RDH BUILDING SCIENCE LABORATORIES

Wind-washing effects on mineral wool insulated sheathings

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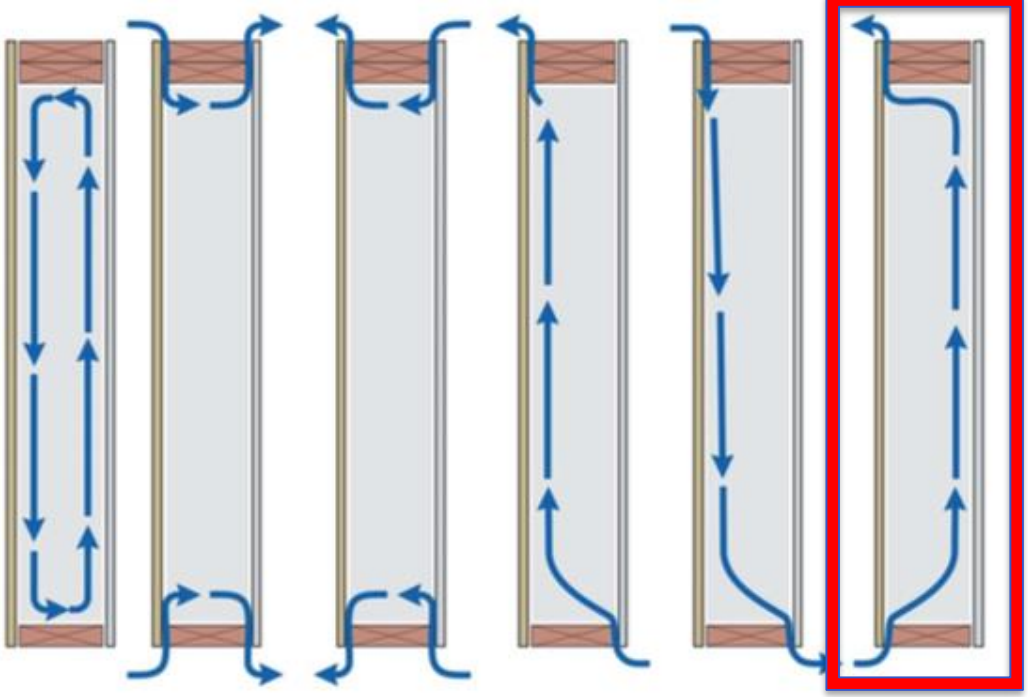
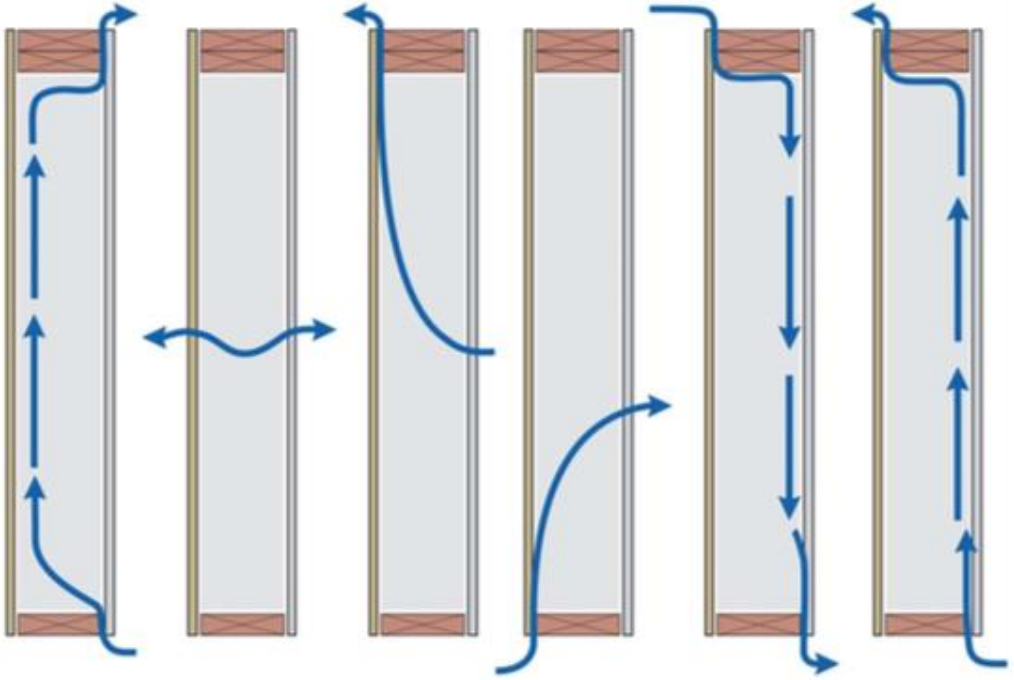
Outline

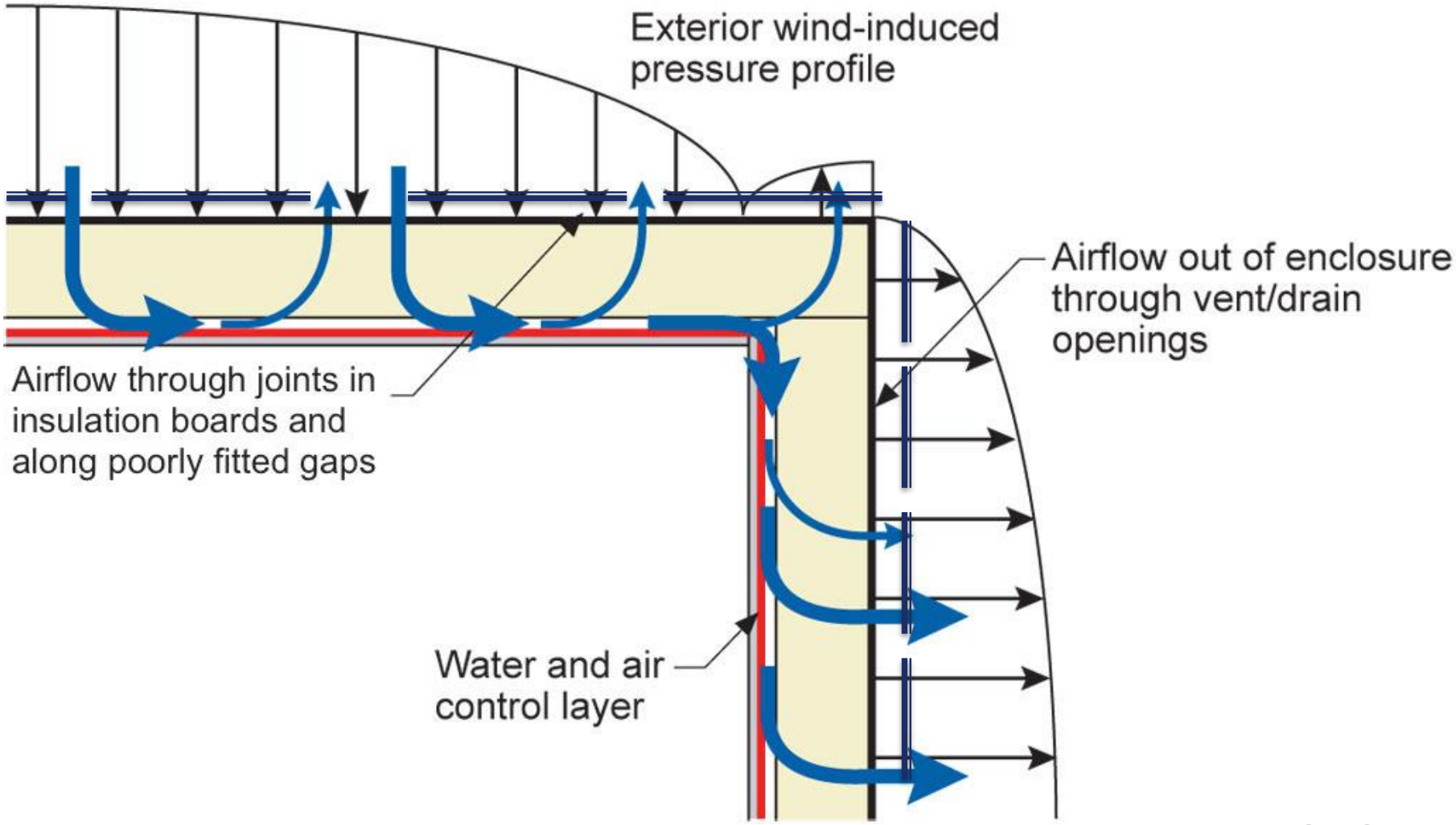
- What is windwashing?
- What air flows are likely behind cladding?
  - Review of literature
- How is mineral wool affected?
  - Lab measurements

- 

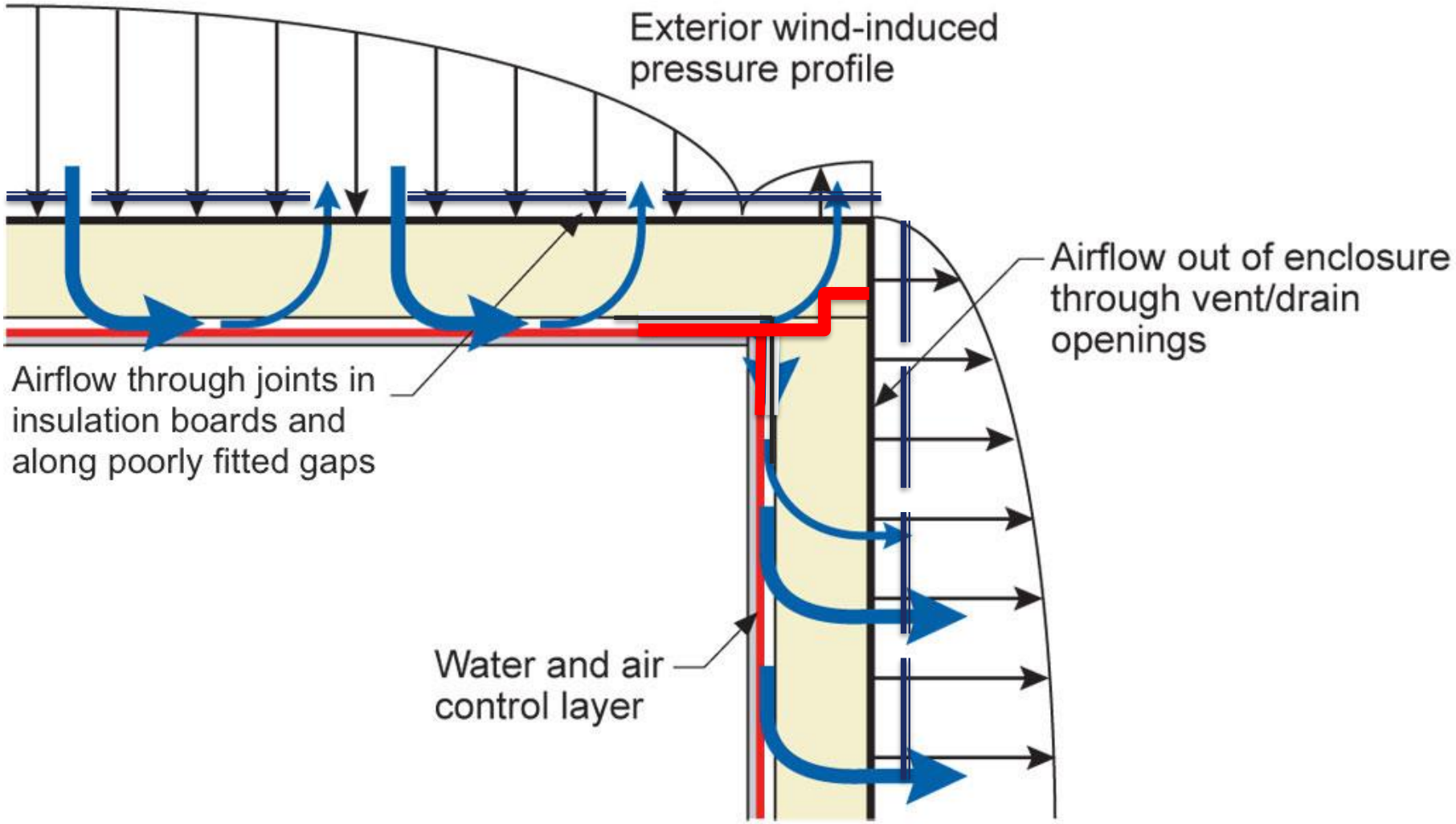
Many Airflow Paths



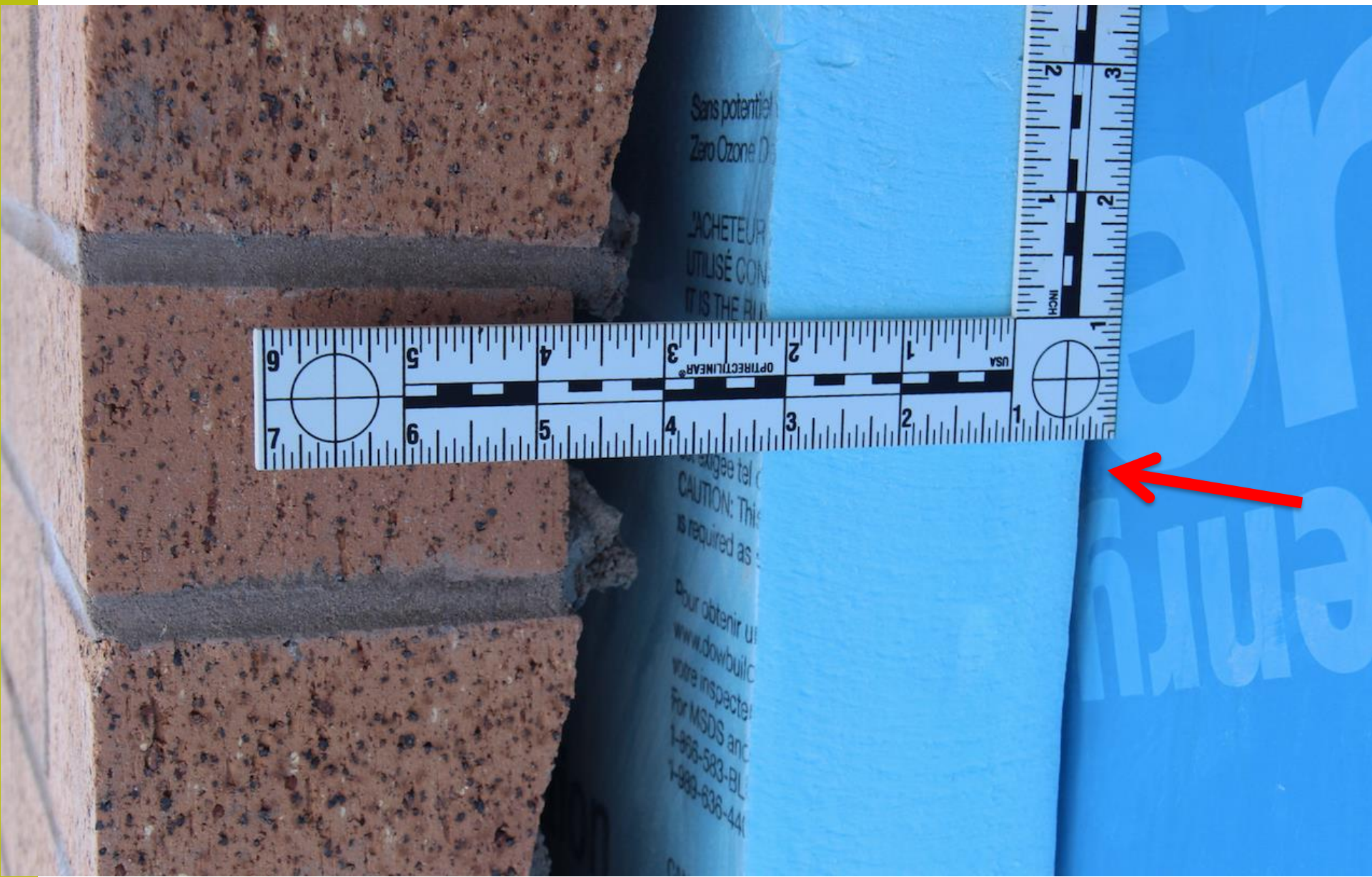
Wind washing behind rigid insulation



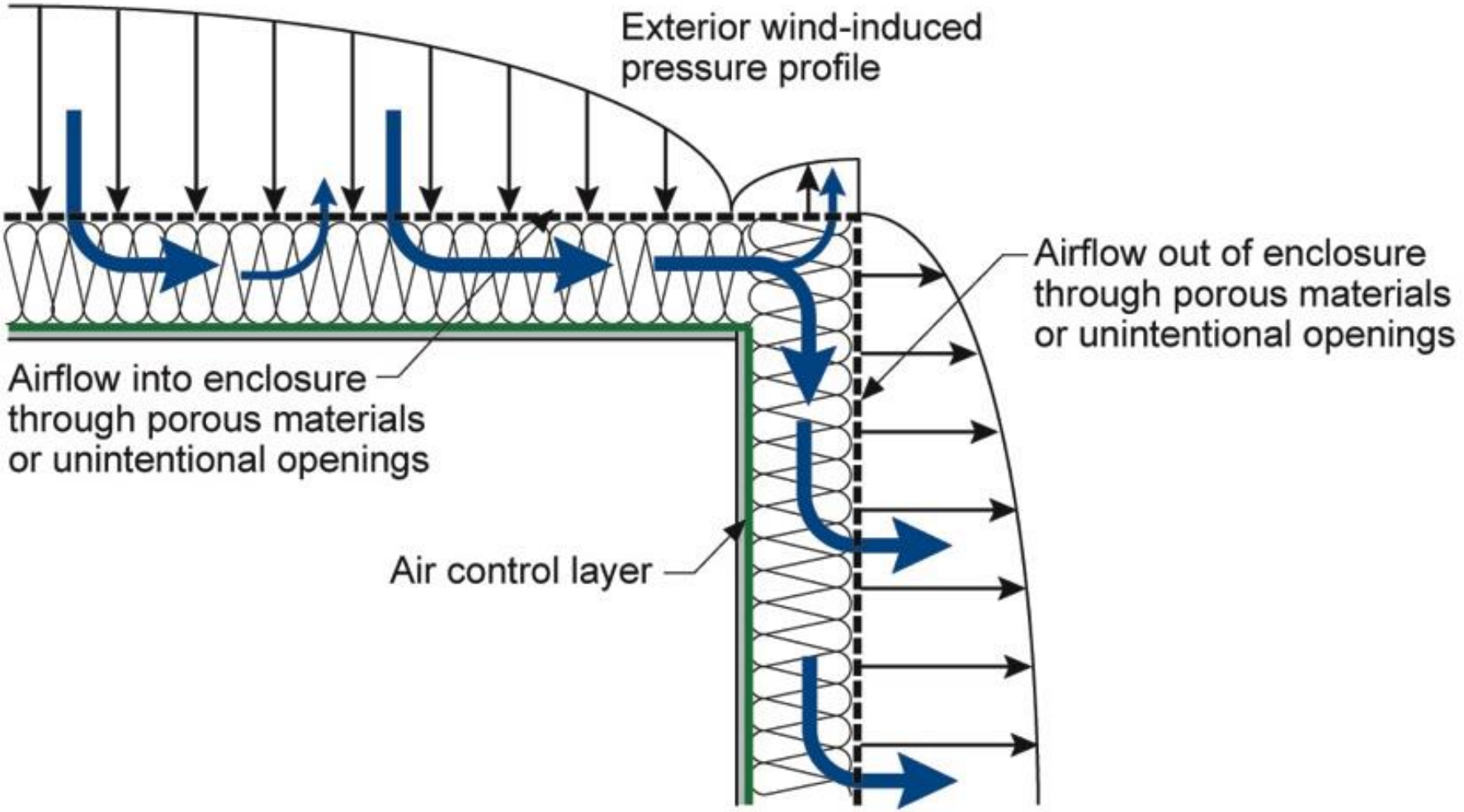
Solution to the worst effect

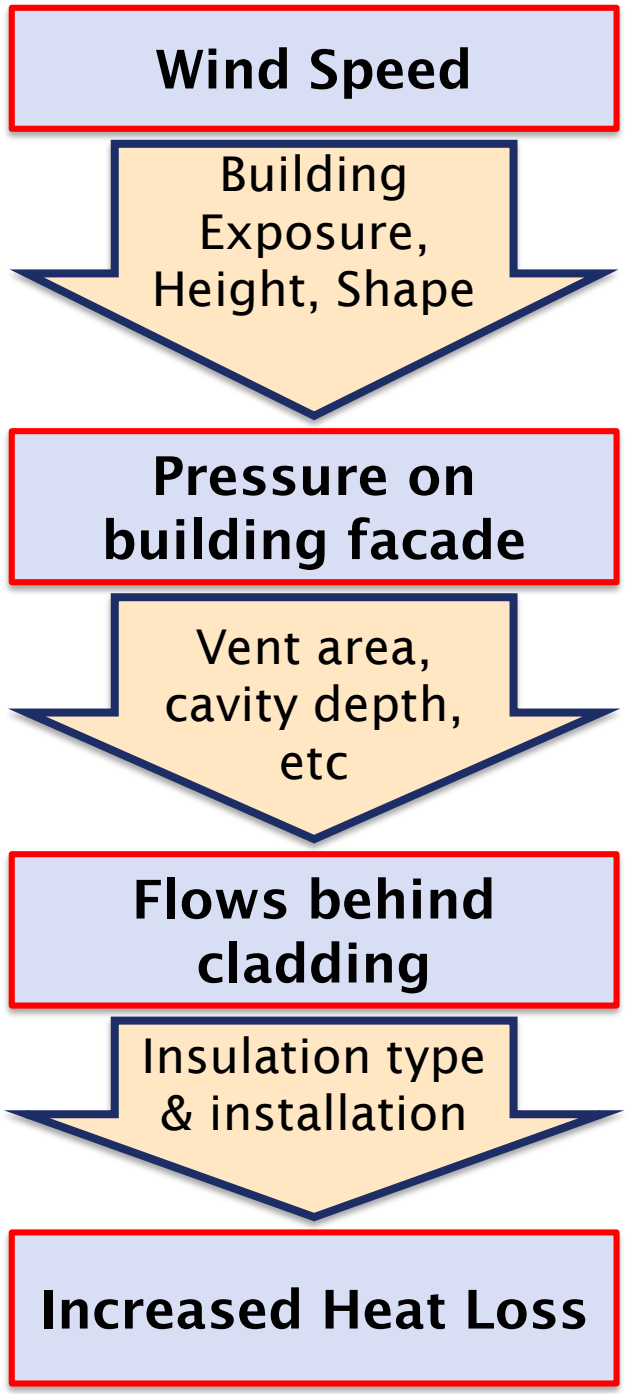


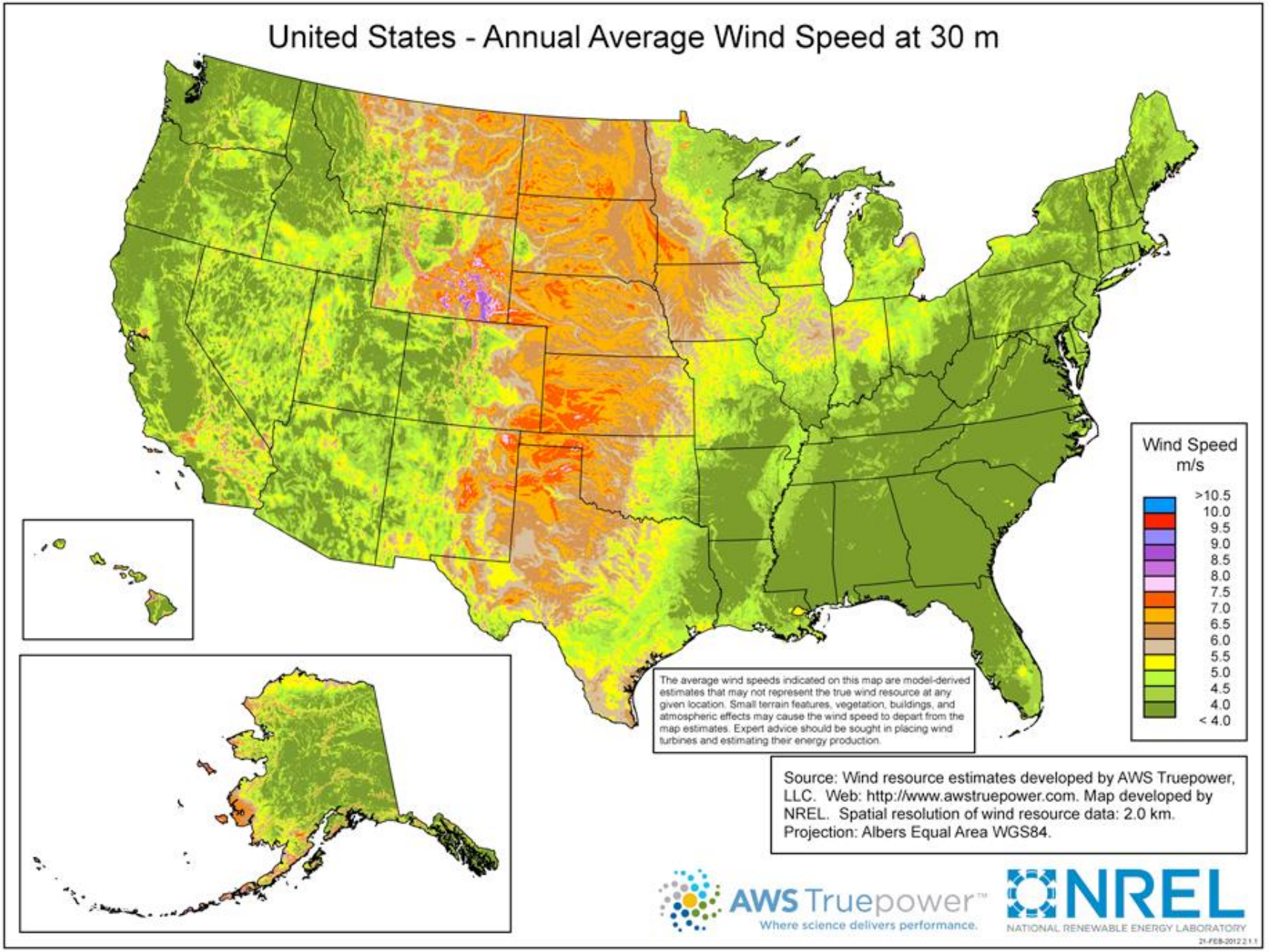
Risk of wind washing



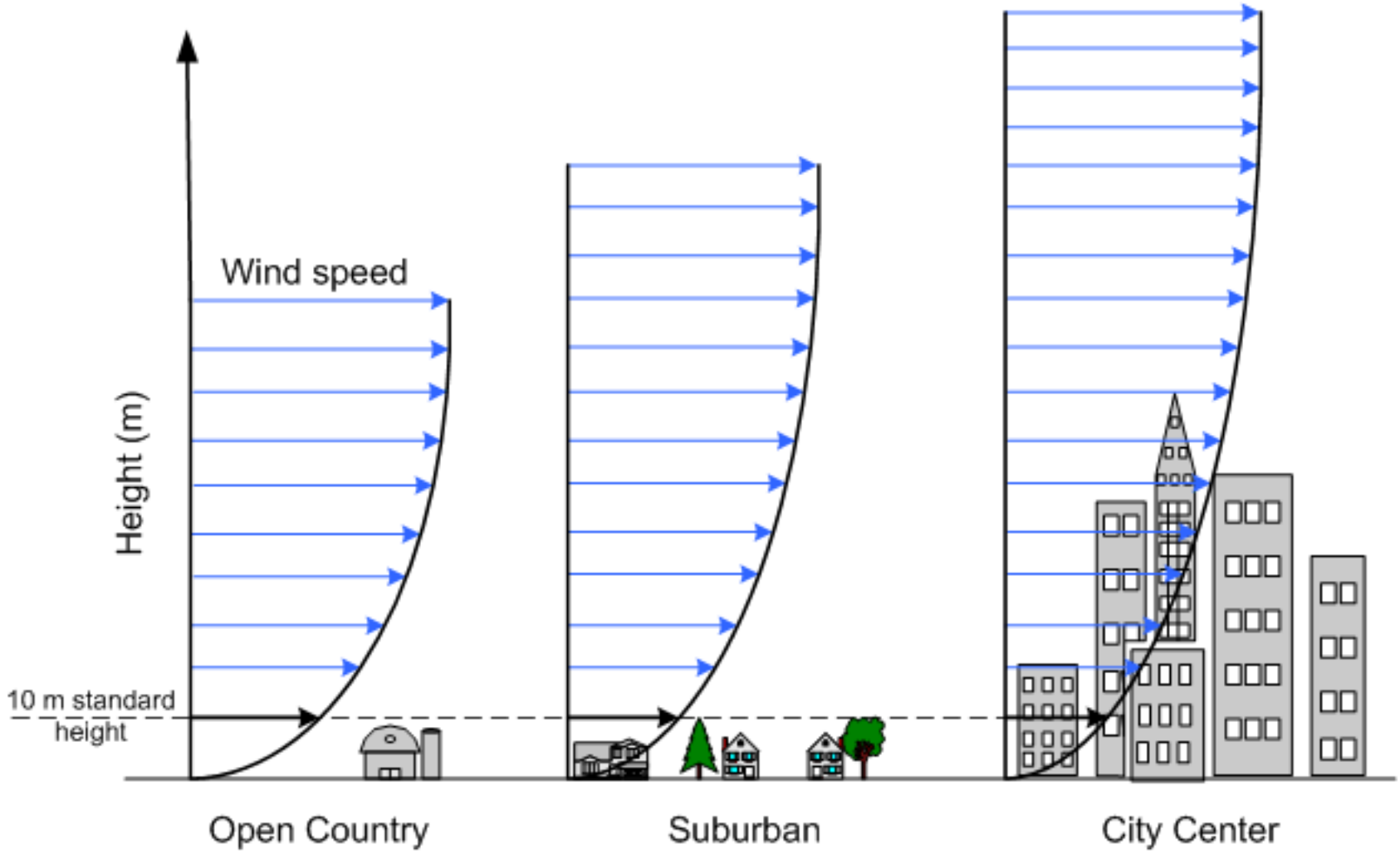
Windflow thru fibrous insulation



- 
Wind Speed
Building Exposure, Height, Shape
Pressure on building facade
Vent area, cavity depth, etc
Flows behind cladding
Insulation type & installation
Increased Heat Loss

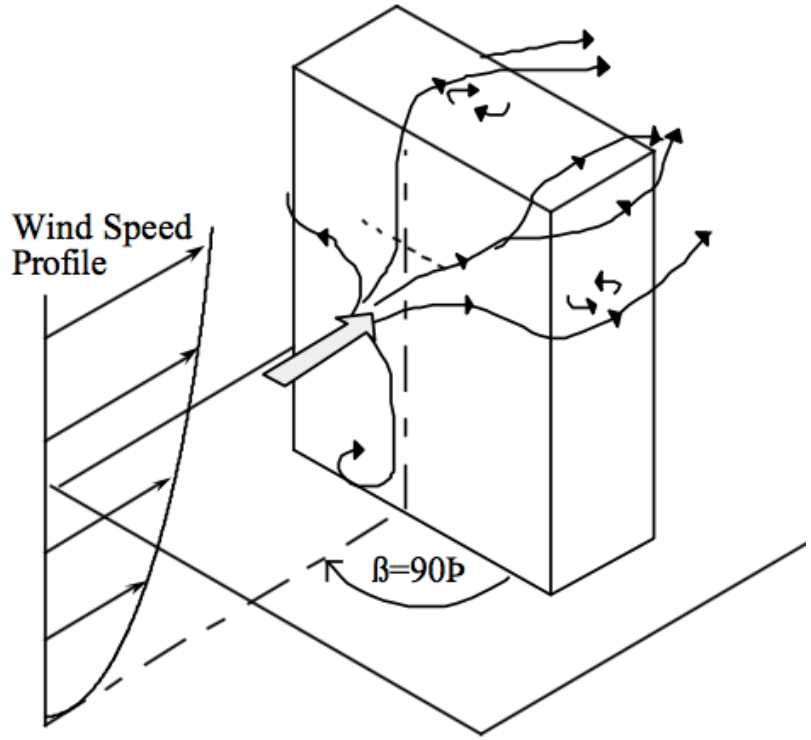

United States - Annual Average Wind Speed at 30 m
Wind Speed
m/s
>10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
< 4.0
The average wind speeds indicated on this map are model-derived estimates that may not represent the true wind resource at any given location. Small terrain features, vegetation, buildings, and atmospheric effects may cause the wind speed to depart from the map estimates. Expert advice should be sought in placing wind turbines and estimating their energy production.
Source: Wind resource estimates developed by AWS Truepower, LLC. Web: http://www.awstruepower.com. Map developed by NREL. Spatial resolution of wind resource data: 2.0 km. Projection: Albers Equal Area WGS84.
AWS Truepower™
Where science delivers performance.
NREL
NATIONAL RENEWABLE ENERGY LABORATORY
21-FEB-2012 2.1.1

Windspeed & Exposure

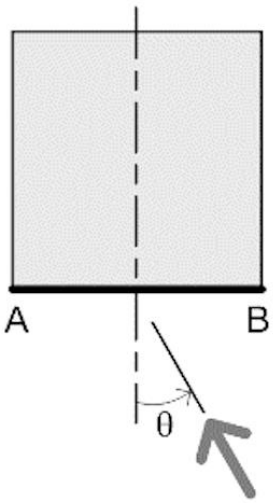


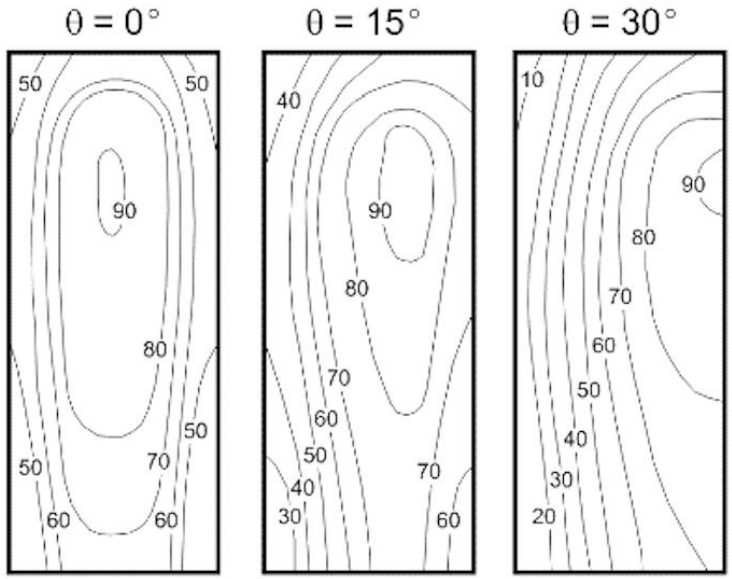
PRESSURE ON BUILDING FACADE

Pressure Distribution

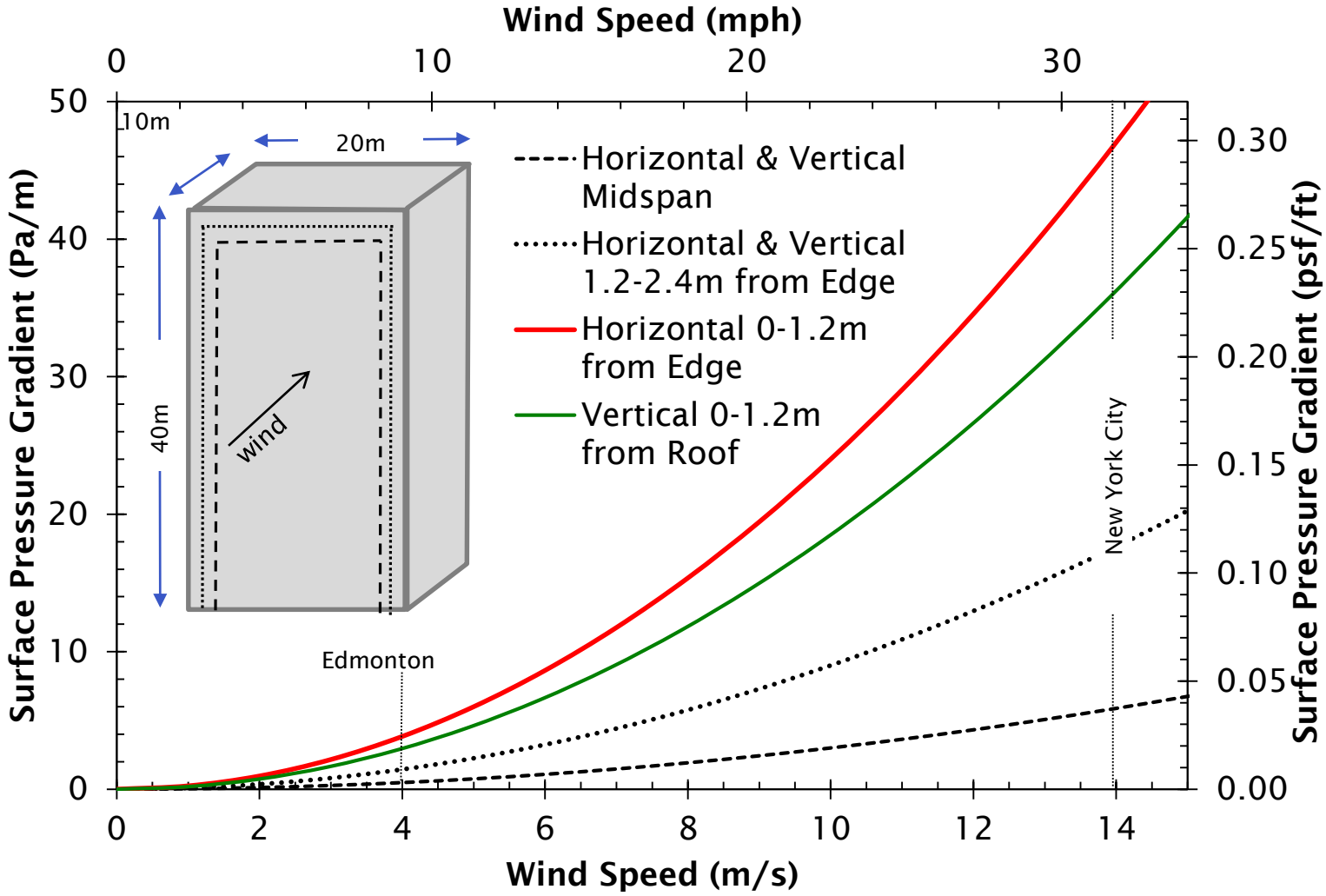


Wind Streamlines On A Building Face





Vert/horiz Gradients



FLOWS/GRADIENT BEHIND CLADDING

What air velocities can we expect?

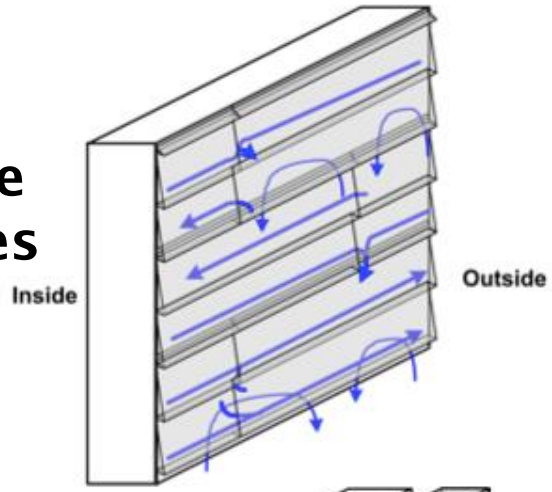
- Pressure Gradients on surface need to converted to flow behind cladding
- A number of field measurements
  - Previous measurements
  - ASHRAE Research Project 1018
  - CMHC Research Project
  - Schwartz
- CFD models (often don't match)

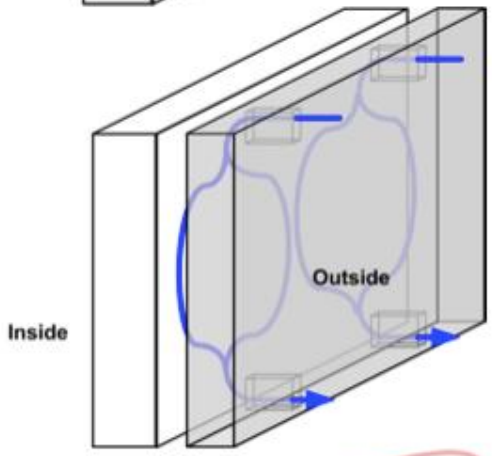
Measurement of Ventilation

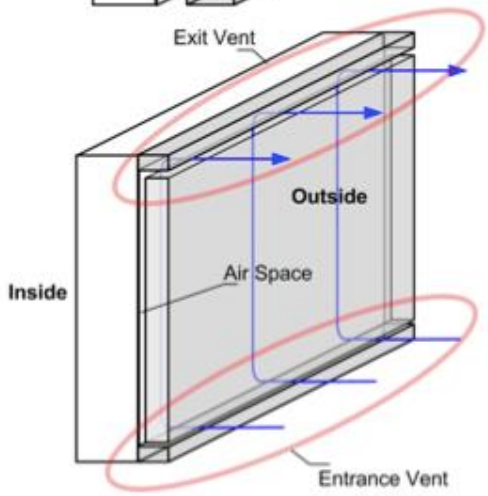
- Uvsløkk (1996) *cavity* pressure gradients
  - Test house for pressure measurements
  - Hot-box to measure thermal flow
- a 23 mm (~1”) clear air gap behind wood siding
  - wind speeds of 3 m/s (6.7 mph) in of a small test house
  - Pressure gradient behind cladding of **0.1- 0.5 Pa/m** (0.001-0.003 pcf/ft)

-Different claddings have different ventilation rates

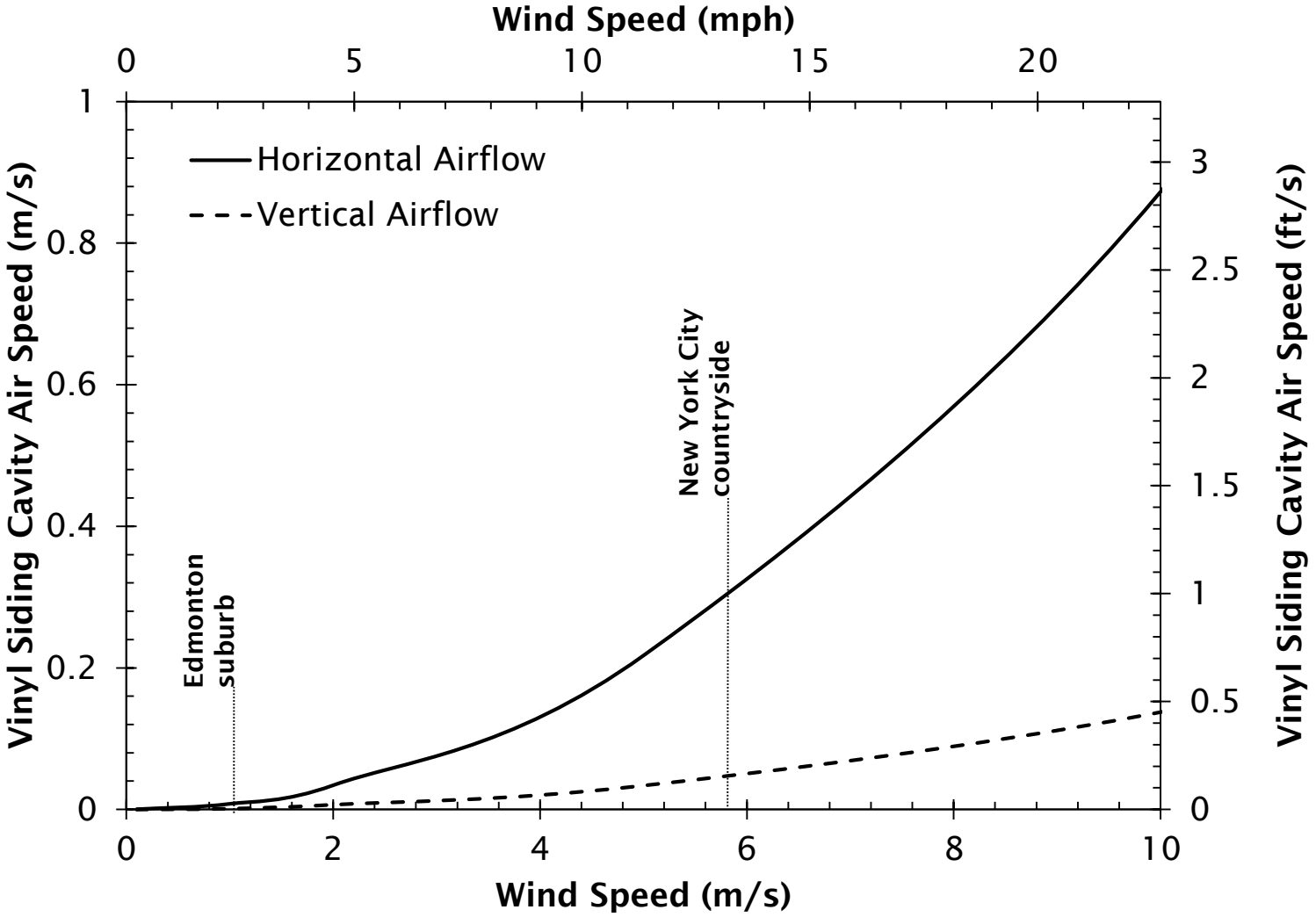
-Flow velocities behind cladding vary over vast range







Vinyl Siding Cavity Flow



THERMAL IMPACT OF FLOWS

Measured thermal impact

- Limited lab measurements by some
- EMPA (Switzerland 1996)
  - Hot box test w/ Simulated wind
  - No cladding over mineral wool (1.25-5 pcf)
  - Small, marginal impact (under 5%)

EMPA HotBox Study 1996

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Veränderung infolge Zunahme der kaltseitigen Luftgeschwindigkeit.

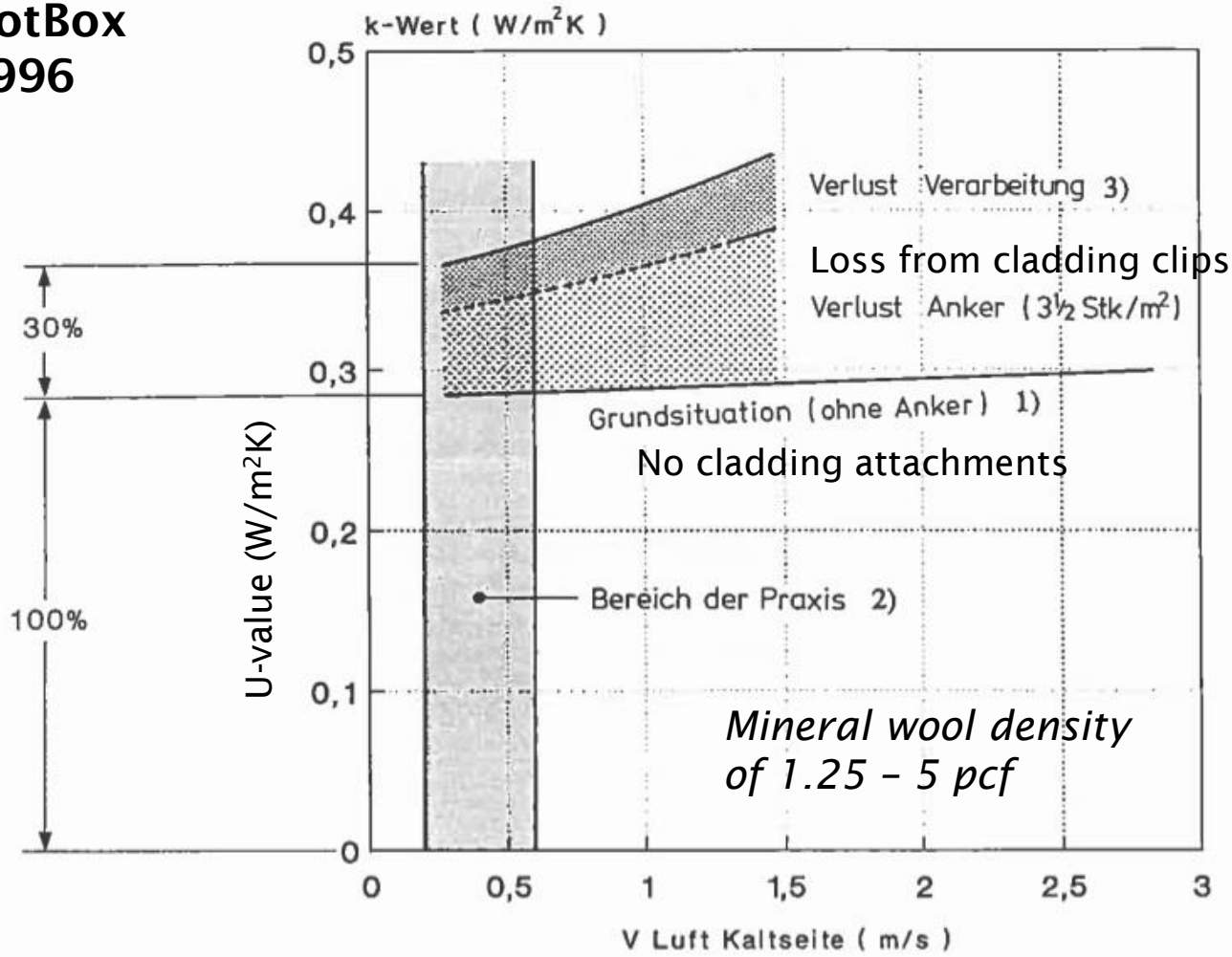


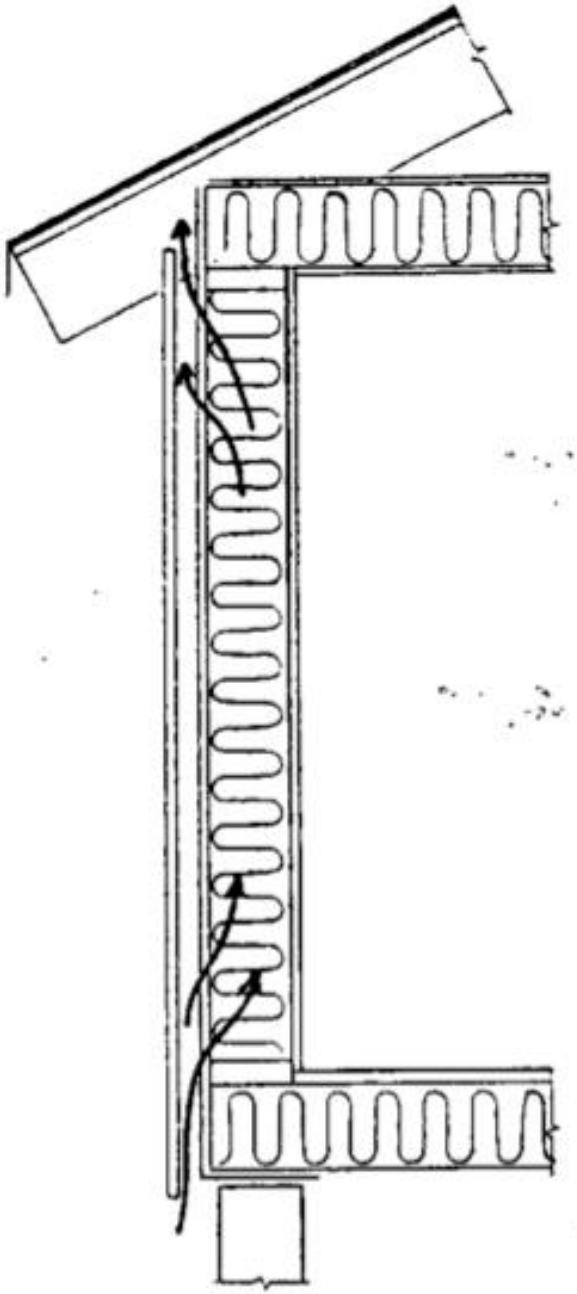
Bild 18

1) 1990 wurden an der EMPA verschiedene k-Wert-Prüfungen an Mineralfaserdämmplatten gemacht, wobei die kaltseitige Luftströmung über die Oberfläche der perfekt versetzten Dämmplatten variiert wurde. Im Bereich der geprüften Rohdichten (20 - 62 kg/m³) hatte die Luftgeschwindigkeit von 0.3 - 1.0 m/s (was den in der Praxis vorkommenden Bereich abdeckt) praktisch keinen Einfluss auf den gemessenen k-Wert.

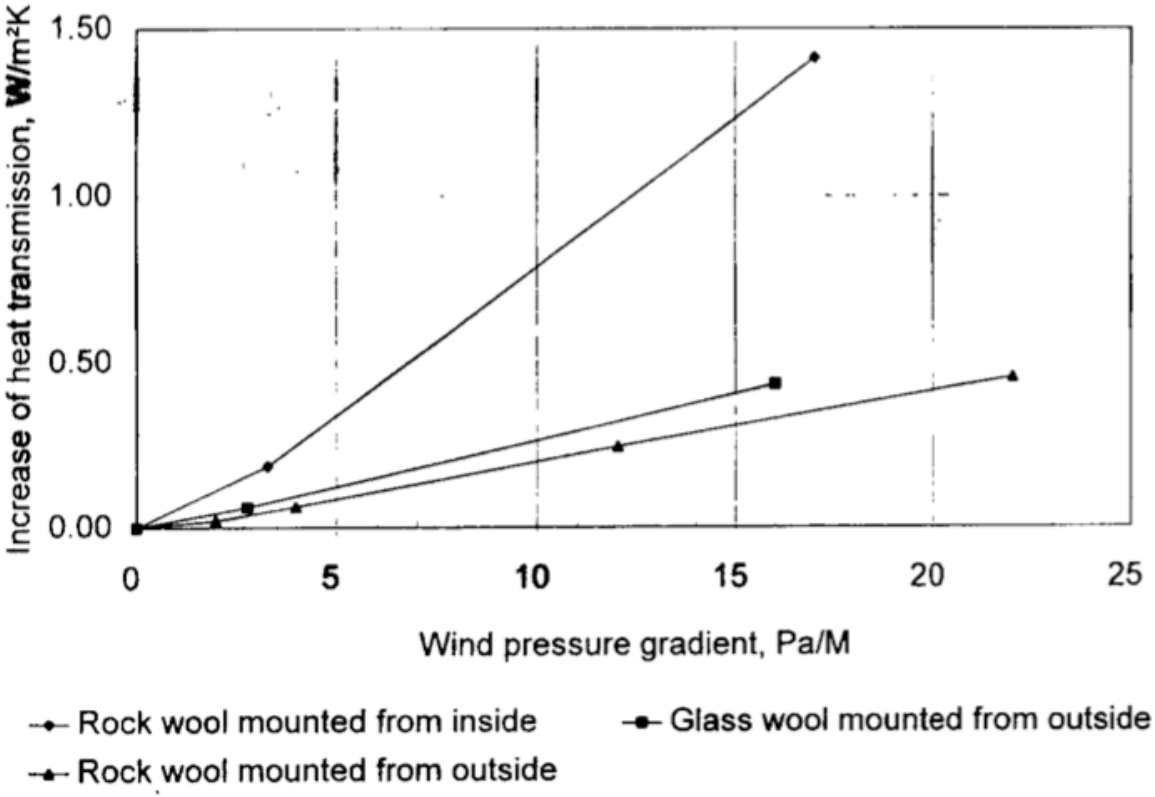
Yarborough and Toor (1983)

- Custom lab test (Guarded hotplate)
- Loose fill fiber insulation (0.8 pcf) at risk
  - 15% reduction at 0.92 m/s
- Higher-density (2.8+pcf) should be OK
  - Almost no impact on cellulose

Uvslokk (1996)



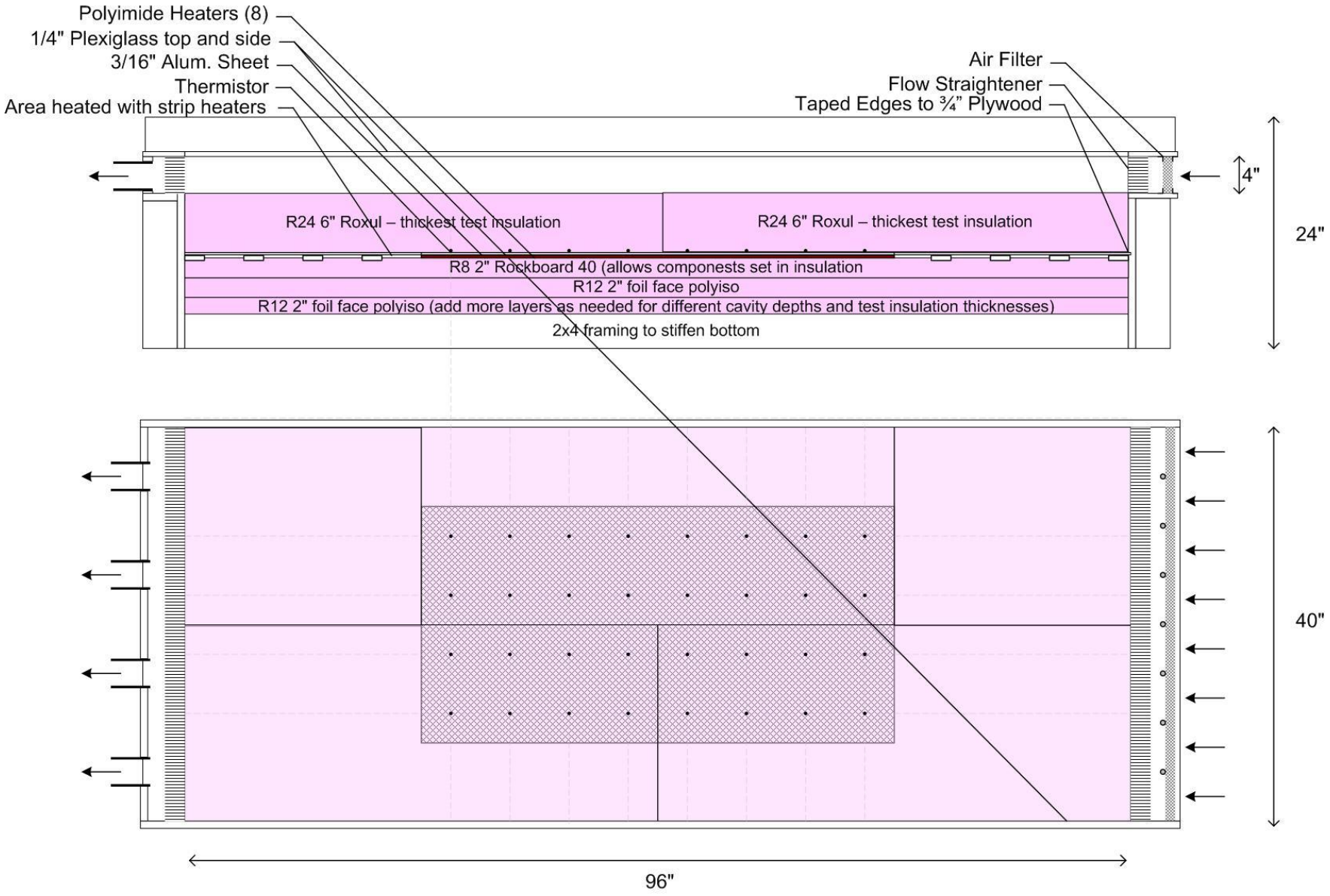
Low-density batt product (22 & 32 kg/m^3)
High pressure gradients = high flow
Low density and poor installation are critical

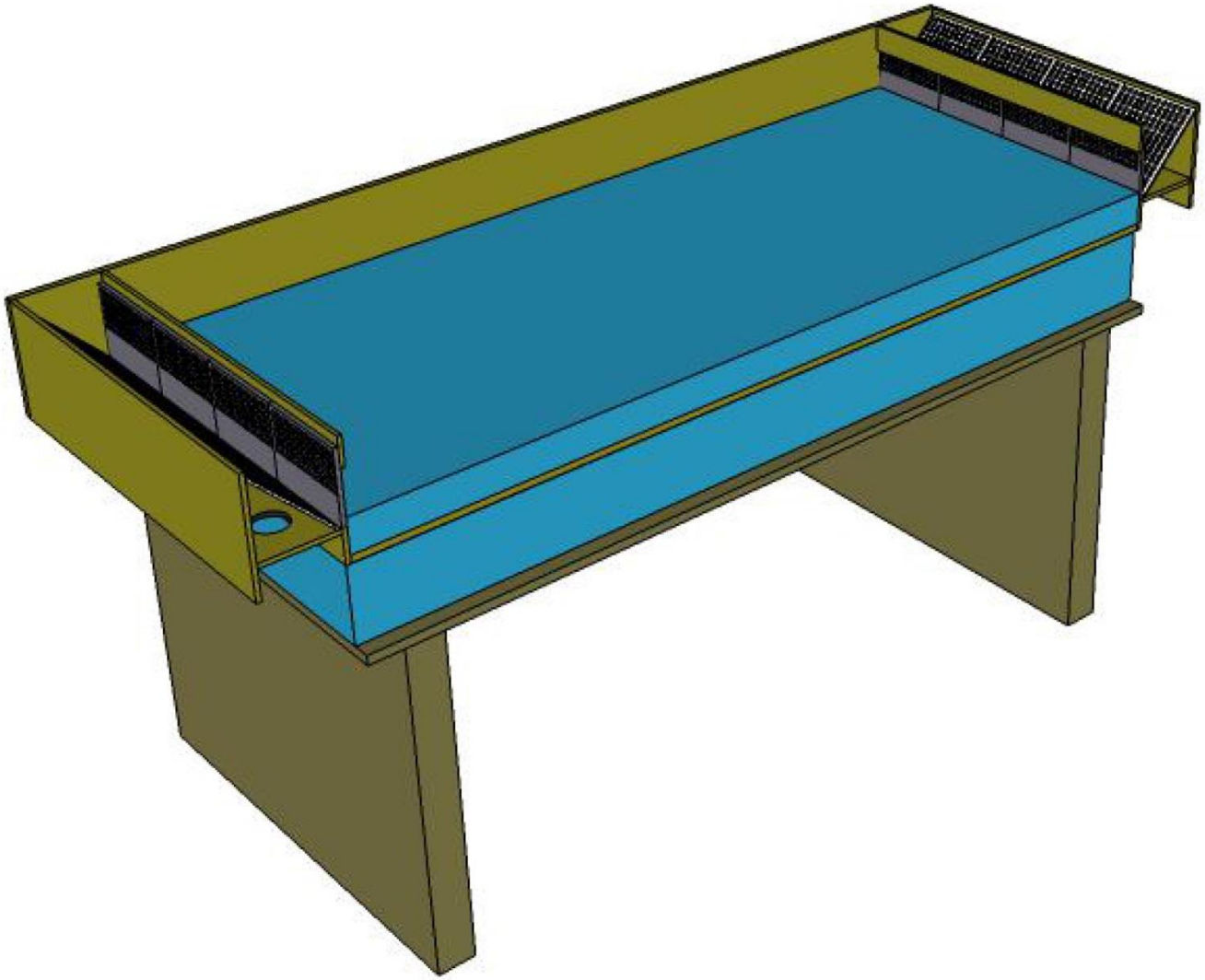


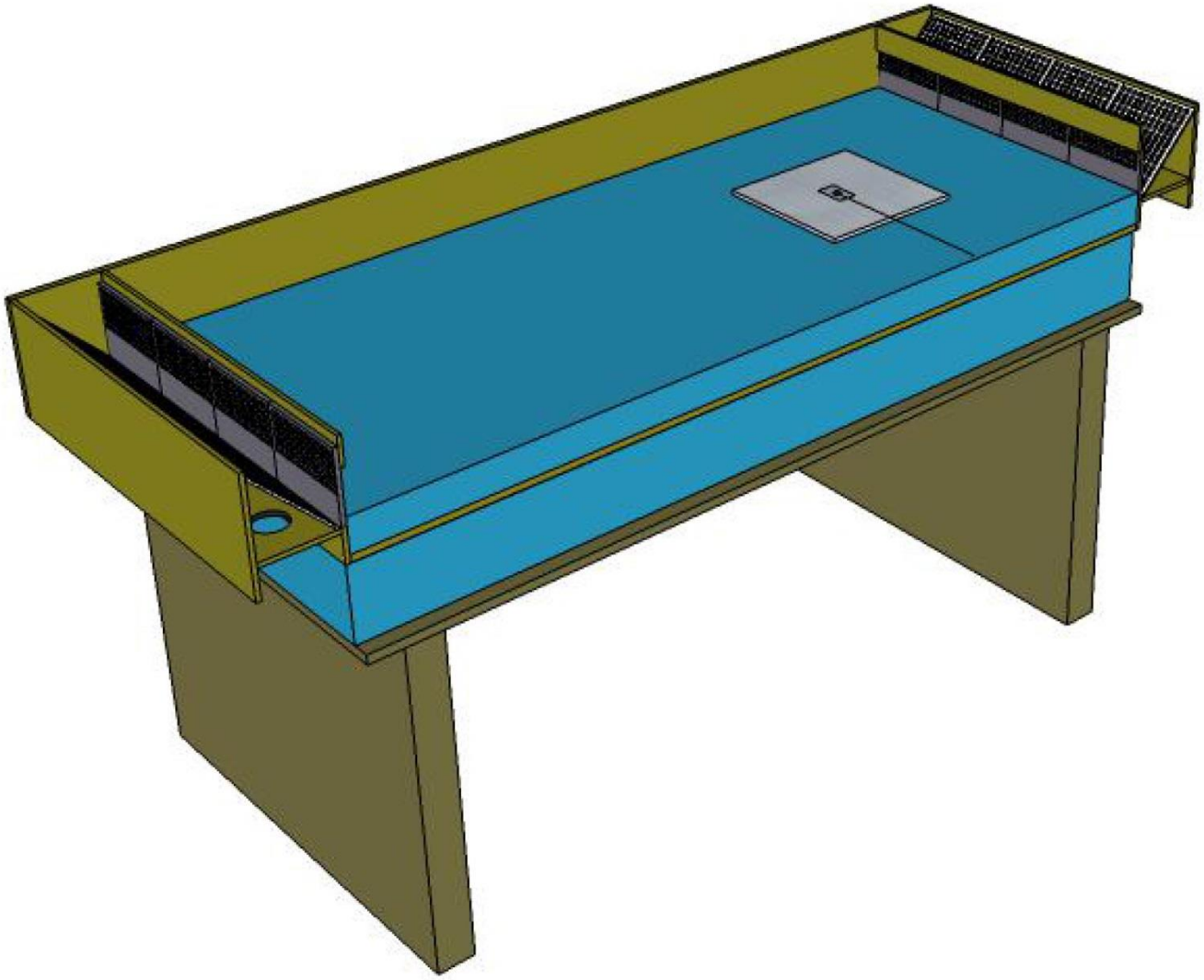
Hens et al 2001

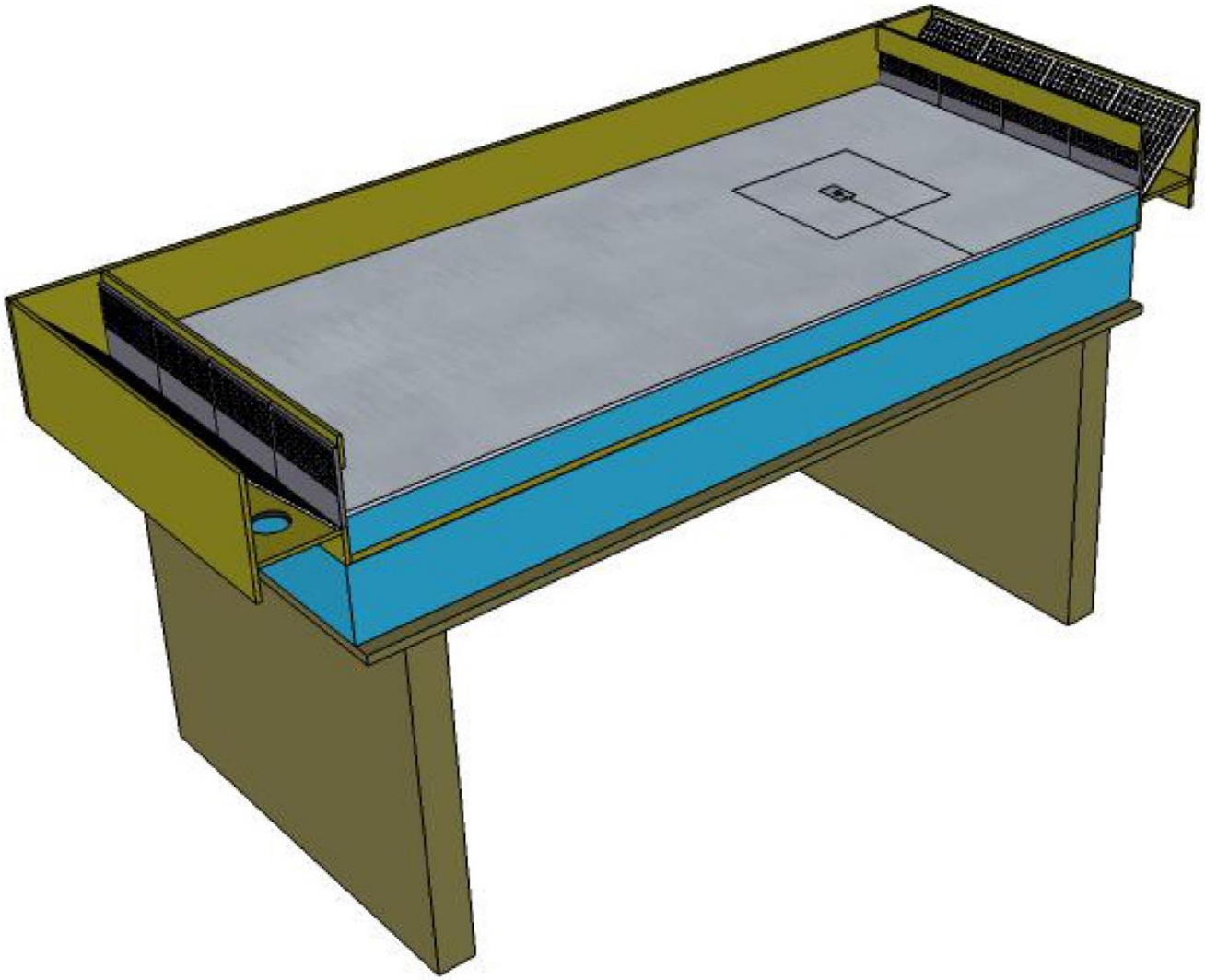
- Extensive Field Testhut study
  - Included poor workmanship and air leakage
  - Measured thermal transmittance over season
  - Masonry walls with brick veneers
- Results
  - Heat loss could more than double with air leakage
  - Convection and windwashing also reduced performance if poor workmanship
  - Properly built walls unaffected

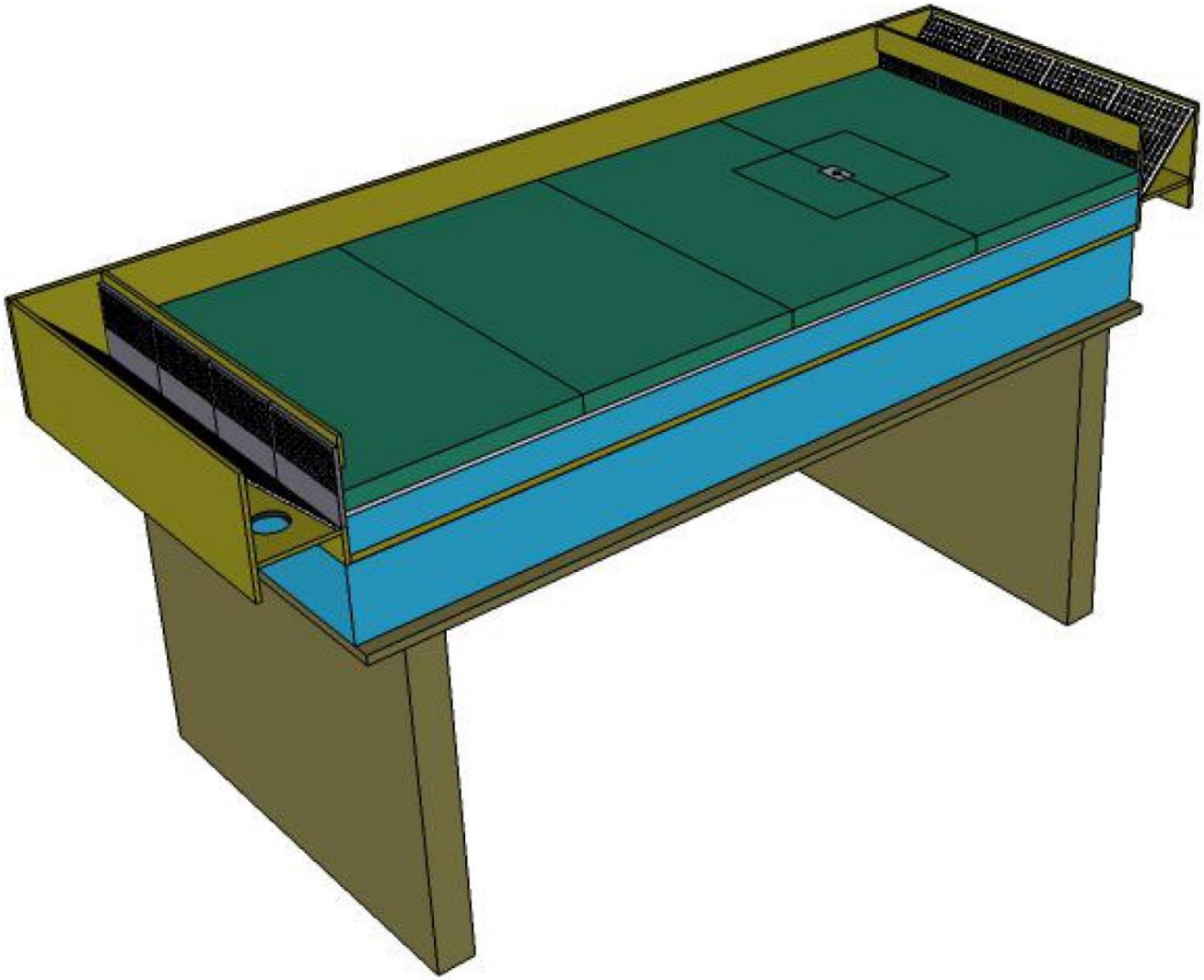
Apparatus

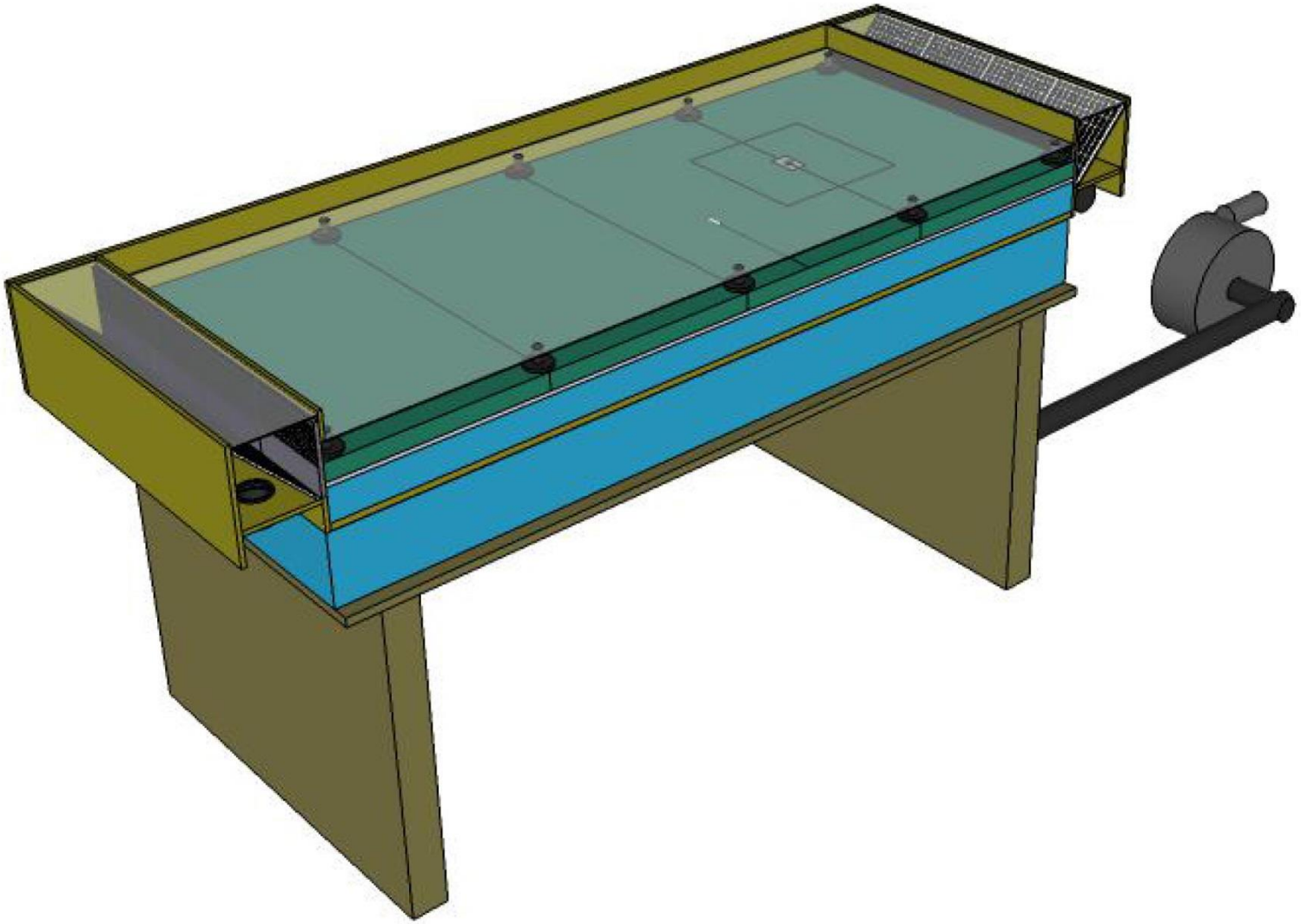

Polyimide Heaters (8)
1/4" Plexiglass top and side
3/16" Alum. Sheet
Thermistor
Area heated with strip heaters
Air Filter
Flow Straightener
Taped Edges to ¾" Plywood
4"
24"
R24 6" Roxul – thickest test insulation
R24 6" Roxul – thickest test insulation
R8 2" Rockboard 40 (allows componests set in insulation
R12 2" foil face polyiso
R12 2" foil face polyiso (add more layers as needed for different cavity depths and test insulation thicknesses)
2x4 framing to stiffen bottom
40"
96"











Apparatus

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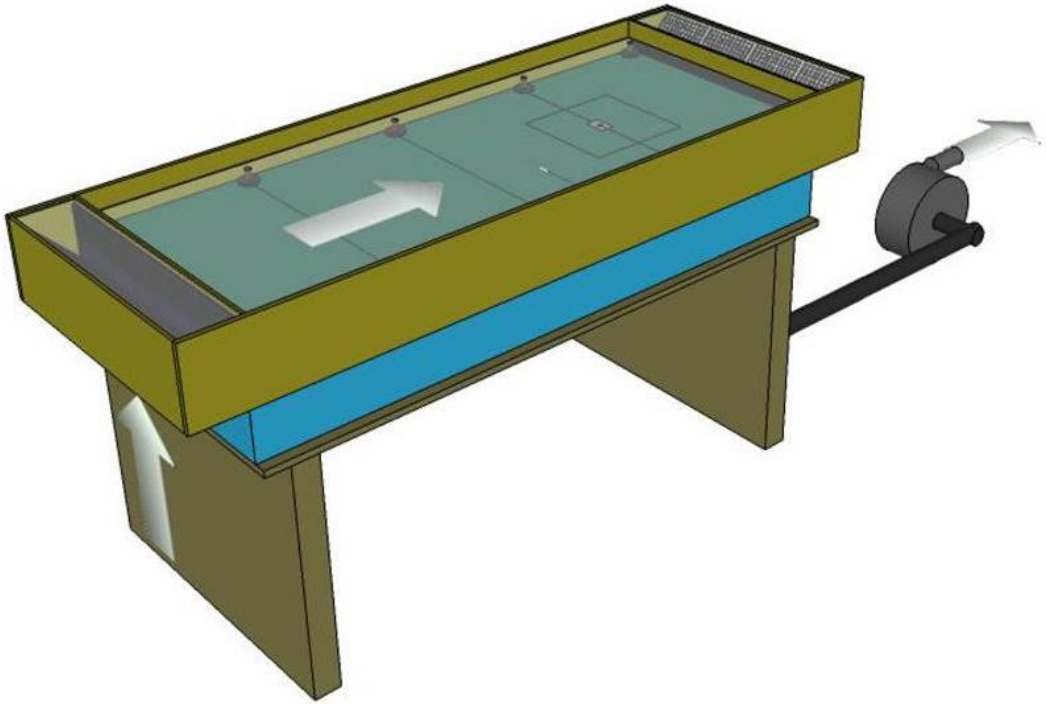
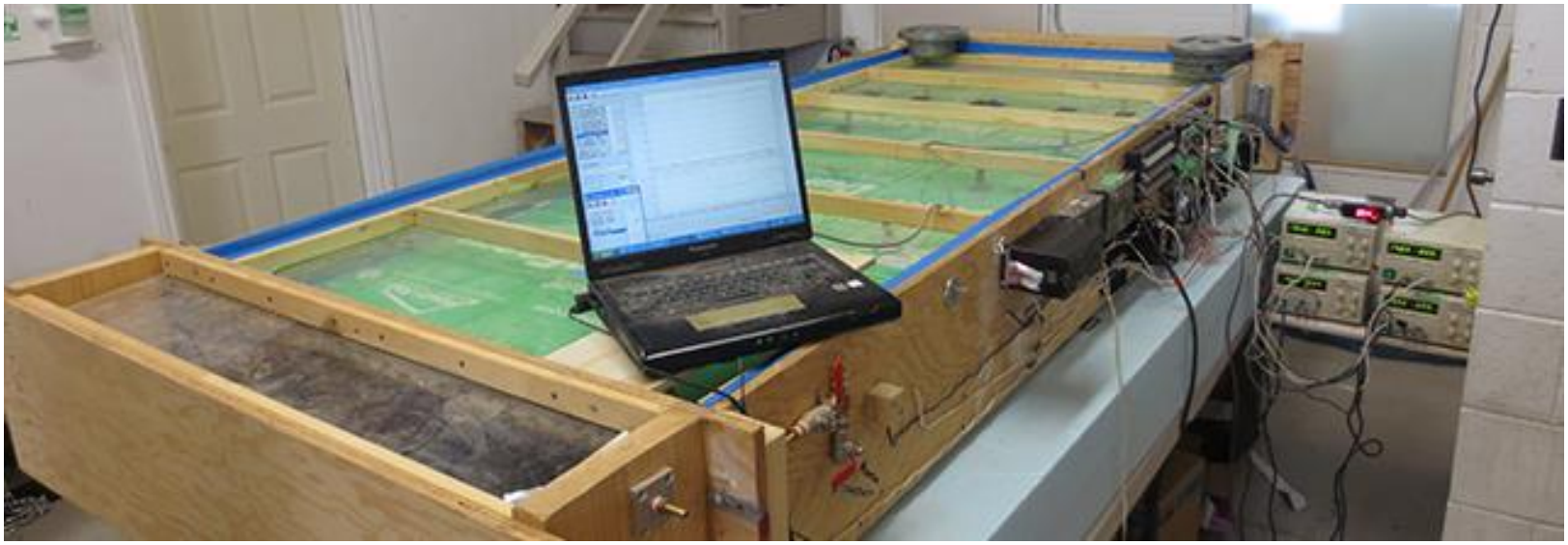
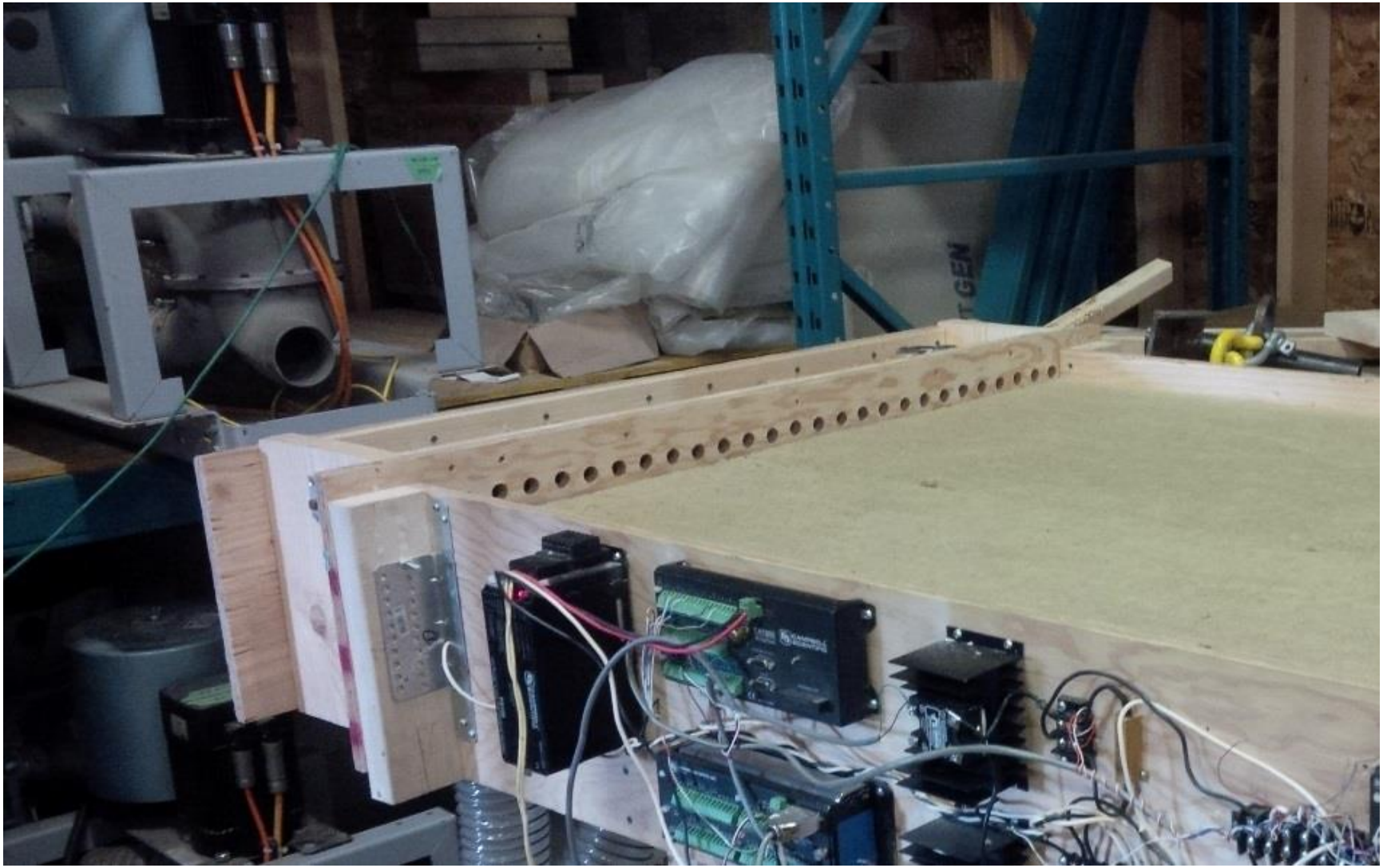


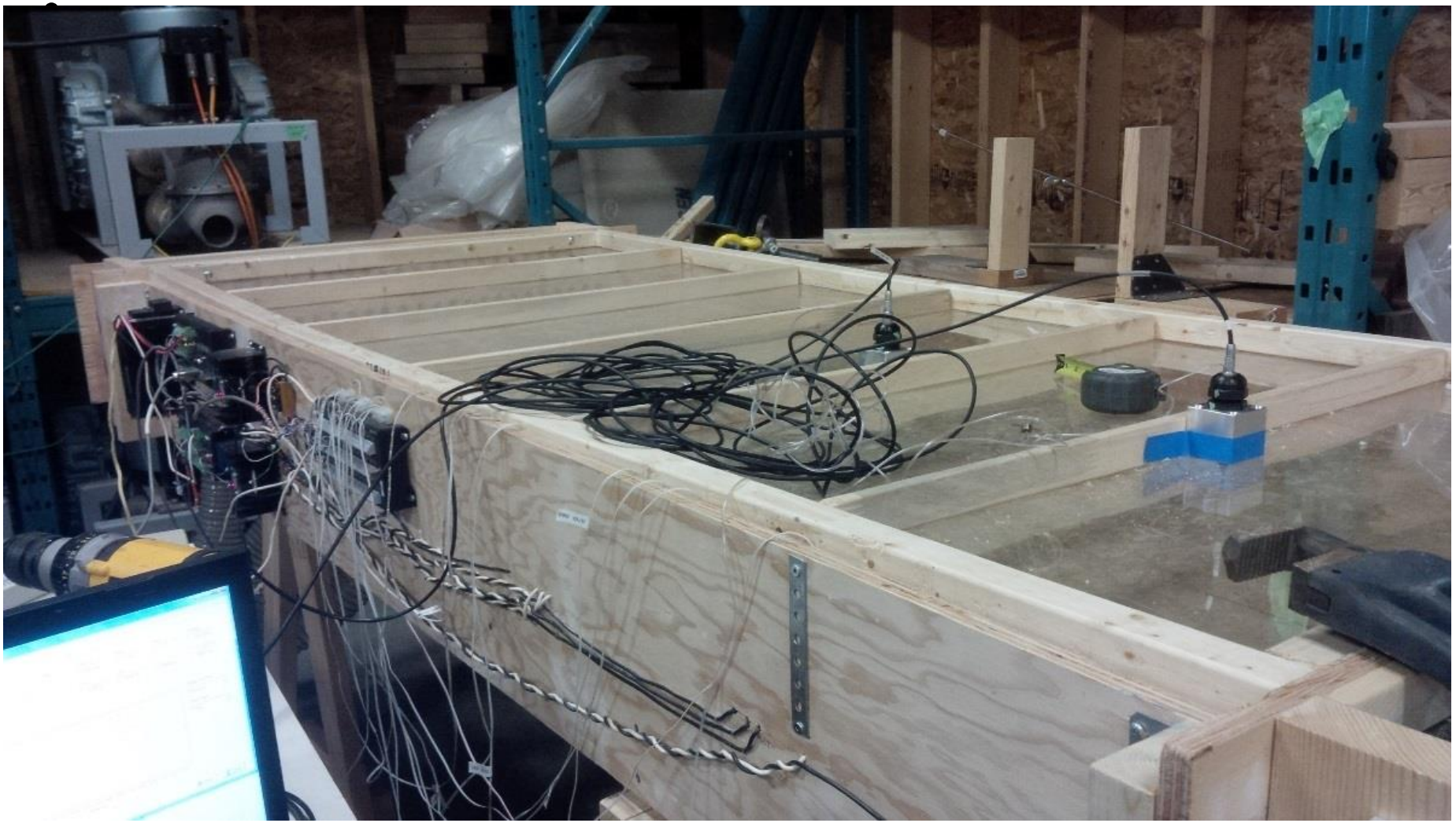


Air Diffuser / Flow Straightener



Temperature of exterior insulation

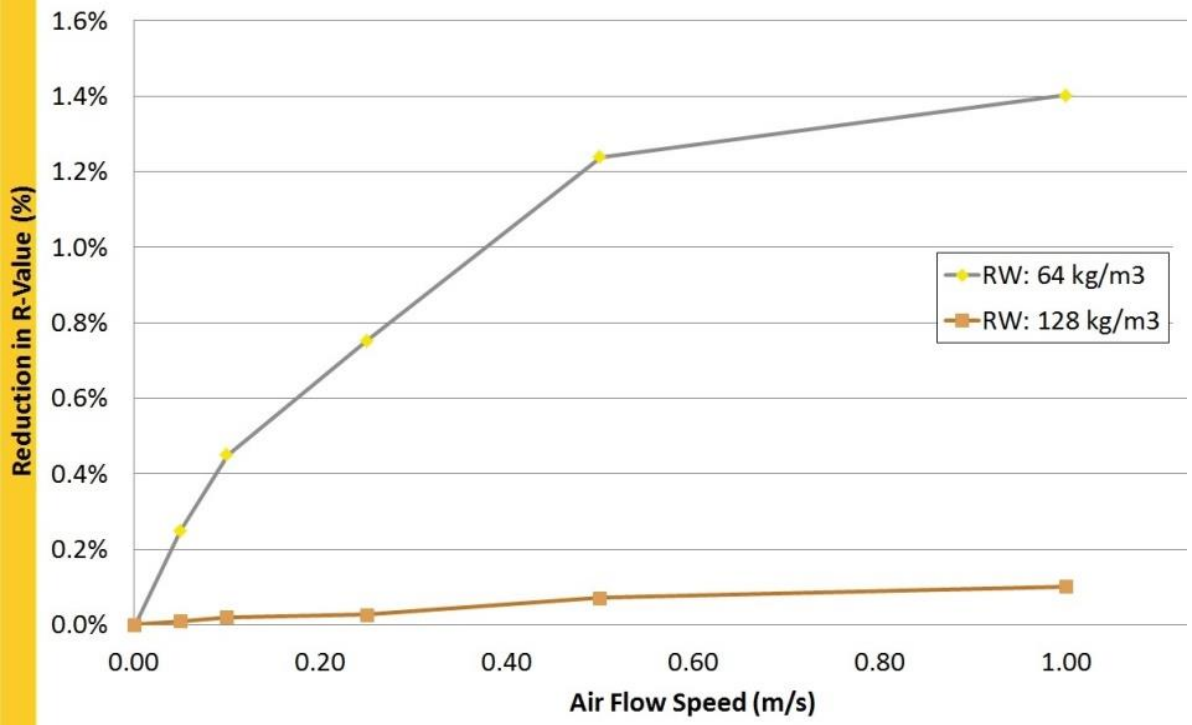
Test Rig w/ lid (cladding)



Velocity sensor @ meter area

Results

4 pcf (48 kg/m³) Stonewool	No Wind		Low wind (0.1) or limited ventilation		High wind (1.0) & well ventilated	
	U-Value W/m2 °C	R-Value hr ft² °F/Btu	U-Value W/m2 °C	R-Value hr ft² °F/Btu	U-Value W/m2 °C	R-value hr ft² °F/Btu
32 mm (1.25")	1.35	4.2	1.35	4.2	1.49	3.8
51 mm (2")	0.68	8.4	0.68	8.4	0.69	8.2
76 mm (3")	0.45	12.6	0.45	12.6	0.46	12.4



Low wind/low venting
- no impact
High (1 m/s) & high vent
- Some impact
-thicker is less affected
9% @1.25"
2.5% @ 2"
1.5% @3"

Conclusions

- Wind washing can increase heat flow
- Pressure gradients over face: 2-20 Pa/m
- Airflow over insulation often 0.01-1.0 m/s
- Most of time / most cladding types
  - 0.01 to 0.1 m/s
- Mid- to high-density fibrous insulations show little impact
  - 0-3% of heat flow
  - Negligible if properly installed