

The Dangers of a Black Box

Read Jones Christoffersen Ltd.
Creative Thinking **Practical Results**



Responsible Registrant

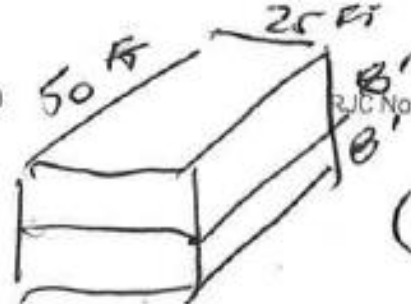
Firms are required to have at least one Responsible Registrant who acknowledges responsibility for the firm and will complete the application.

The Responsible Registrant must be an engineering or geoscience professional who will be responsible for ensuring that the firm's practice meets ethical, quality management, and continuing education requirements.



4.0 OUTPUTS

~ 2500 sq ft House



$$(50 \times 2 + 25 \times 2) \times 8 \text{ ft} = 2400 \text{ ft}^2$$

$$\text{Wall Area} = 220 \text{ m}^2$$

The energy breakdown for the proposed building along with the associated energy savings are outlined in Table A7 (the tabular data in Table A7 is shown in graphical form in Figure A1):

| End Use | Energy Consumption |
|---------------------------------|--------------------|
| Lighting | 58.87 |
| Equipment | 83.64 |
| Elevators | 11.61 |
| Space Heating | 121.40 |
| Service Water Heating | 132.72 |
| Fans | 26.81 |
| Pumps | 2.10 |
| Total [MWh] | 437.15 |
| TEUI [kWh/m ² /year] | 100.48 |

100 W light bulbs
Hrs in a year
 $365 \times 24 = 8760$

$$\frac{100 \text{ W} \times 8760 \text{ hr}}{220} = 3981 \frac{\text{Wh}}{\text{m}^2 \cdot \text{yr}}$$

$$= 4 \frac{\text{kWh}}{\text{m}^2 \cdot \text{yr}}$$

Work is Transfer of Energy

Work: $1 \text{ Joule} = \text{N} \times \text{m}$

Power is the Rate of Work

Power: $1 \text{ Watt} = 1 \text{ Joule} / \text{Second}$

Energy is ability to do Work and Heat is Energy

$1 \text{ kWhr} = 3,600,000 \text{ Joules}$
 $= 1^\circ\text{C temp rise in } 900 \text{ L water}$

A Lamborghini is Powerful and Expensive

$600 \text{ kW (802 HP)} = 0\text{-}100 \text{ kmh in } 2.8 \text{ sec}$
 $= 0.47 \text{ kWhr} = 1.692 \text{ mJ}$
 $= \$2.64\text{M}$

900 Litres



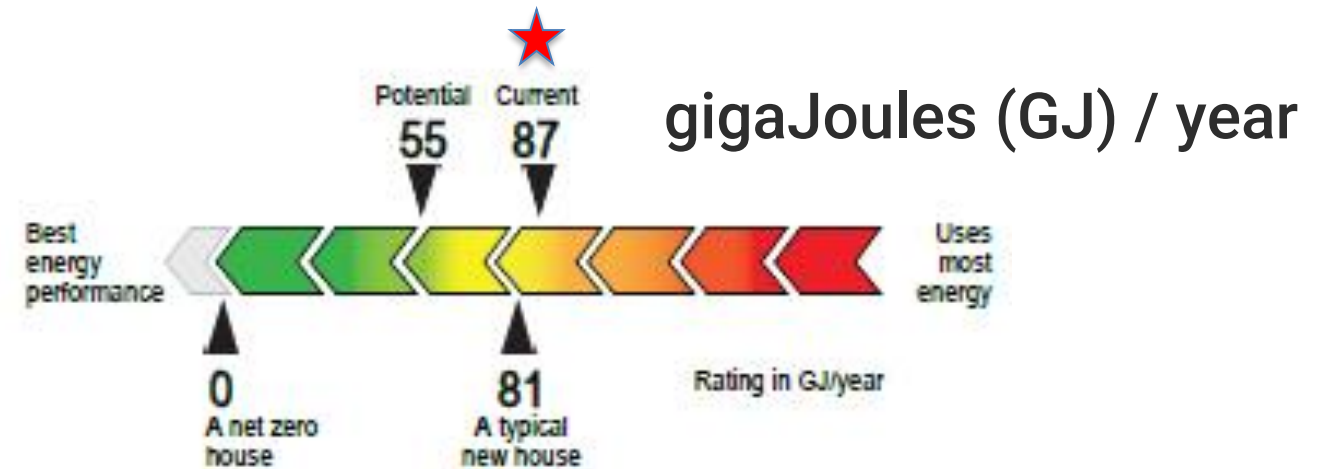
2022 Lamborghini Countach



RENOVATION UPGRADE REPORT

ENERG GUIDE

MY HOUSE



Enclosure

Walls: RSI 2.46 (R14)
Roof: RSI 7.0 & 4.9 (R40 & R28)
Windows: 1.9 W/m²C
Air Leakage: 3.97 ACH at 50 Pa

Mechanical System

Condensing Natural Gas Furnace: 14.4 kW
Natural Gas Fire Place: 2kW
Natural Gas Water Tank: 151 L
Electric Water Tank: 189L

MODEL RESULTS

Natural Gas

56 GJ/Year

74 kWhr/m2/Year

Electricity

31 GJ/Year

41 kWhr/m2/Year

TOTAL

87 GJ/Year

115 kWhr/m2/Year

ACTUAL

140 GJ/Year

185 kWhr/m2/Year

160 GJ

120 GJ

80 GJ

40 GJ

0

TOTAL



Utility Meter
Connected

Demand

Summation

Energy Demand



SOME RELEVANT ASSUMPTIONS

Occupancy Density & Schedules

2 adults and 1 child at home 50% of the time

Electrical Base Loads

Interior lighting

2.6 kWh/day

Electrical appliances

6.3 kWh/day

Other electrical loads

9.7 kWh/day

Average exterior lighting, etc

0.9 kWh/day/unit

Annual total for a house

25.6 GJ/year

1 kW every hour all year

=

32 GJ/year

+ 25%

Live

1 Day

1 Week

1 Month

Always On: 966 W

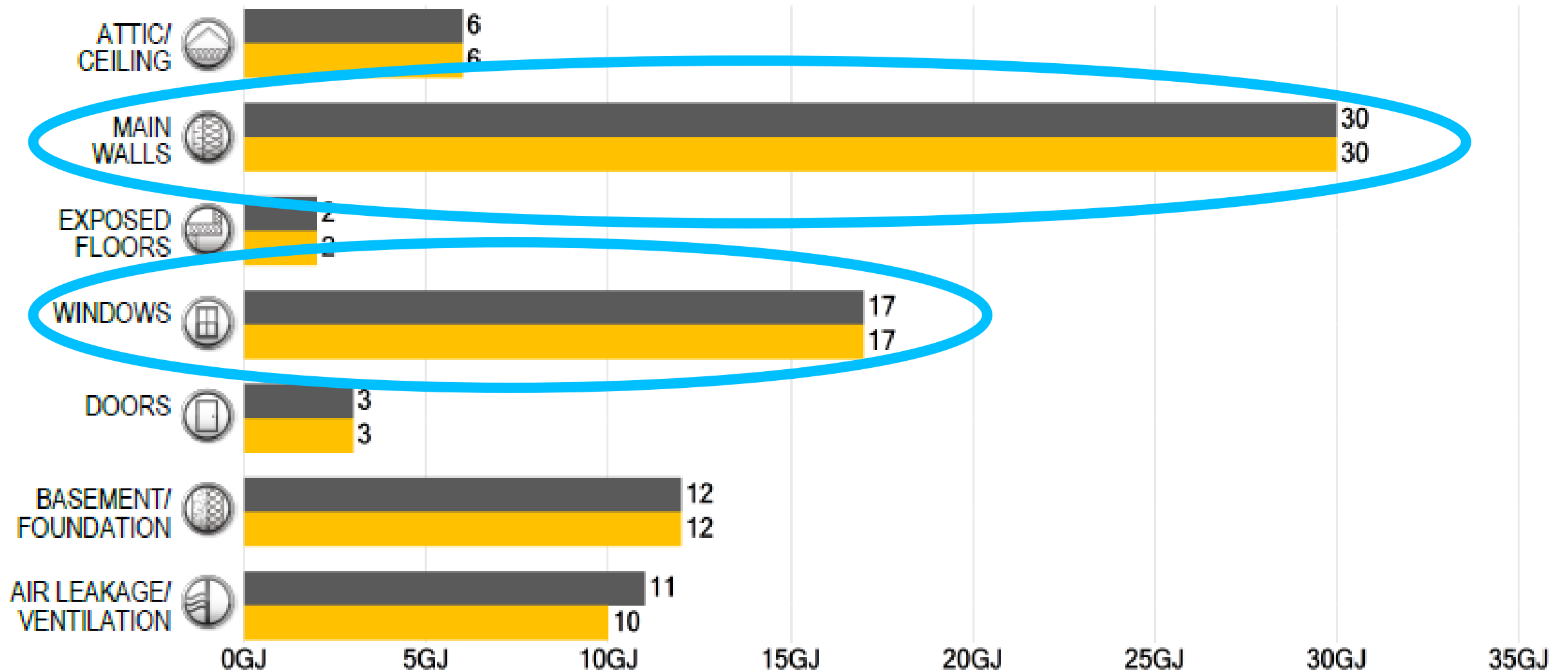
Average: 2.15 kW

Peak: 5.87 kW @ Oct 06, 10:00 pm

Heat loss:

Current
(GJ/year)

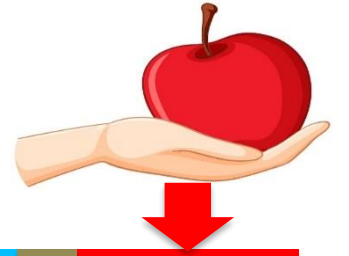
After upgrades
(GJ/year)



Thermal Conductivity: $\lambda = \text{W/m}^2/\text{m}/\text{K} = \text{W/mK}$

Coefficient: **U Value** = $\lambda / \text{Thickness} = \text{W/m}^2\text{K}$

Heat in Watts: $H = A \times U \times (T1 - T2)$



160 W/mK



ALUMINUM

0.17 W/mK

VINYL

0.3 W/mK

POLYAMIDE

17 W/mK

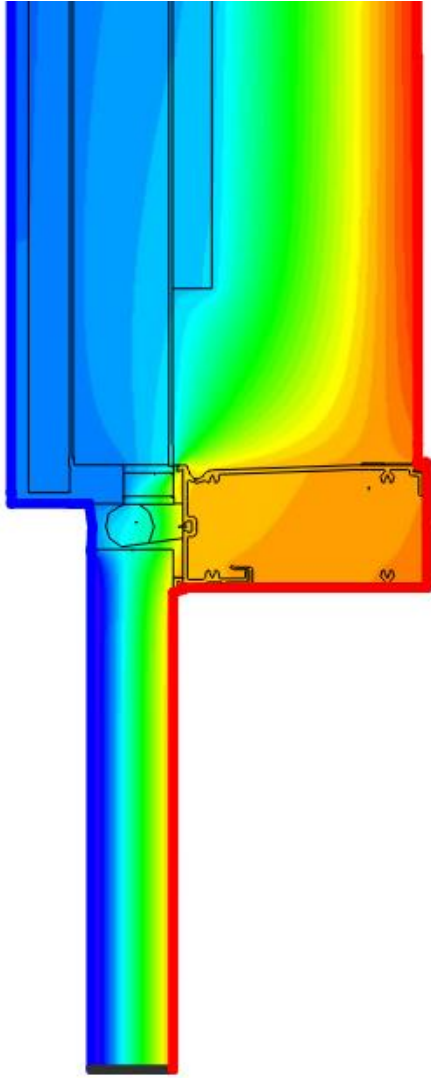


STAINLESS STEEL

56 W/mK

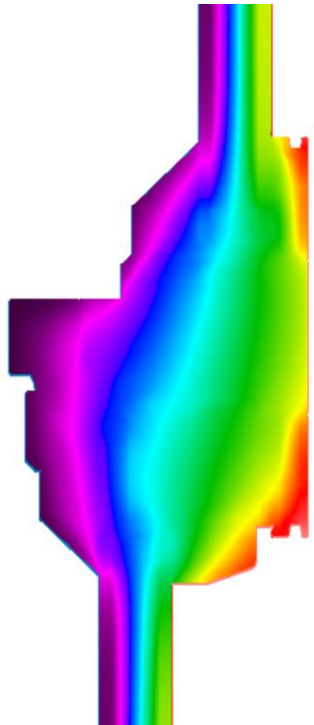


STEEL

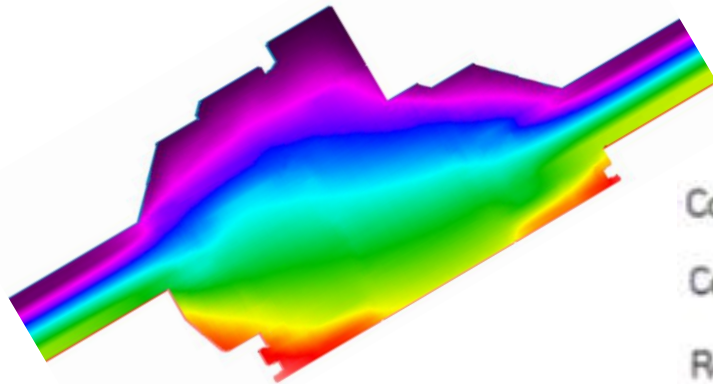


In general _____ is a 2D steady state thermal bridge analysis software using FEM (triangle elements) with an optimized conjugate gradient solver and adaptive remeshing.

Boundary Conditions



$U = 2.25 \text{ W/m}^2\text{K}$
(VERTICAL)



$U = 2.45 \text{ W/m}^2\text{K}$
(@ 20 degrees)
9% difference

Solver Parameters

0.001 → $U = 5.4 \text{ W/m}^2\text{K}$
10.0 → $U = 6.0 \text{ W/m}^2\text{K}$
10% difference

ConRad Simulation

Convergence Tolerance

Relaxation Parameter

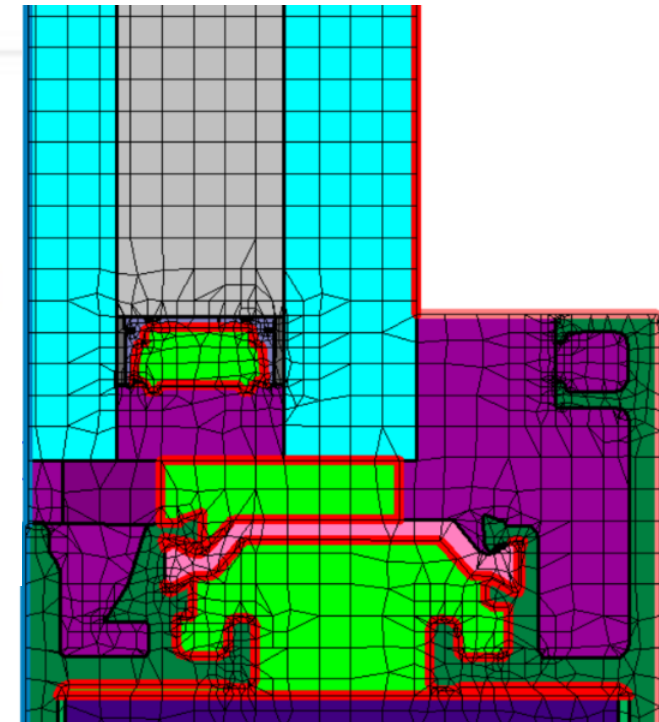
☐ Automatically adjust relaxation parameter

Adjustment step

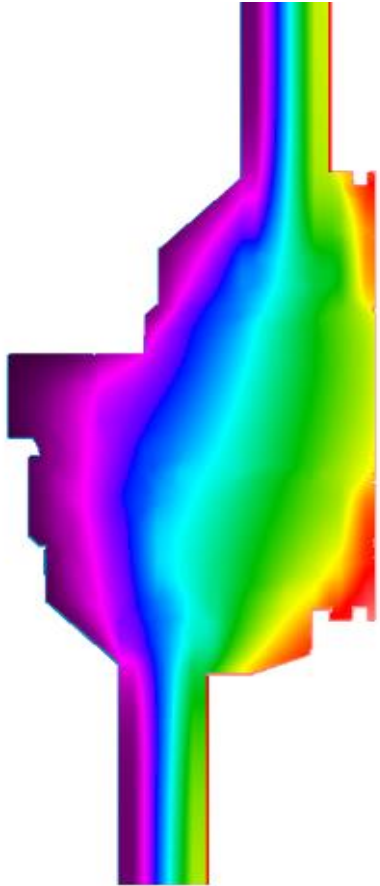
Maximum iterations

☒ View Factor Smoothing

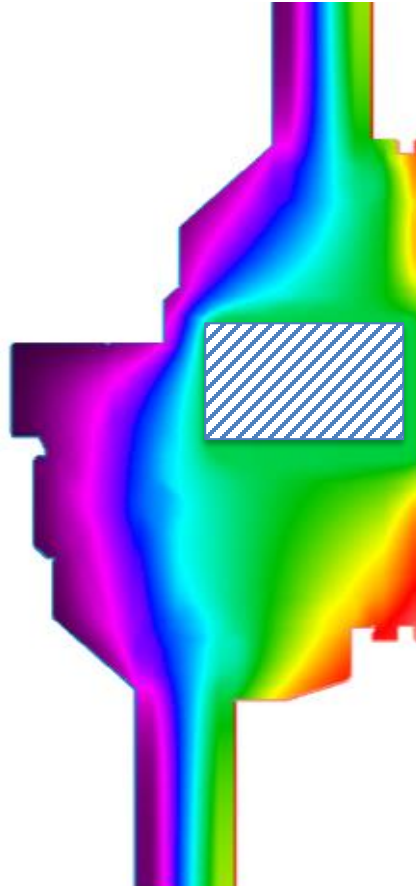
☒ ISO 15099 Jamb Cavity Radiation Fix



Parametric Checking



$U = 2.25 \text{ W/m}^2\text{K}$
Unreinforced Vinyl



$U = 2.65 \text{ W/m}^2\text{K}$
Add Reinforcing
18% difference

Comparing to known Standard





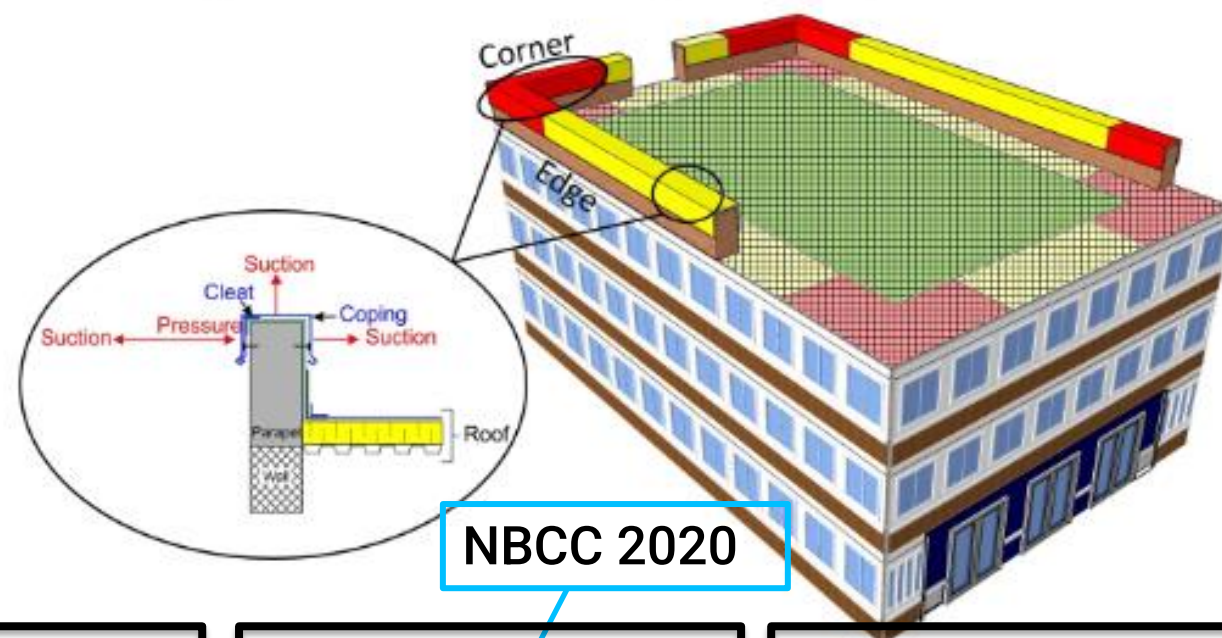
Government
of Canada

Gouvernement
du Canada

Factored wind loads for parapet cladding and metal edge components

| Parapet location on roof area | Wind load |
|-------------------------------|------------|
| Corner (suction) | -5.1 kPa * |
| Edge (suction) | -3.6 kPa * |
| Corner & edge (pressure) | 2.5 kPa * |

*Worst of windward and leeward



Building location

From: National Research Council Canada

Please specify building location. If the city you are entering is not available, please select the nearest city.

Province: (required)
British Columbia

City: (required)
Vancouver Region, Vancouver

(1)

Specify building geometry details

☐ Low-rise
Building with height that is both less than or equal to 20 metres and less than the smaller plan dimension.
(Sentence 4.1.7.6.(1))

☒ High-rise
Building that is rectangular in plan and whose height, H_t , is greater than 20 metres or their smaller plan dimension.
(Sentence 4.1.7.6.(1))

* Height (reference height) in metres: (required)
21

* Width (smaller plan dimension) in metres: (required)
20

* Length (bigger plan dimension) in metres: (required)
30

* Height of perimeter parapet in metres: (required)
Note 1: Enter "0" for roof without parapet.
Note 2: This calculator is limited to roof configurations with perimeter parapet and parapet height less than or equal to 1.5 m. Please see configurations.
1.5

(2)

* Specify building exposure: (required)

☒ Open
Level terrain with only scattered buildings, trees, or other obstructions.
(Clause 4.1.7.3.(5)(a))

☐ Rough
Suburban, urban or wooded terrain
(Clause 4.1.7.3.(5)(b))

(3)

Importance category

From: National Research Council Canada

This calculator is applicable to buildings assigned with importance level of low, normal and high. To calculate wind loads for roof cladding assigned post-disaster, refer to National Building Code of Canada 2020 Article 4.1.7.3.

* Specify importance category: (required)

☐ Low
Buildings that represent a low, direct, or indirect hazard to human life in the event of failure of building:
• low human-occupancy buildings, where it can be shown that a failure is unlikely to cause injury or other serious consequences
• minor storage buildings
(Note 4.1.7.3)

☐ High
Buildings that are likely to be used as post-disaster shelters, or existing buildings where primary use is:
• as an elementary, middle or secondary school
• as a community centre
Manufacturing and storage facilities containing toxic, explosive or other hazardous substances in sufficient quantities to be dangerous to the public if released.
(Note 4.1.7.3)

☒ Normal
All buildings except those listed in low and high importance categories.
(Note 4.1.7.3)

(4)

Building openings

From: National Research Council Canada

Specify building openings: (required)

☐ Category 1
This category deals with buildings without any large or significant openings, but having small uniformly distributed openings amounting to less than 0.1% of total surface area. Such buildings include high-rise buildings that are normally sealed, have no operable windows and screen doors, and are mechanically ventilated. Some less common low-rise buildings, such as windowless warehouses with door systems not prone to storm damage, also fall into this category.
(Note 4.1.7.3)

☒ Category 2
This category covers buildings in which significant openings, where it is shown that they are closed during storms but in which background leakage may not be uniformly distributed. Most low-rise buildings fall into this category provided that all elements - especially shipping doors - are designed to be fully wind-resistant. Most high-rise buildings with operable windows and doors also fall into this category.
(Note 4.1.7.3)

☐ Category 3
This category covers buildings with large or significant openings through which gusts are transmitted to the interior. Examples of such buildings included sheds with one or more open sides as well as industrial buildings with shipping doors, ventilators or the like, which have a high probability of being open during a storm or not being fully resistant to design wind loads.
(Note 4.1.7.3)

(5)

Warranty disclaimer

i The Software is supplied "as is". The NRC disclaims any warranties, expressed, implied, or statutory, of any kind or nature with respect to the Software, including without limitation any warranty of merchantability or fitness for a particular purpose. The NRC is/shall not be liable in any event for any damages, whether direct or indirect, special or general, consequential or incidental, arising from the use of the Software. The NRC does: (1) not assume any legal liability or responsibility for the accuracy, completeness, or usefulness of the Software (2) not warrant that the Software will function uninterrupted, that it is error-free or that any errors will be corrected. By using the Software you are indicating your acceptance of the terms and conditions herein.

I agree

