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Experimental test to assess hygrothermal performance of building envelope systems

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Experimental Tests To Assess Hygrothermal Performance of Building Envelope Systems

Prepared by :

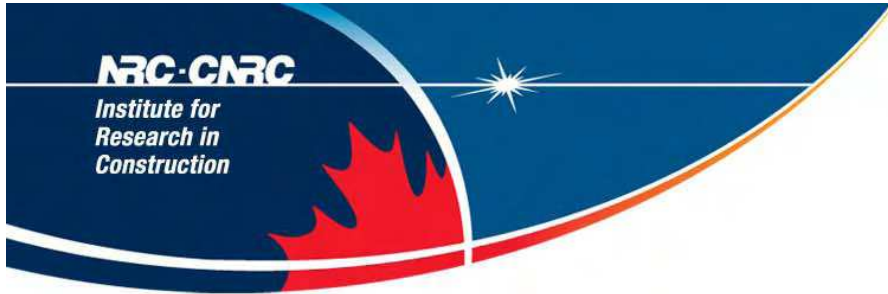
Dr. Wahid Meref, Dr. Michael Lacasse & Madeleine Rousseau

For the
**3rd International Building Physics Conference-
August 27-31, 2006 (Montreal, Qc, Canada)**



National Research
Council Canada

Conseil national
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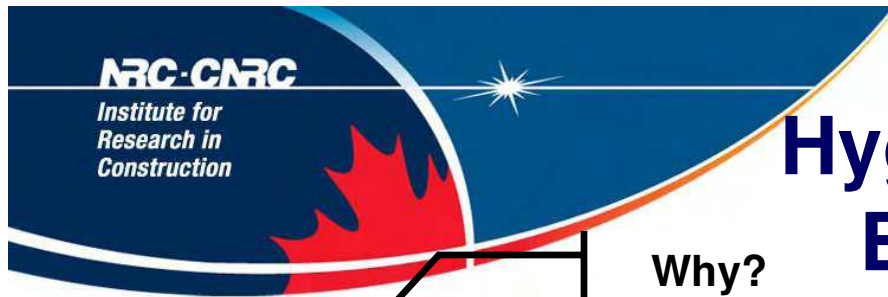
Outline

- Hygrothermal Performance of BES
 - Modeling
 - Field Experiment
 - Laboratory experiments
- Conclusion



Outline

- Hygrothermal Performance of BES
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Hygrothermal Performance of Building Envelope Systems

Why?
How?
Which?
What?

MODELING

(i.e. IRC's HAM Tools
hygIRC 1D & 2D,
WeatherSmart)

FIELD

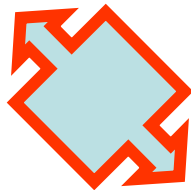
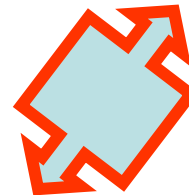
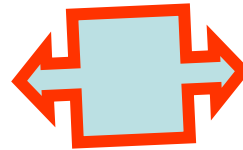
(i.e. IRC RHs, CCHT)

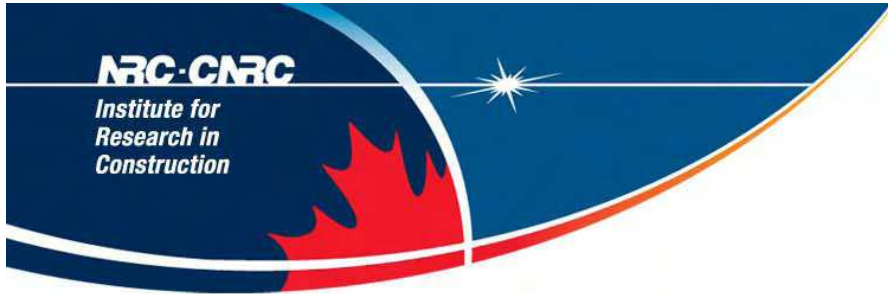
Why?
How?
Which?
What

LABORATORY

(i.e. DWTF, EEEF)

Why?
How?
Which?
What?





Outline

- Hygrothermal Performance of BES
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Modeling

- Why to do modeling?
- How to model?
- Which model to use?
- What do you expect from modeling?



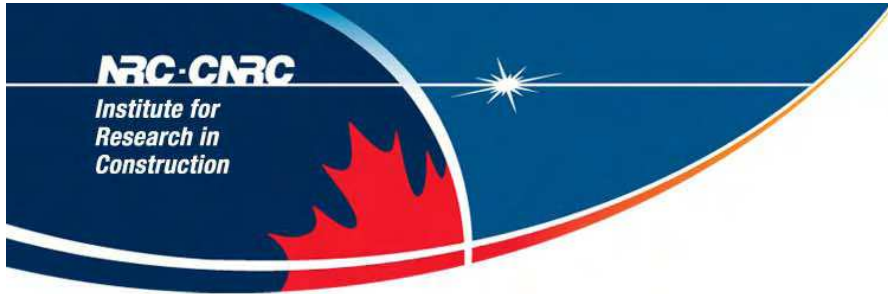
Modeling: IRC's HAM Tools

- *hyglRC* 1-D V. 1.1 is a user-friendly, one-dimensional version of NRC-IRC's *hyglRC*, a state-of-the-art hygrothermal model.
 - ❑ 1-D *hyglRC* can be used for
 - parametric analysis: changing weather (locations), materials, for example
- For more information please visit *hyglRC* Website:
http://irc.nrc-cnrc.gc.ca/bes/software/hyglRC/index_e.html
- *hyglRC* 2D is the Advanced hygrothermal models
 - ❑ Best handled by *hyglRC* 2-D
 - air leakage
 - water leaks
 - gravity effects
 - *WeatherSmart*



Outline

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Field Experiments

- Why to do field experiment?
- How to do experiment?
- Which physical phenomena to investigate,..?
- What do you expect from experiments?



Field Experiments

- IRC's Research Houses:
 - Research House #3 (IE/BES)
 - CCHT
 - Roof Top Garden, etc.

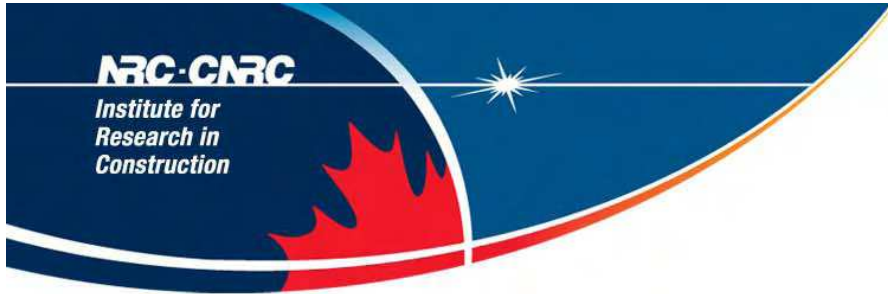




IRC Field Exposure of Wall Facility (FEWF)



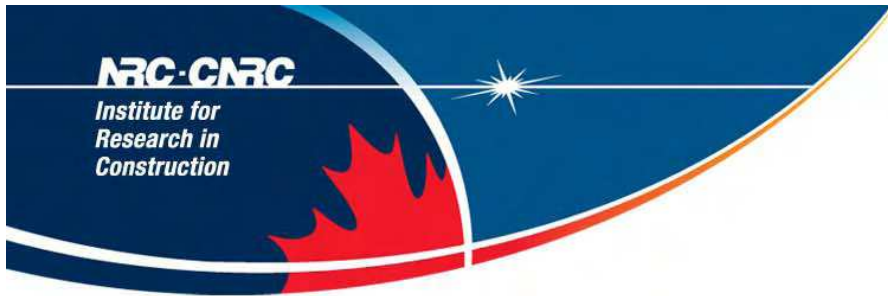
- **Background**
- **Objectives**
 - Compare performance of different side-by-side wall assemblies
 - improve understanding of HAM response of wall and window assemblies exposed to naturally occurring climate loads of Ottawa as well as to indoor environment loads of T, RH and P defined by occupancy and HVAC systems.
 - Research the interaction between the building envelope and the indoor environment
 - Complement IRC's controlled laboratory test and modeling simulations



IRC Field Exposure of Wall Facility (FEWF)

- **Window Monitoring Objectives:**

- The cold weather monitoring will examine the potential for condensation and possibly mould growth at several locations of the windows and the wall adjacent to it, with blinds open and with blinds closed, and that for three orientations:
 - ☐ • Glass edge
 - ☐ • Window frame
 - ☐ • Indoor sill shelf
 - ☐ • Wall/window interface
 - ☐ • Drywall at thermal bridges and dead air pockets



IRC Field Exposure of Wall Facility (FEWF)

Windows Characteristics

- Triple glazed
- Double low-e coatings
- Argon-filled
- Insulating spacer
- Fiberglass box frame
- Combination of fixed and casement sashes



IRC Field Exposure of Wall Facility (FEWF)

- **Experimental Approach**

- **Year 1 (2006-2007)** Commission the facility by monitoring three identical test specimens of traditional construction (2x6) through Fall, Winter and Spring.
- **Year 2 (2006-2007)** Investigate the performance of two to three wall specimens of different innovative designs based on industrial collaboration/partnership.
- **Year 3 and beyond** Expand the program in collaboration with Indoor Environment to examine whole house performance issues.



South facade



Inst
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North facade



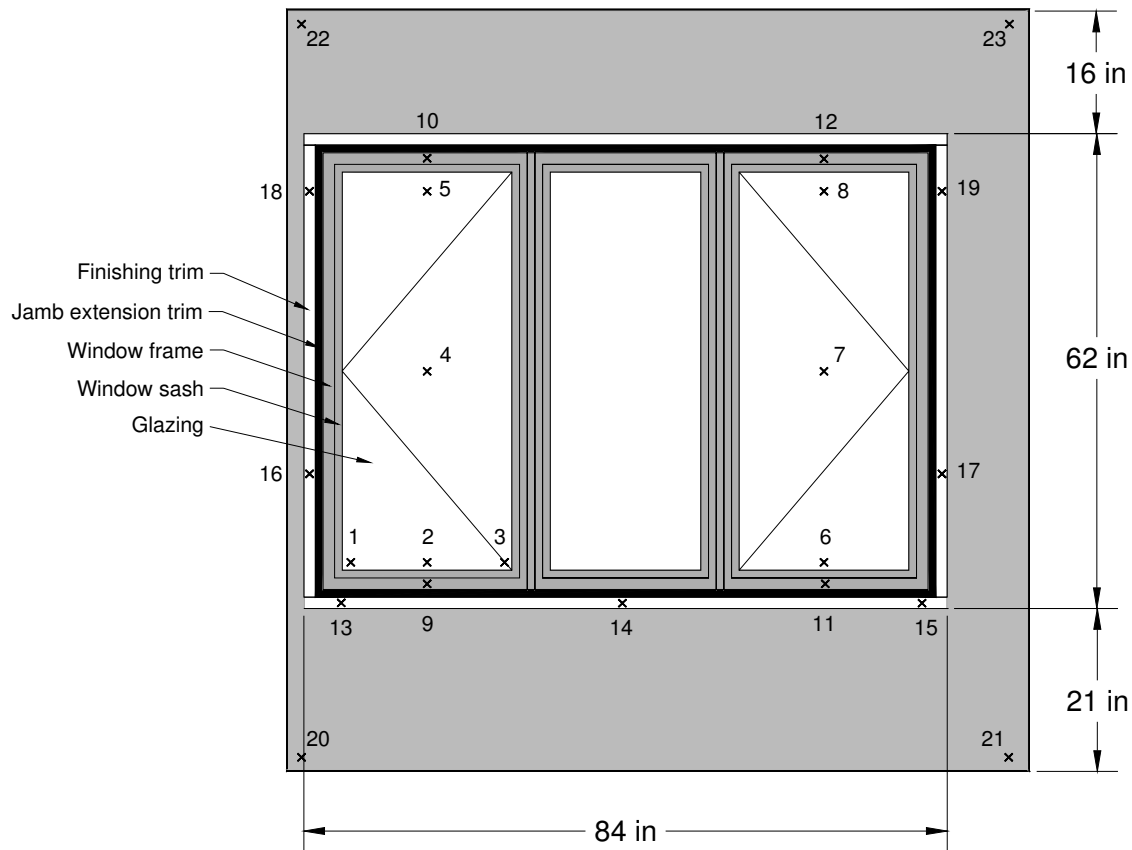
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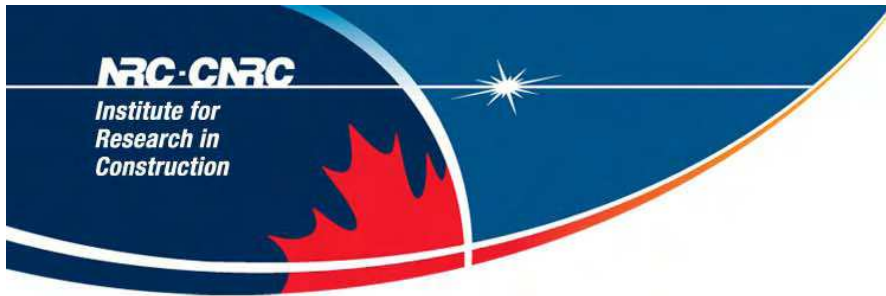
West facade



IRC Field Exposure of Wall Facility (FEWF)



Window Monitoring

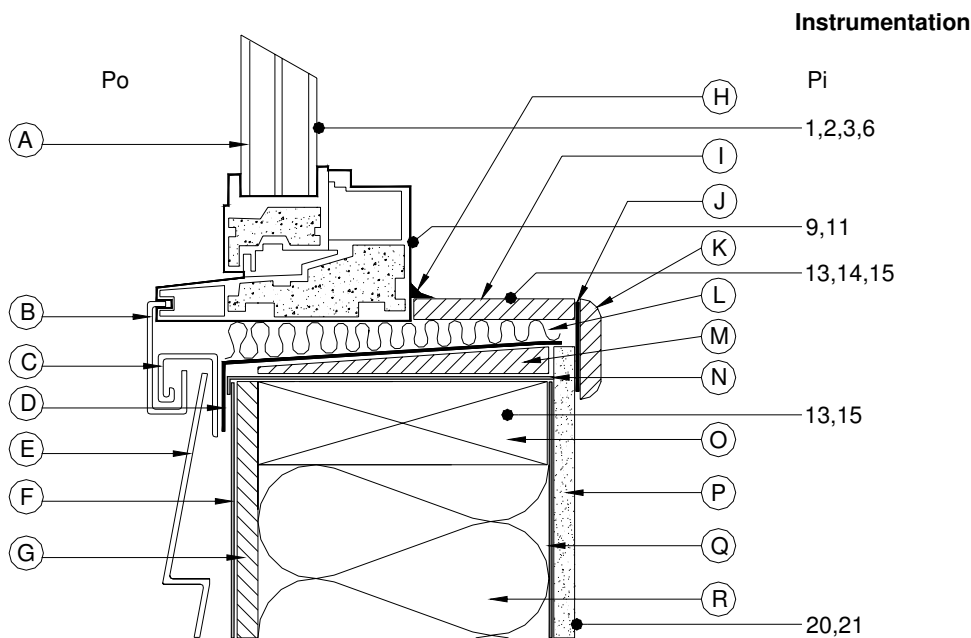


IRC Field Exposure of Wall Facility (FEWF)

Exterior

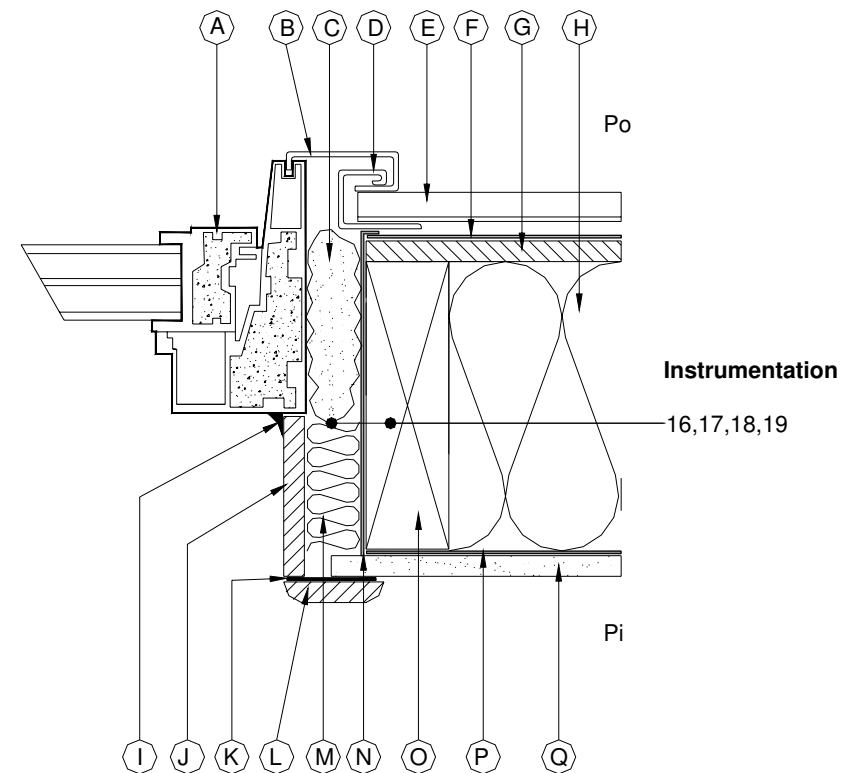
Exterior

Interior



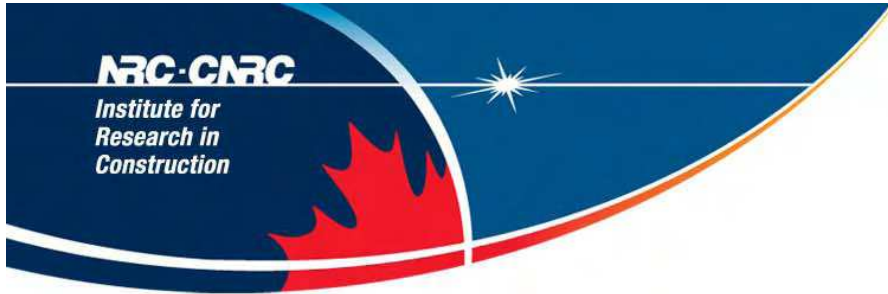
Sill Detail

Window Monitoring



Interior

Jamb Detail



IRC Field Exposure of Wall Facility (FEWF)



West facade

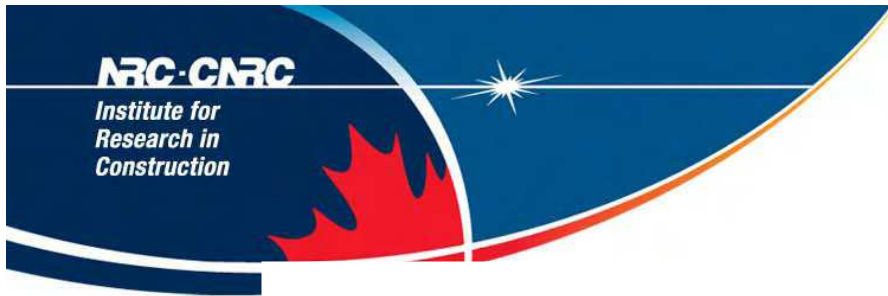
IRC Field Exposure of Wall Facility (FEWF)



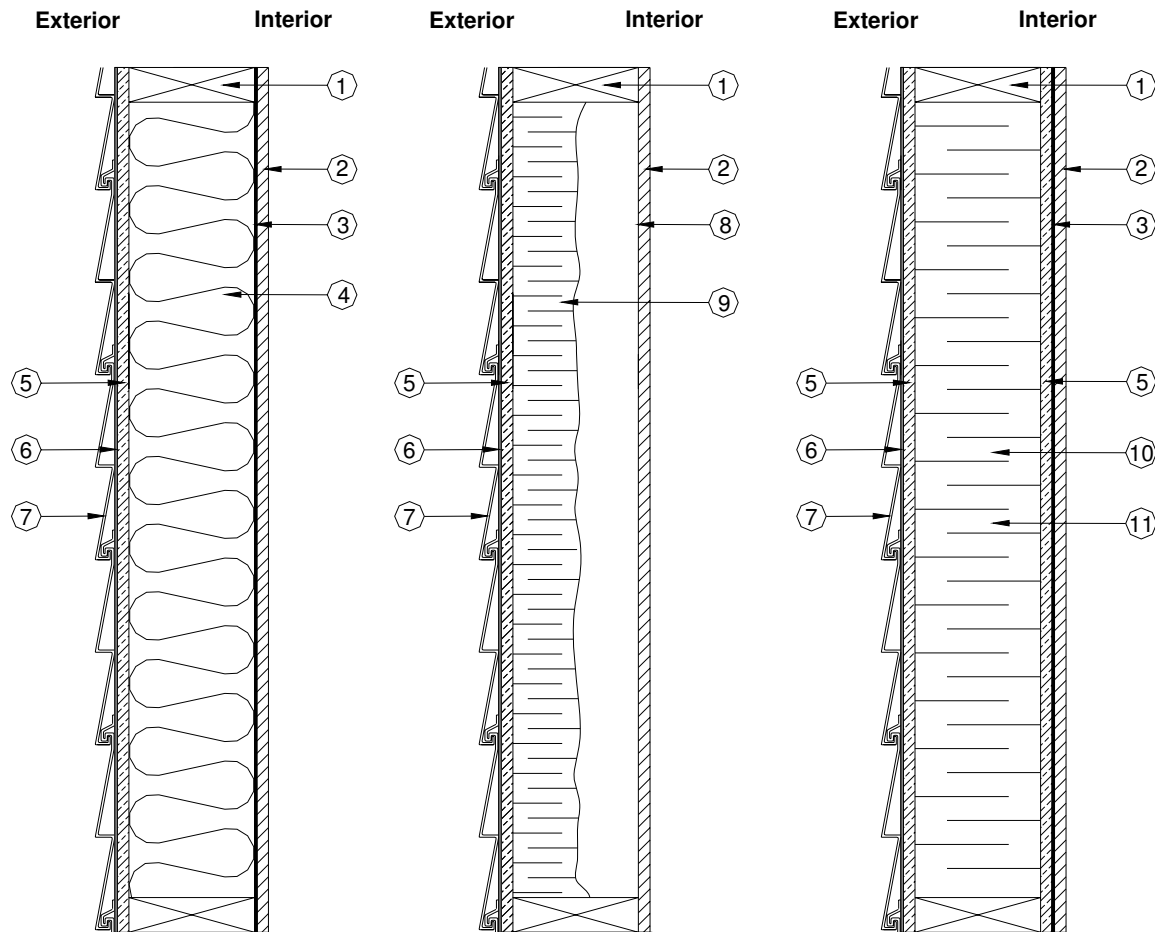
IRC Field Exposure of Wall Facility (FEWF)



Test bay



IRC Field Exposure of Wall Facility (FEWF)



Wall Cross-Section #1

Wall Cross-Section #2

Wall Cross-Section #3

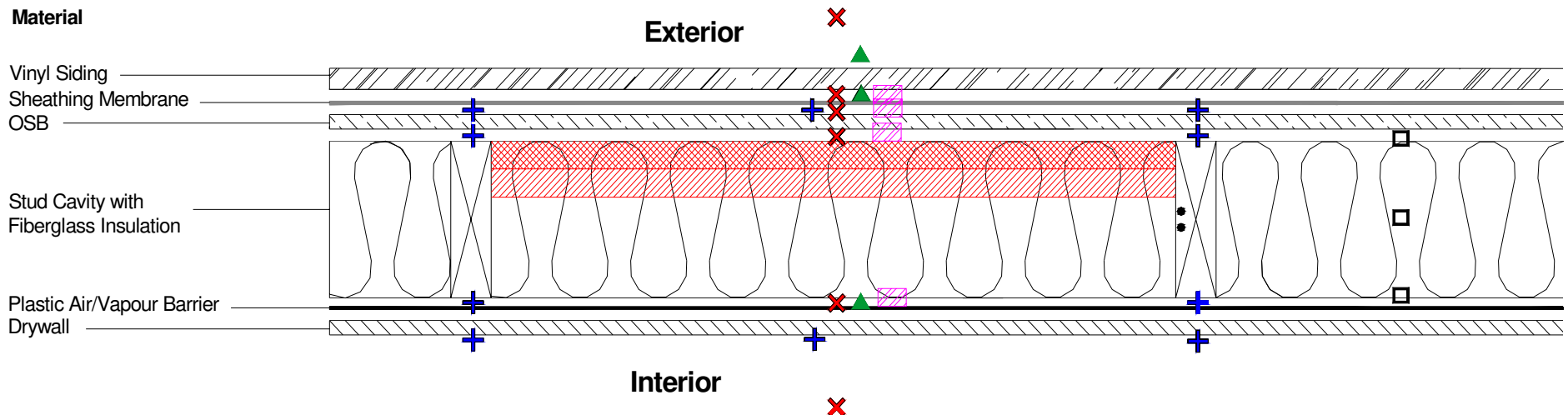
Traditional/Reference

PUF

SIP

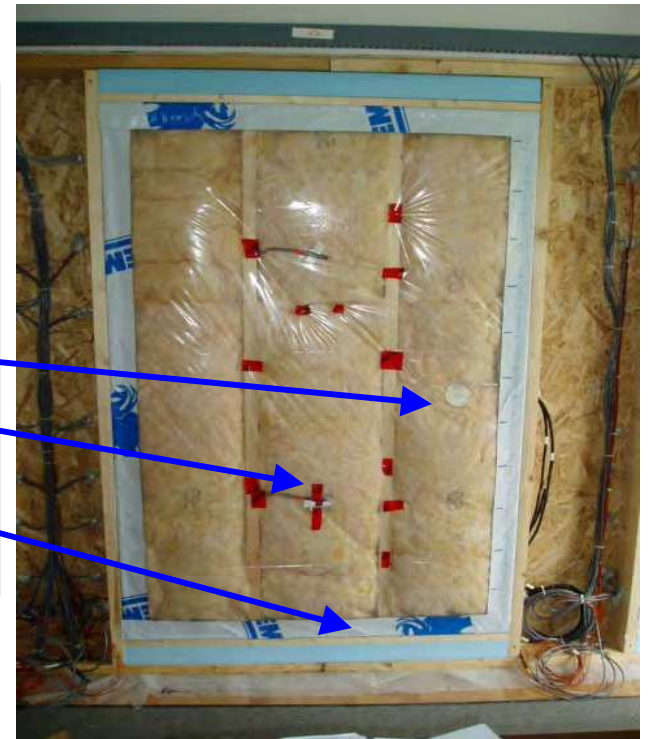
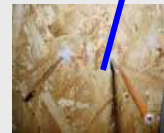
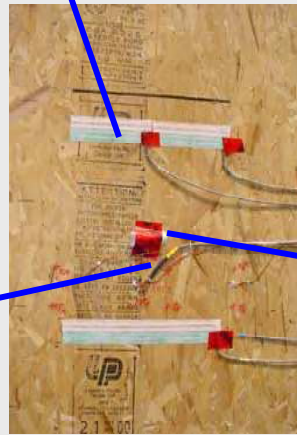


IRC Field Exposure of Wall Facility (FEWF)



Instrumentation - Plan View

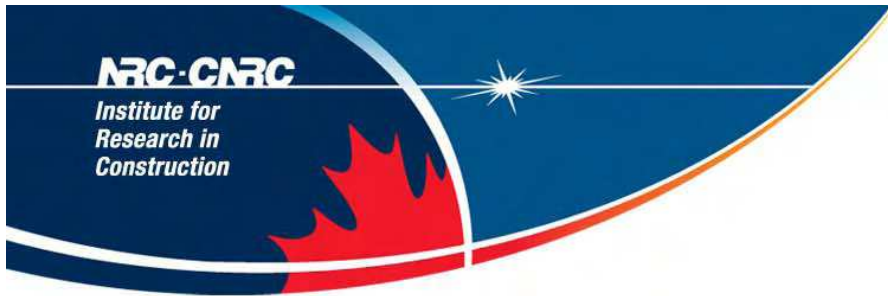
- ✕ RH and T sensors
- ✚ T sensors
- ▲ Air Pressure sensor
- Moisture Pins
- ▨ Jeld-Wen Wireless RH&T Sensors
- Heat Flux Transducer (for W2 only)
- ▨ DETEC





Outline

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 - Field Experiment
 - **Laboratory experiments**
- Conclusion

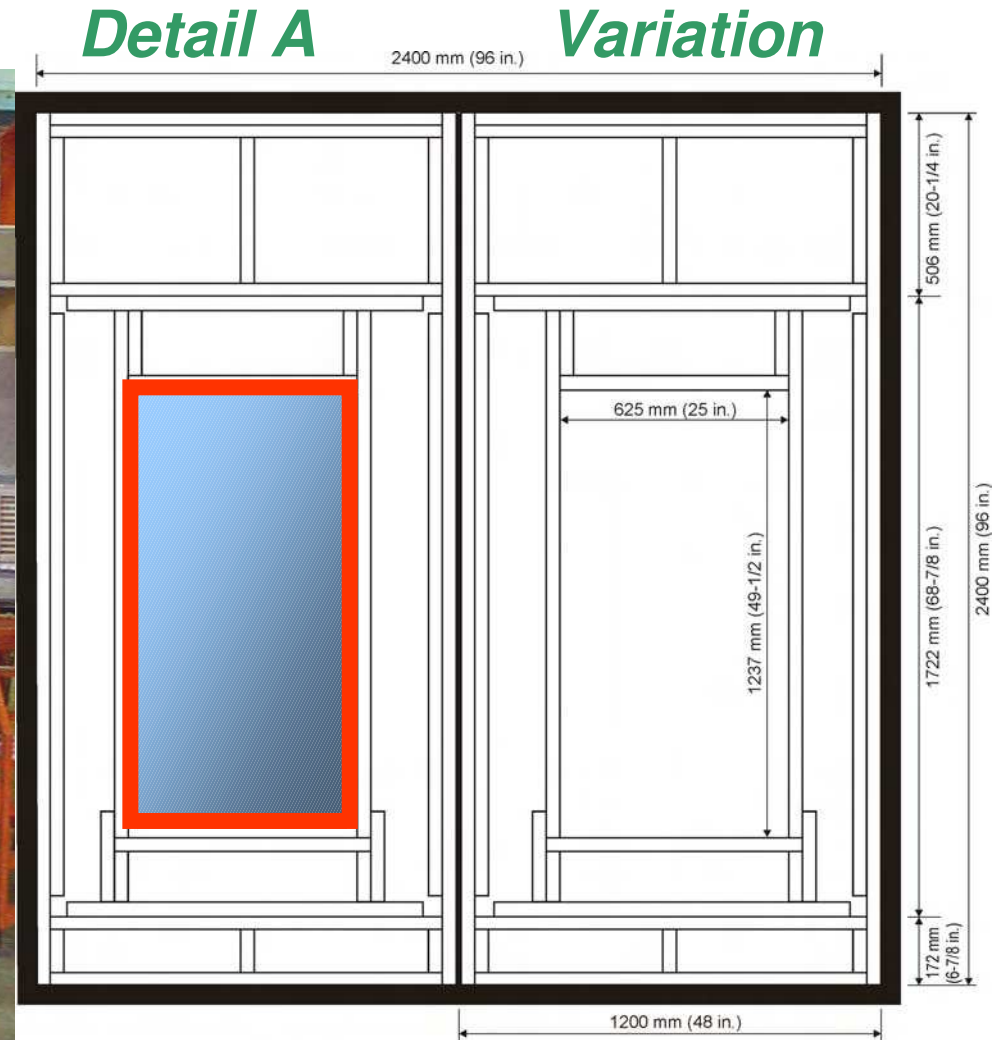


Laboratory Experiments

- Why to do lab experiments?
- How to do experiment?
- Which physical phenomena to investigate,..?
- What do you expect from experiments?

IRC Laboratory Experiments- Test Specimen in DWTF

- *Develop procedures to assess rainwater ingress*
- *Evaluate specific window-wall interface details to determine how effective they manage rainwater intrusion*



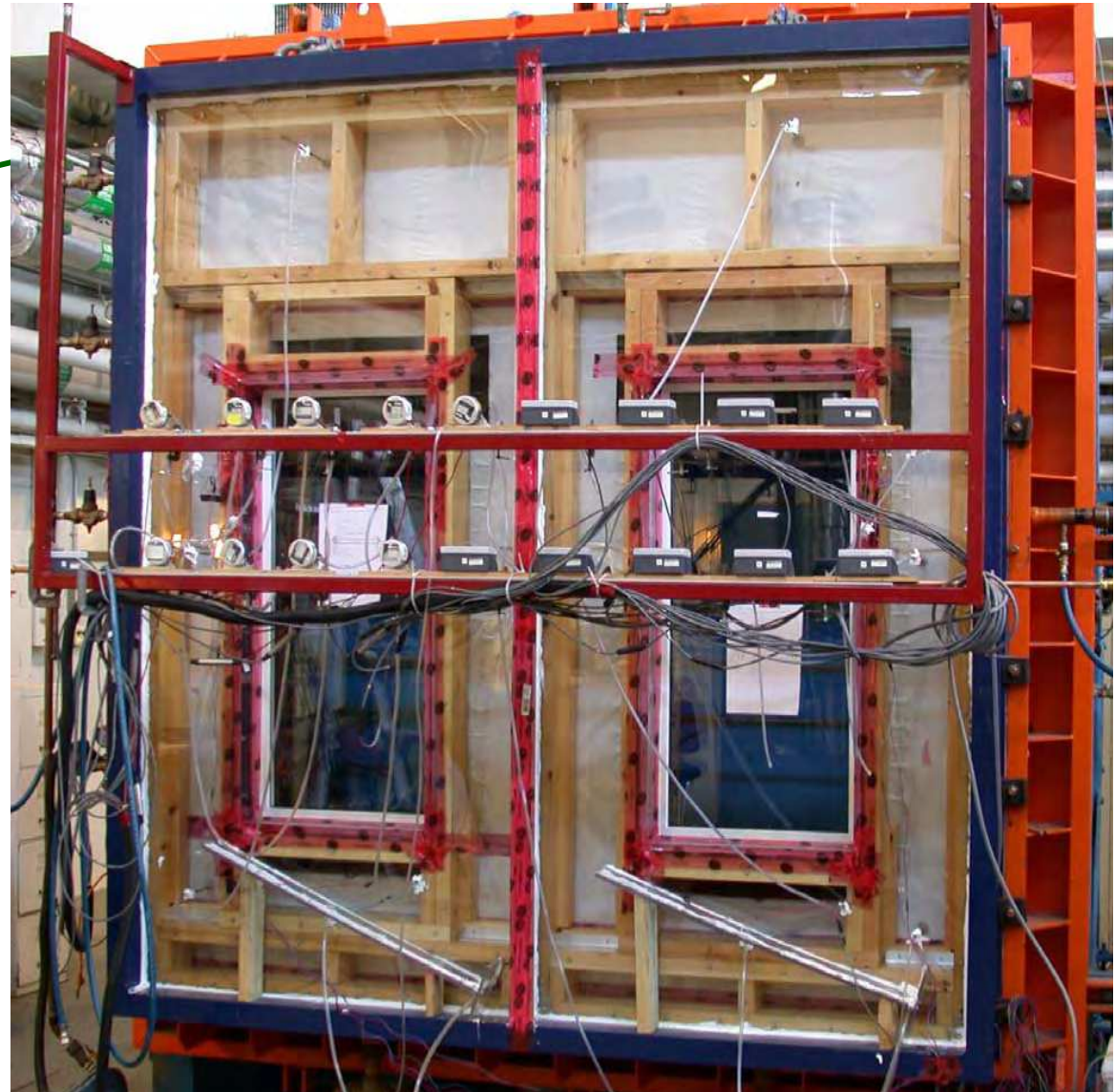
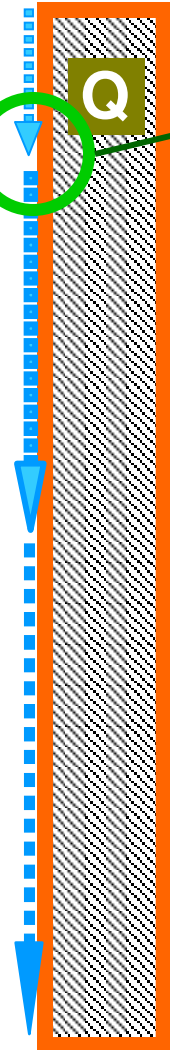
Elevation view of the test frame

IRC Laboratory Experiments - Test Specimen in DWTF

Water Spray

$\pm \Delta P$ Pressure Difference

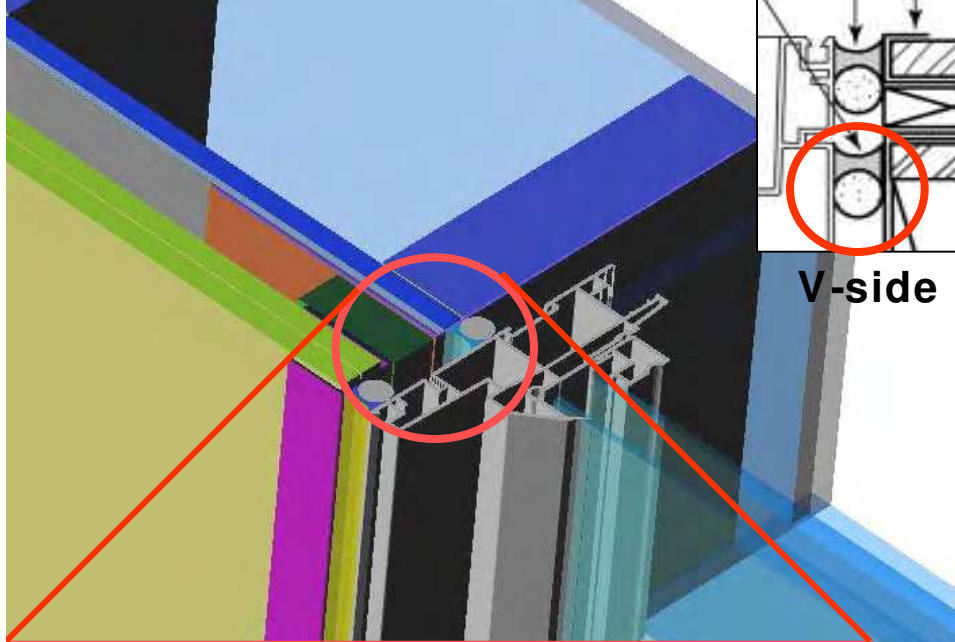
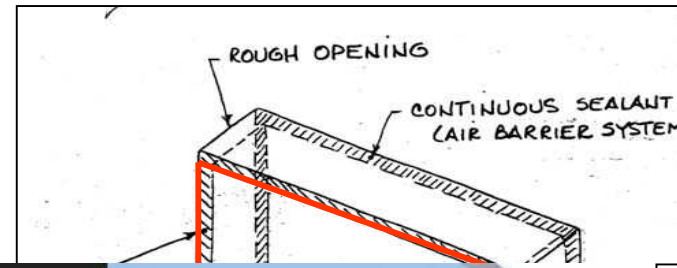
- **Test conditions representative of North American climate conditions**
- **Test Pressures:**
Range between 0-700 Pa
- **Spray rates:**
 - 0.8 to 3.4 L/min.-m²
- **Wall system air leakage:**
 - 0.3 to 0.8 L/s-m² at 75 Pa



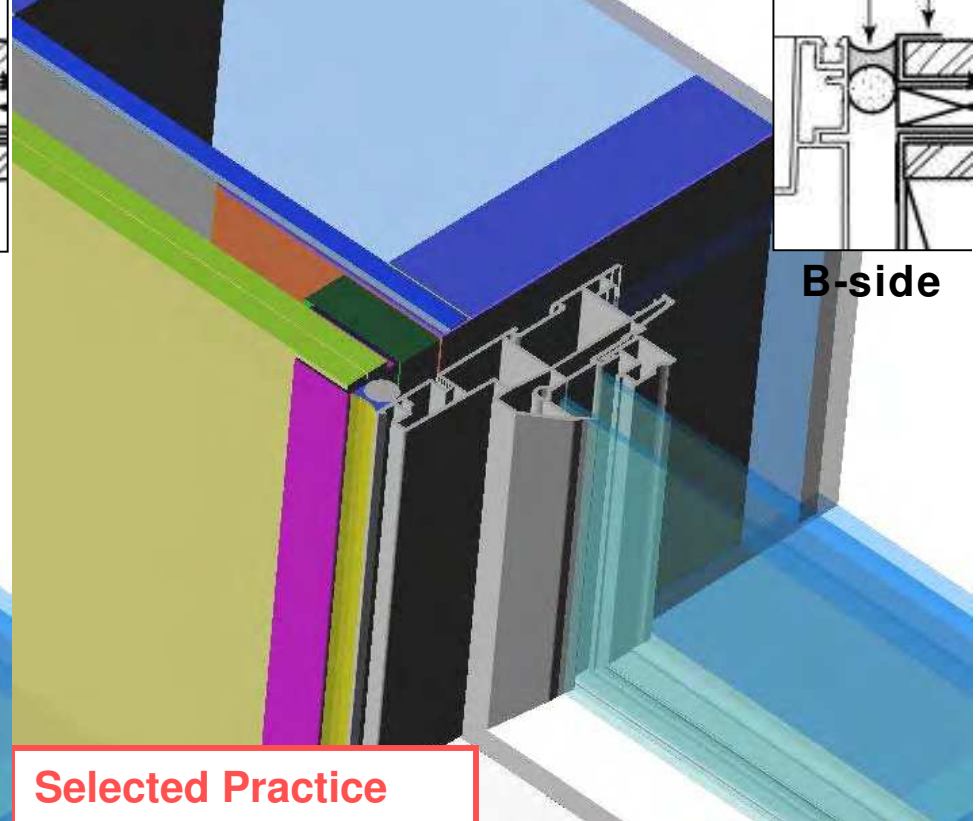
NRC-CIRC

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Research in
Construction

IRC Laboratory Experiments - Specimen Details



V-side



B-side

Variation (V-side)
Caulking and backer rod between
window frame and rough opening

Selected Practice

Location of Deficiencies



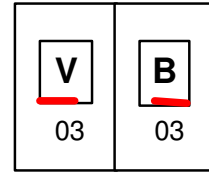
Saw cut in cladding

**Deficiencies in sealant
bead and backer
rod between window
frame and siding**

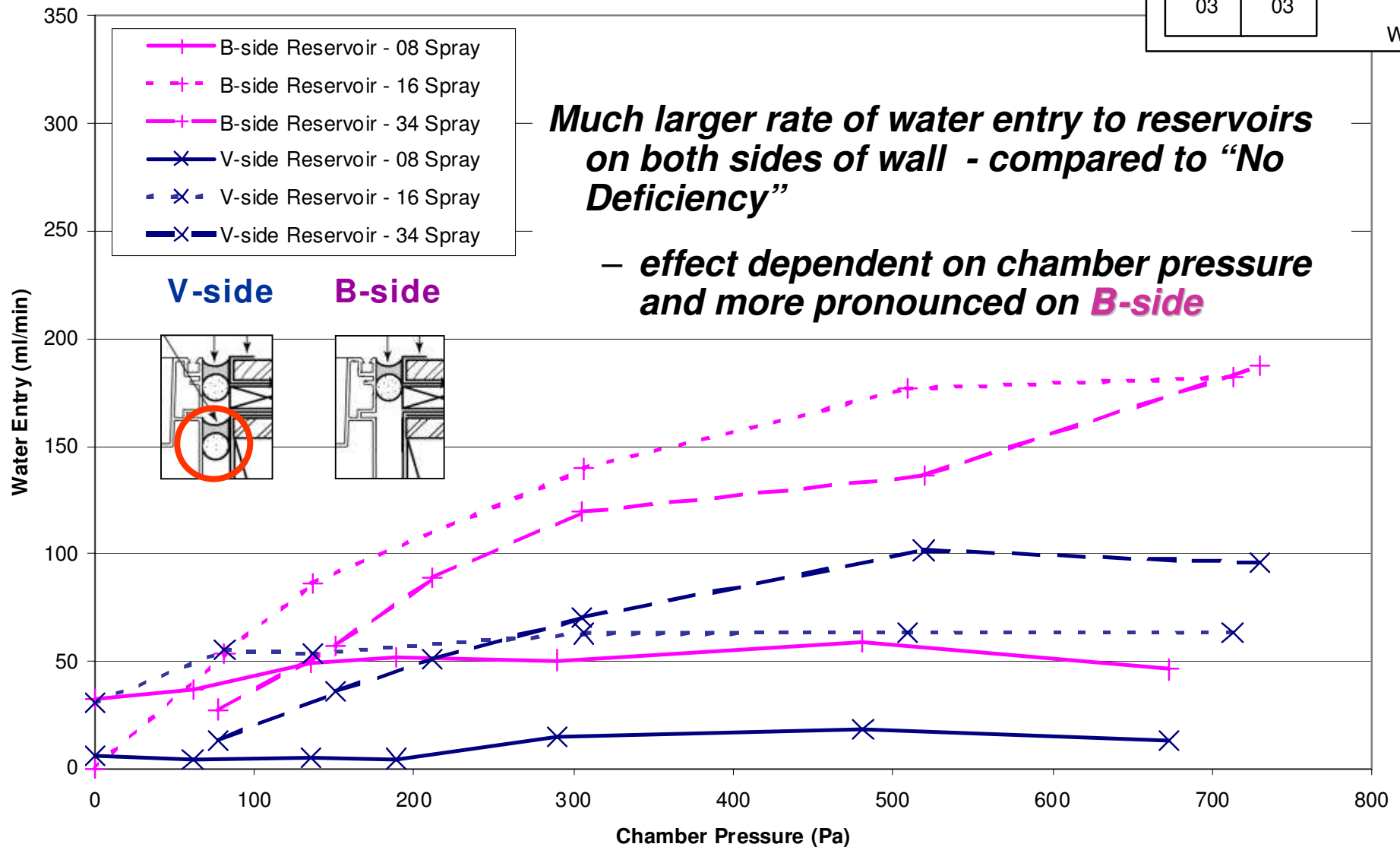
W1

Laboratory - Water Management + Deficiency

Reservoir Water Entry - 03 ABS

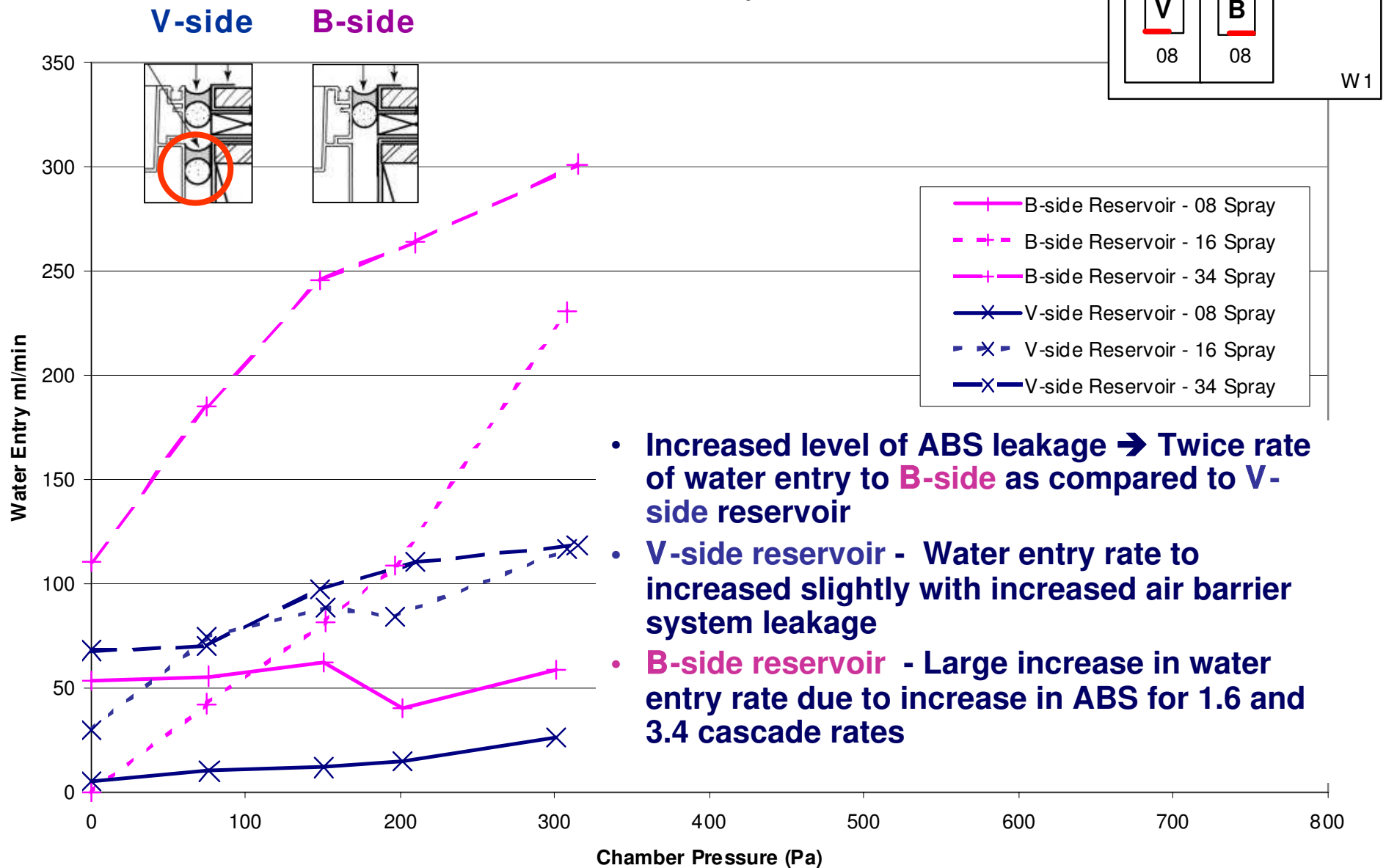


W1



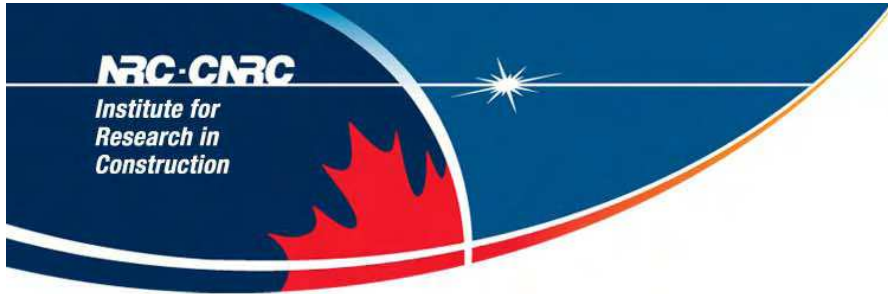
Laboratory-Water Management + Deficiency

Reservoir Water Entry - 08 ABS





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Acknowledgments

- NRC for funding this cross program initiative between IRCs IE and BES programs
- IE/IAQ Group
- FEWF Team:
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 - Marianne Manning
 - Roberts Berzins
 - Stacey Nunes
 - Khaled Abdulghani



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