NFRC 401 Ventilation Rating Update September 2019

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Why have we decided to rate Fenestration Ventilation?

- to expand NFRC reach (open vs sealed shut products)
- to standardize measures across the industry
- Allow NFRC to be a Green Ventilation contributor
- to allow comparison for consumers
- to give manufacturers more to sell
- to fill a demand for information to regulators
- to keep window ratings in the industry

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Current status;

The VR TG will review proposals when the Velux concern has been tested in the MI chamber. The results of this test will determine if we need to add a third category for high aspect ratio projecting products. All previous technical concerns have been answered

NFRC Board unanimously voted to stop the Optional Rating part of this standard and we are proceeding with the completion of the method for other agencies to adopt

Ventilation Research Device

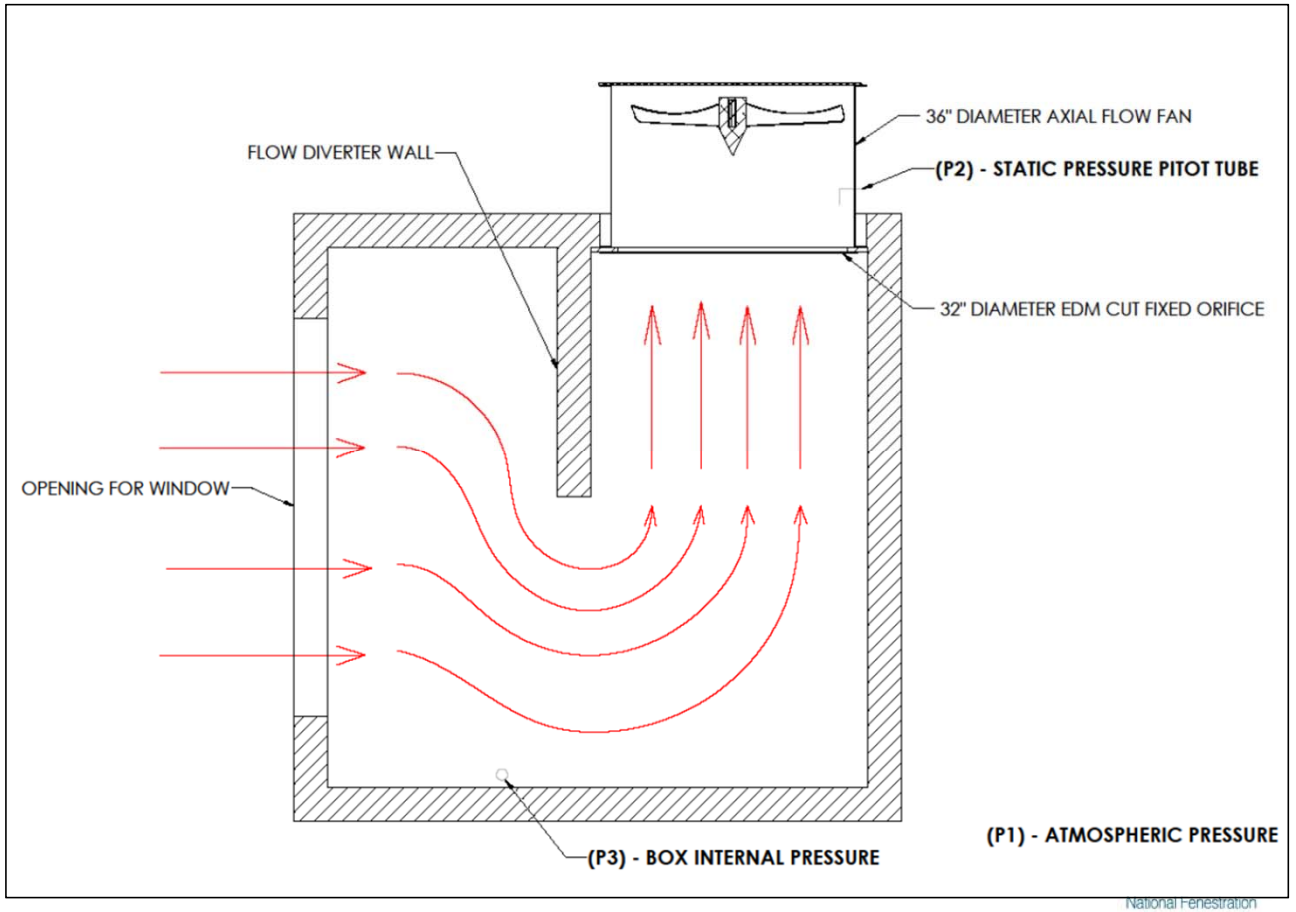
- **Fan: creates flow through the test window**
- **Data Collection: 600 collected data points over a min time period per iteration up to 25 Pa pressure drop**
- **Test Window: Different windows with 5-10 iterations to each variance of the window**

Schematic of Ventilation Device

Flow Diverter Wall: is added to straighten air flow into the orifice

Fan speed is set to create pressure differential between atmospheric pressure (P1) and internal box pressure (P3).

Pressure differential between static pressure pitot tube (P2) above orifice and (P3) is data logged and used to determine volumetric air flow



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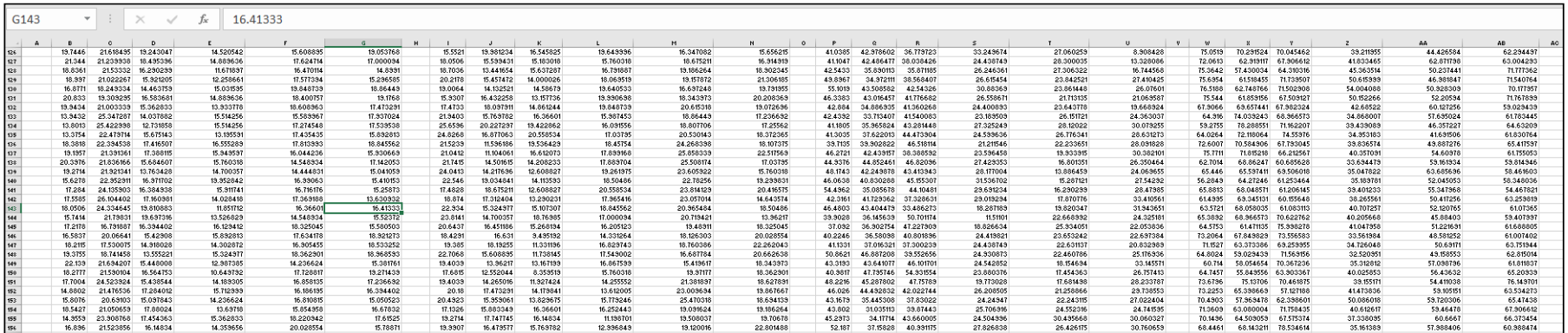
60 Tests and 18,000 data points later…



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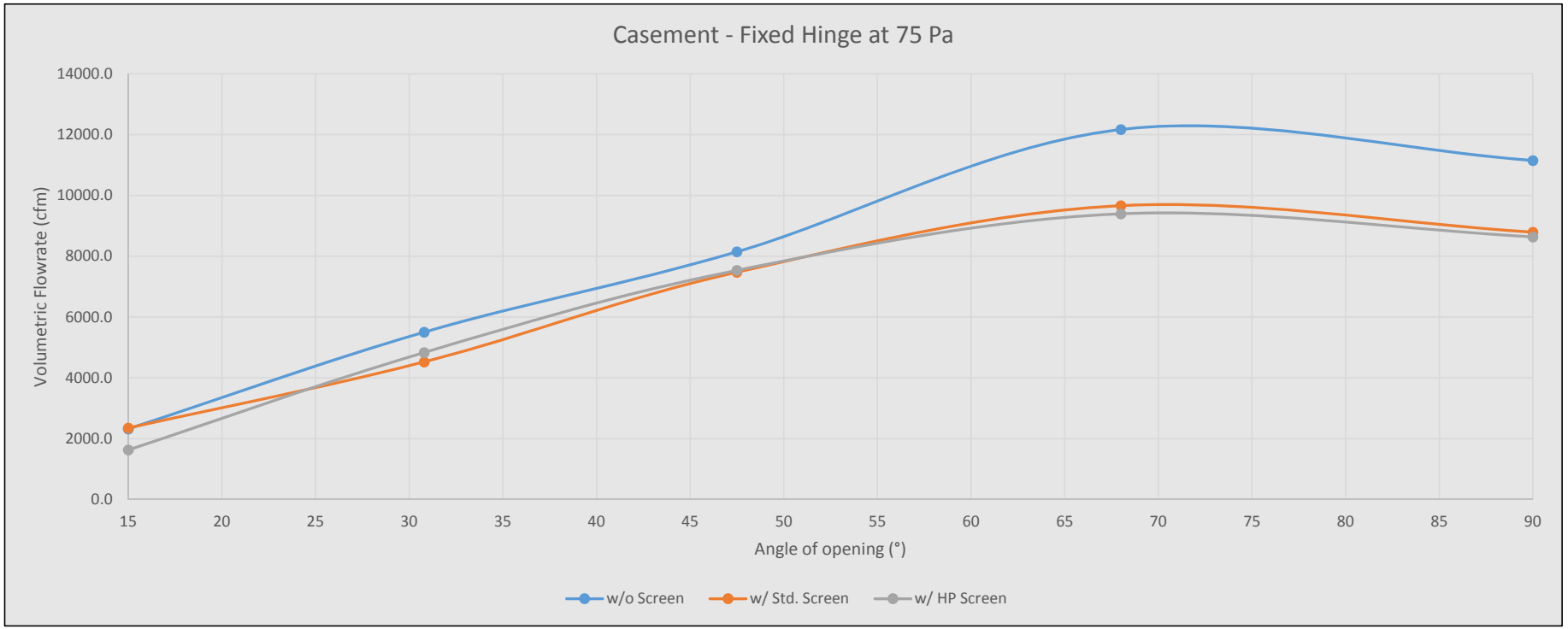
Test results-Casement: Screen Factor & Peak flow



Testing proves screen effect is minimal, even with different mesh. Recommendation is 0.9 screen factor
Peak flow @ 75 Pa in this test is at 68 degrees, at 25 Pa projected peak flow is at lower angles

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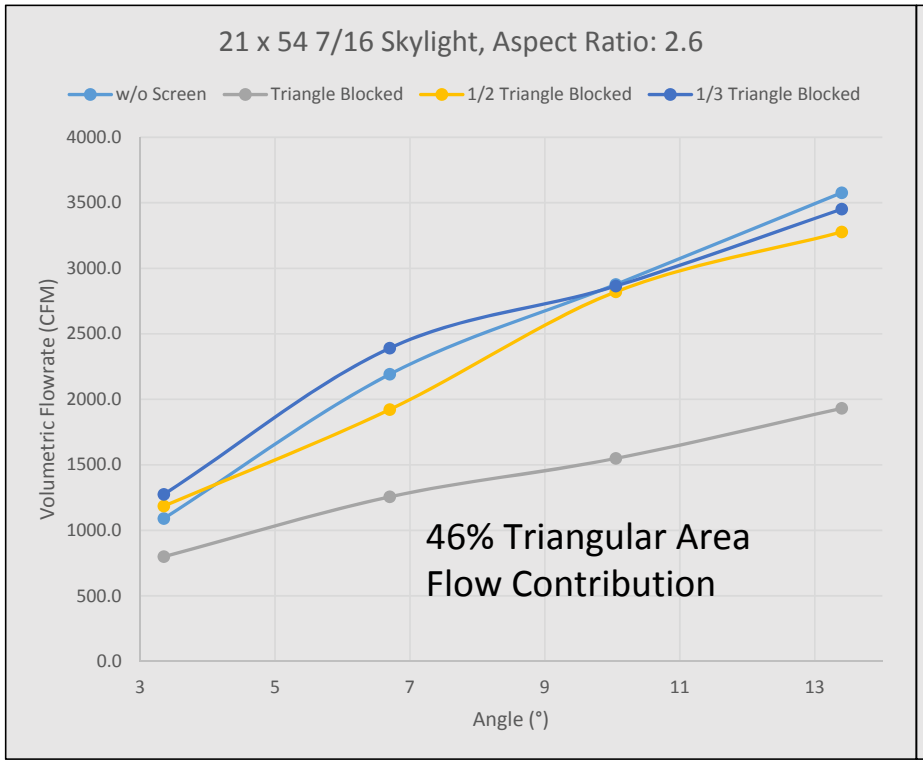
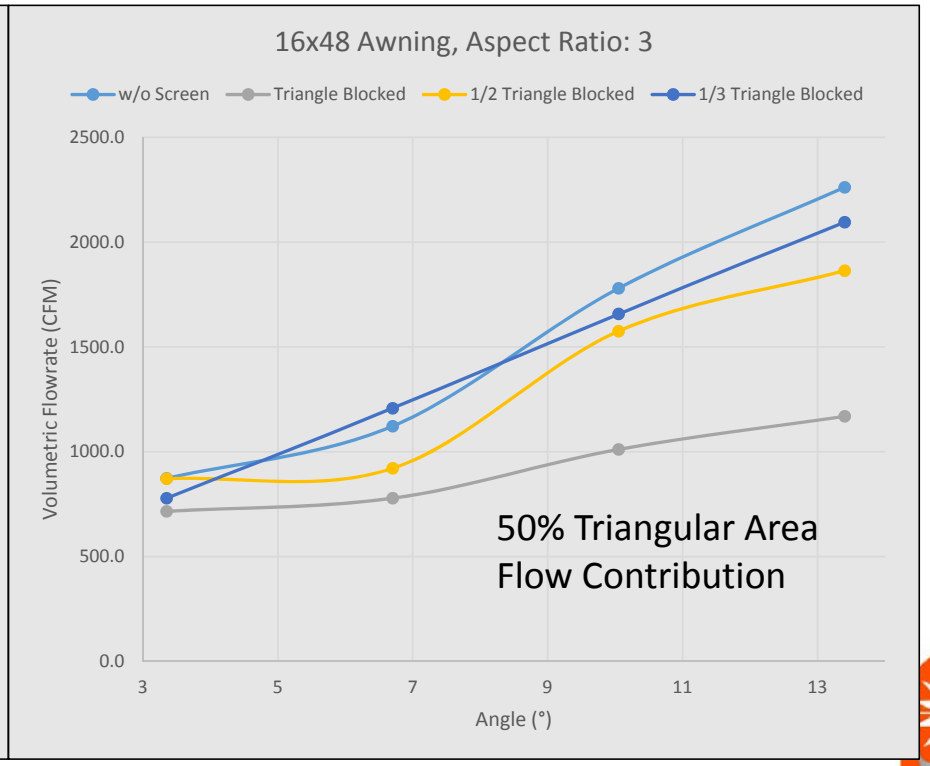
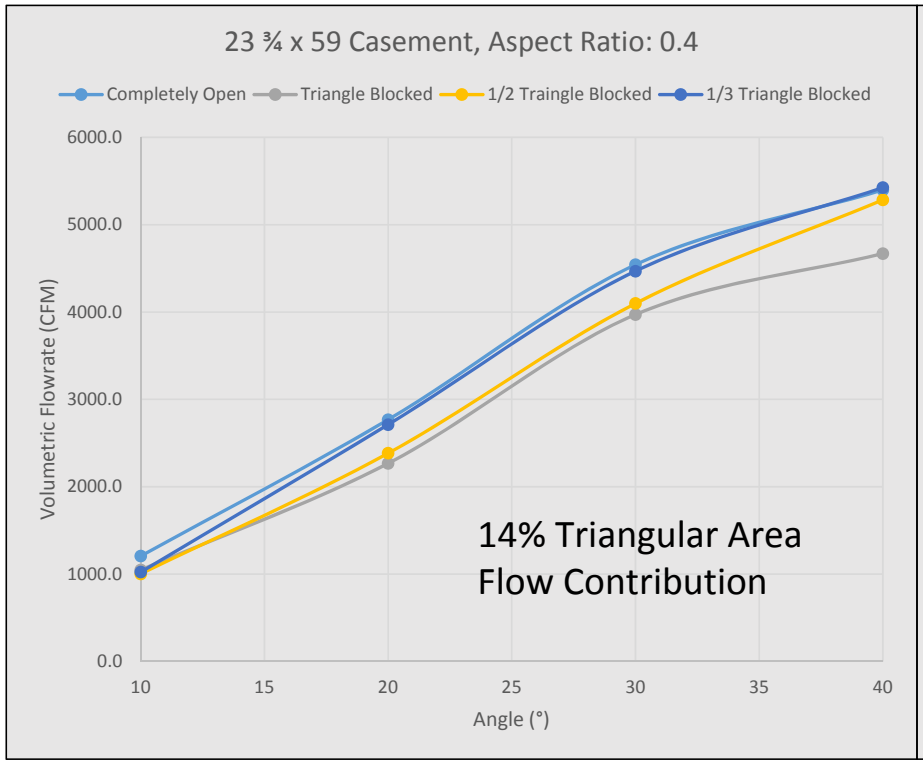
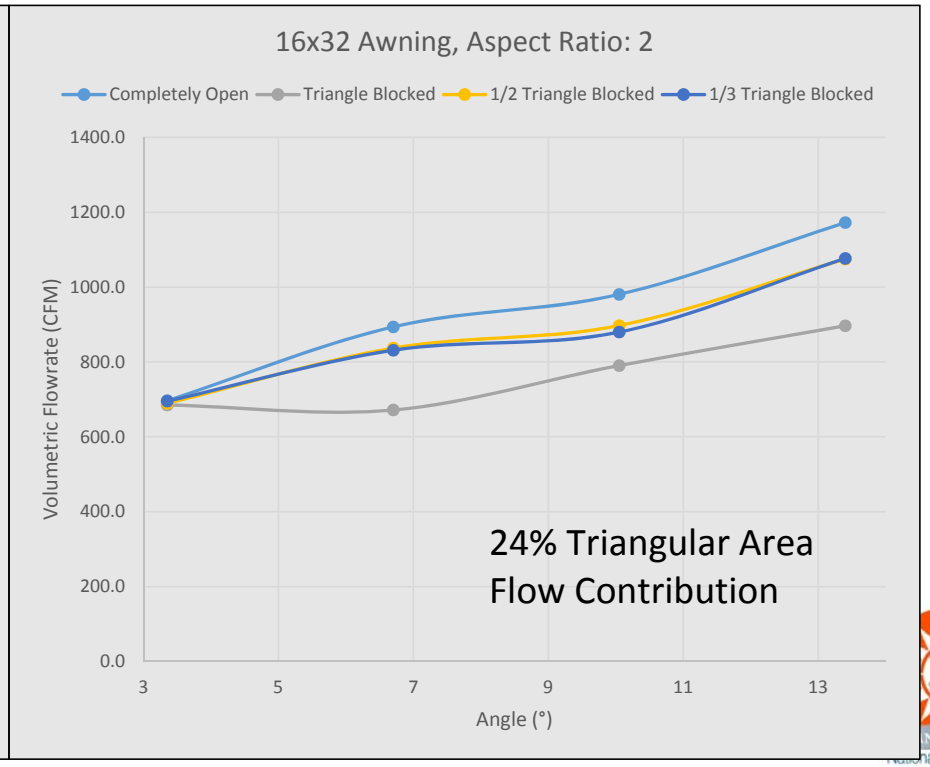
Projected products: Triangular contribution





Projected products: Triangular contribution





Test Data shows a 1/3 triangular area contribution – covers all Aspect Ratios, including skylights

Key Findings

- For Projected products, effects of triangular areas on total air flow depends on aspect ratios.
- Test data has shown projected products triangular area needs consideration. Analysis leads us to propose a 1/3 triangular area adder to all projected products.
- New calculation considers angle and aspect ratio to better represent any opening angle or size.
- The ventilation area is capped by frame opening area.
- Since peak flow happens before 90 degrees, sash width reduction is not required.

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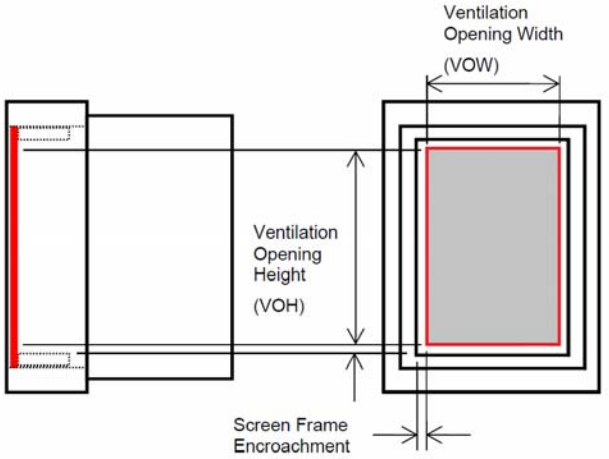
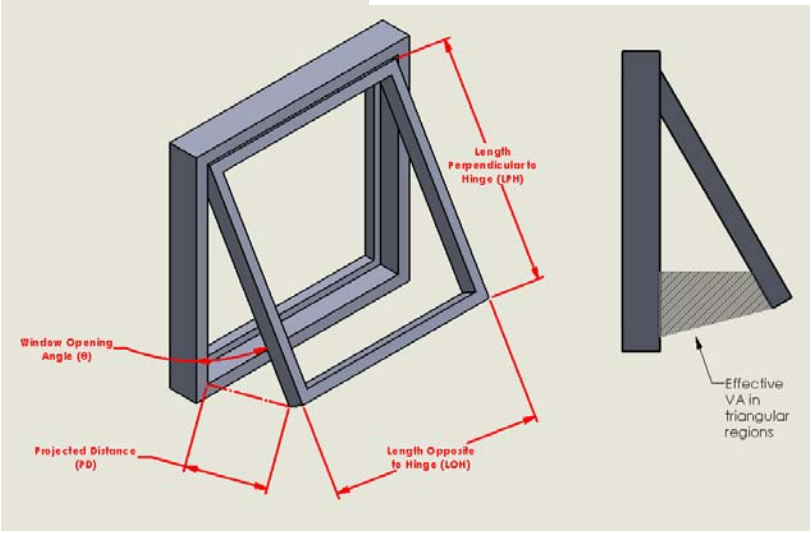
Proposed Method:

- To calculate VA (4.3.2):
  - $\text{Primary Ventilation Opening (PVO)} = \text{VOH} * \text{VOW}$
    - VOH and VOW includes Screen Encroachment
  - Cal. Aspect Ratio (AR) = $\left(\frac{LPH}{LOH}\right)$
  - Cal. VA at specific at Window Opening (θ)
  - VA = $\left(2 * \text{LPH} * \text{LOH} * \text{Sin}\left(\frac{\theta}{2}\right)\right) * \left(\frac{\text{AR}}{3} + 1\right)$
  - VA reaches a maximum at PVO calculation, VA ≤ PVO
    - Where,
      - VOH is Ventilation Opening Height
      - VOW is Ventilation Opening Width
      - LPH is Length Perpendicular to Hinge
      - LOH is Length Opposite to Hinge





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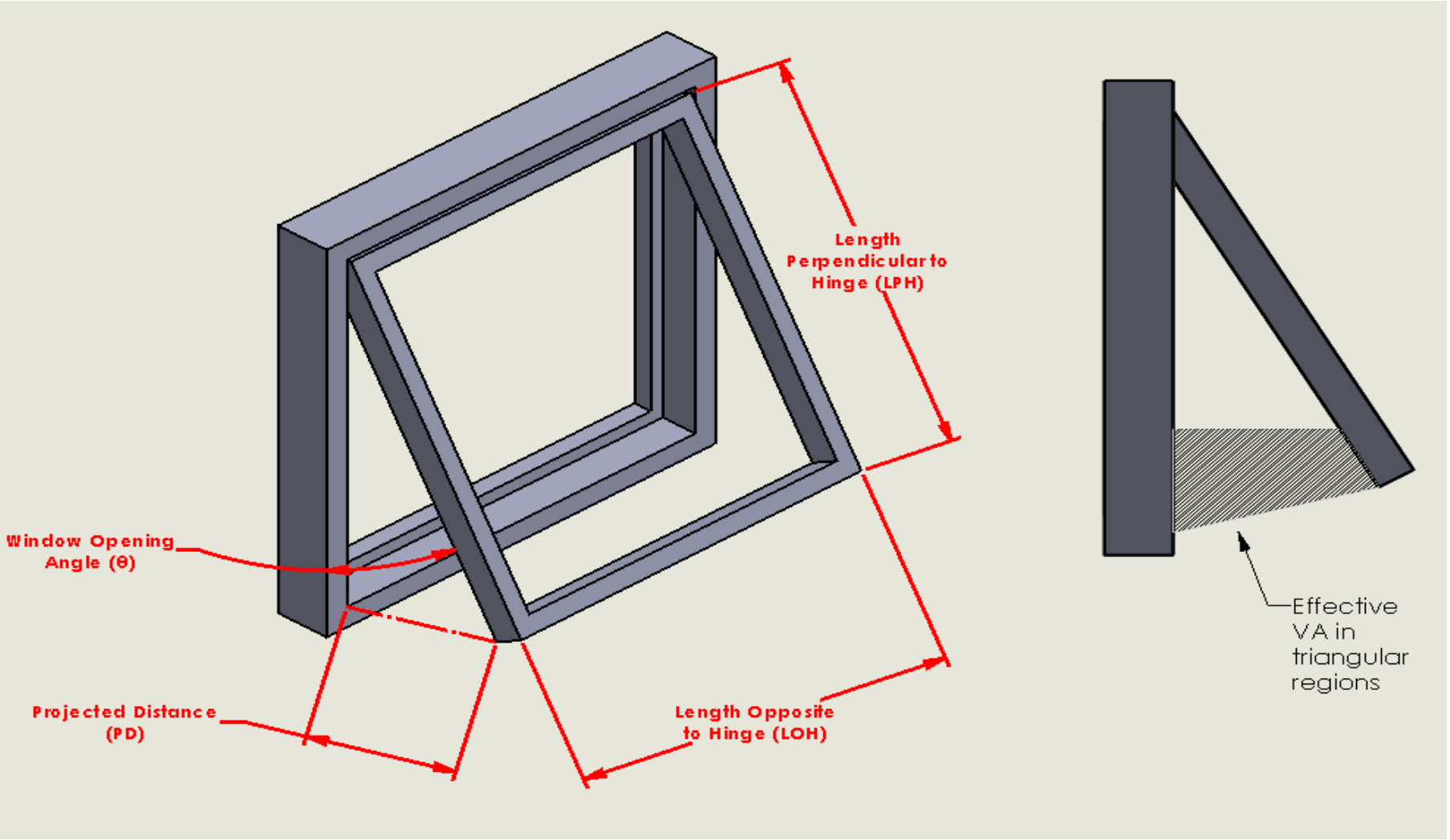

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Examples

- Case #1 – Casement 23.75” X 59” @ 26°
  - LPH = 23.75”
  - LOH = 59”
  - PVO = 7.03 sq. ft.
  - Aspect Ratio = 22/57.5 = 0.4
  - $VA = \left(2 * \text{LPH} * \text{LOH} * \text{Sin}\left(\frac{\theta}{2}\right)\right) * \left(\frac{\text{AR}}{3} + 1\right) = \mathbf{4.97}\boldsymbol{sq.ft.}$
- Case #2 – Skylight/Awning 21” X 54 7/16” @ 26°
  - LPH = 54 7/16”
  - LOH = 21”
  - PVO = 5.49 sq. ft.
  - Aspect Ratio = 54.4375/21 = 2.5
  - $VA = \left(2 * 54\ 7/16 * 21 * \text{Sin}\left(\frac{26}{2}\right)\right) * \left(\frac{2.5}{3} + 1\right) = \mathbf{5.49}\ \boldsymbol{sq.ft.}$
- Case #2 – Skylight/Awning 21” X 54 7/16” @ 13°
  - LPH = 54 7/16”
  - LOH = 21”
  - PVO = 5.49 sq. ft.
  - Aspect Ratio = 54.4375/21 = 2.5
  - $VA = \left(2 * 54\ 7/16 * 21 * \text{Sin}\left(\frac{26}{2}\right)\right) * \left(\frac{2.5}{3} + 1\right) = \mathbf{3.35}\ \boldsymbol{sq.ft.}$

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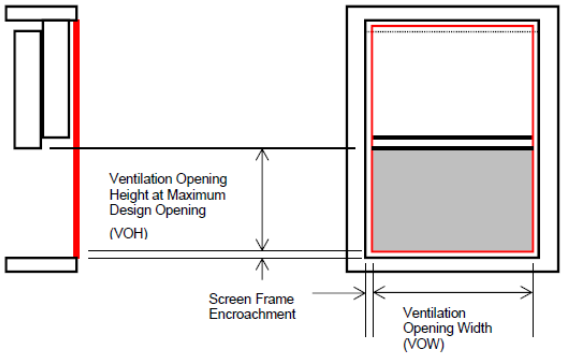
401 standard revisions

Figure 4-1



Projecting Products

4.3.2 For all projecting products, the Ventilation Area (VA) expressed in square meters (square feet) shall be calculated as follows:

1.) PVO = (VOH x VOW)
*VOH & VOW includes Screen Encroachment Width

2.) AR = LPH/LOH

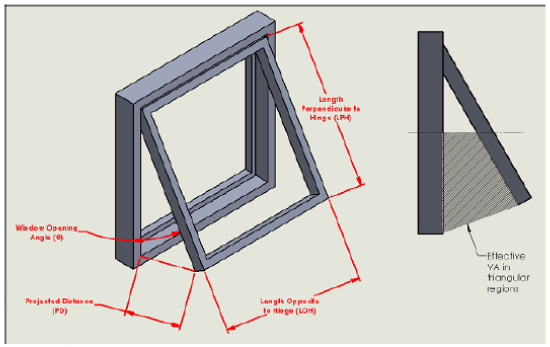
3.) Calculate at an angle Θ

4.) If not using calculator provided, VA ≤ PVO always

Where,

PVO = Primary Ventilation Opening
VOH = Ventilation Opening Height
VOW = Ventilation Opening Width
Θ = Window Opening
AR = Aspect Ratio
LPH = Length Perpendicular to Hinge
LOH = Length Opposite to Hinge

Figure 4-2



~~4.3.3 Projecting Products where the Maximum Design Opening Dimension is 30° or Greater~~

~~For all projecting products (including swinging doors) where the maximum design opening dimension is 30° or greater, the Ventilation Area (VA), expressed in square meters (square feet), shall be the gray shaded area in Figure 4-3 below, calculated as follows:~~

~~$VA = VOH \cdot (VOW - SD)$~~

~~Where:~~

- ~~VA is Ventilation Area~~
- ~~VOH is Ventilation Opening Height~~
- ~~VOW is Ventilation Opening Width~~
- ~~SD is Sash Depth.~~
  - ~~The Sash Depth reduction shall apply only if the open sash is within the VA.~~

- ~~If the screen frame encroaches into the opening, as indicated in red in Figure 4-3, VOH and VOW shall be reduced accordingly.~~
  - ~~Intermediate braces, if used, shall not be included in the VA calculation.~~

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New calculation method is captured in an Excel program for exacting VA by size and angle

LPH	54 7/16	in
LOH	21	in
Frame Thickness (including Screen Frame Width)	2.5	in
PVO Area	5.49	sqft
Aspect Ratio	2.59	

Open Degrees	Calculated Opposite Hinge Area (OHA)	Triangle Contribution Area	Adder Calculated VA Total	Actual Capped VA
1	0.14	0.12	0.26	0.26
2	0.28	0.24	0.52	0.52
3	0.42	0.36	0.77	0.77
4	0.55	0.48	1.03	1.03
5	0.69	0.60	1.29	1.29
6	0.83	0.72	1.55	1.55
7	0.97	0.84	1.81	1.81
8	1.11	0.96	2.06	2.06
9	1.25	1.08	2.32	2.32
10	1.38	1.20	2.58	2.58
11	1.52	1.31	2.84	2.84
12	1.66	1.43	3.09	3.09
13	1.80	1.55	3.35	3.35
14	1.93	1.67	3.61	3.61
15	2.07	1.79	3.86	3.86
16	2.21	1.91	4.12	4.12
17	2.35	2.03	4.37	4.37
18	2.48	2.15	4.63	4.63
19	2.62	2.26	4.88	4.88
20	2.76	2.38	5.14	5.14
21	2.89	2.50	5.39	5.39
22	3.03	2.62	5.65	5.49
23	3.17	2.74	5.90	5.49
24	3.30	2.85	6.15	5.49
25	3.44	2.97	6.41	5.49
26	3.57	3.09	6.66	5.49
27	3.71	3.20	6.91	5.49
28	3.84	3.32	7.16	5.49
29	3.98	3.44	7.41	5.49
30	4.11	3.55	7.66	5.49

AR (Aspect Ratio) = $\left(\frac{\text{LPH}}{\text{LOH}}\right)$

PD (Projected Distance) = $2 * \text{LPH} * \text{Sin}\left(\frac{\theta}{2}\right)$

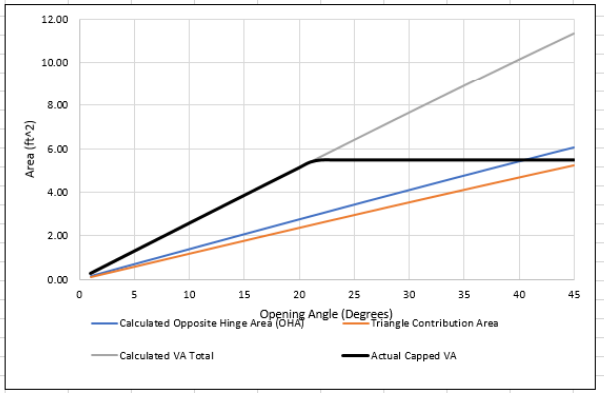
OHA (Opposite Hinge Area) = PD * LOH

$\text{VA} = \left(\frac{\text{AR}}{3} * \text{OHA}\right) + \text{OHA}$

$\text{VA} = \text{OHA} * \left(\frac{\text{AR}}{3} + 1\right)$

Substituting:

$\text{VA} = \left(2 * \text{LPH} * \text{LOH} * \text{Sin}\left(\frac{\theta}{2}\right)\right) * \left(\frac{\text{AR}}{3} + 1\right)$



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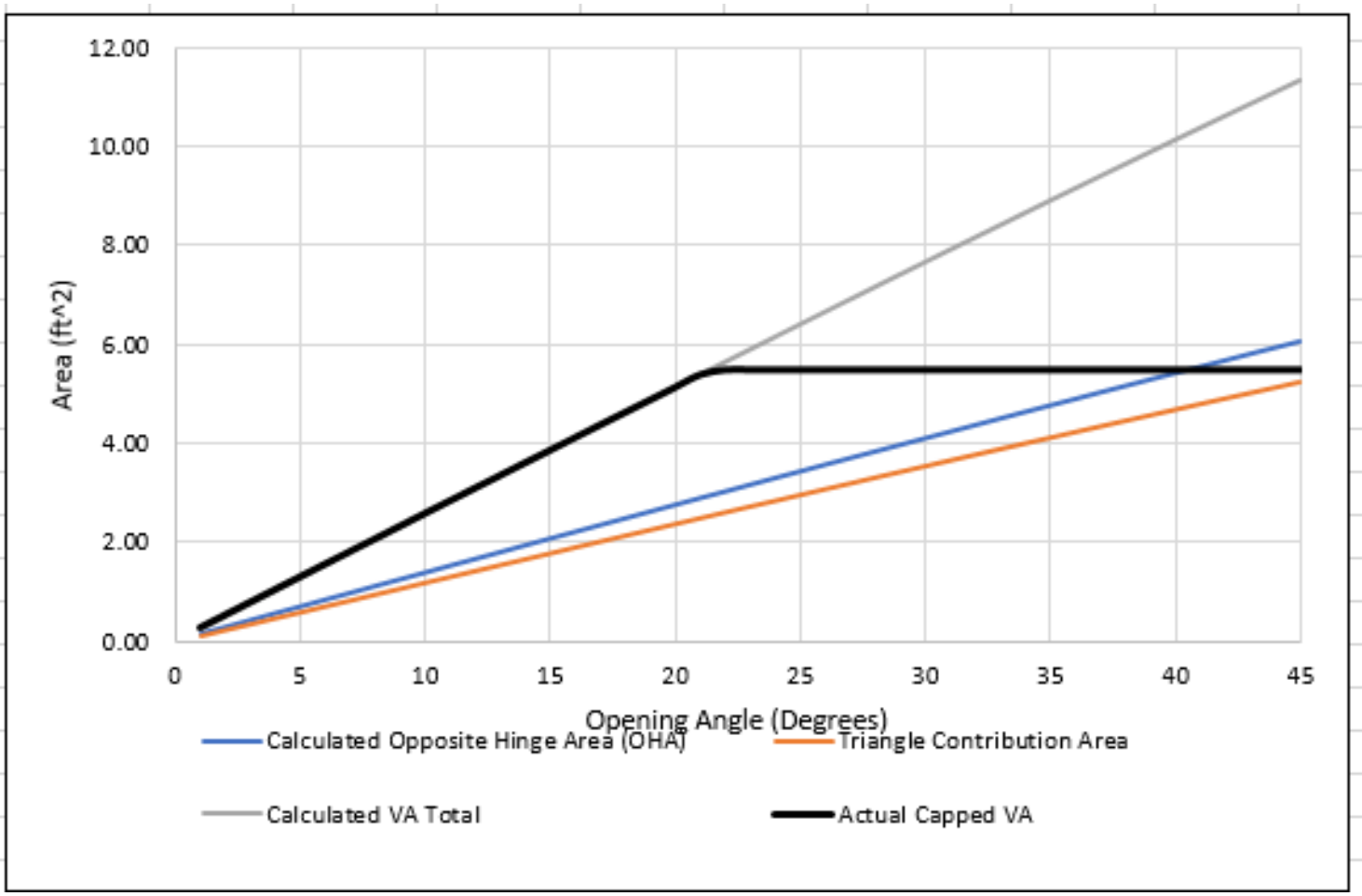
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Area (ft^2)
0
5
10
15
20
25
30
35
40
45
Opening Angle (Degrees)
Calculated Opposite Hinge Area (OHA)
Triangle Contribution Area
Calculated VA Total
Actual Capped VA

Ventilation Rating Calculation based on:			NFRC 401 Section 4			
	NFRC Model Size (NFRC 100 Table 4-3)		Projected Frame Area	Current Vent Area	Vent Area	Potential Ventilation Area
Unit Type	*LPH, mm (in)*	*LOH, mm (in)*	*FA, m^2 (sf)*	*VA, m^2 (sf)*	*VA, m^2 (sf)*	*m^2 (sf)*
Projecting Products - (at AR 0.41 & at 22°)	600 (24)	1500 (59)	0.9 (9.83)	0.49 (5.38)	0.40 (4.26)	0.36 (3.83)
Projecting Products (AR 2.46 at 8°)	1500 (59)	600 (24)	0.9 (9.83)	0.44 (4.77)	0.23 (2.50)	0.21 (2.25)
Skylight (AR 1 at 24°)	47	47	1.44 (15.34)	1.18 (12.71)	0.79 (8.51)	0.71 (7.66)
	width, mm (in)	*height, mm (in)*				
Single Hung (4.3.1)	1200 (47)	1500 (59)	1.8 (19.26)		0.75 (8.1)	0.675 (7.29)
Double Hung (4.3.1)	1200 (47)	1500 (59)	1.8 (19.26)		0.75 (8.1)	0.675 (7.29)
Horizontal Slider (4.3.1)	1500 (59)	1200 (47)	1.8 (19.26)		0.75 (8.1)	0.675 (7.29)
Sliding Door (4.3.1)	2000 (79)	2000 (79)	4.0 (43.34)		1.75 (18.81)	1.575 (16.93)
Swinging Doors (xx, Double Swining Door)	1920 (75.5)	2090 (82.375)	4.01 (43.19)		3.24 (34.83)	2.916 (31.35)

Next steps;

- Task group to evaluate new calculations
- Task group to meet in mid October for review
- Ballot rewrite to TG
- Refine ballot
- Final Ballot for Spring meeting
- Approval and use late Spring 2020
- Celebration!

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Thank you! - Questions?