond the plane of the nailing fin, J-channel, or interior most point of exterior accessory groove, i.e. screen tracks, varying shapes of brickmold formed in (integral) or applied to the frame and that do not change the sightline. [.\[Applicable to high rise residential, motels\]](#)
9. Addition, deletion or changes in hardware and reinforcement [.\[Applicable to high rise residential, motels\]](#)
10. Changes to interior or exterior finishes or coatings [\[Applicable to all products\]](#)
11. Sealing characteristic variables and elements. Limited to changes in gaskets, sealants, adhesives or weather strips in the same profile. Profile changes to accommodate seal changes shall be allowed. [\[Applicable to all products\]](#)
12. Products manufactured in both in-swing and out-swing options. [\[Applicable to high rise residential, motels\]](#)
13. Pocket or sloped sill configuration options. [\[Applicable to high rise residential, motels\]](#)
14. Equal and unequal lite configuration options. [\[Applicable to all products\]](#)
15. Vinyl caps attached to the interior. [\[Applicable to high rise residential, motels\]](#)
16. Any changes to the internal cavities as long as the outside profile geometry does not change. [\[Applicable to all products\]](#)
17. Application of cladding to an unclad product line. [\[Applicable to high rise residential, motels\]](#)
18. Changes in the width (dimension perpendicular to the plane of the glazing) of the main frame or main frame components to allow for installation in different wall thicknesses, i.e., lengthening, shortening, and the addition of reinforcing web wall. [\[Applicable to all products\]](#)

Note: For the purpose of determining U-factors, frame groups shall consist only of frame/sash base profile variations consistent with the changes proposed above. The only allowable exceptions within a frame group are the individual products with different sightlines, simulated as separate individual products.

Appendix A: Letter to Manufacturers and List of manufacturers

Dear Manufacturer,

You may be aware that the National Fenestration Rating Council (NFRC) has awarded Carli Inc. a research contract to develop new frame grouping rules for non-residential products. We, at Carli Inc, believe this to be an opportunity for manufacturer like you to provide input and recommendations for the development of new frame grouping rules. If desired, these rules will provide an option for manufacturers to simplify the process and by using the grouping rules reduce the number of framing systems to be simulated for obtaining ratings.

The frame characteristics that are likely to be important while creating the grouping rules are industry design practice for frame profile changes due to different installations, sightline changes, changes in internal frame cavities, narrow vs. standard frame cross sections, monotonous changes in the same parameter, product lines to meet structural and installation requirements, frame thermal performance, frame width, frame height, frame material thickness, exterior perimeter, glazing bead, positioning of glazing bead – exterior vs. interior, operating hardware, interior/exterior appendages, claddings, etc.

We request that you send us the drawings (Preferably in an AutoCAD drawing or DXF file) of frame profiles of different product types with variations for which groupings should be considered and indicate the reasons for frame grouping. We will study all of the submitted information and based on the thermal performance analysis of selected examples provide recommendations to NFRC Project Monitoring Task Group for their comments.

Carli staff would like to contact you and have an opportunity to discuss the needs for this research. Please email us at bhandari@fenestration.com, or by phone 413-256-4647 and indicate if you would like to participate. Your participation/contribution is highly appreciated.

Sincerely,

XXXX

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