

ICF Wall Testing and Modeling

LAB TESTING REPORT



Prepared for



Prepared by



Acknowledgements

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Disclaimer

Reasonable care has been taken to confirm the accuracy of the information contained herein. However, the authors and funding partners assume no liability for any damage, injury, expense or loss that may result from the use of this report; particularly, the extrapolation of the results to specific situations or buildings.

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Appendix A – Laboratory Air Leakage and Water Penetration Test Reports

1. Introduction

Insulating Concrete Forms (ICF) is a formwork system for reinforced concrete, which stays in place forming a permanent substrate for interior and exterior assemblies. ICF systems consist of modular units which are dry stacked in place filled with reinforcing steel and concrete. In Canada, ICF systems typically consist of light-weight expanded polystyrene (EPS) modular units. The use of ICF systems continues to increase in popularity as a result of the focus on more energy efficient buildings. The use of ICF systems has expanded to include above grade wall structures and support systems for cladding applications in new home construction. ICF systems pose some unique challenges with respect to interfacing with other building elements and in particular windows. There is very little physical test data regarding the air and water resistance performance levels that can be anticipated when integrated together with other assemblies to form an enclosure system. In addition, there are several commonly used methods of terminating the ICF forms at window openings, which can result in varying levels of air and watertightness. There is an immediate need in the industry to develop standard construction installation, and interface procedures that will provide known air and water penetration resistance levels that are comparable or better than other conventional building systems.

RDH Building Engineering Ltd. (RDH) was retained by the Homeowner Protection Office (HPO), a branch of BC Housing, and the BC Ready-Mixed Concrete Association (BCRMCA) to perform testing and analysis of ICF walls and window interfaces. This report details the tests completed to help provide the necessary information to quantify the airtightness, water penetration resistance, and thermal resistance of sample wall assemblies, which included a fixed window and associated detailing.

1.1. Background

In September 2011, RDH completed Phase 1 of the ICF research testing program. In Phase 1, the ICF wall itself was found to be both water and airtight; however, conventional detailing of the window to wall interface was identified a weak point in the system with respect to air and watertightness. Six different window buck and installation methods were tested with varying results. The more successful window interface methods included a watertight tie-in detail to the concrete core of the ICF system. Based on the results of the Phase 1 testing, new details were developed to reliably and economically allow an air and watertight tie-in of the window system to the concrete core of the ICF.

Subsequent to Phase 1 testing, the ICF Technical Committee produced the following summary of objective for the remaining testing and development work on this project:

- Obtain testing data and engineering opinion to support the formulation of “acceptable assembly details” that are deemed compliant with the 2012 BC Building Code provisions for Parts 4, 5, and 9.
- Seek information to support “best practice” details for ICF construction across Canada to be included in product guides and construction details available to customers, and which are compliant with provincial and national code provisions.
- Seek information to support acceptable assembly details for adoption into building codes that recognize the capacity of properly constructed ICF structures to resist air and moisture penetration with the minimum addition of barriers, such as synthetic membranes and capillary break provisions. Quantify the capacity of ICF construction technology to comply with the intent of building codes without adding costly and redundant layers of preventative measures, which may burden the builder.

1.2. Testing Parameters

Utilizing the recommendations from Phase 1, new window interface details were developed with the goal of being easily constructible, while trying to achieve an air and watertight seal between the window frame and the concrete core of the ICF.

Once the details were complete, air and water leakage testing was performed to assess the performance.

The testing uses industry-accepted air and water test methods to evaluate the performance of the ICF wall assembly. Water penetration testing was performed at increasing test pressures to allow a performance comparison between the different samples from zero up to the level that the windows are rated (700 Pa). In practice, the required in situ performance of windows is determined using Driving Rain Wind Pressure (DRWP) for known locations and buildings, and calculating the test pressure that has a one in 10 year chance of reoccurrence (a 10% chance of occurring in a one-year period). For most low-rise buildings, this is in the order of 200 to 300 Pa. The actual performance criteria will be developed in conjunction with the ICF Technical Committee to reflect a range of typical in-service exposures for the ICF wall assemblies; in much the same way it is calculated for windows in the AAMA/WDMA/CSA 101/I.S.2/A440 - NAFS – North American Fenestration Standard/Specification for Windows, Doors, and Skylights.

2. Laboratory Air Leakage and Water Penetration Testing (Phase 2)

Laboratory testing was undertaken to determine the basic airtightness and water penetration resistance characteristics for Phase 2 ICF wall assemblies. The testing was also undertaken to identify opportunities for improved performance and to suggest areas where additional testing may be warranted.

2.1. Test Methodology

Testing of the ICF wall assemblies was undertaken using the testing facility at the Cascadia Windows Ltd.'s manufacturing facility in Langley, BC (Fig.2.1.1 and Fig.2.1.2). The test facility is capable of testing specimens as large as 16' x 12'. This apparatus can be used to perform water penetration resistance testing, air leakage testing, and structural testing.

The purpose of the lab testing is to show that ICF and its interfaces will perform as good as or better than traditional walls with traditional code-compliant weather resistive barriers. The testing program includes one conventional wall sample that will be used as the control sample, and will be compared to the performance of the ICF samples. The testing represents an 'exposed' situation (i.e. no cladding or finishes installed).



Fig. 2.1.1 Front view of test wall.



Fig. 2.1.2 Rear view of test wall.

The information gathered provides basic performance characteristics for typical wall assemblies that are being constructed today. The results will be used to address aspects of the building code related to water penetration control and air leakage control. It may also identify performance issues that need to be addressed through changes in assembly construction or detailing (refer to subsequent phases).

2.2. ICF Wall Assembly Construction

A total of six ICF wall assemblies were constructed and tested for Phase 2 in 2013. Each of the ICF walls were constructed using the Advantage ICF System by Plasti-Fab EPS Product Solutions. The system selected allowed for a 6" steel reinforced concrete core. A 23" x 23" fixed window was installed within the wall assembly. Refer to Appendix A for the laboratory air leakage and water penetration test reports, which include drawings of the various details at the window rough openings.

- Module 1A: Internal with Buck Flashing. A wooden buck was installed on the concrete in the rough opening encased in a galvanized metal flashing (Fig.2.2.1).

- Module 1B: External with Buck Flashing. A wooden buck was installed on the inside of the rough opening over the concrete and EPS formwork with a galvanized metal flashing on the exterior side (Fig.2.2.2).
- Module 2A: Direct to Concrete. The window was mounted directly to the concrete (Fig.2.2.3).
- Module 2B: EIFS Basecoat. An exterior insulation finish system (EIFS) was installed on the exterior (Fig.2.2.4).
- Module 2C: Benchmark – Strapping and Sheathing Paper. The module was constructed similarly to module 1B, with the exception of the galvanized metal flashing as well as the addition of sheathing paper installed on the exterior, foil faced self-adhered into the rough opening at the sill, and with vertical strapping at 16" o/c (Fig.2.2.5).
- Gorilla Buck Module: A Gorilla Buck, which is a proprietary buck for rough openings in ICF construction, was installed in the rough opening in place of the usual wooden buck (Fig.2.2.6).



Fig. 2.2.1 Module 1A – Internal with Buck Flashing



Fig. 2.2.2 Module 1B – External with Buck Flashing



Fig. 2.2.3 Module 2A – Direct to Concrete



Fig. 2.2.4 Module 2B – EIFS Basecoat



Fig. 2.2.5 Module 2C – Benchmark – Sheathing Paper with Vertical Strapping



Fig. 2.2.6 Gorilla Buck Module

2.3. Test Protocol

The air and watertightness of the completed assembly was tested in general conformance to ASTM E283 and ASTM E331, respectively. During the water testing, all ICF walls were tested at 150, 300, and 700 Pa; unless the amount of water ingress prevented further testing. When testing Module 2A, no water ingress was observed when testing at a differential of 700 Pa; and, it was decided to test this module at 1400 and 5000 Pa. Refer to the test reports in Appendix A for further information regarding the setup and the type of equipment used to perform the testing.

2.4. Test Results

Testing of the first four modules was performed on June 5, 2013, and the testing of the last two modules was performed on June 6, 2013. At 75 Pa the air leakage rate for all modules was less than 0.0039 L/s.m². Table 2.4.1 provides a summary of the test results.

Table 2.4.1 Summary of ICF Wall Test Results

	Module 1A	Module 1B	Module 2A	Module 2B	Module 2C	Module GB
	Internal with Buck Flashing	External with Buck Flashing	Direct to Concrete	EIFS Basecoat	Benchmark – Sheathing Paper	Gorilla Buck
Water Test Results	150 Pa – Pass	150 Pa – Pass	150 Pa – Pass	150 Pa – Pass	150 Pa – Fail	150 Pa – Pass
	300 Pa – Pass	300 Pa – Pass	300 Pa – Pass	300 Pa – Pass		300 Pa – Fail
	700 Pa – Pass	700 Pa – Fail	700 Pa – Pass	700 Pa – Pass		
			1400 Pa – Pass			
			5000 Pa – Pass			

2.4.1 Air Leakage

Table A-5.4.1.2(1) and (2) of the 2010 National Building Code of Canada and 2012 BC Building Code recommends that to be considered an air barrier, a material should have an air leakage rate of less than 0.05 L/s-m² at 75 Pa when interior relative humidity is greater than 55%. All tested modules have an air leakage rate of less than 0.05 L/s-m² at 75 Pa, which exceeds the building code requirements or recommendations.

2.4.2 Water Ingress

Out of the six ICF wall assemblies tested, only one module (Module 2C – Benchmark) failed to prevent water ingress at a pressure difference of 150 Pa. The Gorilla Buck Module failed to prevent water ingress at a pressure difference 300 Pa, and Module 1B failed to prevent water ingress at a pressure difference 700 Pa. For Modules 1A, 2A, and 2B, no water ingress was observed at the interior at a pressure difference of 700 Pa. For Module 2A, no water ingress was observed at the interior at a pressure difference up to 5000 Pa.

3. Thermal Performance of ICF Walls

The effective thermal performance of each sample was modeled to allow a comparative analysis of the different installation techniques.

3.1. THERM Simulation Results

The thermal performance of ICF walls depends on the thickness of the insulation used as the formwork, the thickness of the concrete, and the perimeter buck details and material around windows. The following materials values were used in the simulations.

Table 3.1.1 Thermal Conductivity for Used Building Materials

Material	Conductivity Value (W/m-K)
Concrete, Medium-Weight	2.0
Soft-Wood Lumber	0.14
Expanded Polystyrene (EPS)	0.038
Steel – Galvanized Sheet (0.14%)	62
Polyvinylchloride (PVC) – Vinyl/Rigid	0.17

To model the effective R-value, two-dimensional heat transfer simulations of ICF walls were completed using the program THERM. THERM is a finite element analysis program used to calculate the effective R-value of building enclosure assemblies. THERM simulations were completed for each module. Module 1A and 1B were modeled with both galvanized metal flashing and PVC flashing. Each of the modules was modelled as they were constructed for testing; complete with a 23”x23” window installed to accurately model the interface between the window and the wall. Figure 3.1.1 shows the model and a temperature isotherm from a THERM simulation of the internal buck module with galvanized sheet steel (Module 1A).

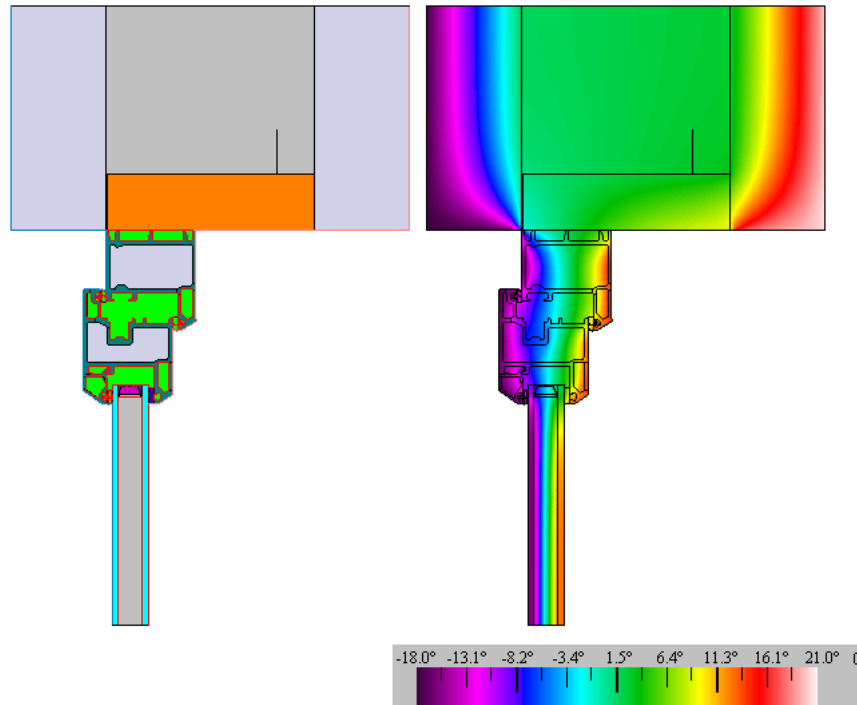


Fig. 3.1.1 THERM simulation for the head of Module 1A –Internal with Flashing

THERM simulations were completed for the head, jambs, and sill for each module. Additionally, a section of the center of the wall was also modelled for calculation purposes. The U-values for each model were calculated for the frame, edge of glass, and edge of wall. Table 3.1.2 shows a summary of the results from the THERM simulation. The window perimeter is defined as 6” onto the wall from the rough opening at the head, jambs, and sill.

Table 3.1.2 THERM Simulation Results Summary

THERM Simulation Summary		
Specimen		Effective ICF Wall R-Value (no window)
		h·ft ² ·°F/Btu
Module 1A - Internal with Buck Flashing	Steel Flashing	16.4
	PVC Flashing	18.8
Module 1B - External with Buck Flashing	Steel Flashing	14.7
	PVC Flashing	18.1
Module 2A - Direct to Concrete	As-Built	17.1
	Thermally Optimized ¹	19.9
Module 2B - EIFS Basecoat	As-Built	17.1
	Thermally Optimized ¹	19.9
Module 2C - Sheathing Paper		18.0
Module GB - Gorilla Buck Module		20.2

Based on the results of the simulation, all of the test walls have effective R-values in excess of the effective R-value for conventional wood stud walls with fibreglass insulation (R-10.7 and R-15.5 for typical 2x4 and 2x6 wall construction respectively²); with the exception of the ICF module utilizing an external metal flashing, which is slightly lower than the 2x6 wall. Using non-conductive materials for the buck flashings and optimizing the details for thermal effects by insulating exposed concrete surfaces will improve the effective R-values further. The highest effective R-values of R-20 were achieved by the gorilla buck and the thermally optimised direct to concrete modules.

¹ Test modules were not optimized for thermal performance. Optimizing Module 2A and 2B by moving the window out 1" and adding 1" of insulation to the interior exposed concrete improves thermal performance without affecting air or watertightness.

² Energy Efficient Building Enclosure Guidelines , FPInnovations, 2013

4. Conclusions

All test walls in Phase 2 (refer to the table below) surpassed the water penetration resistance levels of the control sample with sheathing paper installed in accordance with Part 9. High-rise performance levels were achieved on the buck flashing and direct to concrete walls. The highest level of water penetration resistance of 5000 Pa was reached on the direct to concrete system.

All test walls in Phase 2 (refer to the table below) had an air leakage rate less than the 2010 National Building Code of Canada and 2012 BC Building Code air barrier recommendations of 0.05 L/s-m² at 75 Pa, when interior relative humidity is greater than 55%.

	Module 1A	Module 1B	Module 2A	Module 2B	Module 2C	Module GB
	Internal with Buck Flashing	External with Buck Flashing	Direct to Concrete	EIFS Basecoat	Benchmark – Sheathing Paper	Gorilla Buck
Water Test Results	150 Pa – Pass	150 Pa – Pass	150 Pa – Pass	150 Pa – Pass	150 Pa – Fail	150 Pa – Pass
	300 Pa – Pass	300 Pa – Pass	300 Pa – Pass	300 Pa – Pass		300 Pa – Fail
	700 Pa – Pass	700 Pa – Fail	700 Pa – Pass	700 Pa – Pass		
			1400 Pa – Pass			
			5000 Pa – Pass			

All test walls in Phase 2 (refer to the table below) have effective R-values in excess of the effective R-value for 2x4 and 2x6 conventional wood stud walls with fibreglass insulation, with the exception of the ICF wall utilizing an external metal flashing, which is slightly lower than the 2x6 wall.

THERM Simulation Summary		
Specimen		Effective ICF Wall R-Value (no window)
		h·ft ² ·°F/Btu
Module 1A - Internal with Buck Flashing	Steel Flashing	16.4
	PVC Flashing	18.8
Module 1B - External with Buck Flashing	Steel Flashing	14.7
	PVC Flashing	18.1
Module 2A - Direct to Concrete	As-Built	17.1
	Thermally Optimized ¹	19.9
Module 2B - EIFS Basecoat	As-Built	17.1
	Thermally Optimized ¹	19.9
Module 2C - Sheathing Paper		18.0
Module GB - Gorilla Buck Module		20.2

5. Recommendations for Further Work

The following are our recommendations for future work.

→ Wall Testing In Situ

As the laboratory testing program has verified the details in a controlled situation, the standardized details will need to be included in local construction projects and tested in situ. The site testing may help confirm that the assemblies are effective at controlling air and water infiltration on a full-scale basis; that assumptions regarding the watertightness of the core are correct; and that the details are simple and economical enough to be performed consistently with variable trades and weather conditions. The in situ testing will be performed in accordance with ASTM E 1105 for water penetration resistance and ASTM E1186 for air leakage. It may be beneficial to remove the EPS from the interior of the ICF walls to understand how the concrete walls crack in-service, and if water ingress is observed through any of these cracks.

→ Whole Building Air Leakage Testing

Perform whole building air leakage testing on several buildings.

→ Assemblies and Details

Refine details and assemblies as required in order to address all of the building code compliance issues.

Sincerely,

RDH Building Engineering Ltd.



Brian Hubbs, P.Eng.

Managing Principal, Senior Building Science Specialist , RDH Building Engineering Ltd.

Appendix A

Laboratory Air Leakage and Water Penetration Test Reports

ASTM E283 & E331 – Lab Test Report – Internal with Buck Flash



TEST STANDARDS ASTM E283-04 “Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen”
ASTM E331-00 “Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference”

WALL Module #1A – Internal with Buck Flash

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Appendix A – Test Procedures and Setup

Appendix B – Typical Details for ICF Test Wall Assembly

1. General Information

The following tests were performed to evaluate the performance of the ICF wall with the internal buck:

- 1) A test to determine the ICF wall air leakage rate. Test performed in general conformance with ASTM E283.
- 2) A test to determine the ICF wall water penetration resistance. Test performed in general conformance with ASTM E331.

1.1. Attendees

Table 1.1.1 General Information

General	
Testing Agency	RDH Building Engineering Ltd.
Test Location	27050 Gloucester Way, Langley, B.C.

The following people observed the testing in part or whole:

- Brian Hubbs – RDH Building Engineering Ltd.
- Christopher Black – RDH Building Engineering Ltd.
- Jared Murphy – RDH Building Engineering Ltd.
- Doug Bennion – Quadlock Concrete Building Solutions
- Sean McBeth – Plasti-Fab EPS Product and Solutions
- Herman Sawatzky – Cascadia Windows Ltd.
- Carol Vincent – BC Ready Mix Concrete Association
- Charles Kelly – BC Ready Mix Concrete Association

1.2. Test Specimen Description

Table 1.2.1 Specimen Description

Module #1A	
Wall -Type	Module #1A – Internal with Buck Flash
- ICF Manufacturer	Plasti-Fab EPS Product and Solutions – Advantage ICF Systems
Window - Manufacturer	Cascadia Windows Ltd.
- Series	300A
Age	0
Overall Dimensions (Width x Height)	Window: 584 x 584 mm (23 x 23 in.) Wall: 1994 x 2032 mm (78 1/2 x 80 in.)
Frame Material	Fibreglass
Thermally Broken	Fibreglass integral to frame
Details Included	Fixed Lite, Perimeter interface, and ICF wall
Material List	The wall was constructed using light-weight EPS by Plasti-Fab Advantage ICF as formwork for the steel reinforced 6” thick concrete. A 23” x 23” fixed window was installed within the wall assembly.

An elevation drawing, section details, and the buck flash details can be found in Appendix B. Figure 1.2.1 illustrates the full view of module 1A as viewed from the exterior.



Fig. 1.2.1 Overall exterior view of Module 1A

2. Summary

2.1. Test Results

Table 2.1.1 Test Results Summary

Module 1A – Internal with Buck Flash	
Water Test Pressure	150 Pa 300 Pa 700 Pa
Test Method	ASTM E283 ASTM E331
Details Included	Fixed Lite, Perimeter Interface, and ICF Wall.
Air Test Results	Less than 0.0039 L/s·m ² @ 75Pa
Water Test Results	150 Pa – Pass 300 Pa – Pass 700 Pa – Pass

2.2. Modifications Performed to Achieve Report Performance Rating

No modifications were required to obtain the ratings listed in Table 2.1.1

3. Air Test Results – ASTM E283

3.1. Test # 1 – 75 Pa

Test Conditions

Test Date: June 5, 2013

Test Time: 6:00 pm

Air Temperature: 23°C

Barometric Pressure: 101,800 Pa

Relative Humidity: 73%

Test Parameters

Pressure Difference: 75 Pa – Positive

Direction of Flow: Infiltration

Table 3.1.1 Air Leakage Rate

Results	
Air Leakage Rate per Total Area of Sample (qA)	Less than 0.0039 L/s·m ²

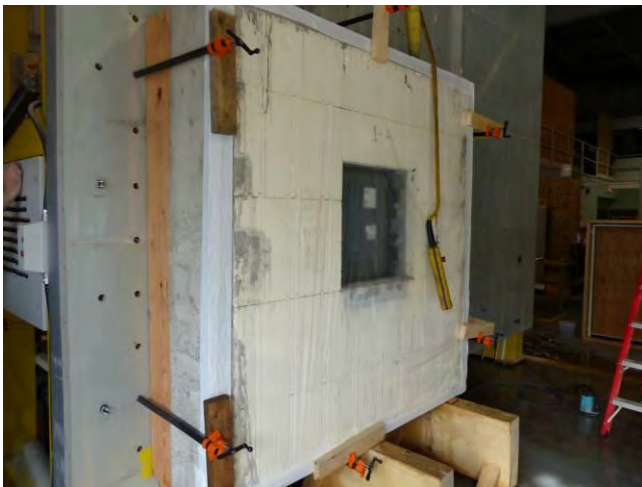


Fig. 3.1.1 Air Leakage Testing

4. Water Test Results – ASTM E331

4.1. Test #2 - 150 Pa

Test Conditions

Test Date: June 5, 2013
Test Time: 6:10 pm
Air Temperature: 19°C
Relative Humidity: 73%

Test Parameters

Pressure Difference: 150 Pa
Duration: 15 min (Complete)
Procedure: Uniform Static
Observations: No evidence of water ingress.

Table 4.1.1 Test Results

Results	
Result	Pass at 150 Pa

4.2. Test #3 - 300 Pa

Test Conditions

Test Date: June 5, 2013
Test Time: 6:30 pm
Air Temperature: 19°C
Relative Humidity: 73%

Test Parameters

Pressure Difference: 300 Pa
Duration: 15 min (Complete)
Procedure: Uniform Static
Observations: No evidence of water ingress.

Table 4.2.1 Test Results

Results	
Result	Pass at 300 Pa

4.3. Test #4 - 700 Pa

Test Conditions

Test Date: June 5, 2013
Test Time: 6:49 pm
Air Temperature: 19°C
Relative Humidity: 70%

Test Parameters

Pressure Difference: 700 Pa
Duration: 15 min (Complete)
Procedure: Uniform Static
Observations: No evidence of water ingress.

Table 4.3.1 Test Results

Results	
Result	Pass at 700 Pa

5. Conclusions

5.1. Air Tightness

When tested to the standard of ASTM E283 at a pressure differential of 75 Pa, the specimen, as prepared, achieved an Air Leakage Rate per fixed area (qA) of less than 0.0039 L/s-m².

5.2. Water Ingress Resistance

When tested to the standard of ASTM E331, no water ingress was observed through the specimen at differential pressures of 150, 300, and 700 Pa.

RDH Building Engineering Ltd.



Christopher Black, MASC, P.Eng.

Senior Project Engineer, RDH Building Engineering Ltd.

APPENDIX A – TEST PROCEDURES AND SETUP

A.1. Test Pressure Difference

Air Test

The ASTM E283 default pressure of 75 Pa was used.

Water Test

The test pressure is increased incrementally until the specimen can no longer meet the requirements of the standard or it was determined to no longer perform the testing.

A.2. Test Procedures

Air Test

Testing is performed in general conformance with ASTM E283-04 “Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen”.

Refer to the individual test parameters for the procedure used.

Water Test

Testing is performed in general conformance with ASTM E331-00 “Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference”

Refer to the individual test parameters for the procedure used.

A.3. Failure Criteria

The following is a list of the failure criteria used during testing:

Air Test

→ The specimen exceeds a specified maximum allowable air flow rate.

Water Test

Criteria as defined by the standard:

→ Failure occurs when water that penetrates through the frame or other portions of the test specimen and reaches a vertical plane inboard of the innermost projection of the specimen or when water reaches interior finishes or hardware.

→ Failure occurs whenever water penetrates through the perimeter frame of the test specimen.

A.4. Test Equipment

Test Wall

The test wall consists of an aluminum plate supported by a steel frame. The plate is perforated at 462 mm vertically and 267 mm horizontally. At every second hole staggered vertically between columns there is a Spraying Systems Co. – 1/8GG-W 2.8W Fulljet Stainless Steel nozzle installed flush with the plate. Water is pumped through the nozzles with a Summit Type CC pump at the calibrated test pressure. The pressure is controlled by throttling the flow of water with gate valves and is measured by a liquid-filled dial water pressure gauge. The test wall is calibrated in accordance with ASTM standards E331 and E547 to a pressure of 159 kPa (23 psi).

The specimen is set in a wood or fibreglass frame to create a chamber and is supported between 203 ± 51 mm from the test wall during the tests.

Depressurization

Depressurization of the test chamber is achieved through a 3” penetration in the test wall. Air is pumped through these penetrations by a model number R93150A GAST regenerative blower and is controlled by a model M12150C LENZE / AC TECH variable frequency drive. The fan moves air into or out of the chamber at a controlled rate to create the desired pressure differential across the specimen. The pressure differential is measured across the chamber wall with one of the following manometers:

Air Test

→ Dwyer Solid Plastic Stationary Gage, model 201

→ Dwyer Solid Plastic Stationary Gage, model 202.5

→ Meriam Inclined Tube Manometer, model 40HEX35WM

Water Testing

→ Dwyer Solid Plastic Stationary Gage, model 244

The volume of air flow is measured with a model Z50MW20-2 Meriam Laminar Flow Element.

The pressure difference between the lateral groove and the exterior was measured with an Alnor AXD 610 manometer.

A.5. Documentation

Terminology

In the report, water ingress paths and various forms of modifications are denoted in the following manner:

Water Penetration Points – Points of water penetration on the indoor face of the test specimen, and any water penetration as defined by the standard.

Adjustments – Adjustments are items on the test specimen where an installed component required realignment to properly interface with another component. These items are designated with an “A” sequence in modifications.

Deficiencies – Deficiencies are items found on the test specimen that are not manufactured or installed per the manufacturer or project requirements. These items are designated with a “D” sequence in modifications.

Modifications – Modifications are items that are performed on the test specimen that differ from the manufacturer or project requirements. These items are designated with an “M” sequence in modifications.

Orientation References

All references denoting orientation are taken as viewed when facing the test wall and the interior face of the specimen.

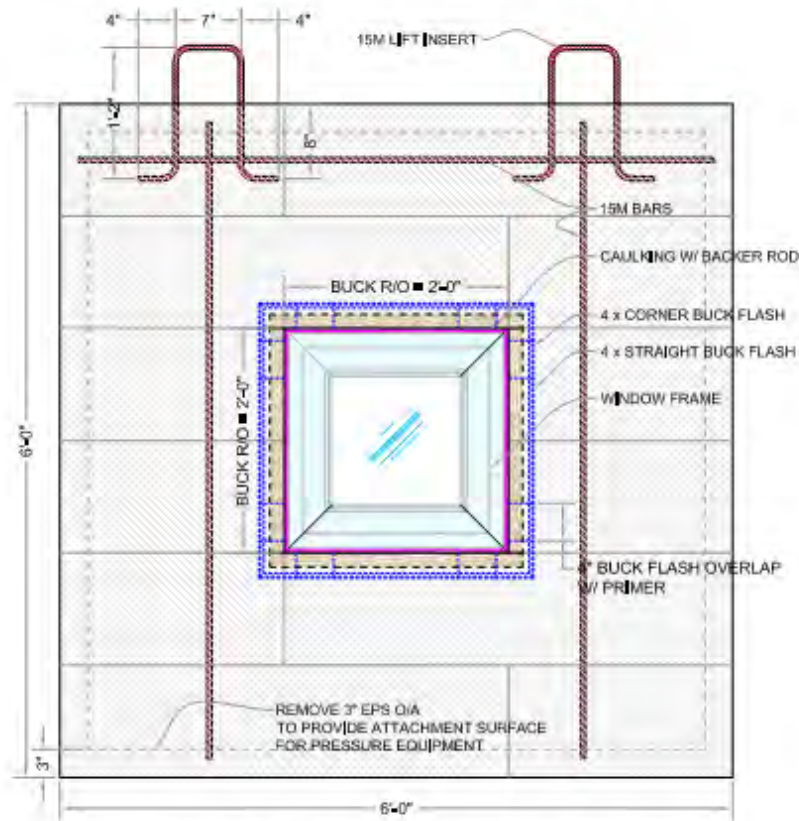
A.6. Deviations from Test Standard

Water Test

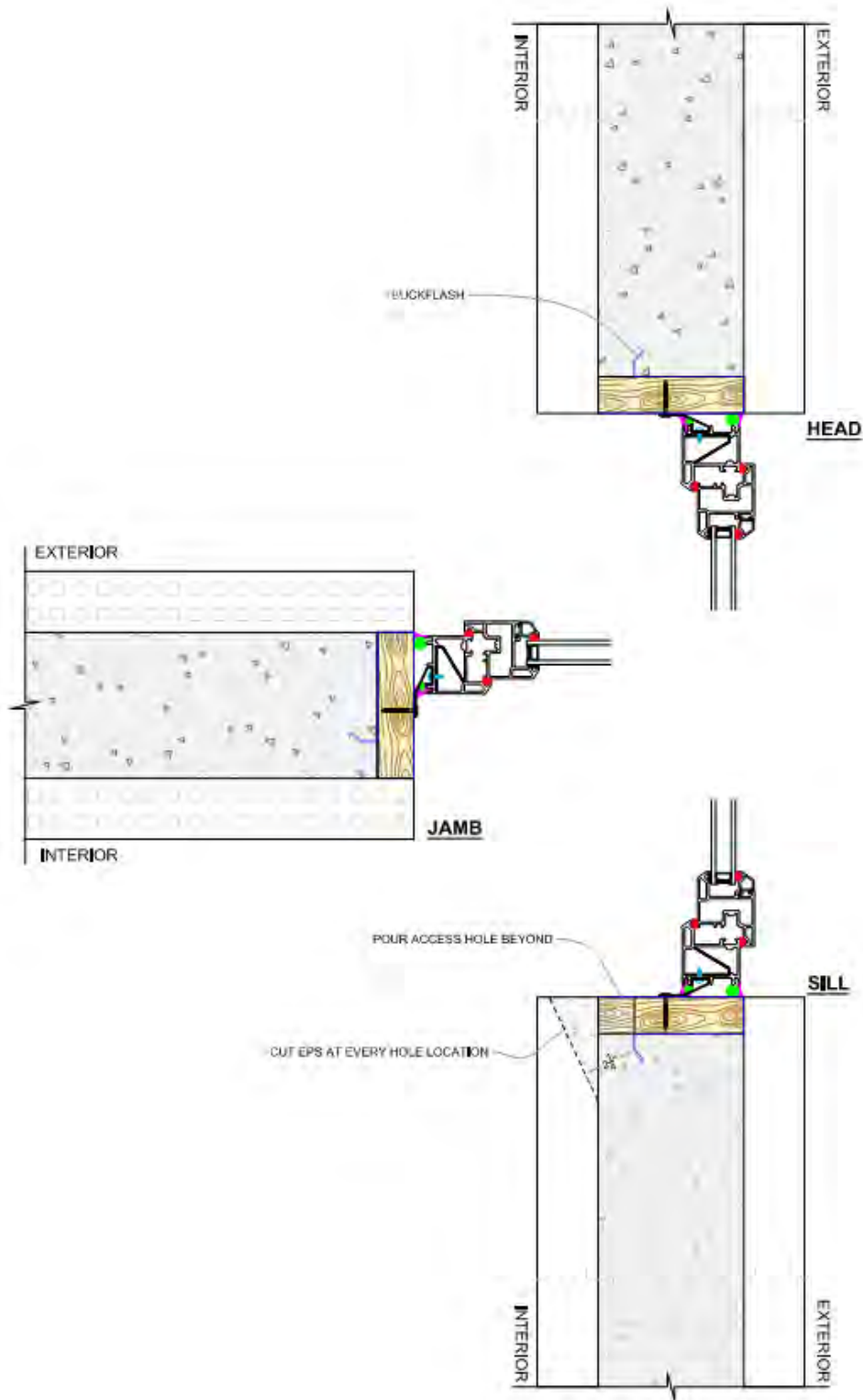
The test is conducted in general conformance with the test standard with the following exception:

→ The barometric air pressure was not recorded, but was obtained afterwards from a nearby weather station in Pitt Meadows, BC.

**APPENDIX B - TYPICAL DETAILS FOR ICF
TEST WALL ASSEMBLY**

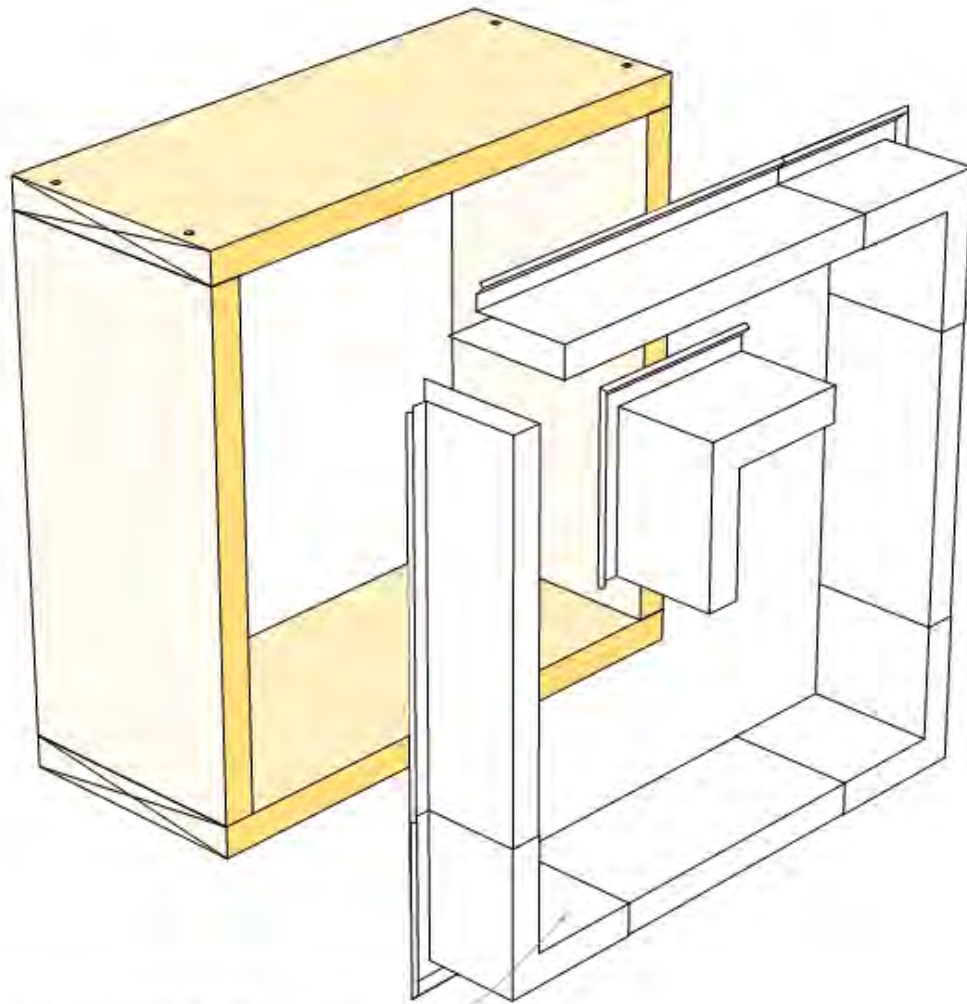


TEST MODULE 1A
INTERNAL WITH BUCK FLASH

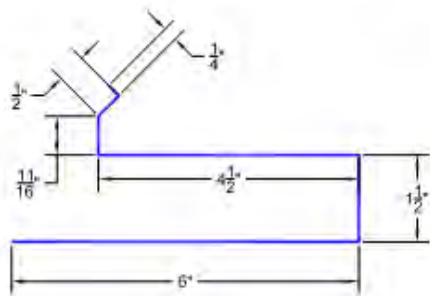


TEST MODULE 1A

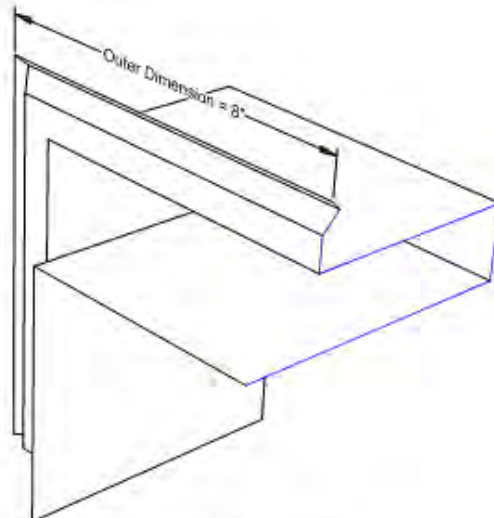
INTERNAL WITH BUCK FLASH



4" BUCK FLASH OVERLAP WITH PRIMER



STRAIGHT BUCKFLASH



CORNER BUCKFLASH

ASTM E283 & E331 – Lab Test Report – External with Buck Flash



TEST STANDARDS ASTM E283-04 “Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen”

ASTM E331-00 “Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference”

WALL Module #1B – External with Buck Flash

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Appendix A – Test Procedures and Setup

Appendix B – Typical Details for ICF Test Wall Assembly

1. General Information

The following tests were performed to evaluate the performance of the ICF wall with the internal buck:

- 1) A test to determine the ICF wall air leakage rate. Test performed in general conformance with ASTM E283.
- 2) A test to determine the ICF wall water penetration resistance. Test performed in general conformance with ASTM E331.

1.1. Attendees

Table 1.1.1 General Information

General	
Testing Agency	RDH Building Engineering Ltd.
Test Location	27050 Gloucester Way, Langley, B.C.

The following people observed the testing in part or whole:

- Brian Hubbs – RDH Building Engineering Ltd.
- Christopher Black – RDH Building Engineering Ltd.
- Jared Murphy – RDH Building Engineering Ltd.
- Doug Bennion – Quadlock Concrete Building Solutions
- Sean McBeth – Plasti-Fab EPS Product and Solutions
- Herman Sawatzky – Cascadia Windows Ltd.
- Carol Vincent – BC Ready Mix Concrete Association
- Charles Kelly – BC Ready Mix Concrete Association

1.2. Test Specimen Description

Table 1.2.1 Specimen Description

Module #1B	
Wall -Type	Module #1B – External with Buck Flash
- ICF Manufacturer	Plasti-Fab EPS Product and Solutions – Advantage ICF Systems
Window - Manufacturer	Cascadia Windows Ltd.
- Series	300A
Age	0
Overall Dimensions (Width x Height)	Window: 584 x 584 mm (23 x 23 in.) Wall: 1994 x 2032 mm (78 1/2 x 80 in.)
Frame Material	Fibreglass
Thermally Broken	Fibreglass integral to frame
Details Included	Fixed Lite, Perimeter interface, and ICF wall
Material List	The wall was constructed using light-weight EPS by Plasti-Fab Advantage ICF as formwork for the steel reinforced 6” thick concrete. A 23” x 23” fixed window was installed within the wall assembly.

An elevation drawing, section details, and the buck flash details can be found in Appendix B. Figure 1.2.1 illustrates the full view of module 1B as viewed from the exterior.



Fig. 1.2.2 Overall exterior view of Module 1B

2. Summary

2.1. Test Results

Table 2.1.1 Test Results Summary

Module 1A – Internal with Buck Flash	
Water Test Pressure	150 Pa 300 Pa 700 Pa
Test Method	ASTM E283 ASTM E331
Details Included	Fixed Lite, Perimeter Interface, and ICF Wall.
Air Test Results	Less than 0.0039 L/s·m ² @ 75Pa
Water Test Results	150 Pa – Pass 300 Pa – Pass 700 Pa – Fail

2.2. Modifications Performed to Achieve Report Performance Rating

No modifications were required to obtain the ratings listed in Table 2.1.1

3. Air Test Results – ASTM E283

3.1. Test # 1 – 75 Pa

Test Conditions

Test Date: June 5, 2013
Test Time: 3:06 pm
Air Temperature: 19°C
Barometric Pressure: 101,800 Pa
Relative Humidity: 73%

Test Parameters

Pressure Difference: 75 Pa – Positive
Direction of Flow: Infiltration

Table 3.1.1 Air Leakage Rate

Results	
Air Leakage Rate per Total Area of Sample (qA)	Less than 0.0039 L/s·m ²



Fig. 3.1.1 Air Leakage Testing

4. Water Test Results – ASTM E331

4.1. Test #2 - 150 Pa

Test Conditions

Test Date: June 5, 2013
 Test Time: 3:17 pm
 Air Temperature: 19°C
 Relative Humidity: 73%

Test Parameters

Pressure Difference: 150 Pa
 Duration: 15 min (Complete)
 Procedure: Uniform Static
 Observations: No evidence of water ingress.

Table 4.1.1 Test Results

Results	
Result	Pass at 150 Pa

4.2. Test #3 - 300 Pa

Test Conditions

Test Date: June 5, 2013
 Test Time: 3:38 pm
 Air Temperature: 19°C
 Relative Humidity: 73%

Test Parameters

Pressure Difference: 300 Pa
 Duration: 15 min (Complete)
 Procedure: Uniform Static
 Observations: No evidence of water ingress.

Table 4.2.1 Test Results

Results	
Result	Pass at 300 Pa

4.3. Test #4 - 700 Pa

Test Conditions

Test Date: June 5, 2013
 Test Time: 3:59 pm
 Air Temperature: 19°C
 Relative Humidity: 70%

Test Parameters

Pressure Difference: 700 Pa
 Duration: 15 min (Complete)
 Procedure: Uniform Static
 Observations: Evidence of water ingress.

Table 4.3.1 Water Penetration Observations

Penetration Point	
Water Penetration Point	P1
Penetration is a Failure Mode	Yes
Location	Lower right corner between wood buck and EPS formwork
Time	7 min
Volume of Water	Slow Trickle



Fig. 4.3.1 Water penetration point P1 for Module 1B at 700 Pa

Table 4.3.2 Test Results

Results	
Result	Failure at 700 Pa

5. Conclusions

5.1. Air Tightness

When tested to the standard of ASTM E283 at a pressure differential of 75 Pa, the specimen, as prepared, achieved an Air Leakage Rate per fixed area (qA) of less than 0.0039 L/s-m².

5.2. Water Ingress Resistance

When tested to the standard of ASTM E331, no water ingress was observed through the specimen at differential pressures of 150 and 300 Pa. Water ingress was observed through the specimen at a differential pressure of 700 Pa.

RDH Building Engineering Ltd.



Christopher Black, MASC, P.Eng.

Senior Project Engineer, RDH Building Engineering Ltd.

APPENDIX A – TEST PROCEDURES AND SETUP

A.1. Test Pressure Difference

Air Test

The ASTM E283 default pressure of 75 Pa was used.

Water Test

The test pressure is increased incrementally until the specimen can no longer meet the requirements of the standard or it was determined to no longer perform the testing.

A.2. Test Procedures

Air Test

Testing is performed in general conformance with ASTM E283-04 “Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen”.

Refer to the individual test parameters for the procedure used.

Water Test

Testing is performed in general conformance with ASTM E331-00 “Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference”

Refer to the individual test parameters for the procedure used.

A.3. Failure Criteria

The following is a list of the failure criteria used during testing:

Air Test

→ The specimen exceeds a specified maximum allowable air flow rate.

Water Test

Criteria as defined by the standard:

→ Failure occurs when water that penetrates through the frame or other portions of the test specimen and reaches a vertical plane inboard of the innermost projection of the specimen or when water reaches interior finishes or hardware.

→ Failure occurs whenever water penetrates through the perimeter frame of the test specimen.

A.4. Test Equipment

Test Wall

The test wall consists of an aluminum plate supported by a steel frame. The plate is perforated at 462 mm vertically and 267 mm horizontally. At every second hole staggered vertically between columns there is a Spraying Systems Co. – 1/8GG-W 2.8W Fulljet Stainless Steel nozzle installed flush with the plate. Water is pumped through the nozzles with a Summit Type CC pump at the calibrated test pressure. The pressure is controlled by throttling the flow of water with gate valves and is measured by a liquid-filled dial water pressure gauge. The test wall is calibrated in accordance with ASTM standards E331 and E547 to a pressure of 159 kPa (23 psi).

The specimen is set in a wood or fibreglass frame to create a chamber and is supported between 203 ± 51 mm from the test wall during the tests.

Depressurization

Depressurization of the test chamber is achieved through a 3” penetration in the test wall. Air is pumped through these penetrations by a model number R93150A GAST regenerative blower and is controlled by a model M12150C LENZE / AC TECH variable frequency drive. The fan moves air into or out of the chamber at a controlled rate to create the desired pressure differential across the specimen. The pressure differential is measured across the chamber wall with one of the following manometers:

Air Test

→ Dwyer Solid Plastic Stationary Gage, model 201

→ Dwyer Solid Plastic Stationary Gage, model 202.5

→ Meriam Inclined Tube Manometer, model 40HEX35WM

Water Testing

→ Dwyer Solid Plastic Stationary Gage, model 244

The volume of air flow is measured with a model Z50MW20-2 Meriam Laminar Flow Element.

The pressure difference between the lateral groove and the exterior was measured with an Alnor AXD 610 manometer.

A.5. Documentation

Terminology

In the report, water ingress paths and various forms of modifications are denoted in the following manner:

Water Penetration Points – Points of water penetration on the indoor face of the test specimen, and any water penetration as defined by the standard.

Adjustments – Adjustments are items on the test specimen where an installed component required realignment to properly interface with another component. These items are designated with an “A” sequence in modifications.

Deficiencies – Deficiencies are items found on the test specimen that are not manufactured or installed per the manufacturer or project requirements. These items are designated with a “D” sequence in modifications.

Modifications – Modifications are items that are performed on the test specimen that differ from the manufacturer or project requirements. These items are designated with an “M” sequence in modifications.

Orientation References

All references denoting orientation are taken as viewed when facing the test wall and the interior face of the specimen.

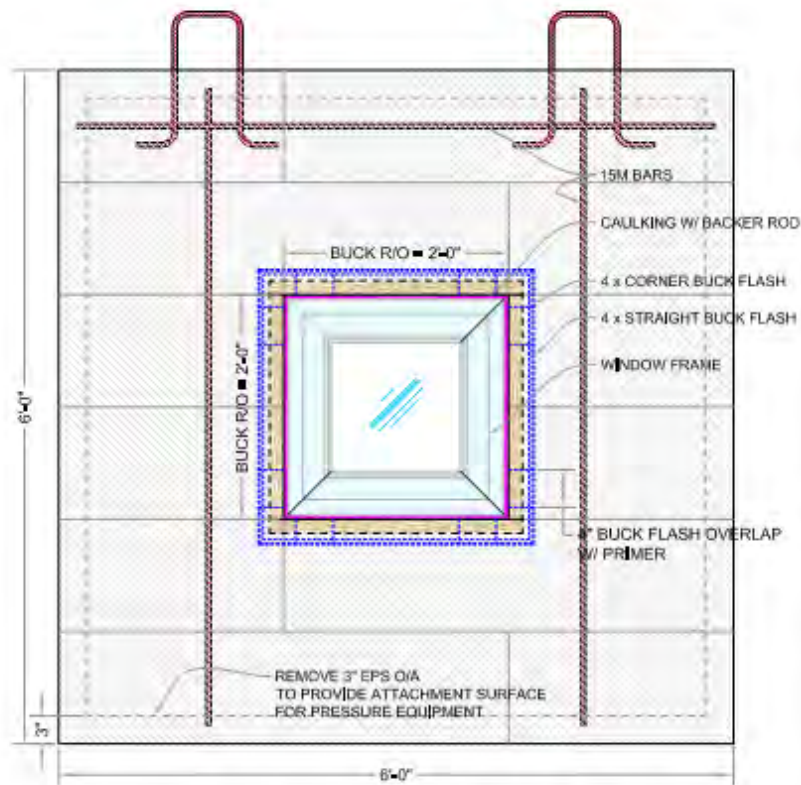
A.6. Deviations from Test Standard

Water Test

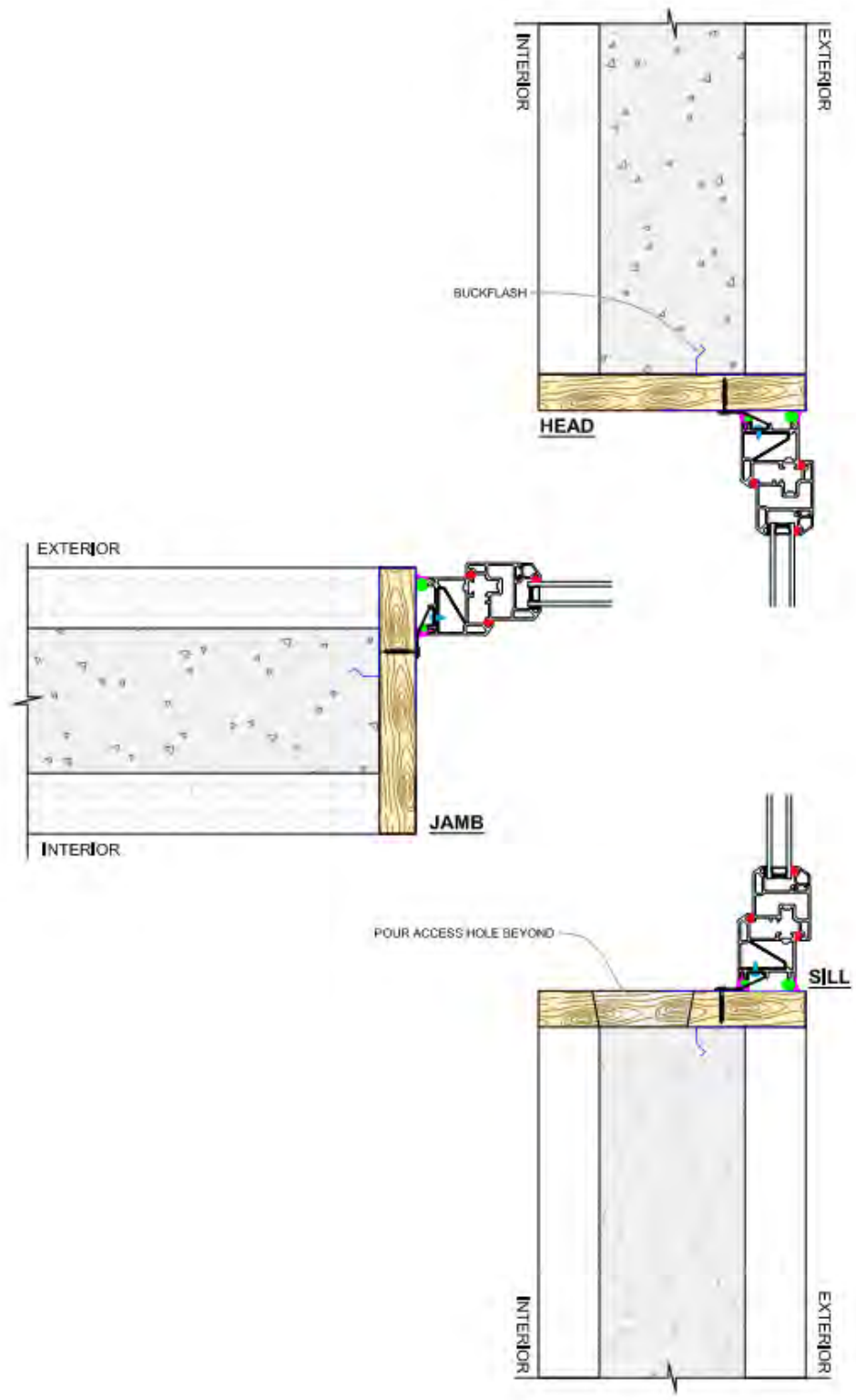
The test is conducted in general conformance with the test standard with the following exception:

→ The barometric air pressure was not recorded, but was obtained afterwards from a nearby weather station in Pitt Meadows, BC.

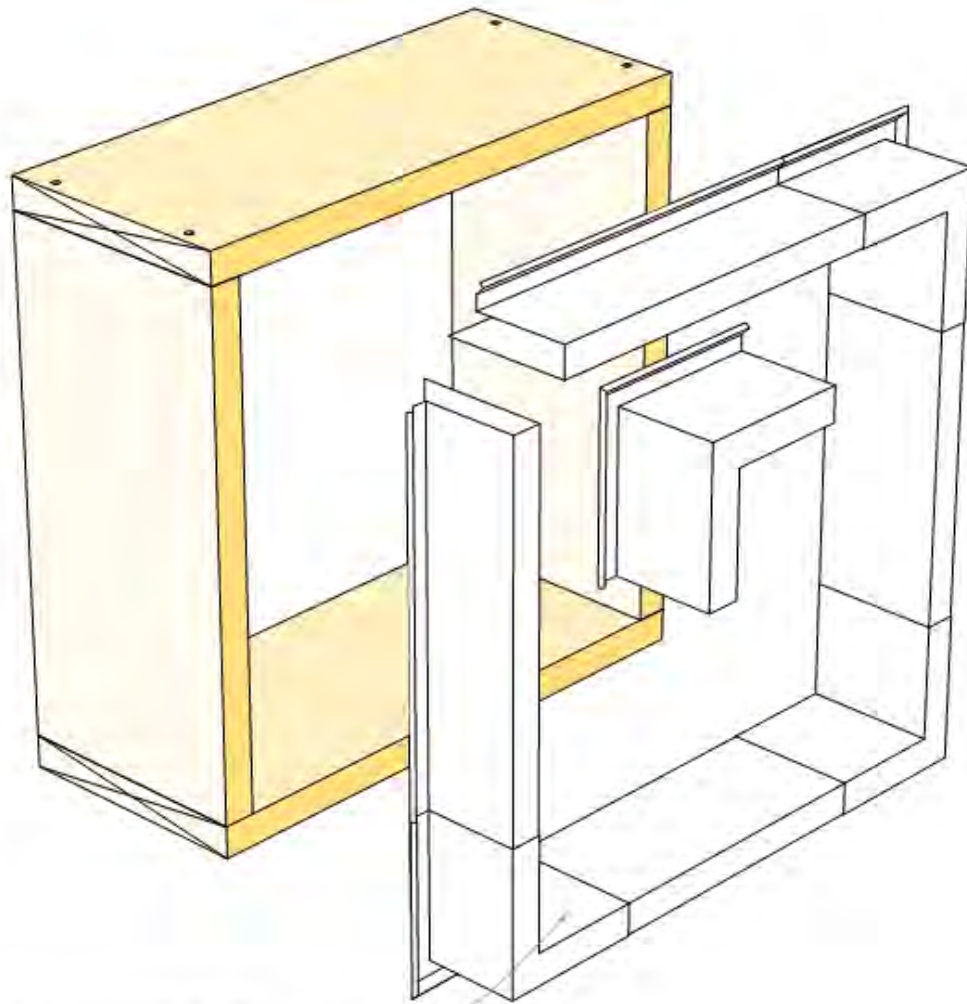
APPENDIX B - TYPICAL DETAILS FOR ICF TEST WALL ASSEMBLY



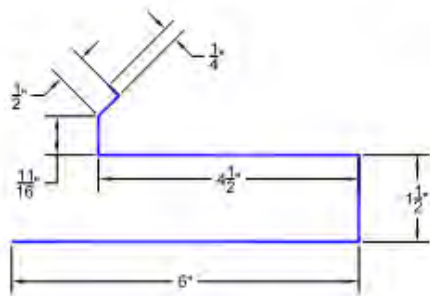
TEST MODULE 1B
EXTERNAL WITH BUCK FLASH



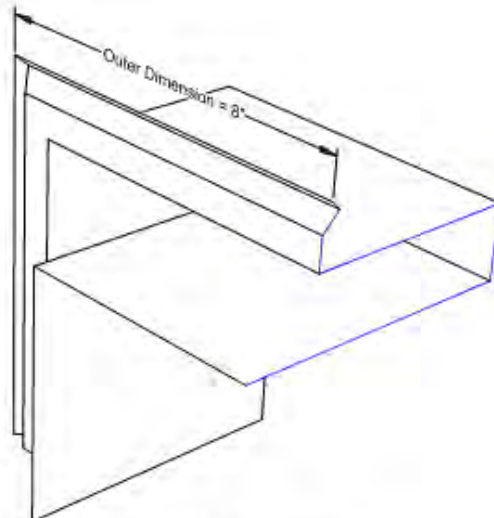
TEST MODULE 1B
 EXTERNAL WITH BUCK FLASH



4" BUCK FLASH OVERLAP WITH PRIMER



STRAIGHT BUCKFLASH



CORNER BUCKFLASH

ASTM E283 & E331 – Lab Test Report – Direct to Concrete



TEST STANDARDS ASTM E283-04 “Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen”

ASTM E331-00 “Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference”

WALL Module #2A - Direct to Concrete

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Appendix A – Test Procedures and Setup

Appendix B – Typical Details for ICF Test Wall Assembly

1. General Information

The following tests were performed to evaluate the performance of the ICF wall with the internal buck:

- 1) A test to determine the ICF wall air leakage rate. Test performed in general conformance with ASTM E283.
- 2) A test to determine the ICF wall water penetration resistance. Test performed in general conformance with ASTM E331.

1.1. Attendees

Table 1.1.1 General Information

General	
Testing Agency	RDH Building Engineering Ltd.
Test Location	27050 Gloucester Way, Langley, B.C.

The following people observed the testing in part or whole:

- Brian Hubbs – RDH Building Engineering Ltd.
- Christopher Black – RDH Building Engineering Ltd.
- Jared Murphy – RDH Building Engineering Ltd.
- Doug Bennion – Quadlock Concrete Building Solutions
- Sean McBeth – Plasti-Fab EPS Product and Solutions
- Herman Sawatzky – Cascadia Windows Ltd.
- Carol Vincent – BC Ready Mix Concrete Association
- Charles Kelly – BC Ready Mix Concrete Association

1.2. Test Specimen Description

Table 1.2.1 Specimen Description

Module #2A	
Wall -Type	Module #2A – Direct to Concrete
- ICF Manufacturer	Plasti-Fab EPS Product and Solutions – Advantage ICF Systems
Window - Manufacturer	Cascadia Windows Ltd.
- Series	300A
Age	0
Overall Dimensions (Width x Height)	Window: 584 x 584 mm (23 x 23 in.) Wall: 1994 x 2032 mm (78 1/2 x 80 in.)
Frame Material	Fibreglass
Thermally Broken	Fibreglass integral to frame
Details Included	Fixed Lite, Perimeter interface, and ICF wall
Material List	The wall was constructed using light-weight EPS by Plasti-Fab Advantage ICF as formwork for the steel reinforced 6” thick concrete. A 23” x 23” fixed window was installed within the wall assembly.

An elevation drawing and section details can be found in Appendix B. Figure 1.2.1 illustrates the full view of module 2A as viewed from the exterior.



Fig. 1.2.2 Overall exterior view of Module 2A

2. Summary

2.1. Test Results

Table 2.1.1 Test Results Summary

Module 1A – Direct to Concrete	
Water Test Pressure	150 Pa 300 Pa 700 Pa
Test Method	ASTM E283 ASTM E331
Details Included	Fixed Lite, Perimeter Interface, and ICF Wall.
Air Test Results	Less than 0.0039 L/s·m ² @ 75Pa
Water Test Results	150 Pa – Pass 300 Pa – Pass 700 Pa – Pass 1400 Pa – Pass 5000 Pa – Pass

2.2. Modifications Performed to Achieve Report Performance Rating

No modifications were required to obtain the ratings listed in Table 2.1.1

3. Air Test Results – ASTM E283

3.1. Test # 1 – 75 Pa

Test Conditions

Test Date: June 6, 2013

Test Time: 4:48 pm

Air Temperature: 25°C

Barometric Pressure: 101,800 Pa

Relative Humidity: 73%

Test Parameters

Pressure Difference: 75 Pa – Positive

Direction of Flow: Infiltration

Table 3.1.1 Air Leakage Rate

Results	
Air Leakage Rate per Total Area of Sample (qA)	Less than 0.0039 L/s·m ²

4. Water Test Results – ASTM E331

4.1. Test #2 - 150 Pa

Test Conditions

Test Date: June 6, 2013
 Test Time: 5:45 pm
 Air Temperature: 20°C
 Relative Humidity: 60%

Test Parameters

Pressure Difference: 150 Pa
 Duration: 15 min (Complete)
 Procedure: Uniform Static
 Observations: No evidence of water ingress.

Table 4.1.1 Test Results

Results	
Result	Pass at 150 Pa

4.2. Test #3 - 300 Pa

Test Conditions

Test Date: June 6, 2013
 Test Time: 6:07 pm
 Air Temperature: 21°C
 Relative Humidity: 56%

Test Parameters

Pressure Difference: 300 Pa
 Duration: 15 min (Complete)
 Procedure: Uniform Static
 Observations: No evidence of water ingress.

Table 4.2.1 Test Results

Results	
Result	Pass at 300 Pa

4.3. Test #4 - 700 Pa

Test Conditions

Test Date: June 6, 2013
 Test Time: 6:24 pm
 Air Temperature: 21°C
 Relative Humidity: 56%

Test Parameters

Pressure Difference: 700 Pa
 Duration: 15 min (Complete)
 Procedure: Uniform Static
 Observations: No evidence of water ingress.

Table 4.3.1 Test Results

Results	
Result	Pass at 700 Pa



Fig. 4.3.1 Water Testing on Module 2A

4.4. Test #5 - 1400 Pa

Test Conditions

Test Date: June 6, 2013
Test Time: 6:39 pm
Air Temperature: 20°C
Relative Humidity: 49%

Test Parameters

Pressure Difference: 1400 Pa
Duration: 15 min (Complete)
Procedure: Uniform Static
Observations: No evidence of water ingress.

Table 4.4.1 Test Results

Results	
Result	Pass at 1400 Pa

4.5. Test #6 - 5000 Pa

Test Conditions

Test Date: June 6, 2013
Test Time: 6:54 pm
Air Temperature: 20°C
Relative Humidity: 49%

Test Parameters

Pressure Difference: 5000 Pa
Duration: 15 min (Complete)
Procedure: Uniform Static
Observations: No evidence of water ingress.

Table 4.5.1 Test Results

Results	
Result	Pass at 5000 Pa

5. Conclusions

5.1. Air Tightness

When tested to the standard of ASTM E283 at a pressure differential of 75 Pa, the specimen, as prepared, achieved an Air Leakage Rate per fixed area (qA) of less than 0.0039 L/s·m².

5.2. Water Ingress Resistance

When tested to the standard of ASTM E331, no water ingress was observed through the specimen at differential pressures of 150, 300, 700, 1400, and 5000 Pa.

RDH Building Engineering Ltd.



Christopher Black, MASC, P.Eng.

Senior Project Engineer, RDH Building Engineering Ltd.

APPENDIX A – TEST PROCEDURES AND SETUP

A.1. Test Pressure Difference

Air Test

The ASTM E283 default pressure of 75 Pa was used.

Water Test

The test pressure is increased incrementally until the specimen can no longer meet the requirements of the standard or it was determined to no longer perform the testing.

A.2. Test Procedures

Air Test

Testing is performed in general conformance with ASTM E283-04 “Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen”.

Refer to the individual test parameters for the procedure used.

Water Test

Testing is performed in general conformance with ASTM E331-00 “Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference”

Refer to the individual test parameters for the procedure used.

A.3. Failure Criteria

The following is a list of the failure criteria used during testing:

Air Test

→ The specimen exceeds a specified maximum allowable air flow rate.

Water Test

Criteria as defined by the standard:

→ Failure occurs when water that penetrates through the frame or other portions of the test specimen and reaches a vertical plane inboard of the innermost projection of the specimen or when water reaches interior finishes or hardware.

→ Failure occurs whenever water penetrates through the perimeter frame of the test specimen.

A.4. Test Equipment

Test Wall

The test wall consists of an aluminum plate supported by a steel frame. The plate is perforated at 462 mm vertically and 267 mm horizontally. At every second hole staggered vertically between columns there is a Spraying Systems Co. – 1/8GG-W 2.8W Fulljet Stainless Steel nozzle installed flush with the plate. Water is pumped through the nozzles with a Summit Type CC pump at the calibrated test pressure. The pressure is controlled by throttling the flow of water with gate valves and is measured by a liquid-filled dial water pressure gauge. The test wall is calibrated in accordance with ASTM standards E331 and E547 to a pressure of 159 kPa (23 psi).

The specimen is set in a wood or fibreglass frame to create a chamber and is supported between 203 ± 51 mm from the test wall during the tests.

Depressurization

Depressurization of the test chamber is achieved through a 3” penetration in the test wall. Air is pumped through these penetrations by a model number R93150A GAST regenerative blower and is controlled by a model M12150C LENZE / AC TECH variable frequency drive. The fan moves air into or out of the chamber at a controlled rate to create the desired pressure differential across the specimen. The pressure differential is measured across the chamber wall with one of the following manometers:

Air Test

→ Dwyer Solid Plastic Stationary Gage, model 201

→ Dwyer Solid Plastic Stationary Gage, model 202.5

→ Meriam Inclined Tube Manometer, model 40HEX35WM

Water Testing

→ Dwyer Solid Plastic Stationary Gage, model 244

The volume of air flow is measured with a model Z50MW20-2 Meriam Laminar Flow Element.

The pressure difference between the lateral groove and the exterior was measured with an Alnor AXD 610 manometer.

A.5. Documentation

Terminology

In the report, water ingress paths and various forms of modifications are denoted in the following manner:

Water Penetration Points – Points of water penetration on the indoor face of the test specimen, and any water penetration as defined by the standard.

Adjustments – Adjustments are items on the test specimen where an installed component required realignment to properly interface with another component. These items are designated with an “A” sequence in modifications.

Deficiencies – Deficiencies are items found on the test specimen that are not manufactured or installed per the manufacturer or project requirements. These items are designated with a “D” sequence in modifications.

Modifications – Modifications are items that are performed on the test specimen that differ from the manufacturer or project requirements. These items are designated with an “M” sequence in modifications.

Orientation References

All references denoting orientation are taken as viewed when facing the test wall and the interior face of the specimen.

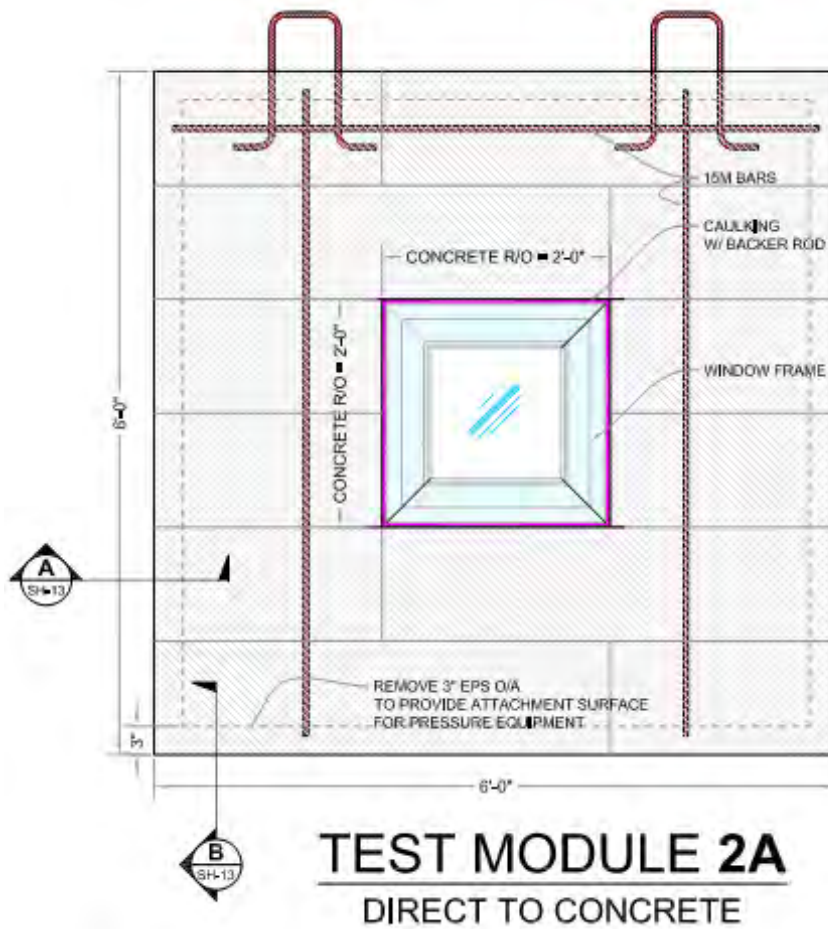
A.6. Deviations from Test Standard

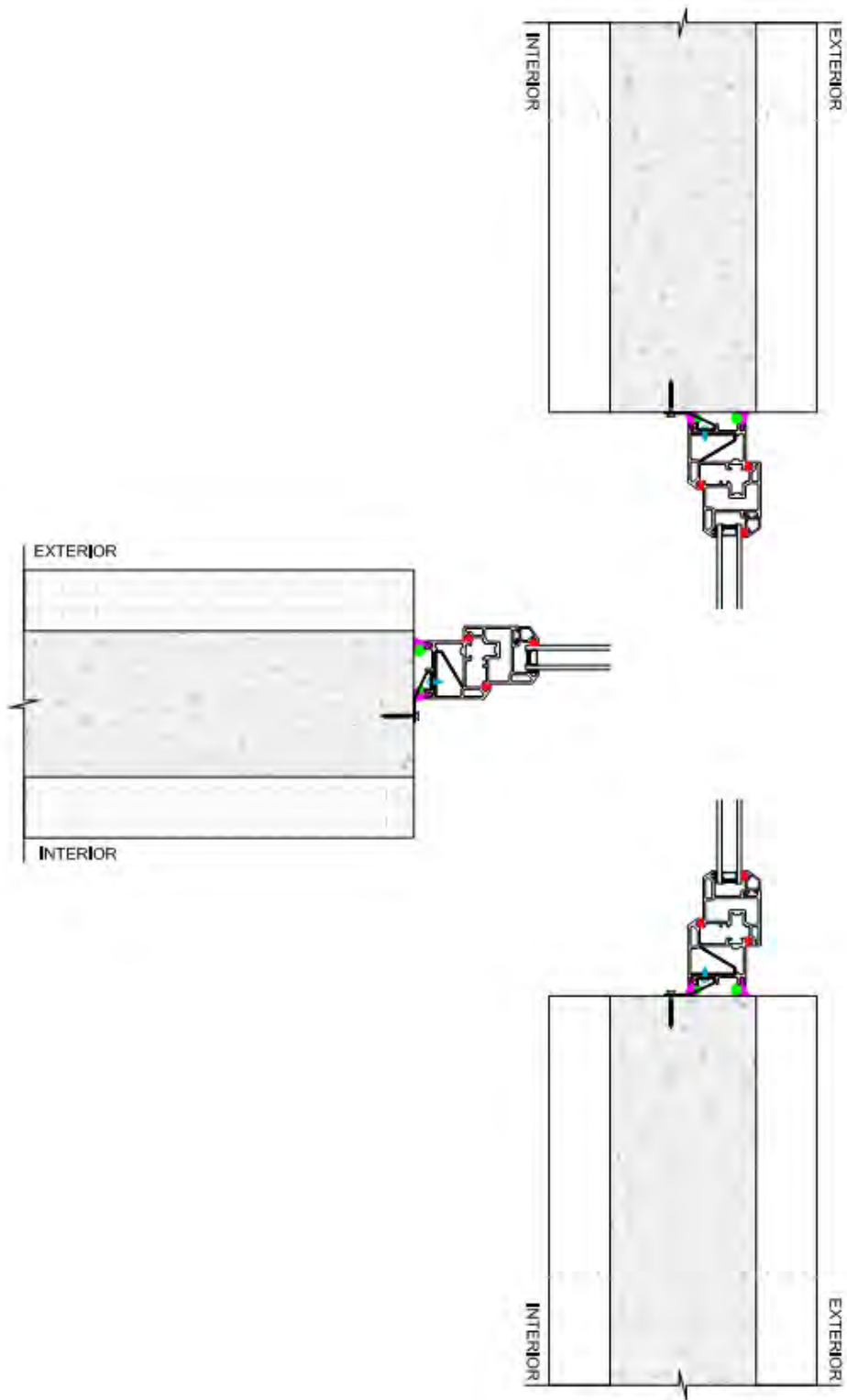
Water Test

The test is conducted in general conformance with the test standard with the following exception:

→ The barometric air pressure was not recorded, but was obtained afterwards from a nearby weather station in Pitt Meadows, BC.

APPENDIX B - TYPICAL DETAILS FOR ICF TEST WALL ASSEMBLY





TEST MODULE 2A

DIRECT TO CONCRETE

ASTM E283 & E331 – Lab Test Report – EIFS Basecoat

4975.10 – ICF Wall Testing



TEST STANDARDS ASTM E283-04 “Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen”
ASTM E331-00 “Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference”

WALL Module #2B – EIFS Basecoat

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Appendix A – Test Procedures and Setup

Appendix B – Typical Details for ICF Test Wall Assembly

1. General Information

The following tests were performed to evaluate the performance of the ICF wall with the internal buck:

- 1) A test to determine the ICF wall air leakage rate. Test performed in general conformance with ASTM E283.
- 2) A test to determine the ICF wall water penetration resistance. Test performed in general conformance with ASTM E331.

1.1. Attendees

Table 1.1.1 General Information

General	
Testing Agency	RDH Building Engineering Ltd.
Test Location	27050 Gloucester Way, Langley, B.C.

The following people observed the testing in part or whole:

- Brian Hubbs – RDH Building Engineering Ltd.
- Christopher Black – RDH Building Engineering Ltd.
- Jared Murphy – RDH Building Engineering Ltd.
- Doug Bennion – Quadlock Concrete Building Solutions
- Sean McBeth – Plasti-Fab EPS Product and Solutions
- Herman Sawatzky – Cascadia Windows Ltd.
- Carol Vincent – BC Ready Mix Concrete Association
- Charles Kelly – BC Ready Mix Concrete Association

1.2. Test Specimen Description

Table 1.2.1 Specimen Description

Module #2B	
Wall -Type	Module #2B – EIFS Basecoat
- ICF Manufacturer	Plasti-Fab EPS Product and Solutions – Advantage ICF Systems
- EIFS Manufacturer	Dryvit Systems Canada
Window - Manufacturer	Cascadia Windows Ltd.
- Series	300A
Age	0
Overall Dimensions (Width x Height)	Window: 584 x 584 mm (23 x 23 in.) Wall: 1994 x 2032 mm (78 1/2 x 80 in.)
Frame Material	Fibreglass
Thermally Broken	Fibreglass integral to frame
Details Included	Fixed Lite, Perimeter interface, and ICF wall
Material List	The wall was constructed using light-weight EPS by Plasti-Fab Advantage ICF as formwork for the steel reinforced 6” thick concrete. A 23” x 23” fixed window was installed within the wall assembly.

An elevation drawing and section details can be found in Appendix B. Figure 1.2.1 illustrates the full view of module 2B as viewed from the exterior. The EIFS basecoat was constructed with Genesis DM by Dryvit, Dryflex by Dryvit, Sandpebble DPR by Dryvit,



Fig. 1.2.1 Overall exterior view of Module 2B

2. Summary

2.1. Test Results

Table 2.1.1 Test Results Summary

Module 2B – EIFS Basecoat	
Water Test Pressure	150 Pa 300 Pa 700 Pa
Test Method	ASTM E283 ASTM E331
Details Included	Fixed Lite, Perimeter Interface, EIFS Basecoat, and ICF Wall.
Air Test Results	Less than 0.0039 L/s·m ² @ 75Pa
Water Test Results	150 Pa – Pass 300 Pa – Pass 700 Pa – Pass

2.2. Modifications Performed to Achieve Report Performance Rating

No modifications were required to obtain the ratings listed in Table 2.1.1

3. Air Test Results – ASTM E283

3.1. Test # 1 – 75 Pa

Test Conditions

Test Date: June 5, 2013
Test Time: 4:33 pm
Air Temperature: 23°C
Barometric Pressure: 101,800 Pa
Relative Humidity: 73%

Test Parameters

Pressure Difference: 75 Pa – Positive
Direction of Flow: Infiltration

Table 3.1.1 Air Leakage Rate

Results	
Air Leakage Rate per Total Area of Sample (qA)	Less than 0.0039 L/s·m ²



Fig. 3.1.2 Air Leakage Testing

4. Water Test Results – ASTM E331

4.1. Test #2 - 150 Pa

Test Conditions

Test Date: June 5, 2013
Test Time: 4:42 pm
Air Temperature: 19°C
Relative Humidity: 73%

Test Parameters

Pressure Difference: 150 Pa
Duration: 15 min (Complete)
Procedure: Uniform Static
Observations: No evidence of water ingress.

Table 4.1.1 Test Results

Results	
Result	Pass at 150 Pa

4.2. Test #3 - 300 Pa

Test Conditions

Test Date: June 5, 2013
Test Time: 5:02 pm
Air Temperature: 19°C
Relative Humidity: 62%

Test Parameters

Pressure Difference: 300 Pa
Duration: 15 min (Complete)
Procedure: Uniform Static
Observations: No evidence of water ingress.

Table 4.2.1 Test Results

Results	
Result	Pass at 300 Pa

4.3. Test #4 - 700 Pa

Test Conditions

Test Date: June 5, 2013
Test Time: 5:22 pm
Air Temperature: 19°C
Relative Humidity: 62%

Test Parameters

Pressure Difference: 700 Pa
Duration: 15 min (Complete)
Procedure: Uniform Static
Observations: No evidence of water ingress.

Table 4.3.1 Test Results

Results	
Result	Pass at 700 Pa

5. Conclusions

5.1. Air Tightness

When tested to the standard of ASTM E283 at a pressure differential of 75 Pa, the specimen, as prepared, achieved an Air Leakage Rate per fixed area (qA) of less than 0.0039 L/s-m².

5.2. Water Ingress Resistance

When tested to the standard of ASTM E331, no water ingress was observed through the specimen at differential pressures of 150, 300, and 700 Pa.

RDH Building Engineering Ltd.



Christopher Black, MASC, P.Eng.

Senior Project Engineer, RDH Building Engineering Ltd.

APPENDIX A – TEST PROCEDURES AND SETUP

A.1. Test Pressure Difference

Air Test

The ASTM E283 default pressure of 75 Pa was used.

Water Test

The test pressure is increased incrementally until the specimen can no longer meet the requirements of the standard or it was determined to no longer perform the testing.

A.2. Test Procedures

Air Test

Testing is performed in general conformance with ASTM E283-04 “Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen”.

Refer to the individual test parameters for the procedure used.

Water Test

Testing is performed in general conformance with ASTM E331-00 “Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference”

Refer to the individual test parameters for the procedure used.

A.3. Failure Criteria

The following is a list of the failure criteria used during testing:

Air Test

→ The specimen exceeds a specified maximum allowable air flow rate.

Water Test

Criteria as defined by the standard:

→ Failure occurs when water that penetrates through the frame or other portions of the test specimen and reaches a vertical plane inboard of the innermost projection of the specimen or when water reaches interior finishes or hardware.

→ Failure occurs whenever water penetrates through the perimeter frame of the test specimen.

A.4. Test Equipment

Test Wall

The test wall consists of an aluminum plate supported by a steel frame. The plate is perforated at 462 mm vertically and 267 mm horizontally. At every second hole staggered vertically between columns there is a Spraying Systems Co. – 1/8GG-W 2.8W Fulljet Stainless Steel nozzle installed flush with the plate. Water is pumped through the nozzles with a Summit Type CC pump at the calibrated test pressure. The pressure is controlled by throttling the flow of water with gate valves and is measured by a liquid-filled dial water pressure gauge. The test wall is calibrated in accordance with ASTM standards E331 and E547 to a pressure of 159 kPa (23 psi).

The specimen is set in a wood or fibreglass frame to create a chamber and is supported between 203 ± 51 mm from the test wall during the tests.

Depressurization

Depressurization of the test chamber is achieved through a 3” penetration in the test wall. Air is pumped through these penetrations by a model number R93150A GAST regenerative blower and is controlled by a model M12150C LENZE / AC TECH variable frequency drive. The fan moves air into or out of the chamber at a controlled rate to create the desired pressure differential across the specimen. The pressure differential is measured across the chamber wall with one of the following manometers:

Air Test

→ Dwyer Solid Plastic Stationary Gage, model 201

→ Dwyer Solid Plastic Stationary Gage, model 202.5

→ Meriam Inclined Tube Manometer, model 40HEX35WM

Water Testing

→ Dwyer Solid Plastic Stationary Gage, model 244

The volume of air flow is measured with a model Z50MW20-2 Meriam Laminar Flow Element.

The pressure difference between the lateral groove and the exterior was measured with an Alnor AXD 610 manometer.

A.5. Documentation

Terminology

In the report, water ingress paths and various forms of modifications are denoted in the following manner:

Water Penetration Points – Points of water penetration on the indoor face of the test specimen, and any water penetration as defined by the standard.

Adjustments – Adjustments are items on the test specimen where an installed component required realignment to properly interface with another component. These items are designated with an “A” sequence in modifications.

Deficiencies – Deficiencies are items found on the test specimen that are not manufactured or installed per the manufacturer or project requirements. These items are designated with a “D” sequence in modifications.

Modifications – Modifications are items that are performed on the test specimen that differ from the manufacturer or project requirements. These items are designated with an “M” sequence in modifications.

Orientation References

All references denoting orientation are taken as viewed when facing the test wall and the interior face of the specimen.

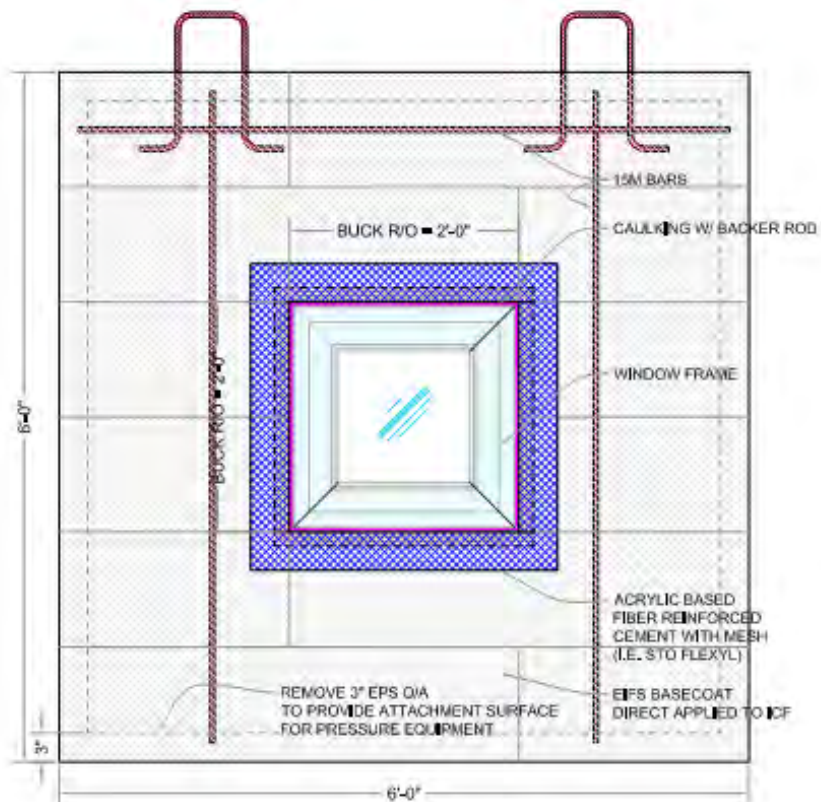
A.6. Deviations from Test Standard

Water Test

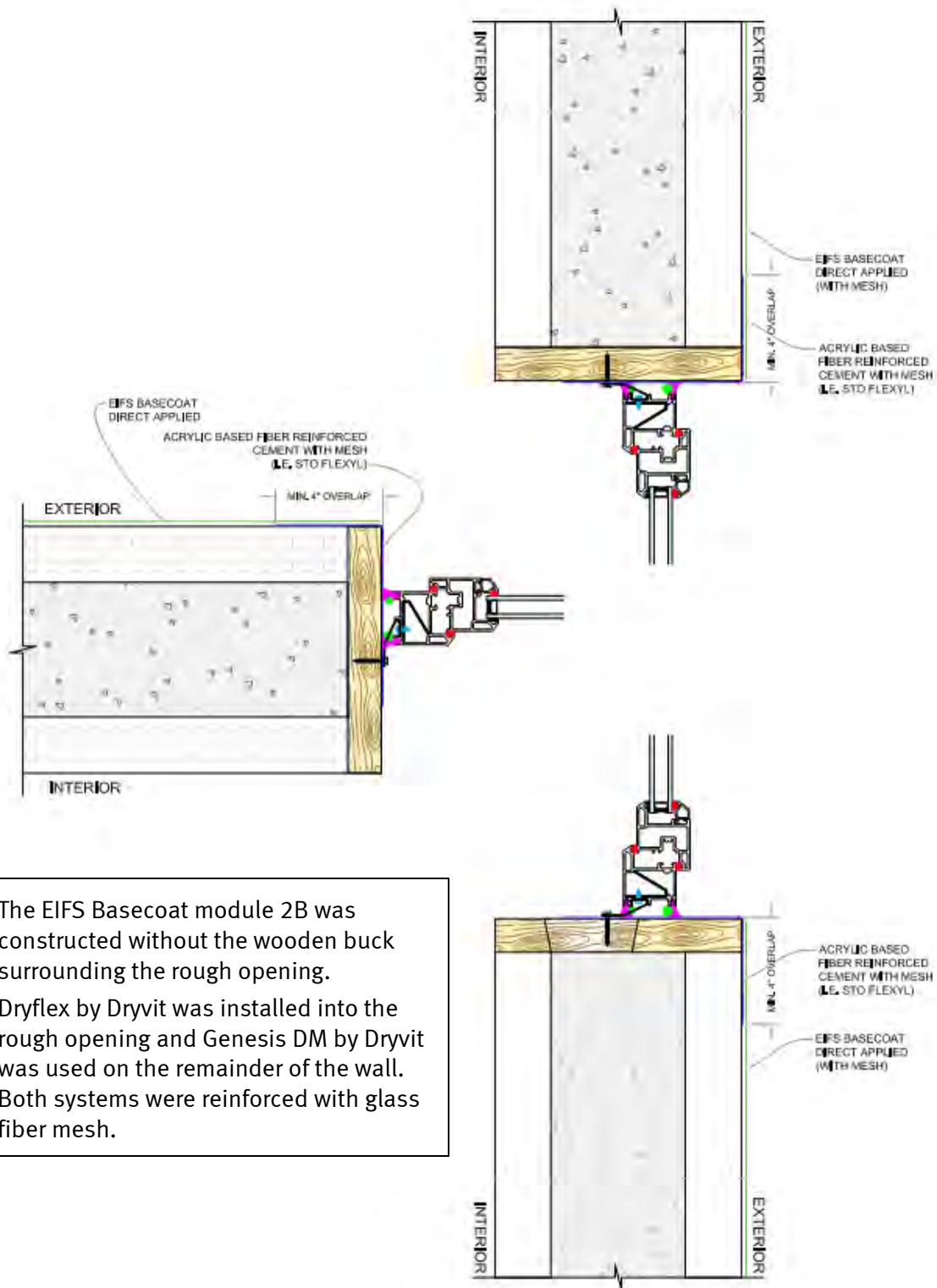
The test is conducted in general conformance with the test standard with the following exception:

→ The barometric air pressure was not recorded, but was obtained afterwards from a nearby weather station in Pitt Meadows, BC.

APPENDIX B - TYPICAL DETAILS FOR ICF TEST WALL ASSEMBLY



TEST MODULE 2B EIFS BASECOAT



- 1) The EIFS Basecoat module 2B was constructed without the wooden buck surrounding the rough opening.
- 2) Dryflex by Dryvit was installed into the rough opening and Genesis DM by Dryvit was used on the remainder of the wall. Both systems were reinforced with glass fiber mesh.

TEST MODULE 2B

EIFS BASECOAT

ASTM E283 & E331 –Lab Test Report – Benchmark (2C) – Sheathing Paper Paper



TEST STANDARDS	ASTM E283-04 “Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen” ASTM E331-00 “Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference”
WALL	Benchmark (2C) – Sheathing Paper

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Appendix A – Test Procedures and Setup

Appendix B – Typical Details for ICF Test Wall Assembly

1. General Information

The following tests were performed to evaluate the performance of the ICF wall with the internal buck:

- 1) A test to determine the ICF wall air leakage rate. Test performed in general conformance with ASTM E283.
- 2) A test to determine the ICF wall water penetration resistance. Test performed in general conformance with ASTM E331.

1.1. Attendees

Table 1.1.1 General Information

General	
Testing Agency	RDH Building Engineering Ltd.
Test Location	27050 Gloucester Way, Langley, B.C.

The following people observed the testing in part or whole:

- Brian Hubbs – RDH Building Engineering Ltd.
- Christopher Black – RDH Building Engineering Ltd.
- Jared Murphy – RDH Building Engineering Ltd.
- Doug Bennion – Quadlock Concrete Building Solutions
- Sean McBeth – Plasti-Fab EPS Product and Solutions
- Herman Sawatzky – Cascadia Windows Ltd.
- Carol Vincent – BC Ready Mix Concrete Association
- Charles Kelly – BC Ready Mix Concrete Association

1.2. Test Specimen Description

Table 1.2.1 Specimen Description

Module #2C	
Wall -Type	Module #2C – Benchmark – Sheathing Paper
- ICF Manufacturer	Plasti-Fab EPS Product and Solutions – Advantage ICF Systems
Window - Manufacturer	Cascadia Windows Ltd.
- Series	300A
Age	0
Overall Dimensions (Width x Height)	Window: 584 x 584 mm (23 x 23 in.) Wall: 1994 x 2032 mm (78 1/2 x 80 in.)
Frame Material	Fibreglass
Thermally Broken	Fibreglass integral to frame
Details Included	Fixed Lite, Perimeter interface, and ICF wall
Material List	The wall was constructed using light-weight EPS by Plasti-Fab Advantage ICF as formwork for the steel reinforced 6” thick concrete. A 23” x 23” fixed window was installed within the wall assembly.

An elevation drawing and section details can be found in Appendix B. Figure 1.2.1 illustrates the full view of module 2C as viewed from the exterior.



Fig. 1.2.2 Overall exterior view of Module 2C

2. Summary

2.1. Test Results

Table 2.1.1 Test Results Summary

Module 2C – Benchmark – Sheathing Paper	
Water Test Pressure	150 Pa 300 Pa 700 Pa
Test Method	ASTM E283 ASTM E331
Details Included	Fixed Lite, Perimeter Interface, and ICF Wall.
Air Test Results	Less than 0.0039 L/s·m ² @ 75Pa
Water Test Results	150 Pa – Fail

2.2. Modifications Performed to Achieve Report Performance Rating

No modifications were required to obtain the ratings listed in Table 2.1.1

3. Air Test Results – ASTM E283

3.1. Test # 1 – 75 Pa

Test Conditions

Test Date: June 5, 2013
Test Time: 3:06 pm
Air Temperature: 19°C
Barometric Pressure: 101,800 Pa
Relative Humidity: 73%

Test Parameters

Pressure Difference: 75 Pa – Positive
Direction of Flow: Infiltration

Table 3.1.1 Air Leakage Rate

Results	
Air Leakage Rate per Total Area of Sample (qA)	Less than 0.0039 L/s·m ²

4. Water Test Results – ASTM E331

4.1. Test #2 - 150 Pa

Test Conditions

Test Date: June 6, 2013

Test Time: 4:55 pm

Air Temperature: 20°C

Relative Humidity: 60%

Test Parameters

Pressure Difference: 150 Pa

Duration: 15 min (Complete)

Procedure: Uniform Static

Observations: Evidence of water ingress.

Table 4.1.1 Water Penetration Observations

Penetration Point	
Water Penetration Point	P1
Penetration is a Failure Mode	Yes
Location	Lower left corner of the window.
Time	4 min
Volume of Water	Small pooling



Fig. 4.1.1 Water penetration point P1 for Module 2C at 150 Pa

Table 4.1.2 Test Results

Results	
Result	Failure at 150 Pa



Fig. 4.1.2 Water ingress at lower left-hand corner of window penetrated through the fasteners

5. Conclusions

5.1. Air Tightness

When tested to the standard of ASTM E283 at a pressure differential of 75 Pa, the specimen, as prepared, achieved an Air Leakage Rate per fixed area (qA) of less than 0.0039 L/s·m².

5.2. Water Ingress Resistance

When tested to the standard of ASTM E331, water ingress was observed through the specimen as prepared at a differential pressure of 150 Pa.

RDH Building Engineering Ltd.



Christopher Black, MASC, P.Eng.

Senior Project Engineer, RDH Building Engineering Ltd.

APPENDIX A – TEST PROCEDURES AND SETUP

A.1. Test Pressure Difference

Air Test

The ASTM E283 default pressure of 75 Pa was used.

Water Test

The test pressure is increased incrementally until the specimen can no longer meet the requirements of the standard or it was determined to no longer perform the testing.

A.2. Test Procedures

Air Test

Testing is performed in general conformance with ASTM E283-04 “Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen”.

Refer to the individual test parameters for the procedure used.

Water Test

Testing is performed in general conformance with ASTM E331-00 “Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference”

Refer to the individual test parameters for the procedure used.

A.3. Failure Criteria

The following is a list of the failure criteria used during testing:

Air Test

⇨ The specimen exceeds a specified maximum allowable air flow rate.

Water Test

Criteria as defined by the standard:

⇨ Failure occurs when water that penetrates through the frame or other portions of the test specimen and reaches a vertical plane inboard of the innermost projection of the specimen or when water reaches interior finishes or hardware.

⇨ Failure occurs whenever water penetrates through the perimeter frame of the test specimen.

A.4. Test Equipment

Test Wall

The test wall consists of an aluminum plate supported by a steel frame. The plate is perforated at 462 mm vertically and 267 mm horizontally. At every second hole staggered vertically between columns there is a Spraying Systems Co. – 1/8GG-W 2.8W Fulljet Stainless Steel nozzle installed flush with the plate. Water is pumped through the nozzles with a Summit Type CC pump at the calibrated test pressure. The pressure is controlled by throttling the flow of water with gate valves and is measured by a liquid-filled dial water pressure gauge. The test wall is calibrated in accordance with ASTM standards E331 and E547 to a pressure of 159 kPa (23 psi).

The specimen is set in a wood or fibreglass frame to create a chamber and is supported between 203 ± 51 mm from the test wall during the tests.

Depressurization

Depressurization of the test chamber is achieved through a 3” penetration in the test wall. Air is pumped through these penetrations by a model number R93150A GAST regenerative blower and is controlled by a model M12150C LENZE / AC TECH variable frequency drive. The fan moves air into or out of the chamber at a controlled rate to create the desired pressure differential across the specimen. The pressure differential is measured across the chamber wall with one of the following manometers:

Air Test

⇨ Dwyer Solid Plastic Stationary Gage, model 201

⇨ Dwyer Solid Plastic Stationary Gage, model 202.5

→ Meriam Inclined Tube Manometer, model 40HEX35WM

Water Testing

→ Dwyer Solid Plastic Stationary Gage, model 244

The volume of air flow is measured with a model Z50MW20-2 Meriam Laminar Flow Element.

The pressure difference between the lateral groove and the exterior was measured with an Alnor AXD 610 manometer.

A.5. Documentation

Terminology

In the report, water ingress paths and various forms of modifications are denoted in the following manner:

Water Penetration Points – Points of water penetration on the indoor face of the test specimen, and any water penetration as defined by the standard.

Adjustments – Adjustments are items on the test specimen where an installed component required realignment to properly interface with another component. These items are designated with an “A” sequence in modifications.

Deficiencies – Deficiencies are items found on the test specimen that are not manufactured or installed per the manufacturer or project requirements. These items are designated with a “D” sequence in modifications.

Modifications – Modifications are items that are performed on the test specimen that differ from the manufacturer or project requirements. These items are designated with an “M” sequence in modifications.

Orientation References

All references denoting orientation are taken as viewed when facing the test wall and the interior face of the specimen.

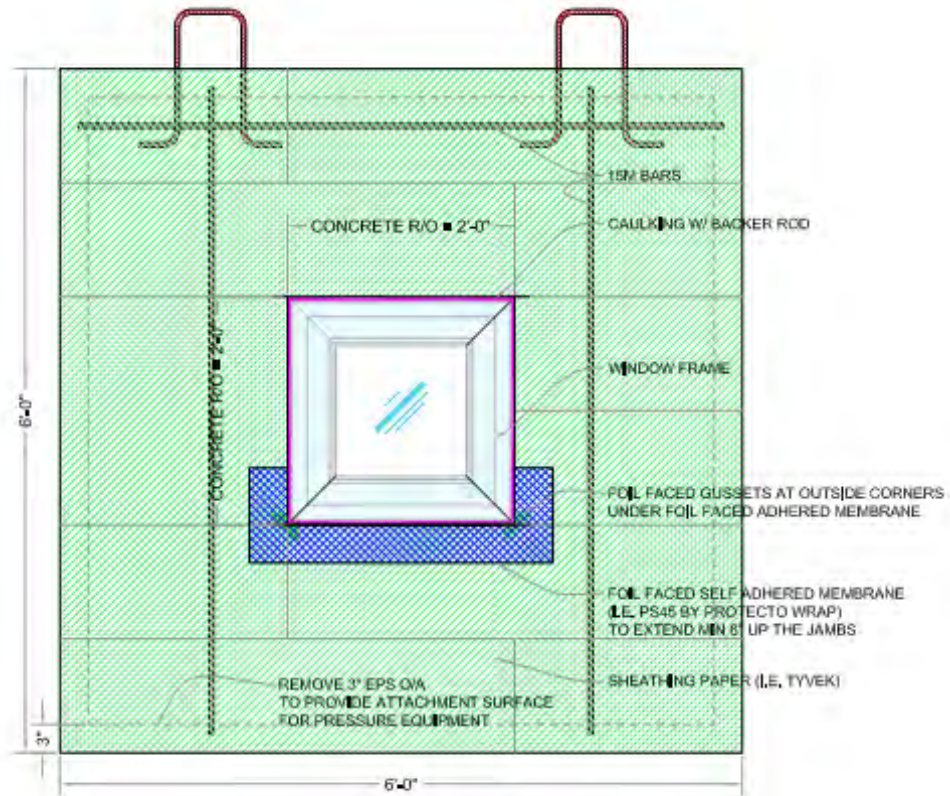
A.6. Deviations from Test Standard

Water Test

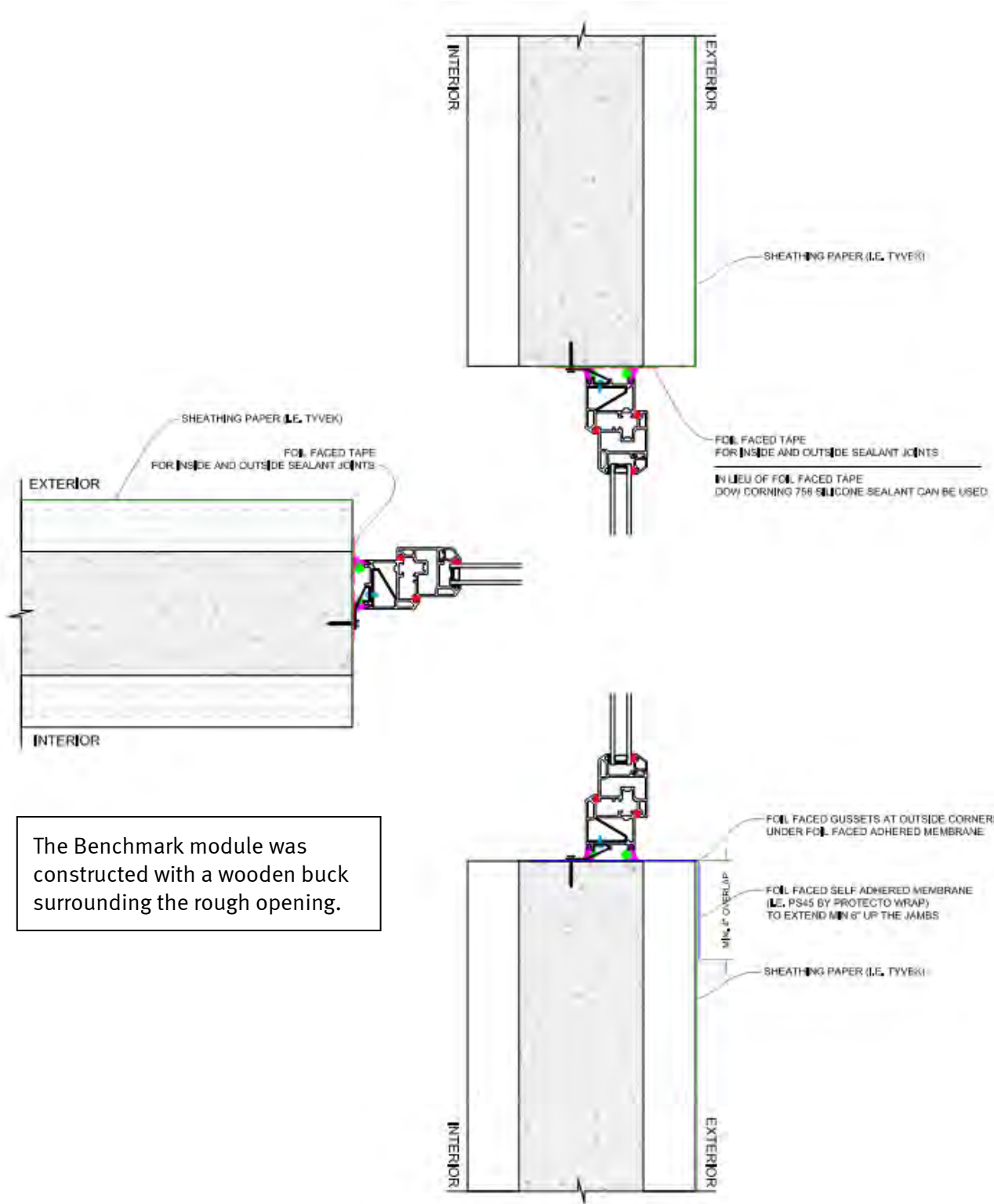
The test is conducted in general conformance with the test standard with the following exception:

→ The barometric air pressure was not recorded, but was obtained afterwards from a nearby weather station in Pitt Meadows, BC.

APPENDIX B - TYPICAL DETAILS FOR ICF TEST WALL ASSEMBLY



BENCHMARK SHEATHING PAPER



The Benchmark module was constructed with a wooden buck surrounding the rough opening.

BENCHMARK

SHEATHING PAPER

ASTM E283 & E331 – Lab Test Report – Gorilla Buck



TEST STANDARDS ASTM E283-04 “Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen”
ASTM E331-00 “Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference”

WALL Gorilla Buck

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Appendix A – Test Procedures and Setup

Appendix B – Typical Details for ICF Test Wall Assembly

1. General Information

The following tests were performed to evaluate the performance of the ICF wall with the internal buck:

- 1) A test to determine the ICF wall air leakage rate. Test performed in general conformance with ASTM E283.
- 2) A test to determine the ICF wall water penetration resistance. Test performed in general conformance with ASTM E331.

1.1. Attendees

Table 1.1.1 General Information

General	
Testing Agency	RDH Building Engineering Ltd.
Test Location	27050 Gloucester Way, Langley, B.C.

The following people observed the testing in part or whole:

- Brian Hubbs – RDH Building Engineering Ltd.
- Christopher Black – RDH Building Engineering Ltd.
- Jared Murphy – RDH Building Engineering Ltd.
- Doug Bennion – Quadlock Concrete Building Solutions
- Sean McBeth – Plasti-Fab EPS Product and Solutions
- Herman Sawatzky – Cascadia Windows Ltd.
- Carol Vincent – BC Ready Mix Concrete Association
- Charles Kelly – BC Ready Mix Concrete Association

1.2. Test Specimen Description

Table 1.2.1 Specimen Description

Gorilla Buck Module	
Wall -Type	Gorilla Buck Module
- ICF Manufacturer	Plasti-Fab EPS Product and Solutions – Advantage ICF Systems
Window - Manufacturer	Cascadia Windows Ltd.
- Series	300A
Age	0
Overall Dimensions (Width x Height)	Window: 584 x 584 mm (23 x 23 in.) Wall: 1994 x 2032 mm (78 1/2 x 80 in.)
Frame Material	Fibreglass
Thermally Broken	Fibreglass integral to frame
Details Included	Fixed Lite, Perimeter interface, and ICF wall
Material List	The wall was constructed using light-weight EPS by Plasti-Fab Advantage ICF as formwork for the steel reinforced 6” thick concrete. A 23” x 23” fixed window was installed within the wall assembly.

An elevation drawing, section details, and the buck flash details can be found in Appendix B. Figure 1.2.1 illustrates the full view of the specimen as viewed from the exterior.



Fig. 1.2.2 Overall exterior view of Gorilla Buck Module

2. Summary

2.1. Test Results

Table 2.1.1 Test Results Summary

Gorilla Buck Module	
Water Test Pressure	150 Pa 300 Pa 700 Pa
Test Method	ASTM E283 ASTM E331
Details Included	Fixed Lite, Perimeter Interface, and ICF Wall.
Air Test Results	Less than 0.0039 L/s·m ² @ 75Pa
Water Test Results	150 Pa – Pass 300 Pa – Fail

2.2. Modifications Performed to Achieve Report Performance Rating

No modifications were required to obtain the ratings listed in Table 2.1.1

3. Air Test Results – ASTM E283

3.1. Test # 1 – 75 Pa

Test Conditions

Test Date: June 5, 2013
Test Time: 8:09 pm
Air Temperature: 18°C
Barometric Pressure: 101,800 Pa
Relative Humidity: 77%

Test Parameters

Pressure Difference: 75 Pa – Positive
Direction of Flow: Infiltration

Table 3.1.1 Air Leakage Rate

Results	
Air Leakage Rate per Total Area of Sample (qA)	Less than 0.0039 L/s·m ²

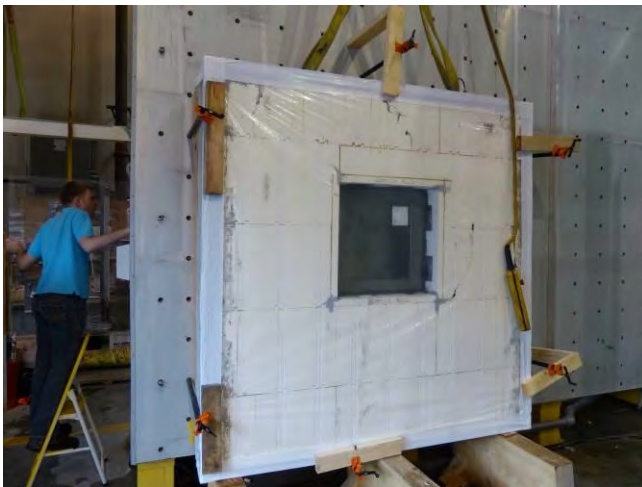


Fig. 3.1.1 Air Leakage Testing

4. Water Test Results – ASTM E331

4.1. Test #2 - 150 Pa

Test Conditions

Test Date: June 5, 2013

Test Time: 8:16 pm

Air Temperature: 18°C

Relative Humidity: 77%

Test Parameters

Pressure Difference: 150 Pa

Duration: 15 min (Complete)

Procedure: Uniform Static

Observations: No evidence of water ingress.

Table 4.1.1 Test Results

Results	
Result	Pass at 150 Pa

4.2. Test #3 - 300 Pa

Test Conditions

Test Date: June 5, 2013

Test Time: 8:32 pm

Air Temperature: 18°C

Relative Humidity: 77%

Test Parameters

Pressure Difference: 300 Pa

Duration: 15 min (Complete)

Procedure: Uniform Static

Observations: Evidence of water ingress.

Table 4.2.1 Water Penetration Observations

Penetration Point	
Water Penetration Point	P1
Penetration is a Failure Mode	Yes
Location	Lower left-hand corner inside the buck at sealant joint
Time	3 min
Volume of Water	Small pooling



Fig. 4.2.2 Water penetration point P1 for Gorilla Buck Module at 300 Pa

Table 4.2.2 Test Results

Results	
Result	Failure at 300 Pa

5. Conclusions

5.1. Air Tightness

When tested to the standard of ASTM E283 at a pressure differential of 75 Pa, the specimen, as prepared, achieved an Air Leakage Rate per fixed area (qA) of less than 0.0039 L/s-m².

5.2. Water Ingress Resistance

When tested to the standard of ASTM E331, no water ingress was observed through the specimen at a differential pressure of 150 Pa. Water ingress was observed through the specimen at a differential pressure of 300 Pa.

RDH Building Engineering Ltd.



Christopher Black, MASC, P.Eng.

Senior Project Engineer, RDH Building Engineering Ltd.

APPENDIX A – TEST PROCEDURES AND SETUP

A.1. Test Pressure Difference

Air Test

The ASTM E283 default pressure of 75 Pa was used.

Water Test

The test pressure is increased incrementally until the specimen can no longer meet the requirements of the standard or it was determined to no longer perform the testing.

A.2. Test Procedures

Air Test

Testing is performed in general conformance with ASTM E283-04 “Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen”.

Refer to the individual test parameters for the procedure used.

Water Test

Testing is performed in general conformance with ASTM E331-00 “Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference”

Refer to the individual test parameters for the procedure used.

A.3. Failure Criteria

The following is a list of the failure criteria used during testing:

Air Test

⇨ The specimen exceeds a specified maximum allowable air flow rate.

Water Test

Criteria as defined by the standard:

⇨ Failure occurs when water that penetrates through the frame or other portions of the test specimen and reaches a vertical plane inboard of the innermost projection of the specimen or when water reaches interior finishes or hardware.

⇨ Failure occurs whenever water penetrates through the perimeter frame of the test specimen.

A.4. Test Equipment

Test Wall

The test wall consists of an aluminum plate supported by a steel frame. The plate is perforated at 462 mm vertically and 267 mm horizontally. At every second hole staggered vertically between columns there is a Spraying Systems Co. – 1/8GG-W 2.8W Fulljet Stainless Steel nozzle installed flush with the plate. Water is pumped through the nozzles with a Summit Type CC pump at the calibrated test pressure. The pressure is controlled by throttling the flow of water with gate valves and is measured by a liquid-filled dial water pressure gauge. The test wall is calibrated in accordance with ASTM standards E331 and E547 to a pressure of 159 kPa (23 psi).

The specimen is set in a wood or fiberglass frame to create a chamber and is supported between 203 ± 51 mm from the test wall during the tests.

Depressurization

Depressurization of the test chamber is achieved through a 3” penetration in the test wall. Air is pumped through these penetrations by a model number R93150A GAST regenerative blower and is controlled by a model M12150C LENZE / AC TECH variable frequency drive. The fan moves air into or out of the chamber at a controlled rate to create the desired pressure differential across the specimen. The pressure differential is measured across the chamber wall with one of the following manometers:

Air Test

⇨ Dwyer Solid Plastic Stationary Gage, model 201

⇨ Dwyer Solid Plastic Stationary Gage, model 202.5

→ Meriam Inclined Tube Manometer, model 40HEX35WM

Water Testing

→ Dwyer Solid Plastic Stationary Gage, model 244

The volume of air flow is measured with a model Z50MW20-2 Meriam Laminar Flow Element.

The pressure difference between the lateral groove and the exterior was measured with an Alnor AXD 610 manometer.

A.5. Documentation

Terminology

In the report, water ingress paths and various forms of modifications are denoted in the following manner:

Water Penetration Points – Points of water penetration on the indoor face of the test specimen, and any water penetration as defined by the standard.

Adjustments – Adjustments are items on the test specimen where an installed component required realignment to properly interface with another component. These items are designated with an “A” sequence in modifications.

Deficiencies – Deficiencies are items found on the test specimen that are not manufactured or installed per the manufacturer or project requirements. These items are designated with a “D” sequence in modifications.

Modifications – Modifications are items that are performed on the test specimen that differ from the manufacturer or project requirements. These items are designated with an “M” sequence in modifications.

Orientation References

All references denoting orientation are taken as viewed when facing the test wall and the interior face of the specimen.

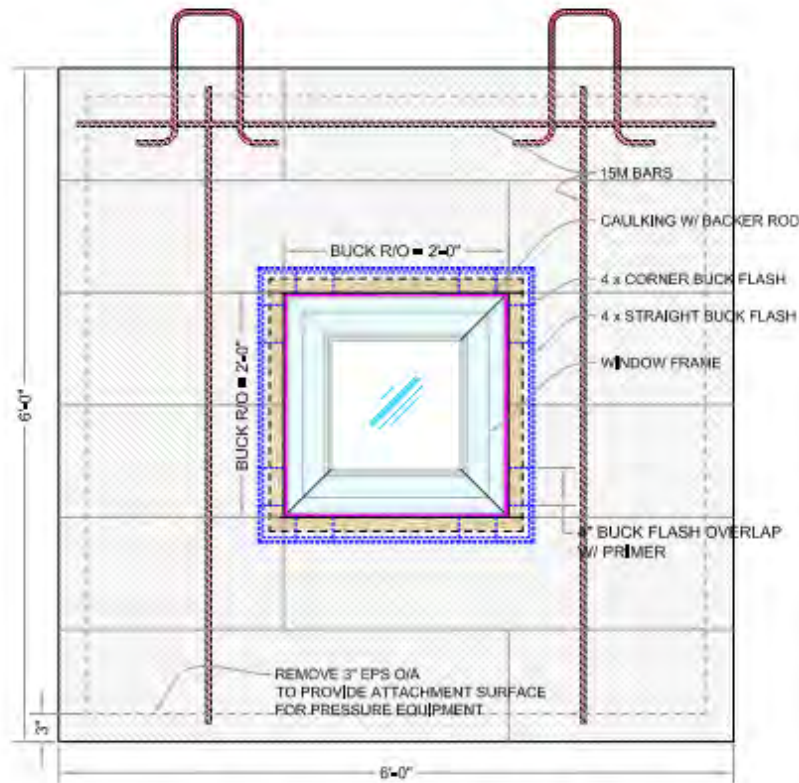
A.6. Deviations from Test Standard

Water Test

The test is conducted in general conformance with the test standard with the following exception:

→ The barometric air pressure was not recorded, but was obtained afterwards from a nearby weather station in Pitt Meadows, BC.

APPENDIX B - TYPICAL DETAILS FOR ICF TEST WALL ASSEMBLY



TEST MODULE 1B
EXTERNAL WITH BUCK FLASH

The Gorilla Buck ICF wall was constructed in a similar manner as Module 1B; the only change is that the wooden buck is replaced with a Gorilla Buck around the window.

The Gorilla Buck is a proprietary system constructed from expanded polystyrene (EPS) for window and doors openings in ICF construction.

