Experimental test to assess hygrothermal performance of building envelope systems

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From Discovery to Innovation...

Experimental Tests To Assess Hygrothermal Performance of Building Envelope Systems

Prepared by :

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For the

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Outline

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

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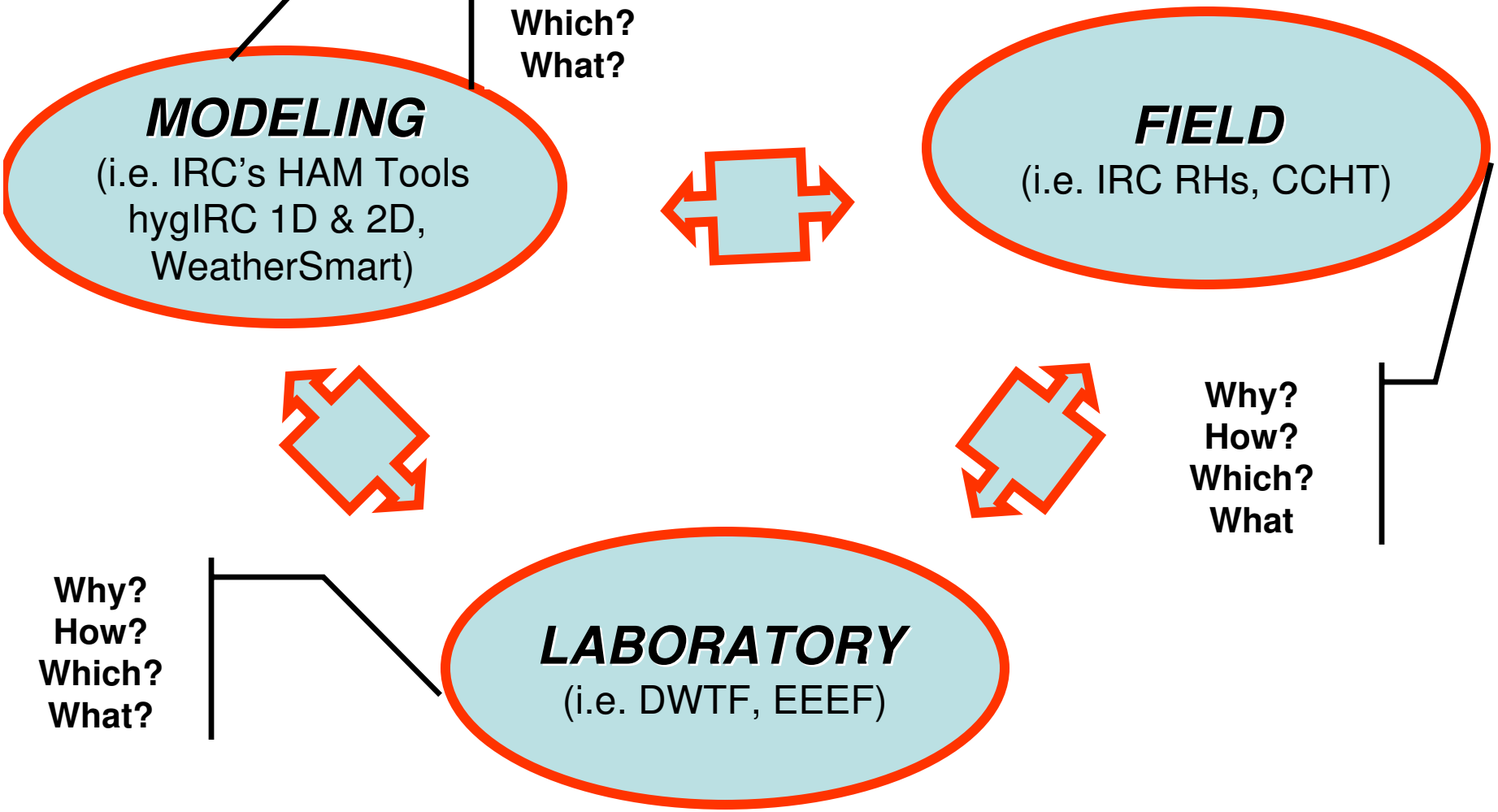
Hygrothermal Performance of Building Envelope Systems



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Modeling

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

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Modeling: IRC's HAM Tools

- *hyg*IRC 1-D V. 1.1 is a user-friendly, one-dimensional version of NRC-IRC's *hyg*IRC, a state-of-the-art hygrothermal model.
  - 1-D hygIRC can be used for
    - parametric analysis: changing weather (locations), materials, for example

    For more information please visit hygIRC Website:

    http://irc.nrc-cnrc.gc.ca/bes/software/hygIRC/index_e.html

- *hyg*IRC 2D is the Advanced hygrothermal models
  - Best handled by hygIRC 2-D
    - air leakage
    - water leaks
    - gravity effects

- *WeatherSmart*

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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?

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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

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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

North facade

West facade

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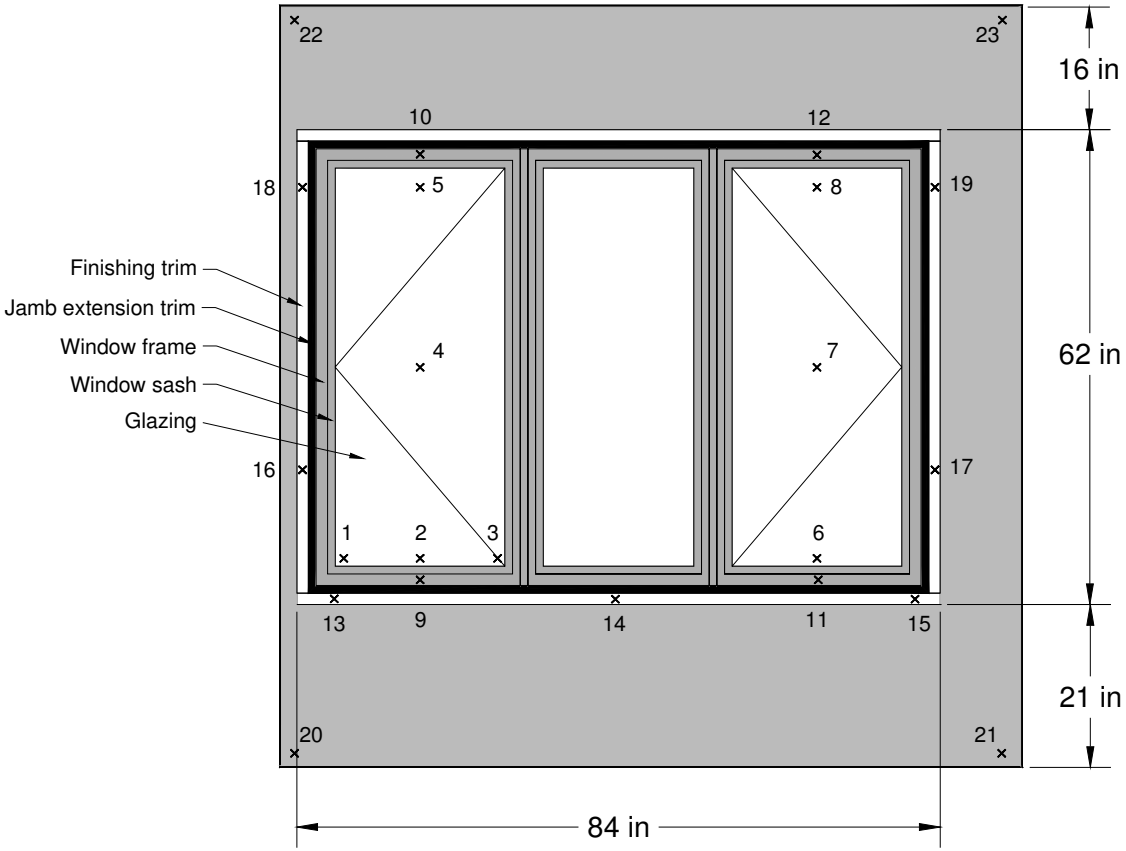
IRC Field Exposure of Wall Facility (FEWF)



Window Monitoring

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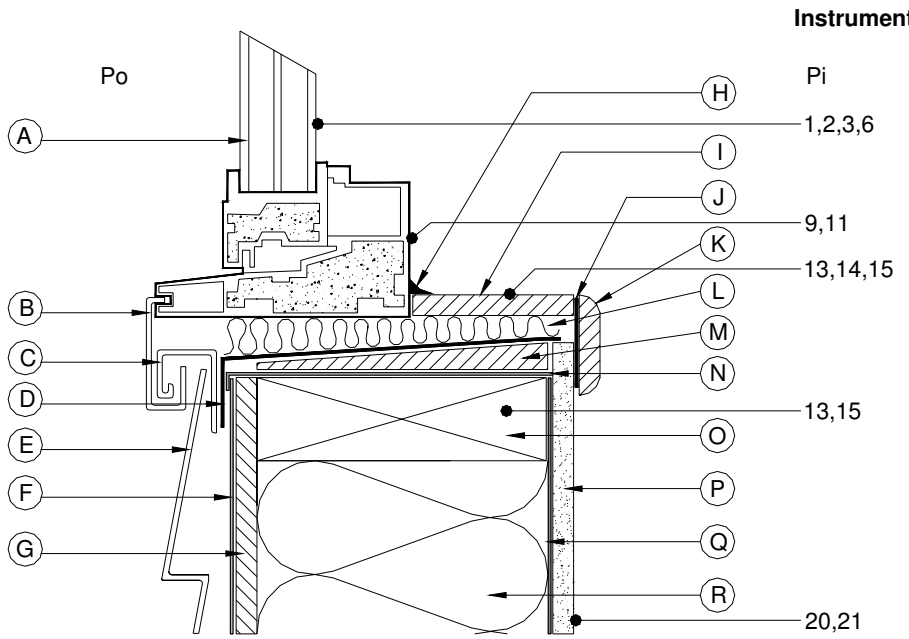
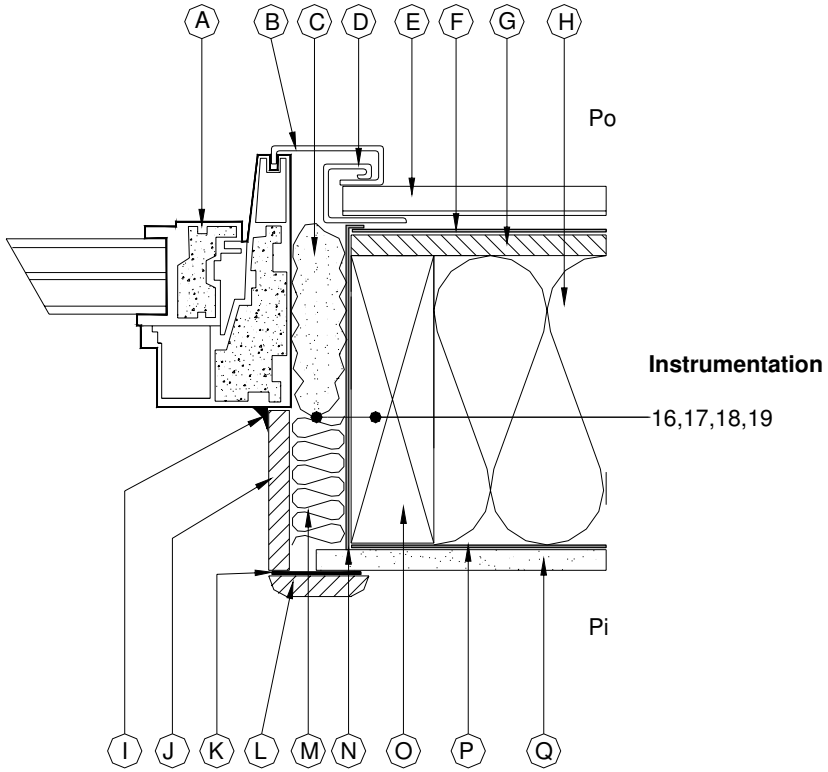
IRC Field Exposure of Wall Facility (FEWF)

Exterior

Exterior **Interior**



Sill Detail



Interior

Jamb Detail

Window Monitoring

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IRC Field Exposure of Wall Facility (FEWF)

West facade

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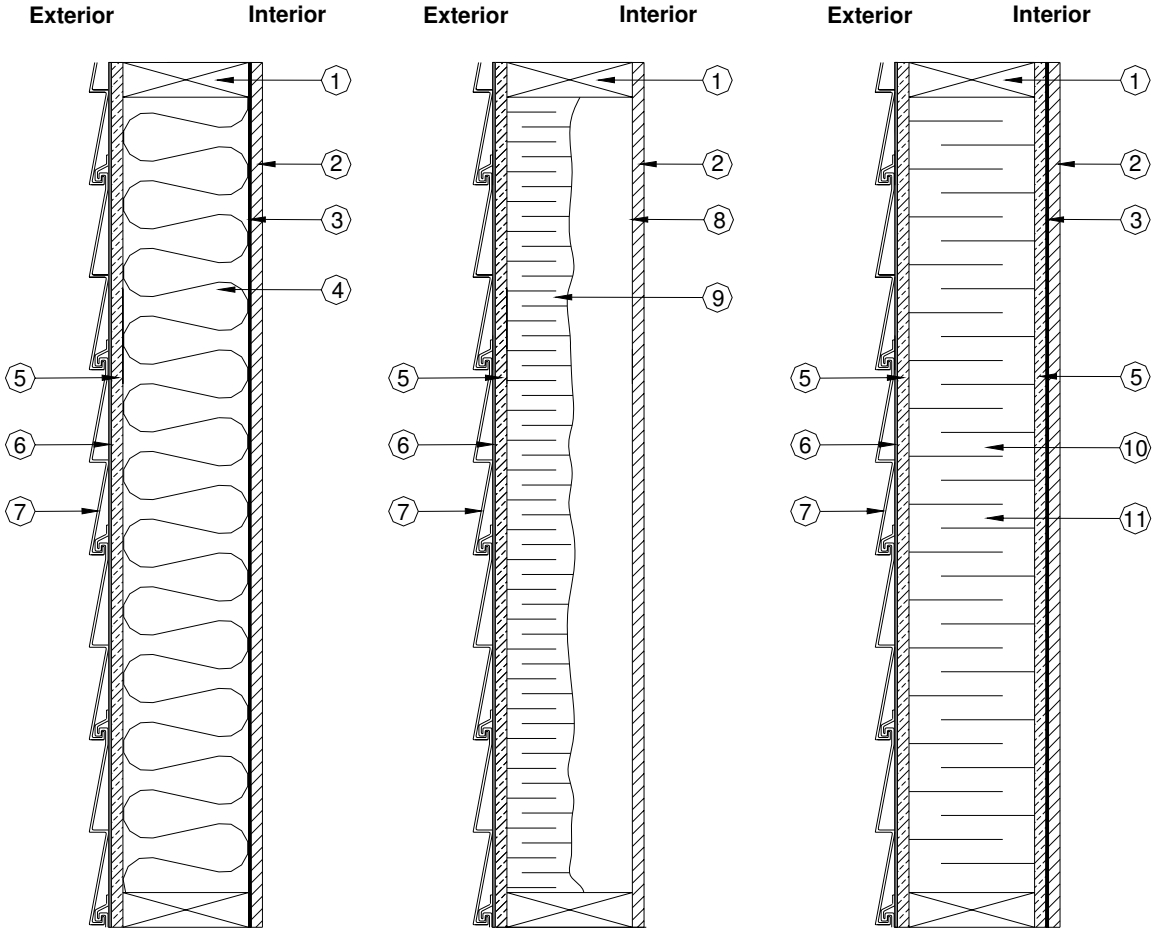
IRC Field Exposure of Wall Facility (FEWF)

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**

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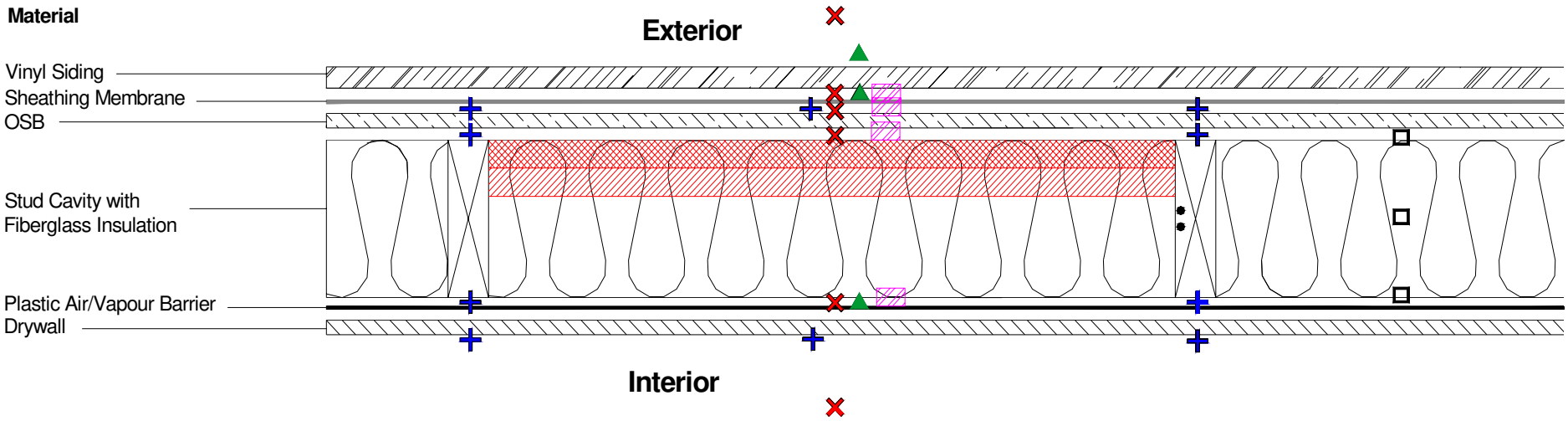
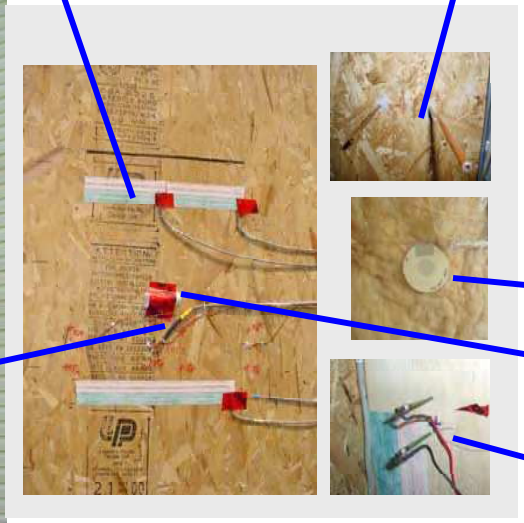
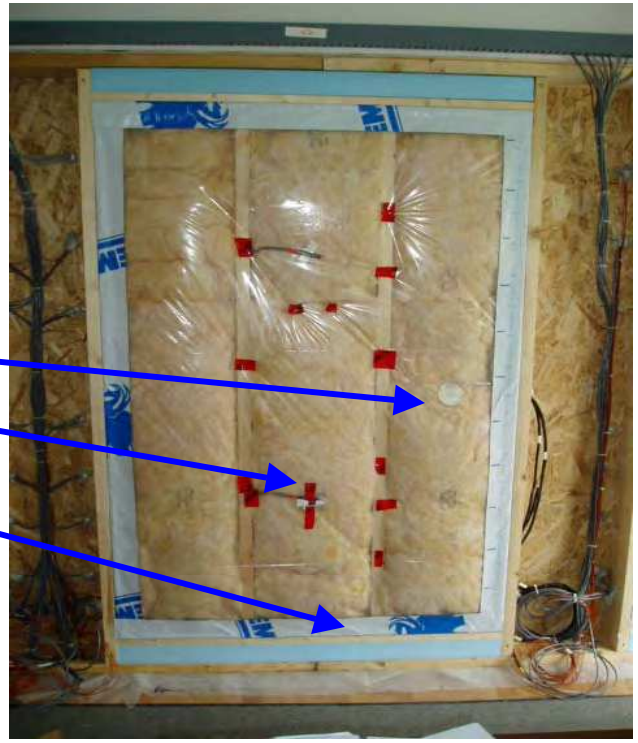
IRC Field Exposure of Wall Facility (FEWF)



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





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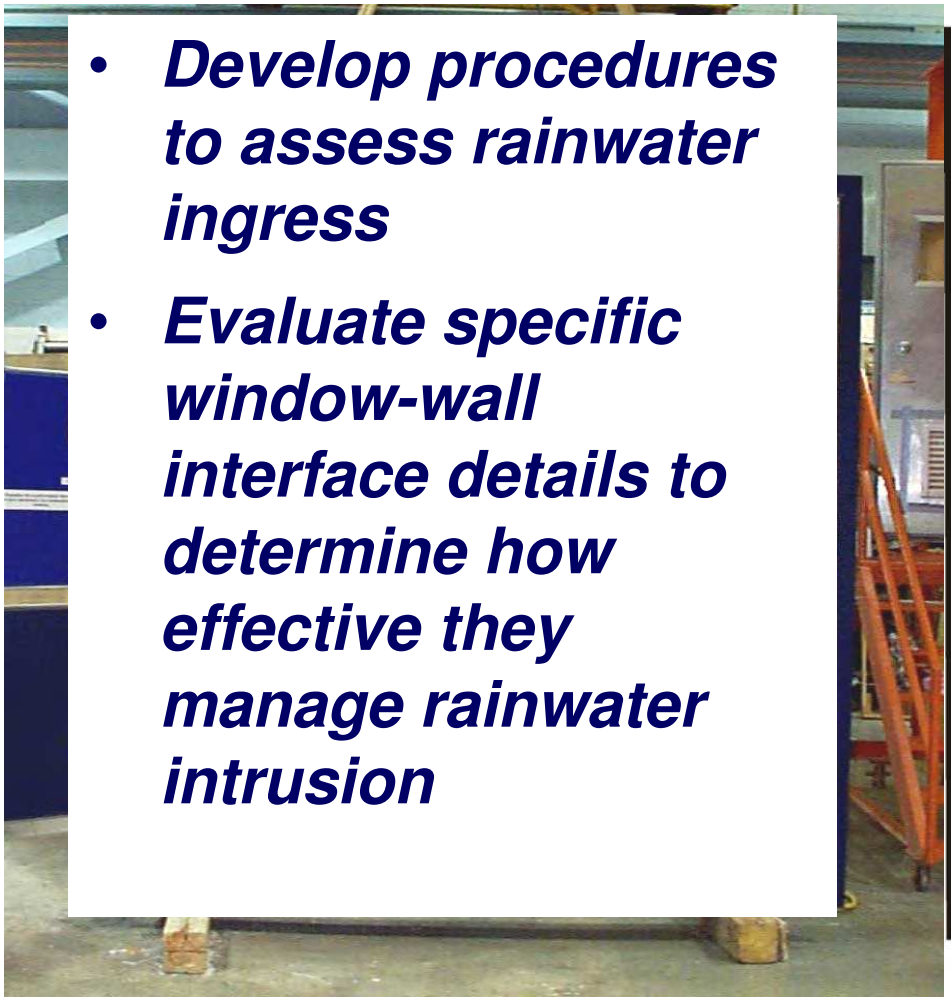
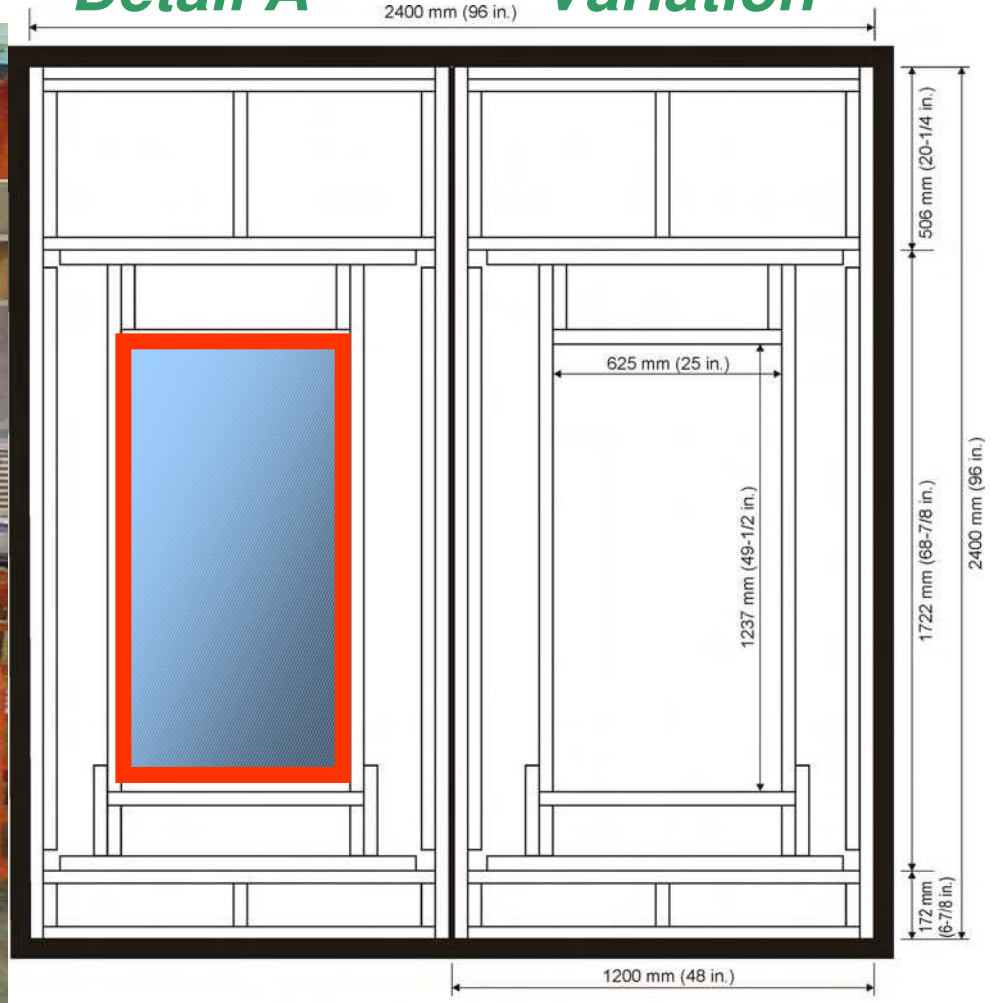
IRC Laboratory Experiments- Test Specimen in DWTF



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

Detail A ***Variation***



Elevation view of the test frame

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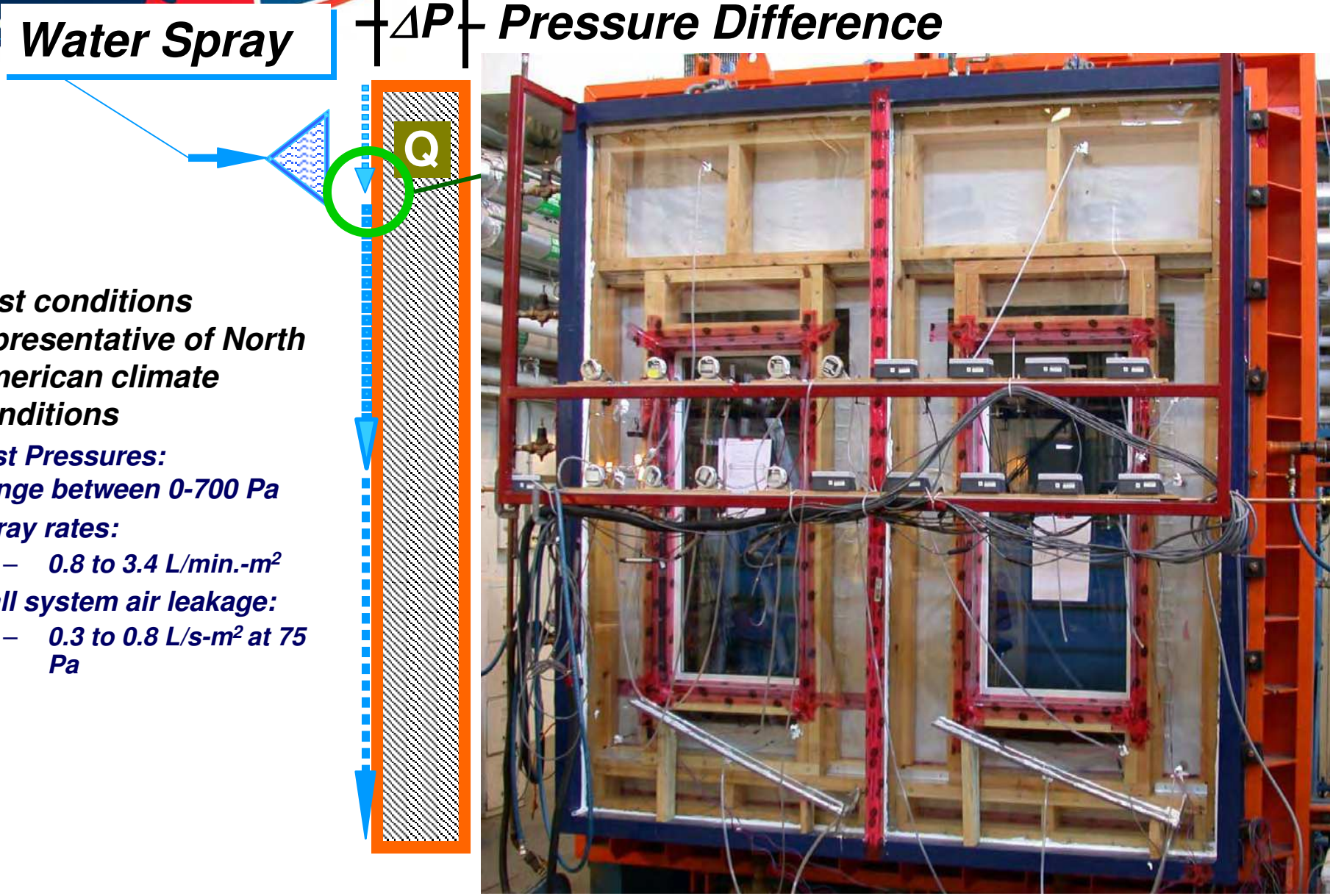
IRC Laboratory Experiments - Test Specimen in DWTF



- *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*

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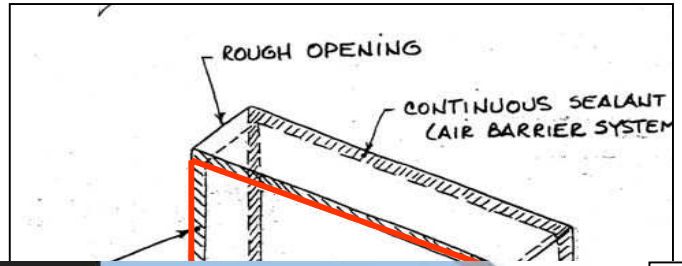
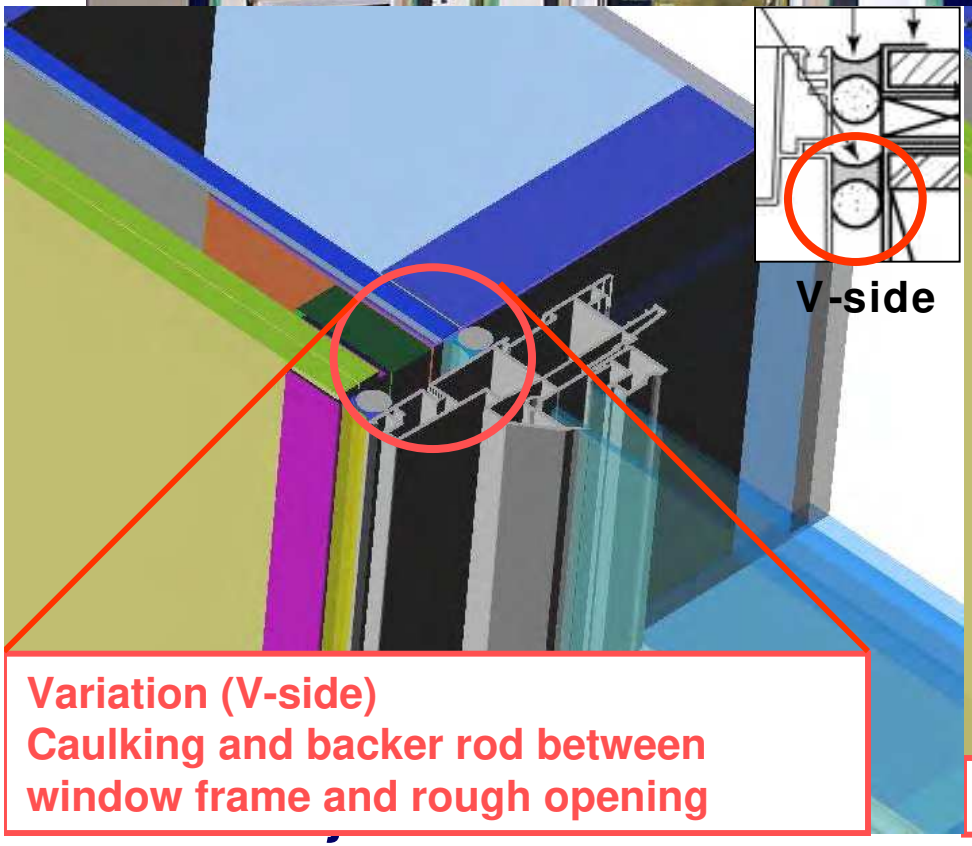
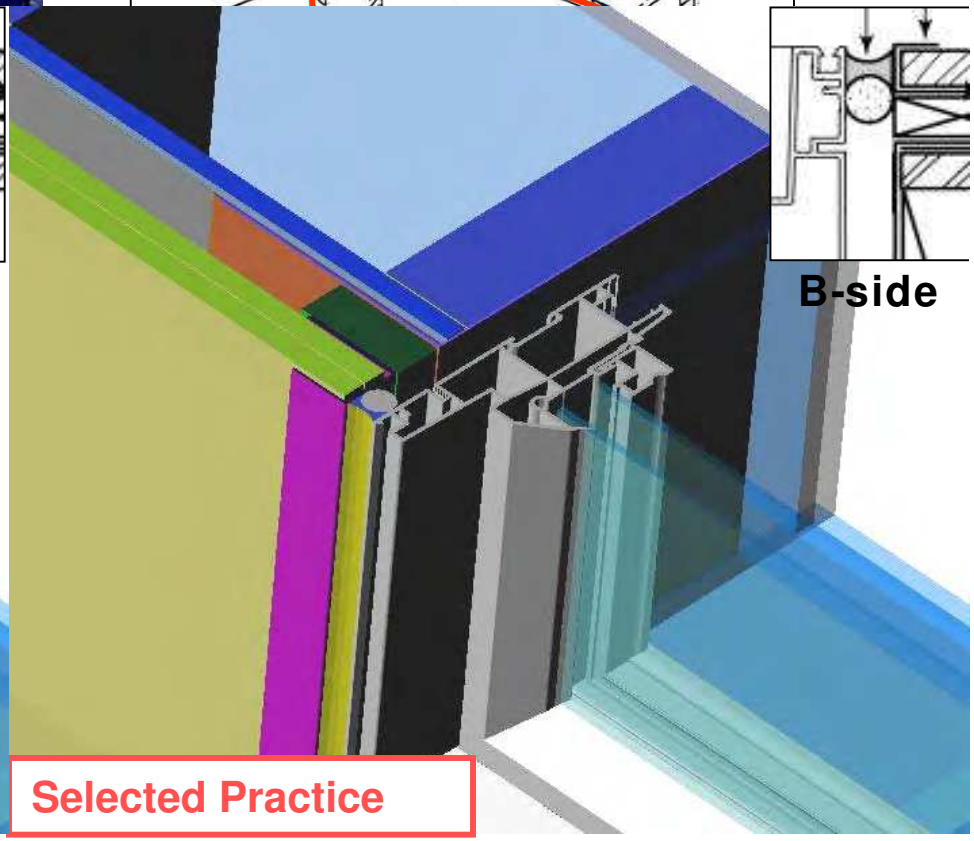
IRC Laboratory Experiments - Specimen Details





V-side

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



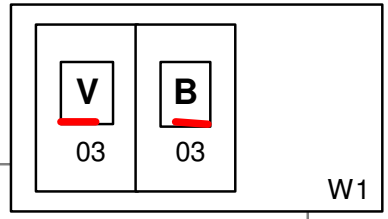
B-side

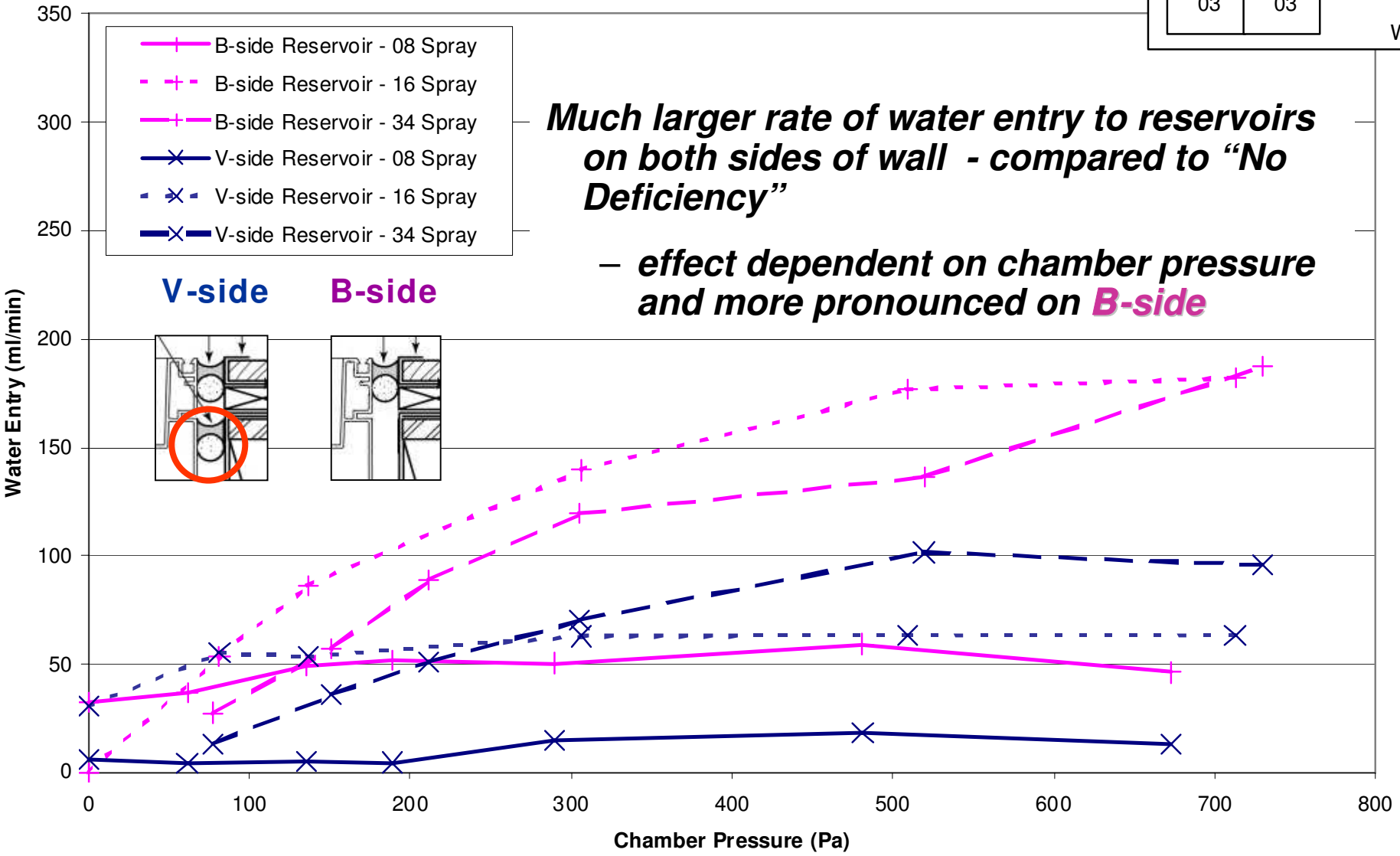
Selected Practice

Location of Deficiencies

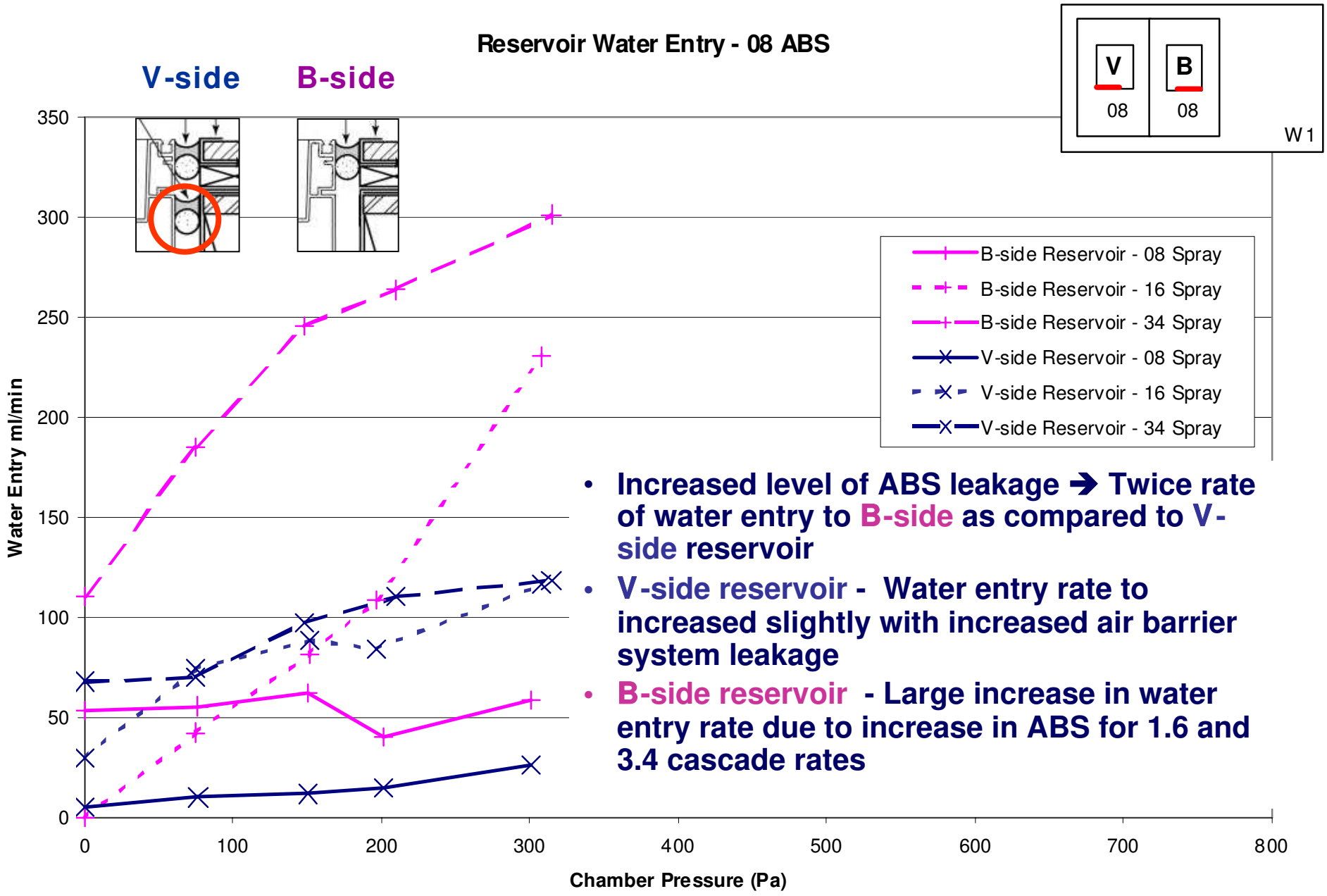
W1

Laboratory - Water Management + Deficiency





Laboratory-Water Management + Deficiency



- **Increased level of ABS leakage ➔ Twice rate of water entry to B-side as compared to V-side reservoir**
- **V-side reservoir - Water entry rate to increased slightly with increased air barrier system leakage**
- **B-side reservoir - Large increase in water entry rate due to increase in ABS for 1.6 and 3.4 cascade rates**

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