Recovery Act: Contributing to Net Zero Building: High Energy Efficient EIFS Wall Systems

DOE AWARD # DE-EE0003915

Recipient: Dow Corning Corporation

Team Members:
Dryvit Systems, Inc.
Fraunhofer USA, Inc. Center for Sustainable Energy Systems

FINAL REPORT

Submitted by Dow Corning Corporation to United States Dept. of Energy (DOE)

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Authorized Distribution Limitations: None

Patent Restrictions: None

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1. EXECUTIVE SUMMARY

DOE DE-EE0003915 High Energy Efficient EIFS Wall Systems is viewed a great learning and success. The team led by Dow Corning collaborated to increase the thermal performance of exterior insulation and finishing systems (EIFS) to reach R-40 performance meeting the needs for high efficiency insulated walls. Additionally, the project helped remove barriers to using EIFS on retrofit commercial buildings desiring high insulated walls.

The three wall systems developed within the scope of this project provide the thermal performance noted in Table 1 by incorporating vacuum insulation panels (VIPs) into an expanded polystyrene (EPS) encapsulated vacuum insulated sandwich element (VISE). The VISE was incorporated into an EIFS as pre-engineered insulation boards. The VISE is installed using typical EIFS details and network of trained installers.

Table 1. Thermal performance of three walls systems with and without fiberglass batts

Design 3/4" Thick VIP in 3" EPS	W/m2K	BTU•in /(h•ft2•°F)	(h•ft2•°F)/BTU•in
Calculated Wall Assembly	U-0.23	U-0.04	R-24.33
Calculated Wall Assembly with batt	U-0.19	U-0.03	R-30.12
Design 1" Thick VIP in 3" EPS	W/m2K	BTU•in /(h•ft2•°F)	(h•ft2•°F)/BTU•in
Calculated Wall Assembly	U-0.20	U-0.04	R-27.93
Calculated Wall Assembly with batt	U-0.17	U-0.03	R-33.67
Design 1 1/2" Thick VIP in 3" EPS	W/m2K	BTU•in /(h•ft2•°F)	(h•ft2•°F)/BTU•in
Calculated Wall Assembly	U-0.16	U-0.03	R-35.09
Calculated Wall Assembly with batt	U-0.14	U-0.03	R-40.82

These three wall systems have been tested and engineered to be fully code compliant as an Exterior Insulation and Finish System and meet all of the International Building Code (IBC) structural, durability and fire test requirements for a code compliant exterior wall cladding system. This system is being commercialized under the trade name Dryvit® Outsulation® HE system. Full details, specifications, and application guidelines have been developed for the system.

The system has been modeled both thermally and hygrothermally to predict condensation potential. Based on weather models for Baltimore, MD; Boston, MA; Miami, FL; Minneapolis, MN; Phoenix, AZ; and Seattle, WA; condensation and water build up in the wall system is not a concern.

Finally, the team conducted a field trial of the system on a building at the former Brunswick Naval Air Station which is being redeveloped by the Midcoast Regional Redevelopment Authority (Brunswick, Maine). The field trial provided a retrofit R-30 wall onto a wood frame construction, slab on grade, 1800 ft^2 building, that was monitored over the course of a year. Simultaneous with the façade retrofit, the building's windows were upgraded at no charge to this program. The retrofit building used 49% less natural gas during the winter of 2012 compared to previous winters.

This project achieved its goal of developing a system that is constructible, offers protection to the VIPs, and meets all performance targets established for the project.

2. PROJECT GOALS, OBJECTIVES AND ACCOMPLISHMENTS

A. Objectives

The objective of this project was to enhance EIFS envelope systems to reach R-40 efficiency levels and meet the need for high efficiency insulated walls. Additionally, the project was designed to remove barriers to EIFS use on retrofit commercial buildings which desire high insulation walls but are limited due to the excessive thickness of conventional insulation required to achieve comparable R-40 values. The project confirmed that VIPs are a viable insulation material to incorporate into EIFS wall systems and are not compromised by structural deficiencies due to lack of tensile strength or mechanical properties. Laboratory and field trials were conducted to determine the viability of the selected design in regards to ease of application and a full productivity analysis. The selected systems were validated for full code compliance. Three different performance VIP designs were developed and under commercialization.

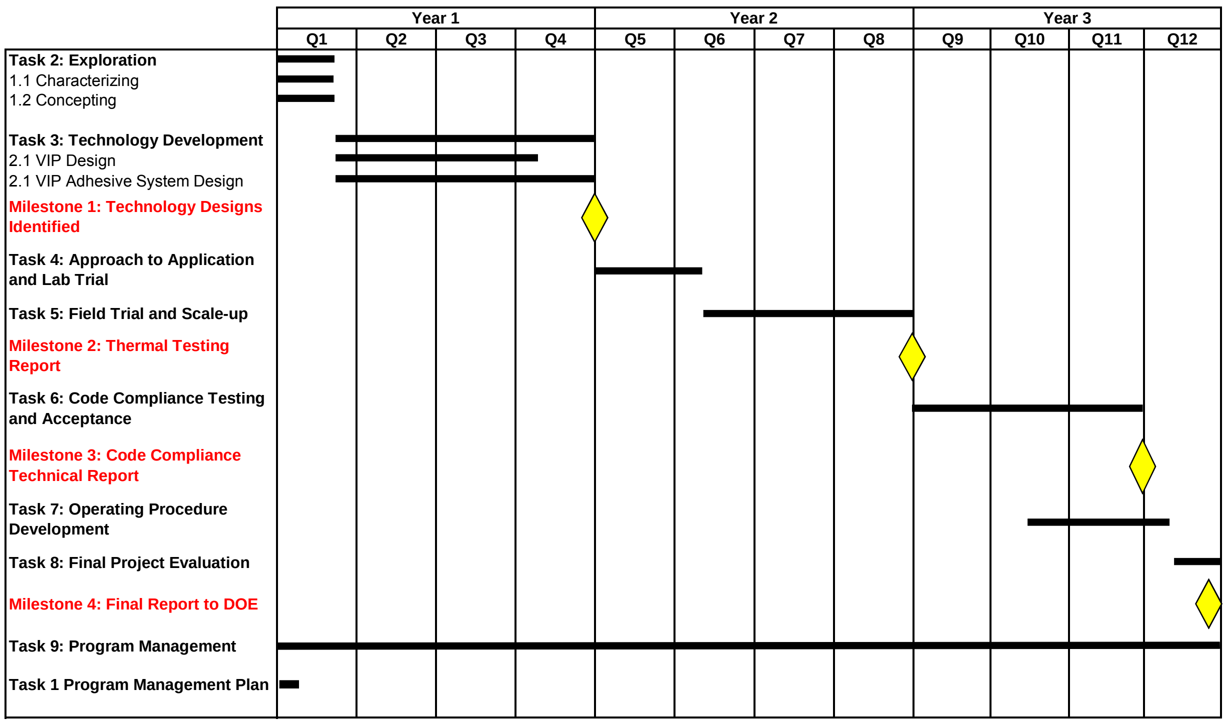
B. Scope of Work

The project focused on eight distinct tasks which cover: materials testing; design concepting and industrial design to minimize VIP limitations; application standards development; lab testing of multiple prototypes; field testing of a selected design; testing for building code compliance and acceptance; a final report to the Department of Energy (DOE); and program management throughout the project. Characterization of the VIP material validated structural and material capabilities. The team developed a selection of new EIFS configurations that utilize VIP and established procedures and techniques to minimize damage to the VIP insulation during installation. Prototypes were refined, lab trials of multiple prototypes evaluated and a field trial conducted to understand the constructability and thermal performance characteristics of the system. The selected system was tested to ensure that it meets all necessary EIFS building and fire codes in partnership with third party laboratories to deliver independent test data for review and approval.

C. Project Accomplishments

Three specific designs of EIFS walls were established after 1) two separate hot box tests at Oak Ridge National Laboratory, 2) thermal modeling of the tested results to validate the model, and 3) installation at a field trial site. The final designs were then modeled to predict the results of the three specific optimized designs. Code compliance testing of the final designs was completed by testing for durability, structural and fire properties. The drawings and details of the new Dryvit ® Outsulation® HE system were completed and submitted for full code compliance. Figure 1 below shares an overview of the project's tasks and milestones.

Figure 1. Original Project Timeline*



* Year 1: August 1, 2010 – July 31, 2011; Year 2: August 1, 2011 – July 31, 2012; Year 3: August 1, 2012 – July 31, 2013. The program was granted a three-month no-cost extension which is not reflected in the figure. The extension impacted completion dates for Tasks 6, 7, 8 and 9.

3. TASK 1 RESULTS: PROJECT MANAGEMENT PLAN

Dow Corning submitted the Project Management Plan (PMP) within 20 calendar days of project award. The PMP was updated by the project team as the project progressed, and Dow Corning used the plan to report schedule and budget variances. A project kickoff meeting was held with the Department of Energy and the project team in September 2010. The PMP has been the guiding document for accomplishing tasks and reviewing direction throughout the project.

4. TASK 2 RESULTS: EXPLORATION

Task 2 – Exploration: *Task 2 will focus on identifying and testing the critical characteristics of VIP material to determine the viability of incorporating VIP into EIFS.*

Subtask 2.1 – Characterization: *Identify and test critical characteristics of VIP technology including mechanical, tensile and thermal properties to understand the boundaries and limitations of VIP technology and its potential use within EIFS.*

Subtask 2.2 – Concepting: *Develop and evaluate potential prototypes using VIP as the insulation board in place of EPS. Configurations will be tested for their application ease and efficacy in delivering long term thermal performance. VIP compatibility with existing adhesives used to bond EPS to the substrate will be evaluated.*

During this task the team concentrated on the primary design of prototype walls using VIPs with an appropriate adhesive system. It was agreed that all VIPs had to be adhesively attached in a protected shell of foam insulation to be easily incorporated into existing EIFS technology. It was known that the change in pressure of a VIP results in altered performance. A literature search was conducted and no compatibility tests of adhesives in conjunction with VIP foil was found. This was unexpected as VIPs are not a new concept and adhesive attachment is the norm.

Dryvit uses cementitious based adhesives to create a drainage plane and attach foam insulation boards to the air and water barrier adhered to the sheathing. Cementitious adhesives have an alkaline component which had unknown compatibility with the VIP encapsulation bag.

The team focused on developing a meaningful compatibility test to identify compatible adhesives. A test protocol was developed using existing knowledge and know how. This test protocol is attached in Appendix A.

Based on this testing, the adhesives used by Dryvit were shown to be compatible because they did not cause a rise in pressure in the VIP. Although the adhesives used in the construction of EIFS should not contact the VIP, the team conducted this test to validate and demonstrate the performance.

5. TASK 3 RESULTS: DEVELOPMENT

Task 3 – Development: *Develop prototypes for selected EIFS concepts and address specific technical challenges associated with the implementation of VIP materials in on-site usage.*

Subtask 3.1 – Design of VIP Insulation: *Address current design limitations of VIP insulation to avoid damage due to cutting and installation of the system.*

Subtask 3.2 – Adhesive system design: *Develop an adhesive system design to bond VIP insulation to a rough wall, EPS barrier or other material used in the system.*

Adhesive development and testing identified two promising adhesives, a moisture curing RTV silicone adhesive and a spray applied curable silicone hot melt adhesive. Both adhesives use moisture curing silicone technology and involve methanol as curing byproduct. Methanol is regarded as neutral curing technology.

One-part silicone adhesive sealants deemed to be compatible are Dow Corning® 795 Silicone Building Sealant and Dow Corning® 791 Silicone Building Sealant. The hot melt curing sealant that was deemed compatible was Dow Corning® HM-2500 Assembly Sealant. The product data sheets and material safety data sheets for these materials can be found on the Dow Corning website at www.dowcorning.com . These materials were evaluated according to the procedure found in Appendix A.

Specimens of expanded polystyrene (EPS) encapsulated VIPs were built using these adhesives to evaluate handling and design aspects. This concepting phase incorporated a team approach and brainstorming. At this point the team was extremely sensitive to the fragility of the VIPs, and protection of the VIPs was deemed a priority. After much discussion and lab prototyping, a first design concept was developed.

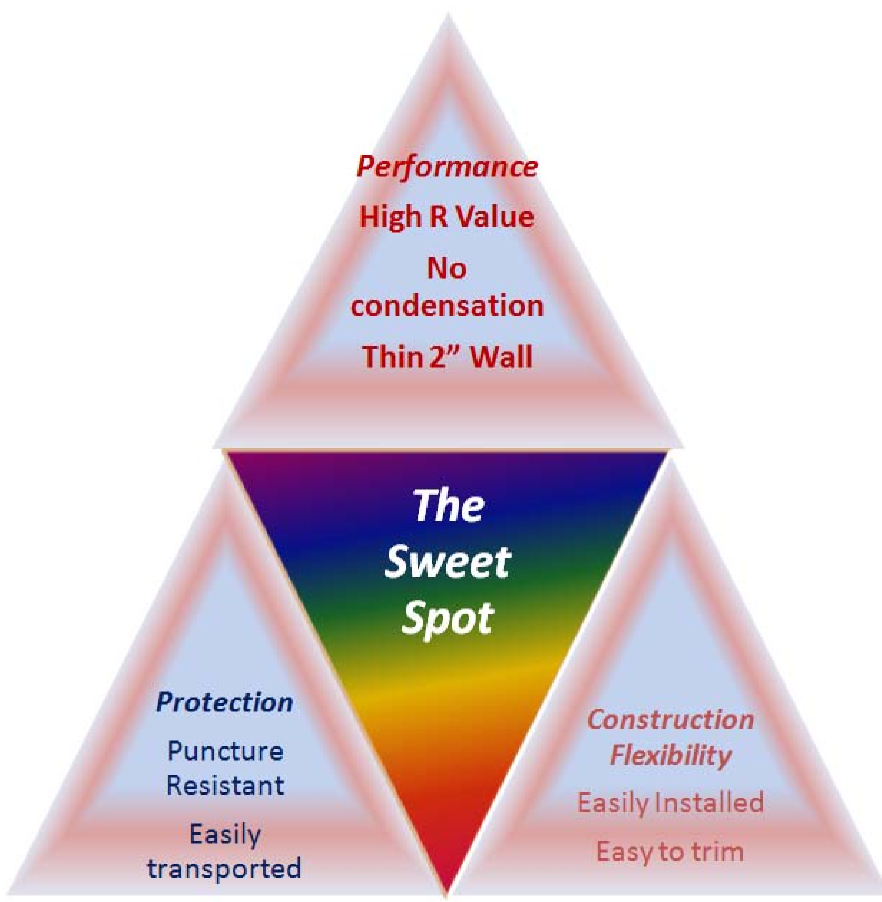
A prototype wall design incorporating VIP was selected for thermal testing according to ASTM C1363-05. The team fabricated high performance insulated panels using both adhesives to be incorporated into the prototype test wall. These efforts gave insights into potential methods of assembly as well as an understanding of necessary tolerances required for incorporating VIP into EIFS. The wall was tested and the results evaluated (Figure 2). The test used 1" thick VIP panels within a total 3" thick vacuum insulation sandwich element (VISE). A second test was run on the same wall system with four punctured panels. These two tests resulted in R values of the wall at 20.8 hr-ft^2-^{o}F/BTU and 20.2 hr-ft^2-^{o}F/BTU, respectively.

Figure 2. ASTM C1363 Guarded Hot Box Test

The Dow Corning and Dryvit team evaluated the results of the first prototype wall tested to ASTM C1363 at Oak Ridge National Lab (ORNL). The team verified that our design concept exhibited good construction flexibility, and the protected VIP panels survived transportation, wall construction, testing, and deconstruction without compromise. The team deconstructed the wall at ORNL to review the individual panel performance after testing. A thermal model of the prototype wall was developed using Therm 5.2 software, and a hygrothermal model of the prototype wall was developed using WUFI Pro software. WUFI Pro and Therm 5.2 models were refined and come within 10% of the tested values of the wall by the SmithGroup.

The team created the concept of the "VIP construction triangle", consisting of protection, construction flexibility and thermal performance (Figure 3). This project has allowed the investigators to fully investigate the three corners of the VIP construction triangle to optimize the system design.

Figure 3. The VIP construction triangle



The team visited the VIP manufacturer to review the manufacturing process and quality control efforts, and discuss technical issues. The technical personnel confirmed that the physical properties and characteristics used for the thermal and hygrothermal models were accurate and up-to-date.

6. TASK 4 RESULTS: APPROACH TO APPLICATION AND LAB TRIAL

Task 4 - Approach to Application and Lab Trial: *Prototypes developed in Task 2 will continue to be refined. Larger scale construction of various prototypes will occur within the application lab to determine how all components fit together and address challenges with the process of installing VIP insulation on-site with minimal damage. A third party testing laboratory will perform hygro-thermal testing on the optimal configuration or configurations to determine the extent of structural damage or delamination that might occur.*

The exercise of fabricating small panels to test in the heat flow meter according to ASTM C518 helped the team understand the balance of minimizing thermal bridging, constructability and performance. It brought the understanding that we need to further minimize the thermal bridges by reducing the edge thickness of the composite panels. To further our understanding of thermal bridges, we fabricated 24" x 24" x 3" composite panels that were then tested by ORNL using ASTM C518 protocol.

Understanding thermal bridges is critical to the success of the VIP encapsulated EIFS system. The panels fabricated for testing to ASTM C518 protocol were brainstormed designs that were then validated for constructability. This small panel thermal testing included typical and atypical EIFS designs. ORNL predicted the clear wall system performance based on the heat flow meter testing of the 24" x 24" x 3" VISE panels in the C518 test protocol. One of the options tested was chosen for the second hot box test because it was constructible, protected the VIP and had the desired thermal performance. This option predicted an R-32.2 for the VISE. It was reasonable to predict an additional R-3 for the renders, sheathing, and sheetrock assemblies. The addition of fiberglass batts in the studs would add an additional R-5 which would meet the R-40 performance goal.

During Q1 2012, the team fabricated a second high performance test wall at ORNL for the ASTM C1363 hot box test. The fabricated wall was allowed to cure for 28 days before commencing thermal testing. During the fabrication of the insulation components, the manufacturing processes were studied to understand the costs associated with manufacturing appropriately sized panels intended to be shipped to the construction site. This second test used Type 2 EPS for VIP encapsulation because it had more integrity and a slightly higher thermal resistance compared to Type 1 EPS. Testing on this wall included a test with and without insulation batts between the metal studs. This was done to confirm the modeling results which showed an additional benefit to the thermal resistance was possible and that with insulation batts the wall would exceed the project goals.

These two tests resulted in R values of the wall at 31.3 hr-ft^2-^{o}F/BTU and 25.7 hr-ft^2-^{o}F/BTU, with and without insulation batts respectively. Including batt insulation in the wall added an additional R-5.6 to the assembly. Although the R-31.3 met the DOE goals of a wall with greater than R-30 performance, the team wanted to achieve R-40 performance. During the deconstruction of this second test wall, ORNL used thermal imaging to determine if any compromised VIPS were within the finished wall assembly. All

VIPs appeared to be intact. A VIP was intentionally punctured and thermal imaging repeated. The results were quite dramatic and shown in Appendix C page 10. Once again it was confirmed that the chosen edge protection of the VIPs was adequate to protect the VIPs during manufacture, transportation and construction. During all of the performed hygro-thermal testing according to ASTM C1363 and ASTM C518 on this configuration, no structural damage, cracking or delamination occurred.

Thermal models were reviewed and are included in Appendix B page 28. This model using Therm 5.2 predicted the hot box tests very accurately with thermal resistances of R-31.9 with batts and R-26.7 without batts. These thermal models were used later in the project to predict the performance of the final designs.

WUFI Pro modeling and WUFI 2D modeling of this system can be reviewed starting on page 14 of Appendix B. Condensation risk analysis of this system can be found on page 33 and Results of WUFI 2D can be found on page 36 of Appendix B. Modeling was done on the system to predict moisture buildup over a 50 year cycle in six cities, Baltimore, MD; Boston, MA; Miami, FL; Minneapolis, MN; Phoenix, AZ; and Seattle, WA. Once the system totally dries after installation, there is no real concern for moisture buildup or mold growth as predicted based on ASHRAE 160. All simulations were done using the guidelines and boundaries established by ASHRAE 160. It was noted that the addition of batt insulation in the stud cavity increases the risk of moisture buildup at high interior relative humidity (RH). When using additional batt insulation in a stud cavity, the interior RH may need to be limited, and/or the use of a "smart" vapor retarder could be considered. Since this will be climate as well as building dependent, it is recommended that a building-specific dew point evaluation be performed to ensure any unsatisfactory conditions are eliminated.

This same wall system was also modeled with the Advanced WUFI 2D as this is a three dimensional evaluation. There were significant issues getting the software to operate with this system, but a three year simulation was run on the 2012 wall design for Minneapolis, MN. When simulating a point at the encapsulated panel to encapsulated panel intersection, it was noted that there was no increase in water content and if there would be any areas of concern, they would be located at the outside corner of the VIP foil. The WUFI 2D model showed similar results to WUFI 5.1 and the areas of potential moisture level increase would dry seasonally. See Appendix B for details.

7. TASK 5 RESULTS: FIELD TRIAL AND SCALE-UP

Task 5 - Field Trial and Scale-up: *A systematic approach to optimizing characteristics and performance capabilities will be applied to ensure that an EIFS product offering a minimum of R-22 for 25 years can be offered to the market. The EIFS/VIP system that passes hygro-thermal testing in Task 3 will be the main candidate for field trial. Analytic testing and accelerated aging studies of the integrated siding materials will be employed to confirm insulation performance and life-cycle performance.*

During Q2 2012, the team constructed a test wall at Oak Ridge National Laboratory's Natural Weathering Facility in Hollywood, South Carolina. The test wall had sensors for temperature and humidity installed on both the interior and exterior of the wall. The system is identical to the wall installed for the second hot box trial previously tested. No batt insulation was installed in the studs. The report concluded "Except near the exterior wall surface, the RH levels at other locations within the wall were below the critical levels for mold growth, and the current design is deemed satisfactory from a moisture performance perspective." The results of this natural weathering testing can be found in Appendix D.

For the field trial, the team selected a test site under the management of the Midcoast Regional Redevelopment Authority (MRRA) in Brunswick, Maine. The building resided within the former Brunswick Naval Air Station. Built in 1950, the building was of 2 x 6 wood frame construction, slab on grade, and had very high ceilings because it was originally designed as a storage building. The retrofit wall design for the field trial was designed to deliver an R-30 retrofit wall on this 1800 ft^2 project. The field trial used 1.5" VIP insulation with a total foam composite thickness of 3" to deliver R-30 retrofit walls. The modeled results of the Brunswick, Maine building can be found in Appendix B page 31.

The team of Dow Corning, Dryvit and Fraunhofer CSE spent two months preparing for the two week construction period in June 2012. The construction period was a two week learning process that solidified the project goals, application guidelines, quality assurance procedures, and details. Once the walls were installed in June 2012, the building was monitored for one year by Fraunhofer CSE to validate performance. The learnings from the field trial were used in Task 7 to develop installation and quality assurance guidelines. Figure 4 below shows before and after photos of the field trial site.

Prior to installing the retrofit walls, MRRA upgraded the building's windows to high performance R-5 windows and moved the location of some of the windows. Fraunhofer CSE obtained funding to evaluate the energy impact of the building upgrade including the R-5 windows. This additional scope to Fraunhofer CSE's project allowed MRRA to have a full façade upgrade to the building. Fraunhofer's report on the window upgrade and energy model is referenced as: Fallahi, A. Misiopecki, C. Shukla, N. Watts, A., Kośny, J. 2013 "Window Testing in the VIP-Based EIFS Retrofitted Building - Brunswick, ME" prepared for Oak Ridge National Laboratory (ORNL), Fraunhofer Center for Sustainable Energy Systems (CSE), Building Energy Efficiency Group, Boston.

Figure 4. Brunswick, Maine field trial site before and after exterior wall installation

With respect to field trial results, Fraunhofer reported that the building used 49% less natural gas compared to previous years. Fraunhofer's report also concluded: "Based on WUFI modeling results and the measurements, the risk of moisture accumulation in the VIP-based EIFS of the retrofitted wall in the Brunswick building is low and the moisture contents of the plank wood and plywood remain below 12% and don't reach the critical threshold for wood deteriorations." The monitoring of this project can be found in the Fraunhofer CSE report in Appendix E.

Based on the field trial experience, wall systems identified as design C, D, and E in Appendix B Figure 9, page 11 were selected as the final wall system configurations. Modeled performance of these designs based on the models that predicted accurate hot box results are found in Tables 4-6, on Page 29 of Appendix B and are included below. All code compliance testing was done using these designs.

Table 2. Tables 4 - 6 from Appendix B: SmithGroup Final Report June 26, 2013

Design C	W/m2K	BTU•in /(h•ft2•°F)	(h•ft2•°F)/BTU•in
Core Layer (Layer 2)	U-0.42	U-0.07	R-13.59
Calculated Wall Assembly	U-0.23	U-0.04	R-24.33
Calculated Wall Assembly with batt	U-0.19	U-0.03	R-30.12

Table 4: Design C (3/4" Thick VIP) Results

Design D	W/m2K	BTU•in /(h•ft2•°F)	(h•ft2•°F)/BTU•in
Core Layer (Layer 2)	U-0.31	U-0.06	R-18.12
Calculated Wall Assembly	U-0.20	U-0.04	R-27.93
Calculated Wall Assembly with batt	U-0.17	U-0.03	R-33.67

Table 5: Design D (1" Thick VIP)

Design E	W/m2K	BTU•in /(h•ft2•°F)	(h•ft2•°F)/BTU•in
Core Layer (Layer 2)	U-0.21	U-0.04	R-27.18
Calculated Wall Assembly	U-0.16	U-0.03	R-35.09
Calculated Wall Assembly with batt	U-0.14	U-0.03	R-40.82

Table 6: Design E (1 ½ " Thick VIP):

8. TASK 6 RESULTS: CODE COMPLIANCE TESTING AND ACCEPTANCE

> ***Task 6 - Code Compliance Testing and Acceptance:*** *Third party testing laboratories will be used to develop independent test data for the purposes of EIFS building code approval and compliance. The final EIFS/VIP system will be fully tested to ensure compliance with building code requirements and fire code requirements. Some of these tests are ASTM for Code E 2570, NFPA 268 and 285 for fire test and ASTME E330 for wind load.*

With the final wall system designs identified, International Building Code (IBC) compliance testing commenced. Dryvit's experience with the code compliance requirements for EIFS walls was important in helping the project successfully pass all of the tests. Based on thermal performance, the project developed three systems that include a 3" thick VISE. The first system incorporates a ¾" VIP, the second a 1" VIP, and the third a 1 ½" VIP in EPS foam. Testing for IBC code compliance was strategically planned so that the highest risk system would be tested and the other two systems would be allowed. Table 3 summarizes the code compliance tests conducted on the wall system. The wall system passed the National Fire Protection Association (NFPA) and American Society for Testing and Materials (ASTM) tests. Full reports on this testing can be found in the Appendices noted below.

Table 3. Code compliance tests conducted on the wall system

Standard	Description*	Test Agency
ASTM E330	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference	Architectural Testing, Inc. (ATI), Lithia Springs, GA
ASTM E119	Standard Test Methods for Fire Tests of Building Construction and Materials	Intertek Testing Services NA, Inc., Elmendorf, TX
NFPA 268	Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source	Intertek Testing Services NA, Inc., Elmendorf, TX
NFPA 285	Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components	Intertek Testing Services NA, Inc., Elmendorf, TX

* Additional information on ASTM tests can be found on http://www.astm.org ; additional information on NFPA tests can be found on and http://www.nfpa.org .

The NFPA 285 test was conducted twice, once on a flat wall (no architectural features) and the second time on a wall which included architectural features made of EPS attached to the VIP insulation (eg, shapes and cornices), typical of the EIFS system used in the market today.

The structural testing from ATI according to ASTM E330 was performed at increasing positive and negative loads until failure. Ultimate failures were not influenced by the VIPs within the VISE.

Full reports for this testing are included in the Appendices noted below

Appendix F: Architectural Testing Test Report ASTM E330 EIFS on Wood Studs

Appendix G: Architectural Testing Test Report ASTM E330 EIFS on Steel Studs

Appendix H: Test Report Intertek ASTM E119 3 ¾" Thick VIP Insulation panels

Appendix I: Test Report Intertek ASTM E119 3 " Thick VIP Insulation panels

Appendix J: Test Report Intertek NFPA 285 3 ¾" Thick VIP Insulation panels

Appendix K: Test Report Intertek NFPA 285 VIP Insulation panels including foam shapes

Appendix L: Test Report Intertek NFPA 268 8 ½" Thick VIP Insulation panels

Appendix M: Test Report Intertek NFPA 268 7 ¾" Thick VIP Insulation panels

Appendix N: Intertek ASTM E84 Test Report VIP panels

Appendix O: Intertek CAN/UL S102 Test Report VIP panels

9. TASK 7 RESULTS: OPERATING PROCEDURE DEVELOPMENT

> ***Task 7 - Operating Procedure Development:*** *Documents that detail Standard Operating Procedures including standards development, specification, application, and quality assurance instructions will be developed.*

Specifications, details, quality control guidelines and application instructions are found in the following Appendices.

Appendix P: Dryvit® Outsulation® HE System Specifications

Appendix Q: Dryvit® Outsulation® HE System Installation Details

Appendix R: Dryvit® Outsulation® HE Application Instructions

10. TASK 8 RESULTS: FINAL REPORT EVALUATION

> ***Task 8 - Final Report Evaluation:*** *Evaluate the results of the project and conduct a final assessment in terms of energy efficiency gains, cost effectiveness, and overall success in the field. Future potential for the product will also be assessed and a plan of either further development or commercialization potential prepared*.

The learnings from this project resulted in an EIFS system that is being commercialized by Dryvit, the Dryvit® Outsulation® HE System. Typical EIFS systems will supply a wall with an R value of 11.6. The goals of this project were to develop wall systems with up to R-40 performance at typical thickness. This project demonstrated that VIP encapsulated in 3" of EPS can provide up to R-35 plus another R-5 if fiberglass batts are used between the studs. Theoretical thermal performance models can show higher performance than test results on actual wall systems, however the balance of protection, performance and constructability must account for real world tolerances and construction techniques. The thermal models developed during this activity reflected tested results, therefore the modeled performance of the three systems developed by this project is deemed to be accurate.

The project gave us an understanding of the complexities of encapsulating VIPs in EPS, creating an engineered layout of wall, and training installers to follow the engineering guidelines. These additional complexities and the VIPs add cost to a typical EIFS system; however this system allows a premium performance upgrade without increasing the thickness of the wall. Increased thickness of wall systems will result in additional fit outs of roof overhangs and fenestration details. Currently there is no other cladding system in the marketplace that can achieve this level of insulation with only a 3" thickness. Additionally there is a readily available contractor base with the required skills to manufacture and install this product.

Future efforts may be directed at reducing the installed costs by optimizing fabrication procedures and supply chain logistics to deliver the product in the most cost effective manner possible. Reduction in costs will make the product more readily accepted by the market and thus contribute to reduction of energy usage as well as support creation of new jobs and commerce.

11. TASK 9 RESULTS: PROJECT MANAGEMENT

The program started on August 1, 2010 and ended on October 31, 2013. Throughout the effort, Dow Corning and its partners had calls, regular correspondence and meetings to review progress, discuss technical aspects, and coordinate team efforts. All the milestones were completed; there was a delay in meeting milestone 3 due to the need to repeat a test for code compliance (Table 4).

Table 4. Project milestone status

Milestone	Description	Milestone Completion Date			Comments
		Anticipated	Actual	% Complete	
1	Technology Design Identification	7/31/2011	7/31/2011	100%	Report submitted January 2011
2	Thermal Efficiency, System Aging and Productivity	7/31/2012	6/30/2012	100%	Report submitted August 2012
3	Code Compliance	10/15/2013*	10/15/2013	100% (awaiting code compliance decision)	Report submitted December 2013
4	Final Report	1/29/2014*	1/29/2014	100%	Final Report submitted January 2013

***** Dates reflect revised dates since the project had a three-month no-cost extension until October 31, 2013. The original anticipated date for milestone 3 was April 30, 2013.

Cost Summary:

The program started on August 1, 2010 and ended on October 31, 2013. Total program expenses were $1,340,190 compared to a budget of $1,551,400 (Table 5). Total direct costs were 99.5% of budgeted total direct costs with labor slightly below budget and travel and supplies slightly higher than budget. Indirect costs were significantly less than budget since Dow Corning did not charge any indirect costs to the program in 2013 due to organizational changes that impacted its rates; the company voluntarily elected not to recover any of its indirect costs in 2013. The indirect costs charged in 2010-2012 (overhead and G&A) have been adjusted to reflect Dow Corning's submitted incurred cost submissions for 2010 – 2012; final rates have not been negotiated yet.

Table 5. Summary of program expenses

Cost Category	Years 1-3 Expenses (Cumulative) Actual	Years 1-3 Budget	Years 1-3 Expenses to Budget %
Personnel (Direct)	$202,925	$226,717	89.5%
Travel	$59,044	$49,277	119.8%
Equipment	$0	$0	
Supplies	$53,627	$33,536	159.9%
Other and Contractual (Subs, vendors, FFRDC)	$613,989	$624,447	98.3%
Total Direct Costs	$929,585	$933,977	99.5%
Indirect Costs	$410,605	$617,423	66.5%
Total Costs	$1,340,190	$1,551,400	86.4%
DOE Share	$1,072,152	$1,241,120	
Cost Share	$268,038	$310,280	
Cost Share %	20.0%	20.0%	

12. PRODUCTS DEVELOPED UNDER THE AWARD AND TECHNOLOGY TRANSFER ACTIVITIES

12.1 Publications

- Dow Corning and Dryvit along with Oak Ridge National Laboratory presented the paper "High Performance External Insulation and Finish System Incorporating Vacuum Insulation Panels – Foam Panel Composite and Hot Box Testing" at the ASTM C16 Symposium on Next Generation Thermal Insulation Challenges and Opportunities (A. Seitz and L. Carbary, Dow Corning Corporation; K. Biswas and K. Childs, Oak Ridge National Laboratory; October 23-24, 2013; Jacksonville, FL).
- Dow Corning and Oak Ridge National Laboratory presented the paper "Thermal Performance of Exterior Insulation and Finish Systems Containing Vacuum Insulation Panels" at the Buildings XII

Conference sponsored by ASHRAE and Oak Ridge National Labs (L. Carbary et al.; December 1-5, 2013; Clearwater Beach, FL).

- ASTM E06 Symposium on Exterior Insulation and Finish Systems (EIFS): Performance, Progress and Innovation titled "High Efficiency EIFS: R30 Walls in 3 inch thickness: Modeling, Performance Testing, and Installation" accepted for presentation in October 2014.

12.2 Websites or other Internet sites

US DOE Building Technologies Office
http://energy.gov/eere/buildings/building-envelope-research - see INSULATION, Vacuum Insulation Panels

12.3 Networks or collaborations fostered

The initial contact with Fraunhofer CSE was based on an effort to collaborate with the Building America Project. Unfortunately at the time, the VIP technology was viewed as too premature for the Building America collaboration; however this led to the collaboration with Fraunhofer CSE.

12.4 Technologies/Techniques - Vacuum Insulation Technology

12.5 Inventions/Patent Applications, Licensing Agreements - None

12.6 Other products - None

13. APPENDICES

The following Appendices are included in this report.

Appendix A: Test procedure developed to evaluate the compatibility of adhesives in contact with VIP

Appendix B: SmithGroup Final Report June 26, 2013

Appendix C: ORNL TM-2012/438 Test Report on Second Hot Box Test

Appendix D: ORNL TM-2013/220Test Report on Natural Weathering Facility

Appendix E: Fraunhofer CSE Report Brunswick Monitoring January 2014

Appendix F: Architectural Testing Test Report ASTM E330 EIFS on Wood Studs

Appendix G: Architectural Testing Test Report ASTM E330 EIFS on Steel Studs

Appendix H: Test Report Intertek ASTM E119 3 ¾" Thick VIP Insulation panels

Appendix I: Test Report Intertek ASTM E119 3" Thick VIP Insulation panels

Appendix J: Test Report Intertek NFPA 285 3 ¾" Thick VIP Insulation panels

Appendix K: Test Report Intertek NFPA 285 VIP Insulation panels including foam shapes

Appendix L: Test Report Intertek NFPA 268 8 ½" Thick VIP Insulation panels

Appendix M: Test Report Intertek NFPA 268 7 ¾" Thick VIP Insulation panels

Appendix N: Intertek ASTM E84 Test Report VIP panels

Appendix O: Intertek CAN/UL S102 Test Report VIP panels

Appendix P: Dryvit® Outsulation® HE System Specifications

Appendix Q: Dryvit® Outsulation® HE System Installation Details

Appendix R: Dryvit® Outsulation® HE Application Instructions

Appendix A: Test procedure developed to evaluate the compatibility of adhesives in contact with VIP

VIP Adhesive Compatibility Test Method, Dow Corning Corporation August 16, 2013

Scope: Determine if contact by an adhesive, tape, or other accessory material will cause a pressure drop in a VIP after aging.

Materials Required:

1. 2 VIP panels 12” x 12” x 1” for a Control and test specimen
2. Vacuum chamber capable of achieving 0.5mBar pressure
3. Laser detector to determine when the VIP film relaxes
4. Pressure gauge to show pressure within the vacuum chamber

Procedure:

1. Measure the pressure inside the VIPs by placing in the vacuum chamber and reducing the pressure till the foil relaxes. Record this in millibar as the initial pressure inside the VIP.
2. Apply 6” square of test material (adhesive, tape, or other accessory material) as shown in Figure 1 to one VIP. Make sure the test material covers a seam.
3. Encapsulate the test specimen in plastic so that any vapors coming from the test material are trapped. A large Ziploc bag is appropriate for this step.
4. Keep both the control and test VIP at standard lab conditions (According to ASTM C717 Standard Conditions) for 7 days.
5. Remove encapsulant from the test VIP and place in the vacuum chamber, reducing the pressure till the foil relaxes 1mm as measured by laser deflection. Record this as the pressure inside the VIP after 7 days confined Room Temperature aging.
6. Record the pressure of the control VIP after 7 days room temperature aging
7. Place the test specimen and control specimen into a 50C oven for 14 days.
8. Remove test specimens and record the pressure of the test VIP and the Control VIP.
9. Place the test specimen and control specimen into a 50C oven for 14 days.
10. Remove test specimens and record the pressure of the test VIP and the Control VIP.

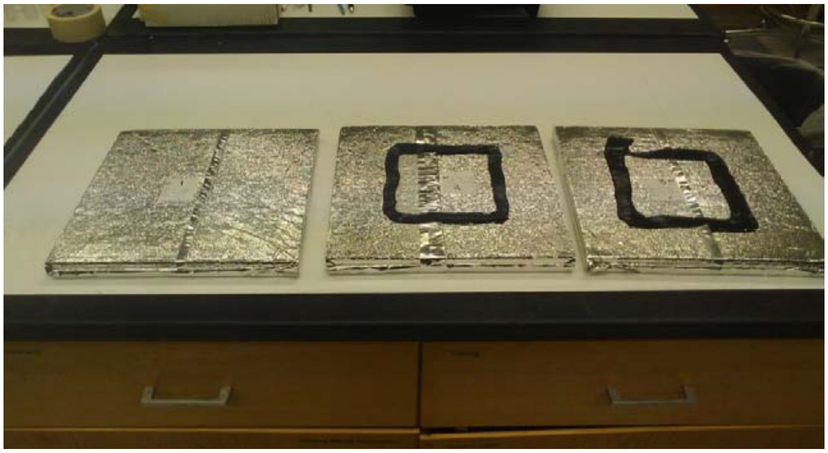


Figure 1: Control and two test specimens

Figure 2. VIP within the vacuum chamber being measured for deflection using a laser

Report: Report the following information:

1. Name of the tested adhesive, tape or accessory material and identifying information.
2. Surface preparation method used on the VIP to achieve desired adhesion for the adhesive, tape or accessory material.
3. Size of the VIP
4. Manufacture date, lot number and manufacture location of the VIP
5. Test dates
6. Type of encapsulation method for the 7 days of confined cure
7. VIP pressures at initial, 7 days room temp, 14 days at 50C and 28 days 50C for both the control and test specimen
8. Nature of test effects observed, such as amount of adhesive or cohesive delaimination, deformation, bubbles, or other characteristics of the adhesive or VIP

9. Record the % change in pressure compared to the control in the original
10. Description of and reasons for any variations from the test procedure

Sample	Initial Pressure mBar	7 days RT aging pressure mBar	% change 7 days	14 days 50C pressure mBar	% change 14 days 50C	28 Days 50C pressure mBar	% change 28 days 50C
Control							
Test							
Difference between control and test							

Actual data from testing of Dow Corning® 1199 Silicone Glazing Sealant and Dow Corning ® 795 Silicone Building Sealant

Nanopore Panels (12" x 12")	Sealant Compatibility						
mBar	Initial	7d Confined Cure	% Change 7d	2 wk 50C	% Change 2wks 50C	4 wk 50C	% Change 4wks 50C
Panel 1 (No Sealant)	6.49	6.64	2.33	6.70	3.28	6.76	4.23
Panel 3 (795)	6.19	6.11	-1.37	6.43	3.75	6.50	4.95
Panel 4 (1199)	5.74	5.74	0.00	5.98	4.23	6.05	5.44

The conclusion of this test data is that changes compared to the control are not significant. If the change in pressure would increase by 20% or greater than the control, a retest and evaluation should be made.

Hygrothermal Evaluation of Exterior Insulation Finish System (EIFS) with Encapsulated Vacuum Insulation Panels (VIP)

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SGJJR Project No. 22597.001
June 26th, 2013
Final Report

SMITHGROUPJJR

Table of Contents

Executive Summary

The SmithGroupJJR was retained within the scope of the DE-EE003915 High Efficient EIFS Walls by Dow Corning to perform computer modeling and design work for the thermal performance of a new exterior enclosure product that combines traditional Exterior Insulation Finish System (EIFS) with a Vacuum Insulation Panel (VIP). The use of VIP's within a polystyrene foam panels as part of the EIFS assembly proves to deliver very high performance to an intuitive and thermally efficient wall system.

Modeling of the system was done with two different software programs, THERM© 5.2, a two dimensional thermal modeling program supported by Lawrence Berkeley National Laboratory, and WUFI Pro 5.1 a transient hygrothermal modeling program supported by Oak Ridge National Laboratory (ORNL). THERM© is the standard used in North America for certifications and code compliance of fenestration product. WUFI is an internationally known and accepted program to model transient moisture migration in exterior enclosure assemblies over multiple year simulation periods.

Two hot box tests performed according to ASTM C1363 were performed at ORNL. Minor adjustments were made to the THERM© 5.2 models to replicate the test conditions. Minimal differences were observed between the results of the physical tests and modeled walls which provided validation of the modeling procedure. Based on these models and correlating tests, three wall assemblies are proposed as a result of this project to deliver on the project goals. Each wall assembly uses a unique foam encapsulation of the VIP's. The basic difference in the performance of the wall assemblies is the thickness of the VIP's that are encapsulated within the foam insulation. Additionally, the inclusion of fiberglass batt insulation within the steel stud cavity of the structural wall was modeled and tested as an option to the base wall assemblies. The three basic systems can be improved with the use of fiberglass batts within the studs, thus providing six wall options.

VIP thickness in 3" of foam	R value without Batt Insulation	R value with Batt Insulation
0.75"	24.33	30.12
1.0"	27.93	33.67
1.5"	35.09	40.82

Transient hygrothermal modeling using WUFI Pro 5.1 was performed on a wall assembly in six major cities to determine if water accumulation within the wall assembly would occur over a 50 year simulation period. The worst case scenario was in a very cold climate (Minneapolis, MN) and it indicated a very minor gain in water content within the wall assembly over the 50 year period. The moisture increase occurred within the VIP and was due to the low permeability of the protection barrier foil envelope coupled with the low thermal conductivity of the panel. This minor accumulation of diffused moisture is something that has been measured by the researchers studying VIP's over the past number of years and can be expected.

Thermal modeling was also performed on the as built design of the test site in Brunswick Maine that was installed in June of 2012. The models show that the wall erected on the test structure that included real jobsite tolerances provided an R30 composite wall thermal performance.

Professional modeling was done in concert with actual laboratory testing and jobsite erection to steer the project to meeting the goals outlined with the DOE at the beginning of the project. This report provides a detailed description of the VIP's, wall assemblies evaluated, methods of evaluation and results, and recommendations for additional evaluation.

Definitions

Condensation: The change in physical state of a vapor to a liquid due to the an increase in relative humidity or a decrease in temperature.

Dewpoint: The temperature at which the water vapor in the air becomes saturated and condensation begins.

Hygrothermal: Pertaining to heat and humidity.

Hygrothermal Effect: Change in a material's properties due to changes in the material's moisture content and/or temperature.

Relative Humidity (RH): The ratio of the amount of water in the air (moisture content) at a given temperature to the maximum amount it could hold at that temperature; expressed as a percentage.

Total Product Thermal Performance: The measured or calculated thermal performance of a enclosure system composed of multiple materials with varying conductivities including the effects of thermal bridges within the system.

Transient Hygrothermal Evaluation: The study of heat and moisture movement through an exterior enclosure system at varying temperature and relative humidity conditions.

Vacuum Insulation Panel (VIP): An insulation element containing an open cell core material within an envelope; where the internal pressure inside the envelope is much lower than the ambient air pressure.

Vacuum Insulated Sandwich Element (VISE): An insulation element containing at least one VIP and additional components like cover layers, tapes, and the like.

Vapor Pressure: The pressure exerted by a vapor, that is calculated based upon difference between the relative humidity and temperature two adjacent environments. The greater the difference in relative humidity and/or temperature, the greater the vapor pressure will be.

Vapor Permeance: The diffusion rate of water vapor through a given material.

Vapor Retarder / Vapor Barrier: A material that can retard/block the diffusion of water vapor.

Introduction

Under a grant provided by the United States Department of Energy (DOE), Dow Corning Corporation (DCC) is studying the viability of developing a new exterior enclosure product that combines an Exterior Insulation Finish System (EIFS) with a newly developed Vacuum Insulation Panel (VIP). The VIP is encapsulated within the insulation components of the EIFS. The combined unit is referred to as a Vacuum Insulated Sandwich Element (VISE).

The VISE's considered in this evaluation are incorporated into an EIFS assembly designed by DRYVIT Systems Incorporated, a manufacturer of the primary components of these systems. Their "Outsulation Plus MD" design is the basis of the EIFS assembly into which the VISE is incorporated for this new wall design.

As part of DCC's study, SmithGroupJJR (SGJJR) was retained by DCC to evaluate the performance of new wall designs utilizing VIP's. Throughout the evaluation many different wall assembly designs were reviewed to determine an optimum size and configuration that would produce an energy efficient, durable, and constructible assembly. This report summarizes the analysis of five specific design variations of the wall assembly. The number of VIP's within a single VISE, the dimensions and thickness of the VIP and the VISE, and the arrangement of both within the wall assembly varied in the wall designs.

Several types of analysis approaches and software modeling programs were used to perform the evaluation. The evaluation includes transient hygrothermal modeling of the base wall system, total product U-factor determination, and localized condensation risk assessment.

Transient hygrothermal modeling utilized WUFI 5.1, developed by Oak Ridge National Laboratory (ORNL) and the Fraunhofer Institute of Building Physics (IBP). WUFI is an advanced transient hygrothermal modeling software that calculates transient coupled one dimensional heat and moisture transport in building enclosure systems. The modeling included 50 year simulation periods at 6 locations throughout the United States. Results of the transient hygrothermal modeling were further analyzed with Microsoft Excel and compared to the moisture performance evaluation criteria as described in ASHRAE Standard 160, "Criteria for Moisture-Control Design Analysis in Buildings".

Total product wall assembly thermal performance for each wall assembly considered was estimated by the Parallel Path Method (PPM), as described in ASHARE Fundamentals. THERM© 5.2 was used to calculate the total product U-factor for the assemblies. THERM© 5.2, developed by Lawrence Berkeley National Laboratory, simulates two-dimensional heat transfer effects through the wall assemblies based on the finite-element calculation method. The results of two of the wall designs are compared to physical testing that was performed at ORNL.

The risk of localized condensation within the VISE panels at VIP to VIP joints and at the joints between two VISE's was also evaluated. THERM© 5.2 was utilized to estimate the localized surface temperatures within the system and then compared to the expected dewpoint temperature at that location. The localized dewpoint temperature for each point was determined through the use of SGJJR proprietary moisture migration software. WUFI 2D, similar to WUFI 5.1 but simulates two-dimensional components, was also utilized to further evaluate the condensation risk within the assemblies.

The results of each of the specific analyses are summarized in their respective sections of this report. Additional conclusions and recommendation related to the limitations and future testing are also provided for consideration.

Description of Panels and Wall Systems

Vacuum Insulation Panels (VIP's) are defined as an insulation element containing an open cell core material within an envelope; where the internal pressure inside the envelope is much lower than the ambient air pressure. The VIP evaluated incorporates a fumed silica core and a trilaminate foil envelope. The manufacturer's specific product name for the foil envelope is MF-3. By applying a vacuum to the fumed silica core material, the thermal performance of the core material increases. To create the vacuum, the core material is placed in the MF-3 envelope which is then sealed and evacuated of air. However, the high conductivity of the MF-3 envelope causes thermal bridging at the perimeter of each VIP which reduces the overall thermal performance of the VIP. The size of the VIP can have a significant impact on the thermal bridging effect. The thermal performance of larger VIP's will be affected less by the thermal bridging than smaller VIP's. The effects of the thermal bridging are further discussed in the Total Product Thermal Performance section of this evaluation. **Figure 1** identifies the key components of a VIP.

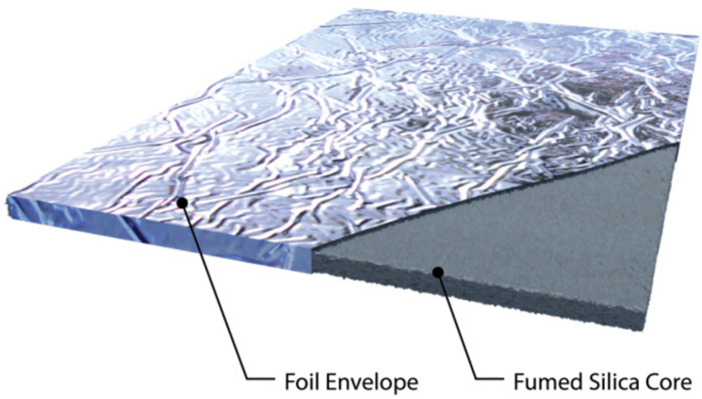


Figure 1: VIP Section Diagram

A Vacuum Insulated Sandwich Element (VISE) is formed by encapsulating a VIP within an additional and separate insulation element. The primary goal of this insulation element is to protect the VIP's from damage that may occur during installation. However, this insulation offers some additional thermal performance to the VISE. Typical VISE's considered in this evaluation are 2'x4'x3" and have 1" expanded polystyrene (EPS) coverage on the front and back of the panels. Depending on the configuration and size of the panels, the edge coverage thickness varies. **Figure 2** identifies the key components within a VISE. **Figures 3 and 4** show the construction of a 4'x2'x3" and a 2'x2'x3" VISE respectively.

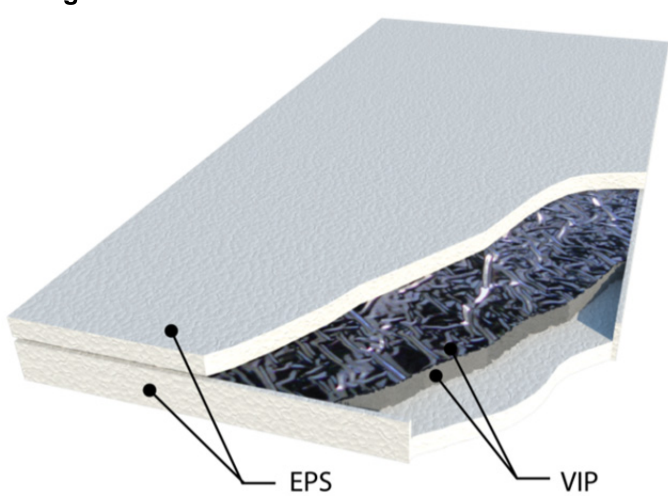


Figure 2: VISE Section Diagram

Figure 3: Construction of 4'x 2' x 3" VISE

Figure 4: Construction of 2' x 2' x 3" VISE

Wall Systems

Five wall designs are included in the evaluation (Designs A – E). The number of VIP's within a single VISE, the dimensions and thickness of the VIP and the VISE, and the arrangement of the both within the wall assembly are modified in the each design. The following describes the components included in the each of the five wall designs and an industry standard base wall assembly used for comparison.

Base EIFS Assembly

DRYVIT Systems Incorporated "Outsulation Plus MD" EIFS wall assembly is the base wall used in this evaluation. It is an industry standard EIFS wall and is used to compare the 5 wall designs of this evaluation. **Figure 5** describes the components of the base wall assembly.

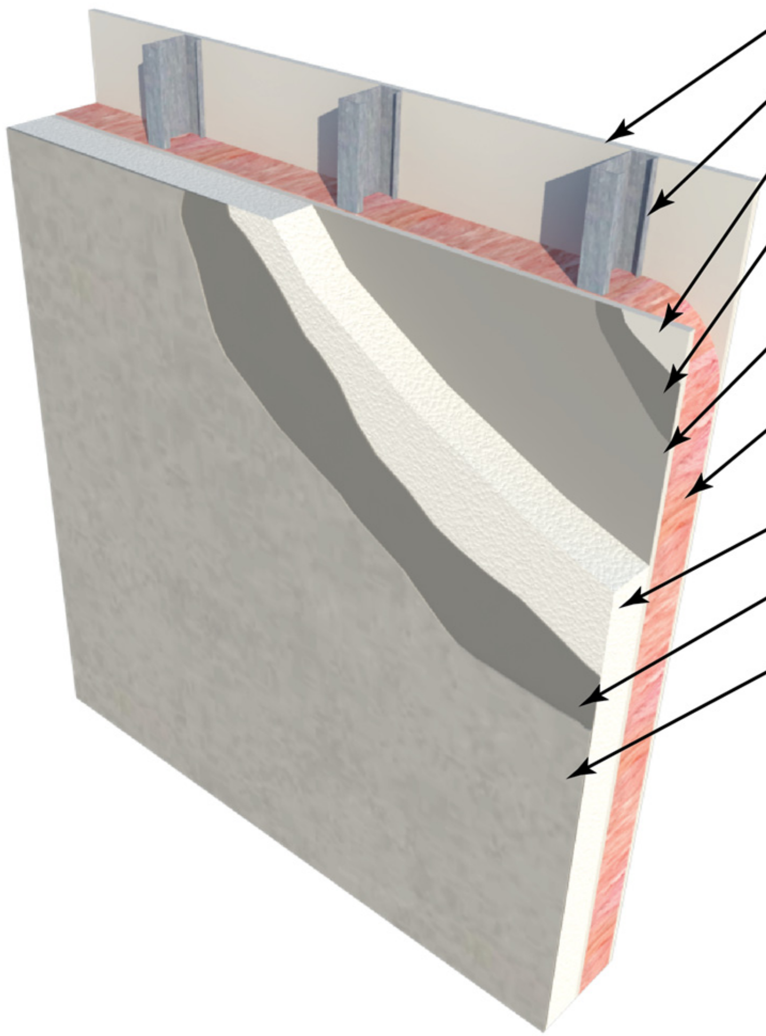


Figure 5: Base EIFS Wall Section Diagram.

Modified EIFS Assembly

Throughout the evaluation, the evaluated wall assemblies changed very little with the exception of the insulation layers [**Figure 6**]. The evaluation includes multiple configurations of the VIP and VISE that were compared as alternates to the standard 3” EPS insulation found in the base wall. VISE’s are attached to the wall in the same manner as the base wall’s EPS, and are configured in a running bond pattern. The VISE then receives the same base coat and finish coat as the base wall.

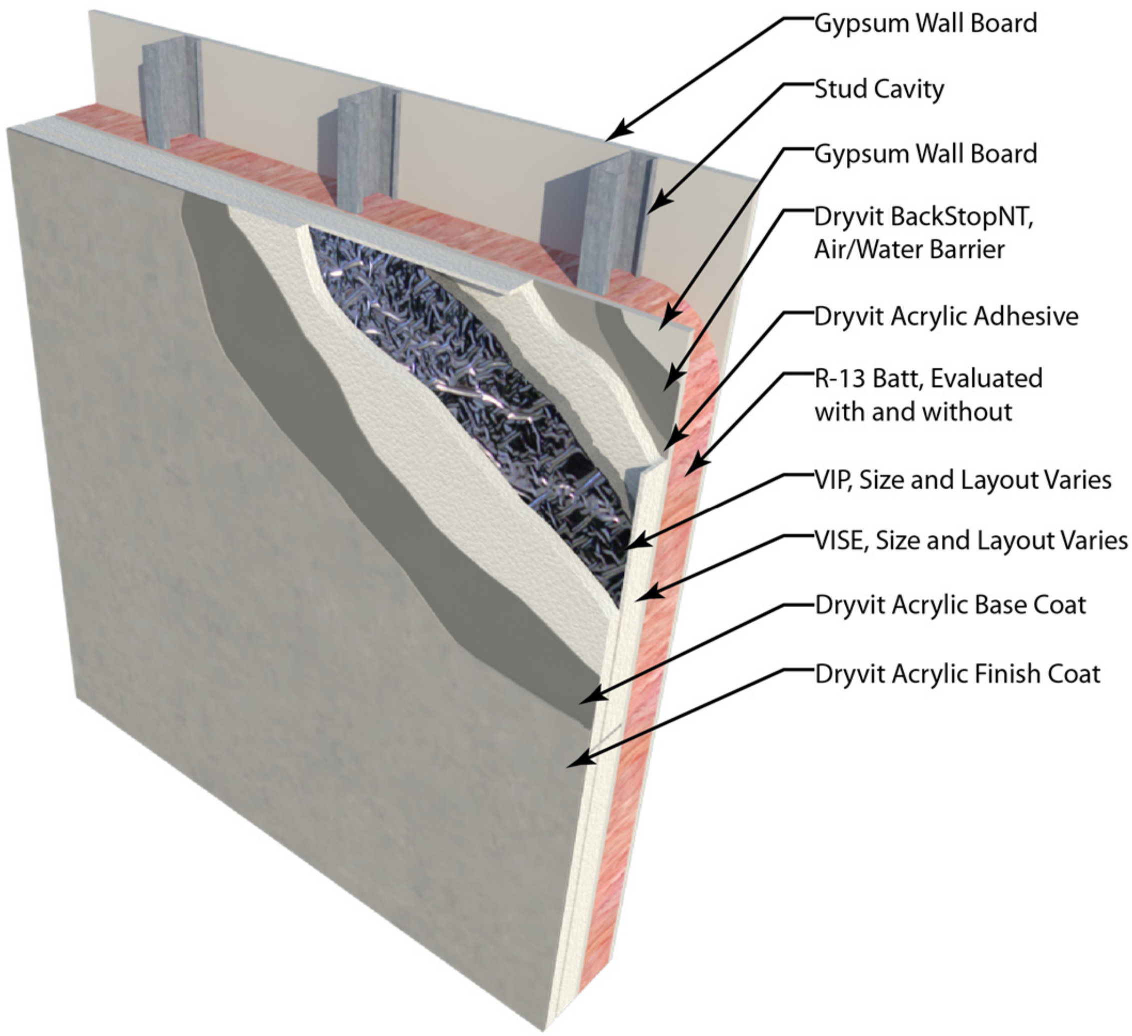


Figure 6: Modified EIFS Wall Section Diagram

Design A

Design A is constructed in the same manner as the base wall except the 3" EPS is substituted by a 3" VISE. **Figure 7** illustrates 10"x11.25"x1" VIP's arrayed in either a 2x4 or a 2x2 pattern. The extent of EPS edge coverage on each VISE is also evident.

4'x 2' x 3" VISE [**Figure 5**]

- 1 3/16" Vertical EPS Edge Coverage
- 1" Horizontal EPS Edge Coverage
- 1.88" Horizontal EPS Center Spine

2' x 2' x 3" VISE [**Figure 6**]

- 5/8" Vertical EPS Edge Coverage
- 1" Horizontal EPS Edge Coverage
- 1.88" Horizontal EPS Center Spine

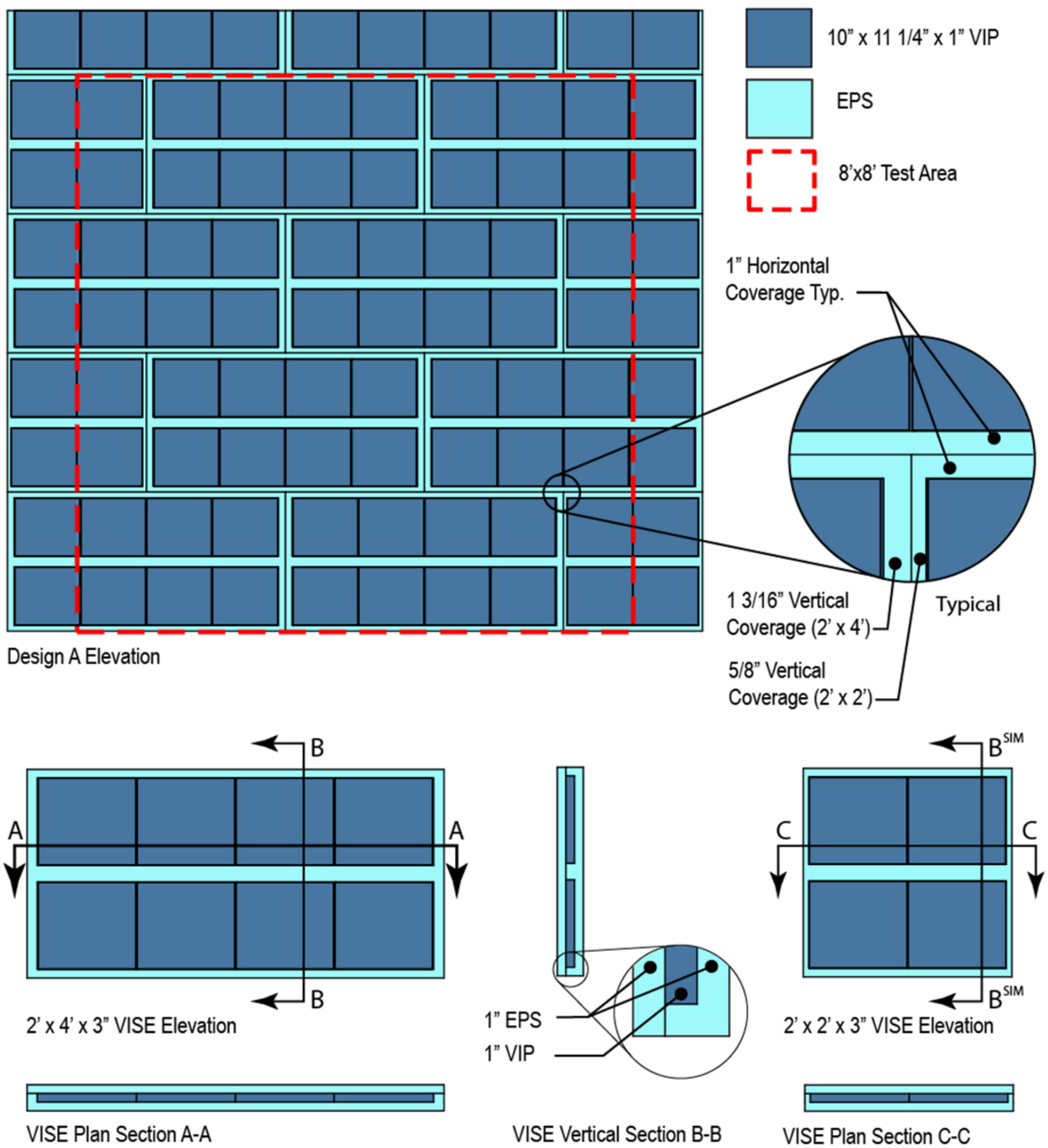


Figure 7: Design A VISE Layout

Design B

Design B was developed to reduce thermal bridging through the foil envelope of the VIP's. The VIP's in Design B are enlarged to minimize the number of required panels. This will reduce the amount of panel perimeter and therefore the thermal bridging from the MF-3 foil at the edges. The EPS coverage was also reduced to ½" around the perimeter of both the 2'x2' and the 4'x4' VISE's to maximize the amount of VIP within a VISE in order to increase the overall thermal performance. **Figure 8** illustrates 23" x 23" x 1" and 24" x 23" x 1" VIP's contained in a single VISE, and the extent of EPS edge coverage for each VISE.

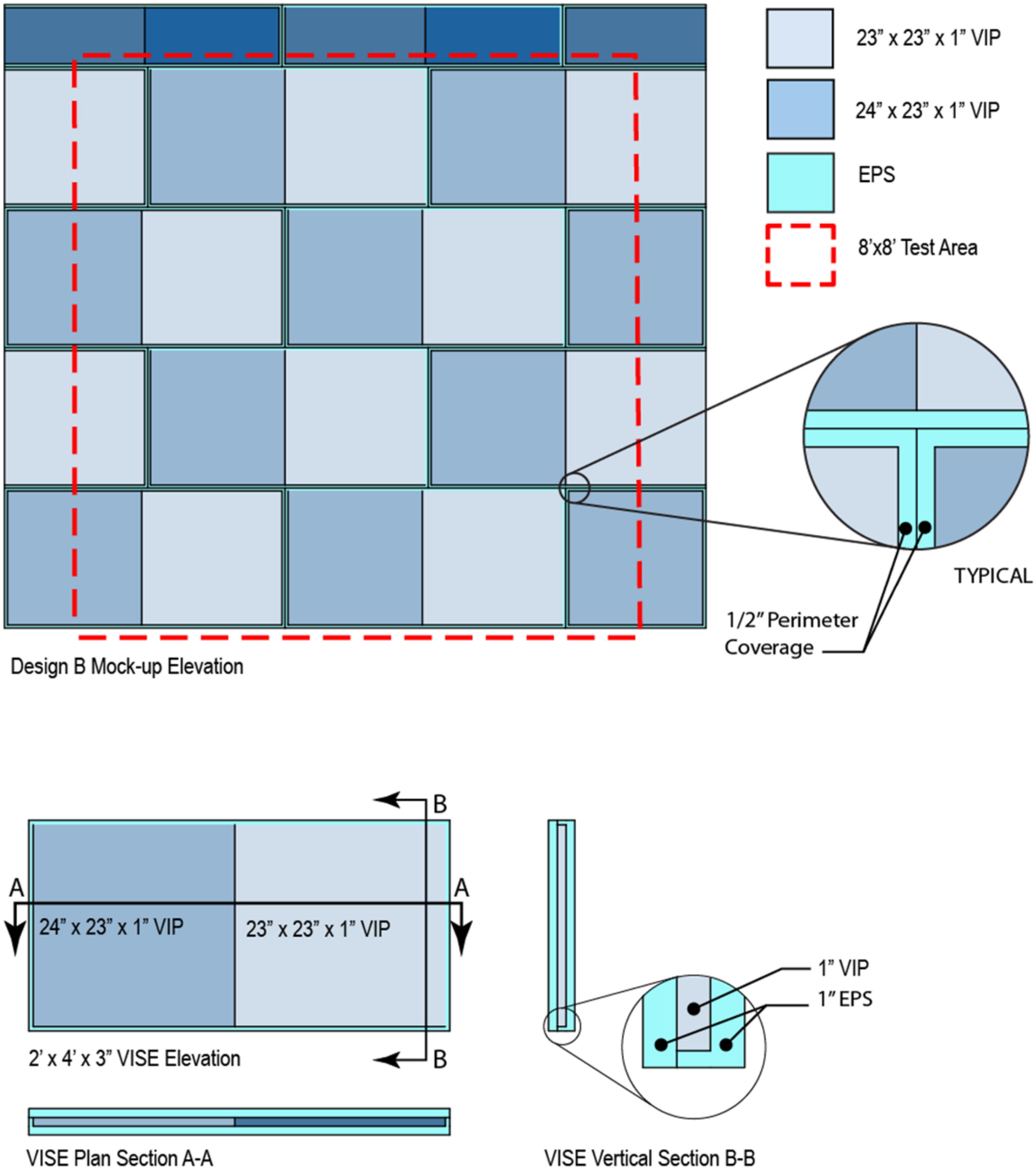


Figure 8: Design B VISE Layout

Design C, D, & E

Further improvement of the assembly was explored by decreasing the number of VIP's within a VISE, increasing the size of the VIP within the VISE, increasing the thickness of the VIP, and by further reducing the protective EPS edge on the VISE's from ½" on the perimeter edge to ¼". The thickness of the VIP was reduced to ¾" in Design C to determine if reduction of thermal bridging or if VIP thickness is a more effective method of producing better overall thermal performance. **Figure 9** illustrates Designs C, D, & E containing 4' x 2' and 2' x 2' VISE's with 47 ¼" x 23 ¼" and 23 ¼" x 23 ¼" VIP's, respectively. The only difference between the designs is the thickness of the VIP. Designs C, D, & E are ¾", 1", and 1 ½" thick respectively. The EPS is thicker in Design C and thinner in Design E to compensate for the VIP.

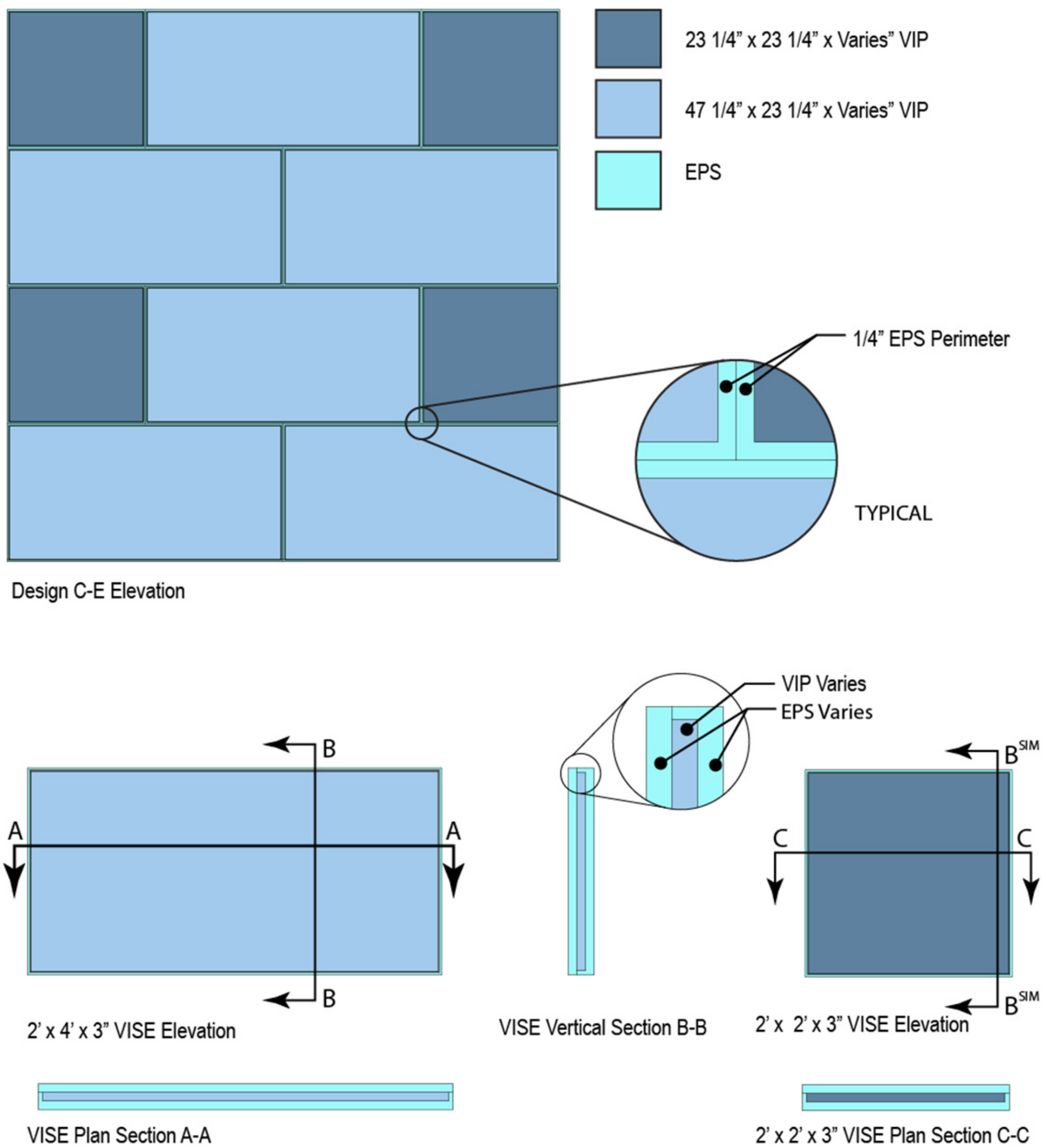


Figure 9: Design C, D, & E VISE Layout

Material Properties

The various types of modeling programs used in this evaluation require input of specific properties of the materials in order to produce accurate results (see list below).

Multiple sources of information were researched and evaluated to determine the appropriate material properties. Manufacturer data and test reports, past research papers, industry organizations, and software databases were all used throughout the evaluation to identify the needed property information. Material properties were provided by DRYVIT Systems Incorporated and DCC for materials they produce, and ASHRAE Fundamentals, THERM Database, and the WUFI Database were referenced for properties of other materials.

Thermal conductivity and vapor permeance are the two primary material properties needed to evaluate the performance of the designs. However, additional material properties are also required to perform the transient hygrothermal analysis. WUFI requires more detailed material properties than other modeling programs used in order to produce valid results. The software allows for input of the following properties:

- Thermal Conductivity
- Permeability
- Specific Heat Capacity
- Porosity
- Bulk Density
- Moisture Storage Function
- Liquid Transport Coefficient (Suction and Redistribution)
- Moisture Dependent Permeability
- Moisture Dependent Thermal Conductivity
- Temperature Dependent Thermal Conductivity
- Temperature Dependent Enthalpy
- Typical Built-In Moisture Content

When tested materials properties were provided by DCC or DRYVIT, they were inputted into the analysis. However, in some instances when certain properties were not provided, the analysis was supplemented with properties of similar materials in the software databases or from past research. This is considered a standard practice when no other data is available. The supplemented material properties are not expected to have a significant impact on the results of the evaluation. Refer to the resource section for a list of past research papers and presentations that were studied to determine the appropriate material properties used in the evaluation when not provided or available. The following indicates the materials included in the assemblies, and their primary material properties.

Material Data provided by DRYVIT

- Finishcoat (1/16" thick, nominal)
  - Thermal Conductivity = 0.22 Btu/h·ft·°F
  - Permeability = 0.7 perm in

- Basecoat/Adhesive (1/16" thick, nominal)
  - Thermal Conductivity = 0.27 Btu/h·ft·°F
  - Permeability = 0.38 perm in

- Expanded Polystyrene Insulation (1" thick)
  - Thermal Conductivity = 0.021 Btu/h·ft·°F
  - Permeability = 3.6 perm in

- Backstop NT (12 mil thick air/water barrier)
  - Thermal Conductivity = 0.092 Btu/h·ft·°F
  - Permeability = 0.007 perm in

Materials from WUFI Database

- Gypsum Sheathing (1/2" thick)
  - Thermal Conductivity = 0.094 Btu/h·ft·°F
  - Permeability = 21.467 perm in

- Air Space (based on 6" stud cavity)
  - Thermal Conductivity = 0.543 Btu/h·ft·°F
  - Permeability = 1840.0 perm in

- Interior Gypsum Board (1/2" thick)
  - Thermal Conductivity = 0.092 Btu/h·ft·°F
  - Permeability = 18.321 perm in

Material Data provided by DCC

- MF-3 Foil Trilaminate (0.004" thick)
  - Thermal Conductivity = 0.578 Btu/h·ft·°F
  - Permeability = 0.000002 perm in

- Fumed Silica Core (1" thick)
  - Thermal Conductivity = 0.002 Btu/h·ft·°F
  - Permeability = 10 perm in

Thermal performance of the VIP is based on the composite of both the foil envelope and the fumed silica core material. The tested center of panel thermal performance for a 1" VIP is approximately R39.06 (U-factor = 0.0256 BTU•in/(h•ft^2•°F)). As previously stated, the foil envelope creates a thermal bridge around each panel which depending on the size of the VIP can have a significant impact on the total product thermal performance and condensation risk. Refer to the "Total Product Thermal Performance" and "Condensation Risk Analysis" sections of this report for a detailed evaluation of the thermal bridging.

Effects of thermal bridging are not included in the transient hygrothermal analysis component of this evaluation. Transient hygrothermal analysis is a one dimensional calculation. It is essentially reviewing the center of panel performance and not including any degradation due to the thermal bridging. However, there are other aspects that are included in the transient hygrothermal analysis are not included in the total product thermal performance or condensation risks such. Consideration for how certain material properties change due to temperature and moisture content are evaluated as part of the transient hygrothermal analysis.

Certain types of materials are also able to hold more moisture within the material as the moisture content (MC) of the material increases. Many of the materials listed above include these properties, which are either provided by the manufacturer or supplemented by the software database. The fumed silica core material is of specific interest as it is one of the primary materials evaluated in this report. Its thermal performance lowers as its moisture content increases. Also the amount of moisture it is able to hold within the core increases as the relative humidity of the core increases. Both of these properties are included and a more detailed evaluation of the impact on the total performance is provided in the transient hygrothermal analysis section. Age of the VIP will also impact the performance of the system. The thermal performance of the panels decreases with age. This is a result of the VIP losing its vacuum and of the VIP gaining moisture content over time. The first aspect is not included in the analysis but the loss due to moisture increase is included.

Transient Hygrothermal Analysis

WUFI 5.1, developed by Oak Ridge National Laboratory (ORNL) and the Fraunhofer Institute of Building Physics (IBP) was utilized as the primary software to perform the transient hygrothermal analysis. WUFI is an acronym for the German phrase of "Wärme und Feuchte instationär" that translates to Transient Heat and Humidity. WUFI is an advanced hygrothermal modeling software that calculates transient coupled one dimensional heat and moisture transport in building enclosure systems based on user defined interior environmental conditions, temperature and relative humidity (RH), and hourly exterior weather data for specific geographic locations. As indicated by ORNL, it has been validated by detailed comparison with measurements obtained in the laboratory and on outdoor testing fields.

This modeling program is used to investigate the potential for water accumulation within wall assemblies. Each component of the wall assembly is input into the model as a specific material at its actual specified thickness and location. As indicated, the software is a one dimensional simulation. It does not include the effects of two dimensional thermal bridging such as steel studs that interrupt batt insulation or foil packaging of a VIP. It only uses the thermal performance of what might be considered the "center of panel" performance. Due to this, the size of the VIP or the VISE does not affect the results of this type of simulation. The modeling and results presented in this report represent Wall Designs A, B, and D as they are the wall assemblies that incorporate 1" VIP's in the VISE. Wall Design C (3/4" VIP) and Wall Design E (1-1/2" VIP) were also reviewed and the results did not vary significantly from the designs with a 1" VIP.

Prior to starting the simulation, the initial moisture content for each of the materials and the interior and exterior environments are defined by the user. The software uses location specific hourly weather data that includes the effects of temperature, precipitation, relative humidity, wind, and solar radiation. The outside conditions continuously change as dictated by weather files that are included in the software database. The software includes a library of cities to use for exterior weather data. Moisture movement through the wall assembly is accounted for in two directions, from the interior to the exterior and from the exterior to the interior depending on the specific conditions of the two environments and the temperature and RH of the materials at any given hour. Wetting and drying of the individual materials within the wall assembly is also considered from both directions, as well as the accumulation of water within the wall system.

As previously indicated, properties of certain materials can be affected by their temperature and moisture content. As this is a transient simulation, each hour the program is recalculating and incorporating the changes in the properties of the materials in the assembly and the temperature, water content, and RH within each material. Thermal mass of materials is also included in the calculations which in turn incorporate material's ability for thermal storage and the effects of thermal lag. Hourly changes in the conditions on the interior and exterior and within adjacent materials result in changes of the complete assembly and the individual components.

The transient hygrothermal modeling procedures performed generally conformed to ASHRAE Standard 160, "Criteria for Moisture-Control Design Analysis in Buildings". The standard indicates to define the initial moisture content of the individual materials equal to two times the equilibrium moisture content (EMC) at 80% RH. Elevating the initial moisture content is performed in order to account for the likelihood that materials are "wetter" during new construction.

The Standard 160 also indicates simulating a period of five consecutive years when performing typical transient hygrothermal modeling. The primary reason for the five year simulation period is to identify if there are any trends of continual wetting or drying of a system or of individual system components.

However, the five year period is only considered as a minimum duration. Due to the nature of product development, the properties of the VIP, and service life of most buildings, it was determined that it was more appropriate to extend the simulation period to 50 years to verify that no abnormal effects would be encountered over an extended period of time.

After a simulation is complete, the following considerations are reviewed as a part of the evaluation of the results.

1. The moisture content of the individual materials, to determine if it is at an acceptable amount for each material.
2. Moisture content of an individual materials is not increasing over time.
3. Moisture content of the enclosure assembly is not increasing over time. Essentially indicating that the assembly has more potential for drying than wetting over a one year period.
4. Comparison of individual materials to the moisture performance evaluation criteria described in ASHRAE Standard 160, "Criteria for Moisture-Control Design Analysis in Buildings".

The following is a direct excerpt from the standard.

> ***Conditions Necessary to Minimize Mold Growth.*** *In order to minimize problems associate with mold growth on the surfaces of components of building envelope assemblies, all of the following conditions shall be met.*
>
> *a. 30-day running average surface RH<80% when the 30-day running average surface temperature is between 5°C (41°F) and 40°C (104°F).*
> *b. 7-day running average surface RH<98% when the 7-day running average surface temperature is between 5°C (41°F) and 40°C (104°F).*
> *c. 24-hour running average surface RH<100% when the 24-hour running average surface temperature is between 5°C (41°F) and 40°C (104°F).*

WUFI has multiple ways of presenting results and graphic outputs available. One of the primary outputs used for evaluation is an animation of the temperature, RH, and water content of the materials of the enclosure assembly as the simulation is in process. While the animation is playing, the enclosure assembly is reviewed to identify possible problem areas within the individual materials. Areas identified are then further analyzed to determine if they conform to the criteria indicated above. Various types of graphs can also be developed from the data produced by the simulation. The following graphs are generally used to verify whether or not the criteria are met.

1. Water content of the enclosure assembly over the duration of the simulation.
2. Water content of the individual materials over the duration of the simulation.
3. Temperature and RH at a given surface within the wall assembly over the duration of the simulation.

The raw data produced by the simulation or graphs can also be extracted and analyzed separately through the use of 3rd party software such as Microsoft Excel to further analyze the results. Specifically this process is used to determine compliance with ASHRAE 160 criteria.

For this evaluation, the performance of the system was considered for various exterior climates to determine the suitability across multiple environments. The six diverse locations throughout the United States selected for analysis included Baltimore, MD, Boston, MA, Miami, FL, Minneapolis, MN, Phoenix, AZ, and Seattle, WA. **Figure 10** indicates the location of the cities depicted on the International Energy Conservation Code Climate Zone Map.

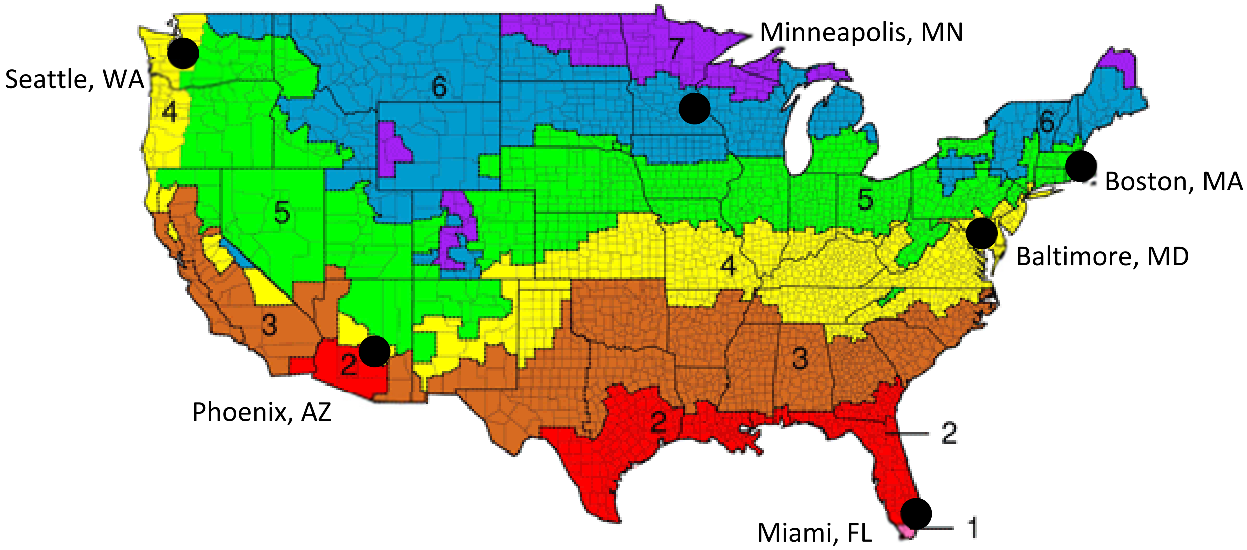


Figure 10: Locations included in the Evaluation overlaid onto Climate Zone Map

Minneapolis, MN was the first location simulated. The site was selected as it was suspected to have the worst case exterior environmental conditions. It has the coldest exterior temperatures and would likely cause more severe conditions of condensation and elevated moisture content within the assembly than the other climates. As indicated previously, WUFI has the ability to fluctuate the interior temperature and RH throughout the yearly cycle to replicate in-service conditions. However, in order to limit the number of variables; the interior temperature and humidity were held constant throughout the duration of the individual simulations. The following interior conditions were used in all simulations.

- Interior Temperature = 70°F
- Interior Relative Humidity = 50% RH

Although the interior conditions may be different or vary throughout a year for a given building or building function, it was determined that the selected conditions should appropriately represent a building with relatively demanding interior environment. Often, the interior temperature will be slightly cooler in the winter months and warmer in the summer months, and it is very common for the RH to be lower in the winter and slightly higher in the summer.

Review of Minneapolis, MN Results

The simulation results were reviewed to determine if there were any locations within the model that would indicate concerns. **Figure 11** is a screen capture of the results of the WUFI animation after the 50 year simulation was completed. The exterior is on the left and the interior is on the right. The individual material layers are illustrated by light color coded shading, and are labeled below the graphs. For instance, on the far left, the outer layer of EPS is indicated by light yellow shading. Indication of the temperature, RH, and water content are overlaid onto the material layers. In the top graph, the dark red line is the temperature through the assembly at the time the animation was complete, and the light red shading signifies the history of the temperature throughout the 50 year simulation. In the graph on the bottom, the dark blue line near the bottom of the graph is the water content, and the light blue shading indicates the history. Also, in the bottom graph, the dark green line is the RH, and the history is represented by the light green shading.

The red and green small horizontal triangles to the right and left of both the top and bottom graphs indicate the interior and exterior temperature and RH conditions that were occurring at the point in which the simulation completed. The clock on the upper right indicates the time and date when the simulation completed. The blue arrows between the two graphs, some pointing to the interior and some pointing to the exterior, represent the direction of moisture flow for the individual material layers.

The following summarizes observations made during the review of the animation and the final results.

1. The history of the RH (light green shading) is elevated in the interior gypsum wall board, stud cavity, exterior gypsum sheathing, and interior layer of EPS. However, as previously indicated this is a result of the elevating the initial water content to 2x the 80% EMC. When reviewing the animation while it is playing, it is evident that the materials dry within the first few months of the simulation. After the initial drying, the RH of these materials balances out to the EMC and fluctuates between approximately 40% and 70% and not of concern. Note, the peak high and low RH continues to increase and decrease. This item will be discussed further in Observation 5 **(Figure 12).**
2. The standard EIFS wall system was also simulated in Minneapolis to compare the initial drying effects of the components of the assembly to the drying of the new wall designs. As indicated in **Figures 13 - 16**, the increased initial moisture content for both systems dries within a reasonable and similar timeframe.
3. The history of the RH is also elevated in the exterior layer of EPS. The RH cycles from high to low during each year throughout the duration of the simulation. It is high enough to require further analysis. The raw data of the Temperature and RH at the interior surface of the exterior layer of EPS was extracted, evaluated, and compared to the ASHRAE 160 criteria previously indicated. Additional explanation and review of the criteria comparison is presented later in this section **(Table 1).**
4. The core material of the VIP continuously increases throughout the duration of the simulation. The increase of RH also causes an increase of the moisture content of the core material as it continuous to adjust to its EMC for the respective RH. This condition is primarily caused by the composition of the VIP. The foil envelope is a vapor barrier with an extremely low water vapor permeance. The vapor pressure at certain times throughout a year is high enough to allow a minor amount of moisture to enter the VIP from the interior side. However it is not high enough to drive the vapor out the other side of the VIP as it is also the foil with low permeance. The subtle increase of moisture content continues to increase throughout the duration of the simulation. However, the end resultant moisture content is approximately 0.22 lbs/ft^3 or 2% MC **(Figures 17 and 18).**
5. The increase in moisture content of the VIP core material results in a slight but continual decrease in thermal performance of the VIP over the duration of the simulation. The decrease in thermal performance causes the surface of the adjacent interior layer of EPS to be slightly cooler in the winter and warmer in the summer. The resultant temperature coupled with the typical water content at that location produces a higher RH in the winter and a lower RH in the summer respectively **(Figure 12).**
6. No other materials in the wall assembly, with the exception of the fumed silica core, experienced increased moisture content throughout the duration of the simulation.
7. The total water content in the wall assembly increases throughout the duration of the simulation. However, the increase is only due to the elevation of water content in the VIP not from the other components **(Figure 19).**

Simulations with a 50 year duration for the other 5 cities were also performed, reviewed, and evaluated. The results were similar for all simulated cities and in no case were they worse. Due to the similarity of results, the graphs for the other locations are not included in this report.

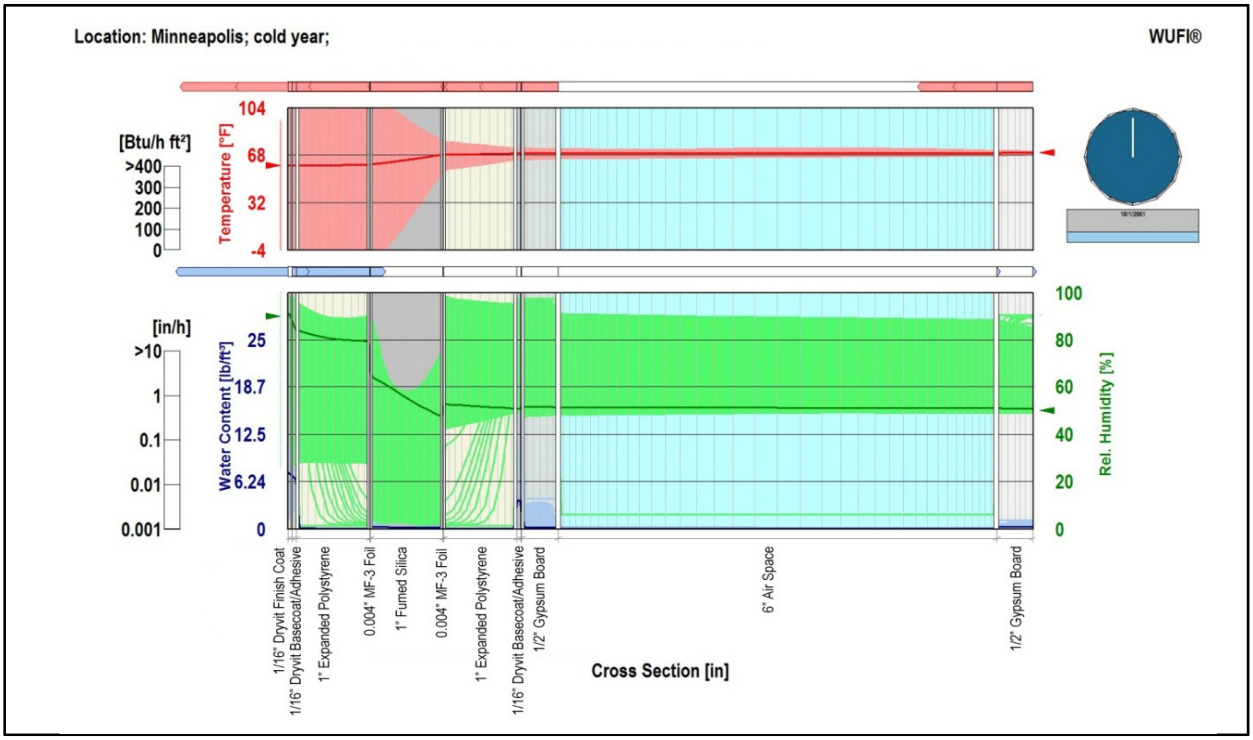


Figure 11: Results of the WUFI animation after completion of the 50 year simulation.

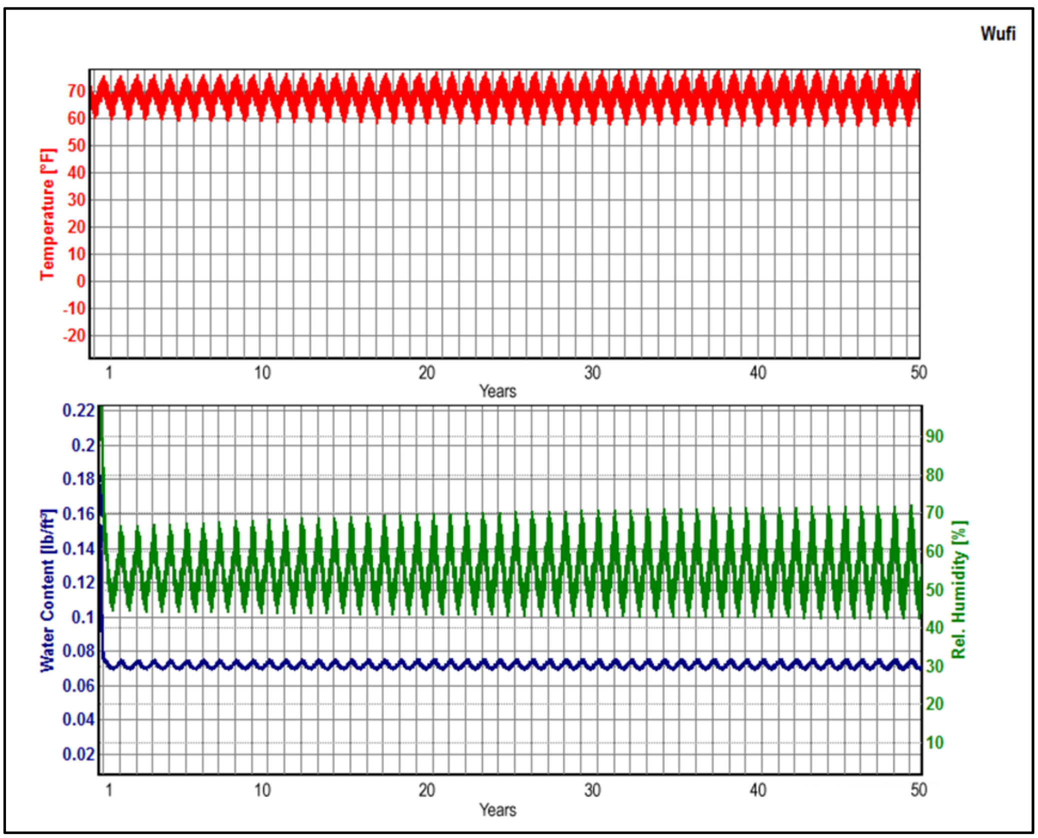


Figure 12: Graph of Temperature, RH, and Water Content at the exterior surface of the interior layer of EPS of Design A over the 50 year simulation period.

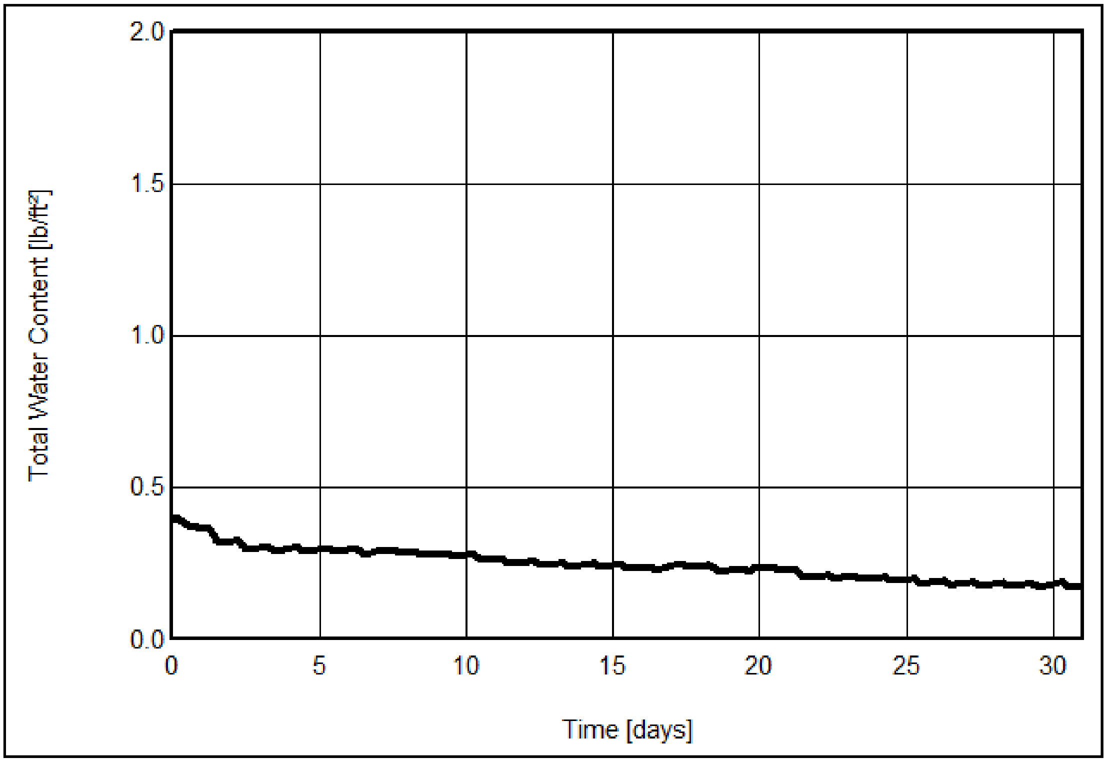


Figure 13: Total Water Content of Design A with VIP included indicates drying of the elevated initial moisture content within the first 30 days.

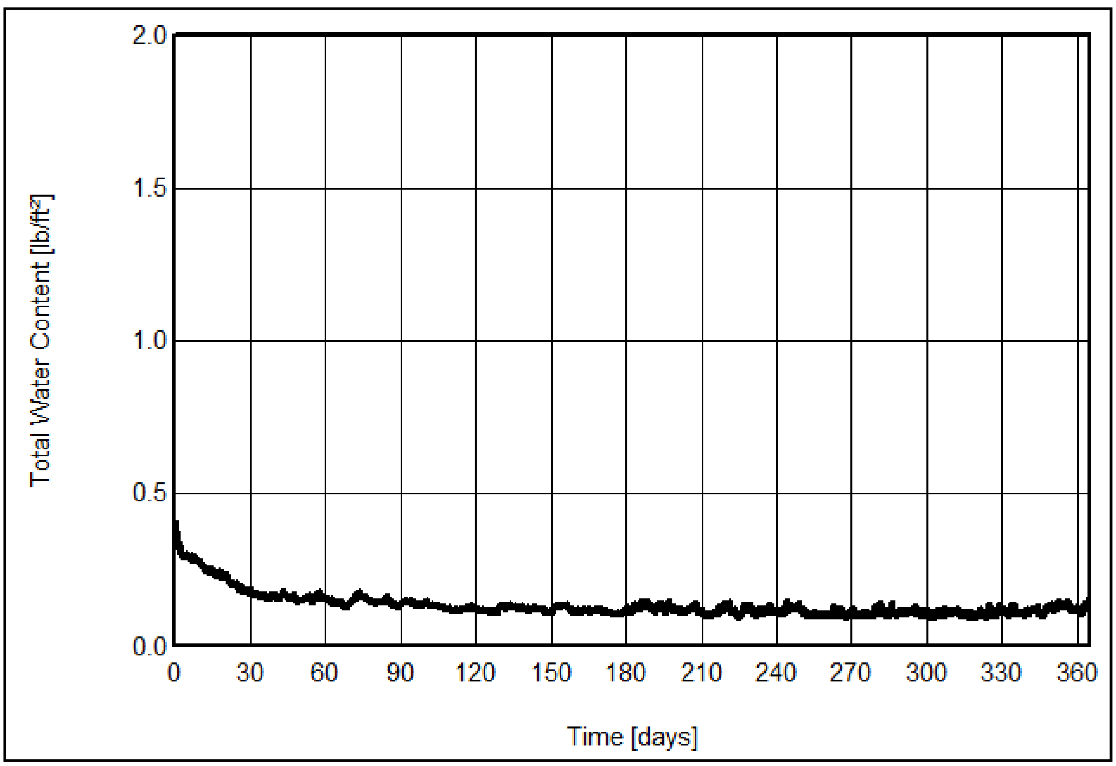


Figure 14: Total Water Content of Design A with VIP included indicates drying of the elevated initial moisture content within the first year.

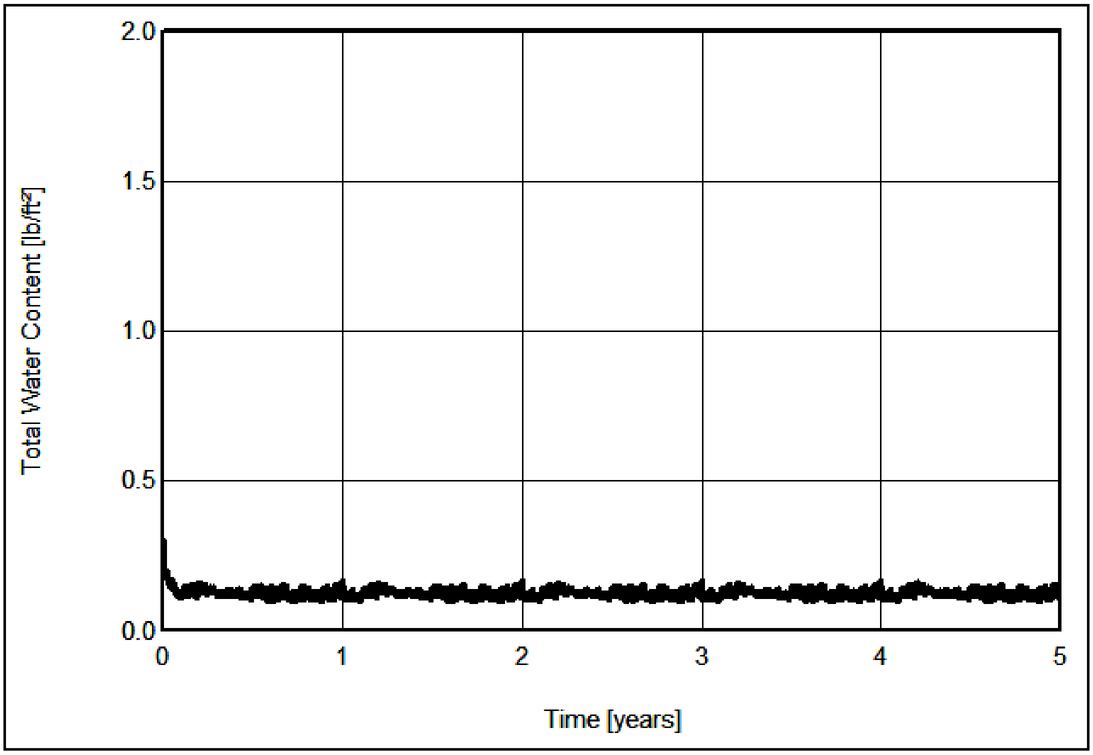


Figure 15: Total Water Content of standard EIFS wall without a VIP included indicates drying of the elevated initial moisture content over a 5 year simulation period.

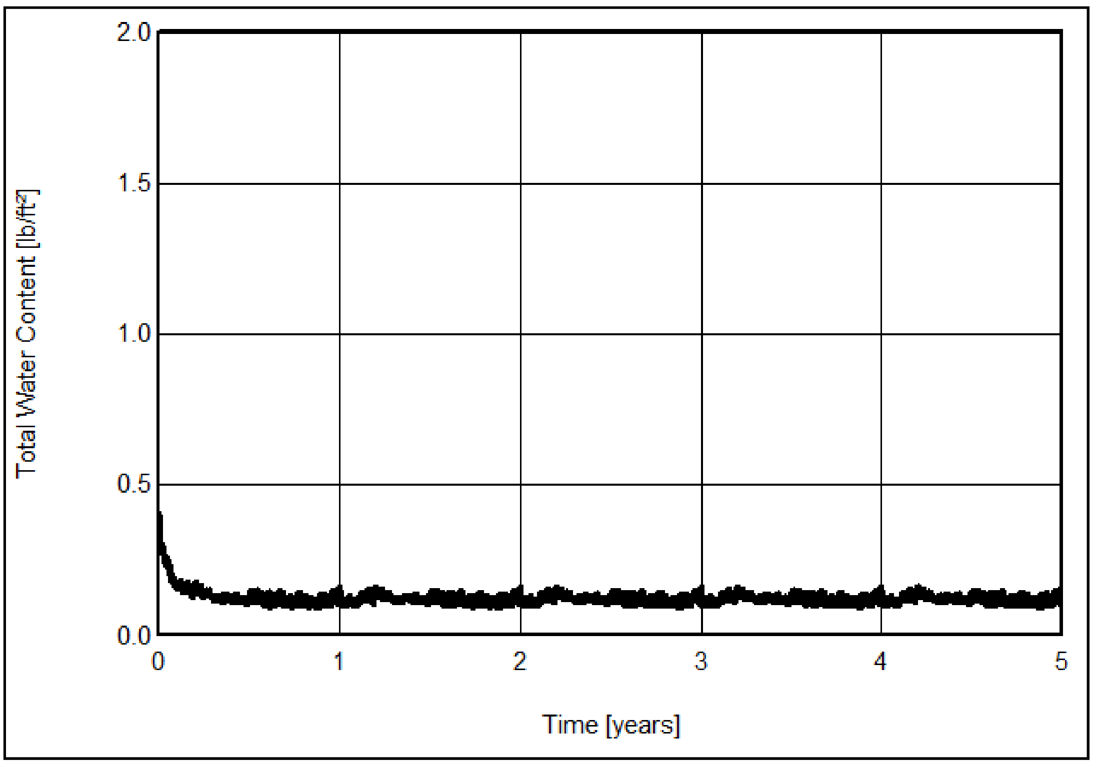


Figure 16: Total Water Content of Design A with VIP included indicates drying elevated initial moisture content over a 5 year simulation period similar to the standard EIFS in **Figure 15.**

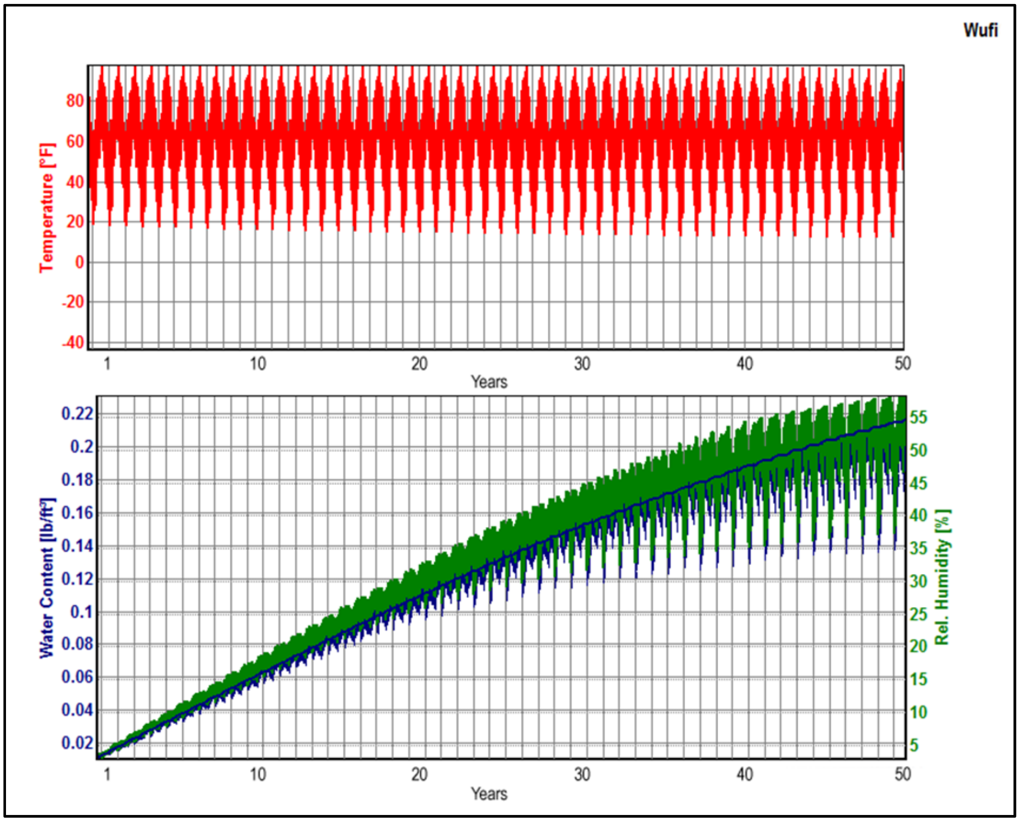


Figure 17: Graph of Temperature, RH, and Water Content at center of the VIP core material of Design A over the 50 year simulation period.

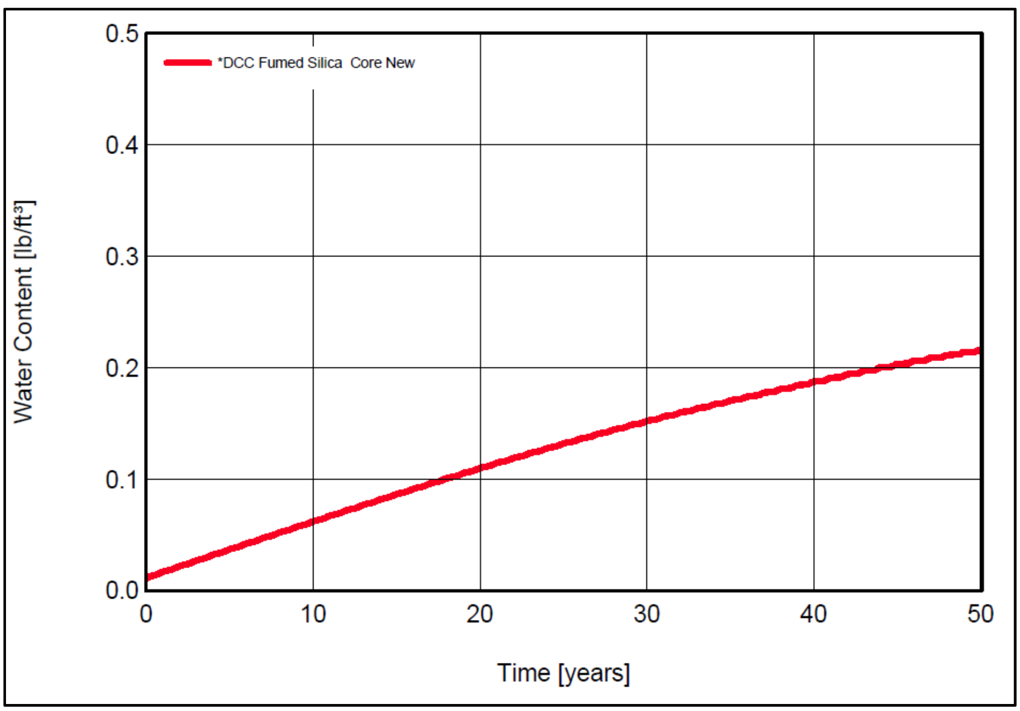


Figure 18: Water Content of VIP core material in Design A over the 50 year simulation period.

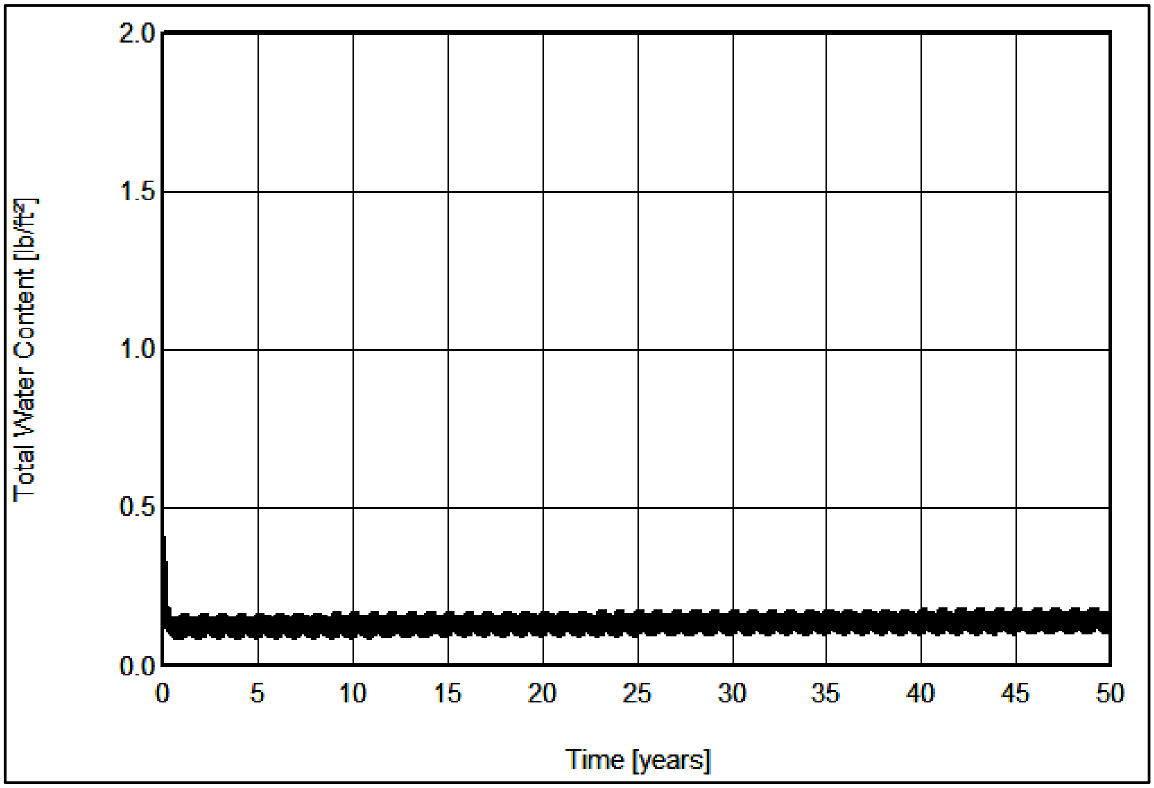


Figure 19: Total Water Content of Design A with VIP included indicates slight increase in water content over the 50 year simulation period.

ASHRAE 160 Criteria Evaluation

As previously indicated, the procedure indicated in ASHRAE 160, was utilized to evaluate if conditions were present in which there may be a potential to sustain mold growth. The first step in this process it to review the animation and identify locations that appear to experience higher levels of relative humidity for an extended period of time. The only location within the wall assembly that appeared to meet this first indicator of concern was the surface between the interior face of the exterior layer of EPS and the exterior face of the VIP, approximately 1" in from the exterior (**Figure 11**). The RH cycles from high to low during each year throughout the duration of the simulation. In all instances, this point in the wall system was identified to be above 80% RH for an extended period of time. No other locations of concern were indicated by the results. However, due to the fact that the VIP package is a very effective vapor retarder the other side of the VIP was also analyzed to verify that there was no concern.

The raw data (temperature, relative humidity, and water content) calculated by WUFI at that point was exported to a file that was imported into MS EXCEL for further evaluation. The MS EXCEL spreadsheet file was setup to calculate the number of times that specific location met any of the 3 types of moisture performance criteria related to the conditions necessary to minimize mold growth in ASHRAE 160.

The data was analyzed at multiple points throughout the 50 year simulation period, during the 1st, 2nd, and 48th years. In many conditions, for the initial months of the first year, at least one of the ASHRAE criteria was not met. This is a common result in most models as they are required by the ASHRAE 160 standard to increase the initial moisture content to 2x the EMC at 80% RH. The purpose is to illustrate some amount of increase moisture content due to new construction and to show that the system has drying potential. This is not of particular concern as long as the system does not continue to show these results in Year 2. Year 48 was reviewed to identify any long term concerns that might develop as the system ages. If the system does not show an indication of concern in Years 2 or 48, then it would be reasonable to conclude that there are no concerns in any of the years between.

The results of all locations were also reviewed with batt insulation installed within the steel stud cavity. Only conditions that appeared to be of particular concern are indicated in the results. Conditions that include batt insulation in the steel stud cavity that are not indicated were not evaluated as it was determined that they would not perform any worse than the original assembly.

ASHRAE 160 Conclusions
Refer to **Table 1** for a summary of the results of the detailed analysis at two locations, 1" in from the exterior in the EPS and 2" in from the exterior in the EPS (the surfaces directly adjacent to the both sides of the VIP). The table indicates the percentage of a year in which the conditions did not meet any of the 3 types of moisture performance criteria in ASHRAE 160.

The following is a legend of the criteria as indicated in ASHRAE 160 for use with Table x.
Criteria 1 (C1): 30-day running average surface RH<80% when the 30-day running average surface temperature is between 5°C (41°F) and 40°C (104°F).

Criteria 2 (C2): 7-day running average surface RH<98% when the 7-day running average surface temperature is between 5°C (41°F) and 40°C (104°F).

Criteria 3 (C1): 24-hour running average surface RH<80% when the 24-hour running average surface temperature is between 5°C (41°F) and 40°C (104°F).

Results
1. As indicated in lines 1-6 of **Table 1**, conditions met the 3 criteria at all locations at 1" into the EPS, adjacent to the exterior surface of the VIP. This was based on a wall assembly without batt insulation.

2. Lines 7-12 indicate that there is a minor amount of the 1st year where 2 of the 3 criteria are not met in most of the locations. This is at 2" into the EPS adjacent to the interior surface of the VIP. However, as indicated previously this can be expected within the first year and as indicated it does not continue in the 2nd year. Additionally the conditions met the 3 criteria in year 48. This was also based on a wall assembly without batt insulation. The elevated initial moisture content within the wall assembly takes longer to dry to the interior as it cannot dry to the exterior due to the VIP foil envelope. The initial moisture at the 1" position is able to more readily dry to the exterior and meets all of the criteria categories.

3. Lines 13-18 are the results of the system with Batt insulation included in the steel stud wall.

4. With the exception of Line 15 (Miami), all other cities were evaluated at the 2" location into the EPS. Those climates all have colder winter months, and there is a concern that the additional insulation may cause the interior surface of the VIP to be cooler and potentially cause higher relative humidity. In all cities expect for Minneapolis (Line 16), the initial conditions did not meet the criteria for a longer period of time than the assembly without the batt insulation. However, it did not continue into the 2nd year and is not of particular concern.

5. In Minneapolis (Line 16), similar results were found for the first year. However, conditions in year 48 did not meet Criteria C1. This may suggest that as the VIP becomes less effective over time, that location becomes more susceptible to mold formation. Note, this evaluation is assuming 50% interior

RH and Minneapolis is a very cold climate. This wall system with batt insulation included would not be recommended for similar climates on buildings with high interior RH.

6. Line 15, Miami, was evaluated at 1" into the EPS from the exterior because it is in a hot humid climate. The concern was that the high vapor drive from the exterior to the interior could cause an issue on the exterior surface of the VIP due to the addition of the batt insulation. However, the conditions met the 3 criteria categories.

Line	Location	Batt	Year 1			Year 2			Year 48			Location in Wall
			C1	C2	C3	C1	C2	C3	C1	C2	C3	
1	Baltimore	No	0	0	0	0	0	0	0	0	0	1" into EPS
2	Boston	No	0	0	0	0	0	0	0	0	0	1" into EPS
3	Miami	No	0	0	0	0	0	0	0	0	0	1" into EPS
4	Minneapolis	No	0	0	0	0	0	0	0	0	0	1" into EPS
5	Phoenix	No	0	0	0	0	0	0	0	0	0	1" into EPS
6	Seattle	No	0	0	0	0	0	0	0	0	0	1" into EPS
7	Baltimore	No	23%	7%	0	0	0	0	0	0	0	2" into EPS
8	Boston	No	24%	8%	0	0	0	0	0	0	0	2" into EPS
9	Miami	No	16%	0	0	0	0	0	0	0	0	2" into EPS
10	Minneapolis	No	22%	1%	0	0	0	0	0	0	0	2" into EPS
11	Phoenix	No	17%	0	0	0	0	0	0	0	0	2" into EPS
12	Seattle	No	22%	8%	0	0	0	0	0	0	0	2" into EPS
13	Baltimore	Yes	41%	17%	0	0	0	0	0	0	0	2" into EPS
14	Boston	Yes	46%	23%	0	0	0	0	0	0	0	2" into EPS
15	Miami	Yes	0	0	0	0	0	0	0	0	0	1" into EPS
16	Minneapolis	Yes	51%	22%	0	0	0	0	21%	0	0	2" into EPS
17	Phoenix	Yes	21%	0	0	0	0	0	0	0	0	2" into EPS
18	Seattle	Yes	38%	17%	0	0	0	0	0	0	0	2" into EPS

Table 1: Summary of ASHRAE 160 Criteria Results.

Total Product Thermal Performance

Total product wall assembly thermal performance was estimated for the wall systems. The Parallel Path Method (PPM), as described in ASHARE Fundamentals, was used in conjunction with THERM© 5.2 to calculate the total product U-factor for the assemblies. Developed by Lawrence Berkeley National Laboratory, THERM© 5.2 simulates two-dimensional heat transfer effects through enclosure assemblies based on finite-element calculation method. The LBNL software was originally developed to estimate fenestration thermal performance and is certified by the National Fenestration Rating Council (NFRC) to simulate and calculate center-of-glass (COG) and total product U-factor and solar heat gain coefficient (SHGC).

Parallel Path Method

In order to predictively model design options, a method of computer modeling was developed and verified. Due to thermal bridging in three dimensions, multiple calculations using the Parallel Path Method (PPM) were used to predict total product thermal performance. The following formula was used to determine the total product thermal performance:

$C_{total} = a \cdot C_a + b \cdot C_b + \ldots + n \cdot C_n$,

Where

For a given layer within an enclosure assembly: a, b, …, n are the percentage of the area of a specific material within a layer composed of several different materials with Conductance of C_a, C_b,…, C_n.

In order to calculate the various types of thermal bridging, the VISE of the assembly was broken down into layers. **Figure 20** illustrates the how the VISE was divided into layers.

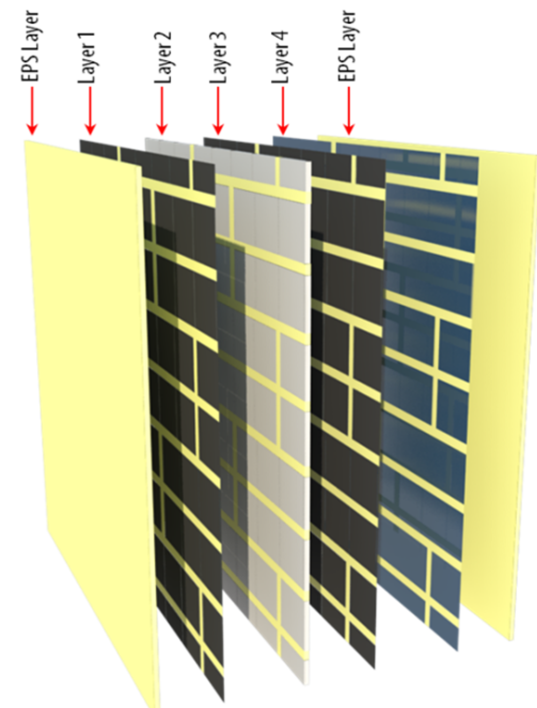
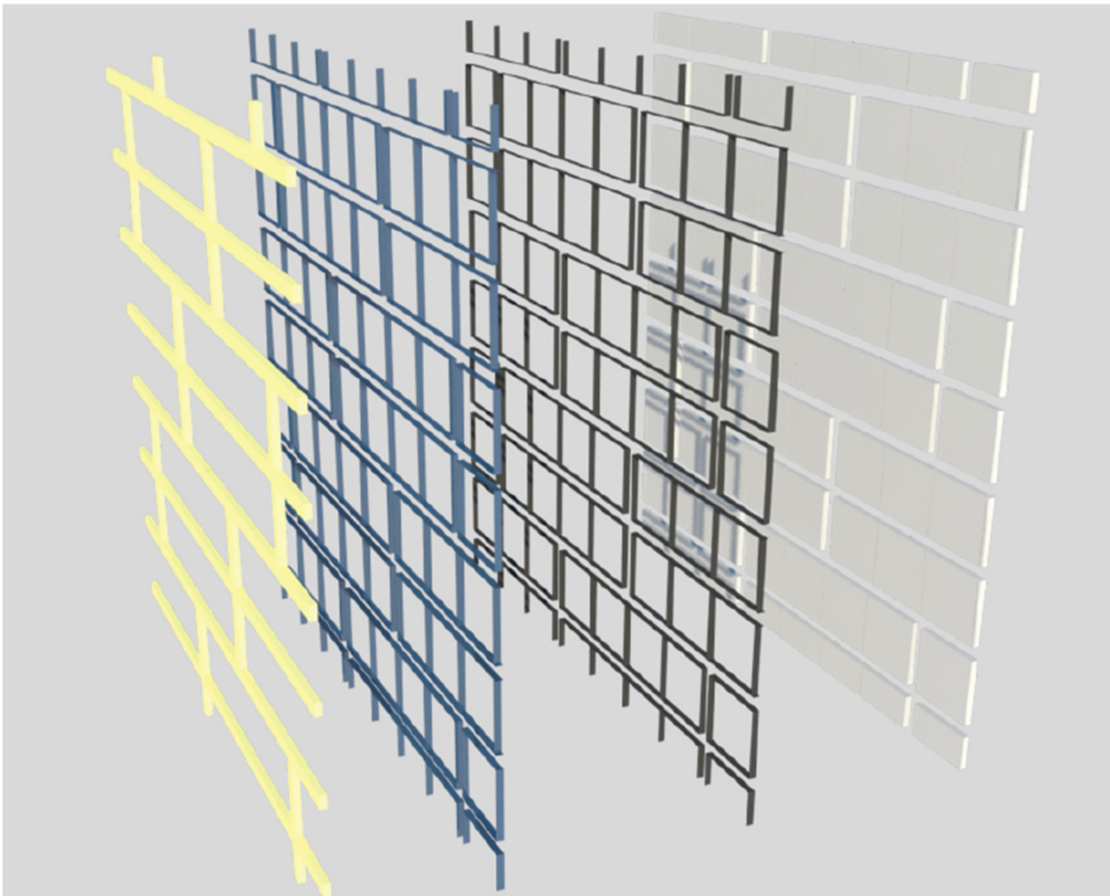


Figure 20: Layers of a typical VISE.

The U-factor of the individual layers was calculated using the parallel path method. Within each layer, the areas of the individual bridging materials were calculated as a percentage of the whole layer and multiplied by the conductance of the material of the bridge. The products of these values are then summed to calculate total layer conductance. **Figure 21** illustrates the materials as individual components of the core 1” layer of the VISE and the equation used to find the total layer conductance. This process accounts for the thermal bridging of the various materials as they relate to each other.



$$\text{Average Conductance} = C_{av} = aC_a + bC_b + \ldots + nC_n$$

EPS 20.32% | Air 1.50% | Foil 0.16% | Silica Core 78.03%

$$(0.0216 \times 0.2032) + (0.0886 \times 0.0150) + (0.5778 \times 0.00016) + (0.00213 \times 0.7803) = 0.00830 \ \text{BTU/(h·ft·°F)}$$

Figure 21: Example of thermal bridges within layer 2.

The total conductance of each layer was inputted as a material within THERM© 5.2 and applied to a model to calculate the total product thermal performance of each of the wall designs [**Figure 22**].

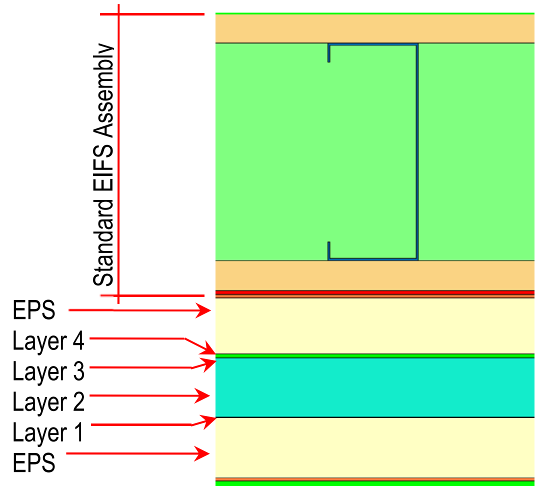


Figure 22: THERM© 5.2 Model of the Wall Assembly.

During the modeling process, it was observed that due to the thermal bridging of the high conductivity VIP envelope in layer 2, the VIP which has a center of panel R-value of approximately R40 was reduced to approximately R10 when utilizing the 10"x11.25"x1" VIPS. Calculations and physical tests were performed to develop a design that results in a higher thermal performance. Designs A and B were physically tested, and results were calculated for Designs A through E to determine the most effective method to reduce thermal bridging through layer 2.

Physical Test

ORNL conducted physical testing per ASTM C1363-11 "Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus" for wall designs A and B. A 10'-0" x 8'-10" mockup of the wall assemblies was built and placed into a hot box testing chamber [**Figure 23**]. The hot box controls the interior side of the assembly to 100°F and the exterior to 50°F. Within the test chamber an 8'x8' area measures heat flux thought the assembly. The heat flux is then converted into a measured R-value. Refer to **Figures 7 and 8** for location of 8'x8' area.

Figure 23: Hot Box Testing Chamber

Total Product Thermal Performance Results

Design A Results

Design A consisted of 10"x11.25"x1" VIP's in 24"x24"x3" and 48"'X24"x3" VISE's. Calculations and physical testing were performed on this design, neither included batt insulation within the stud cavity. The results of the test are indicated in **Table 2.**

Design A	W/m2K	BTU•in /(h•ft2•°F)	(h•ft2•°F)/BTU•in
Core Layer (Layer 2)	U-0.57	U-0.10	R-10.04
Calculated Wall Assembly	U-0.28	U-0.05	R-19.92
Tested Wall Assembly	U-0.28	U-0.05	R-20.10

Table 2: Design A Results

Design A Conclusions

Throughout the physical testing and calculation process, it was observed that there were opportunities to improve the performance of Design A. Large quantities of thermal bridges are present due to the small size of VIP's. By increasing the size of the VIP's and limiting the number of VIP's in each VISE the thermal bridging through the MF-3 foil is reduced. Removal the EPS spine that runs horizontally along the VISE, and reducing the protective EPS edge coverage are two other methods that were determined in order to reduce the overall thermal bridging within a VISE.

Design B Results

Design B consisted of a 23"x23"x1" VIP and a 24"x23"x1" VIP in a 48"x24"x3" VISE. The EPS spine was removed and the protective EPS edge coverage was reduced in this Design. Calculations and physical testing were performed on this design. Both were performed with and without batt insulation within the stud cavity. The results of the test are indicated in **Table 3.**

Design B	W/m2K	BTU•in /(h•ft2•°F)	(h•ft2•°F)/BTU•in
Core Layer (Layer 2)	U-0.34	U-0.06	R-16.90
Calculated Wall Assembly	U-0.22	U-0.04	R-26.67
Calculated Wall Assembly with batt	U-0.18	U-0.03	R-31.85
Tested Wall Assembly	U-0.23	U-0.04	R-25.70
Tested Wall Assembly with batt	U-0.18	U-0.03	R-31.20

Table 3: Design B Results

Design B Conclusions

The reduction of the thermal bridging from Design A, proved to be effective as indicated by the results of the physical testing and calculations. To further increase thermal performance of the assembly, the VIP's could be limited to one per VISE. This will reduce the thermal bridging through the MF-3 foil between the two VIP's. Additionally, further improvement can be achieved by reducing the protective EPS edge cover. However, this does expose the VISE to more risk of damage during installation.

As indicated by the results of Designs A and B, there was minimal difference between the results of the calculations and physical tests. This comparison provides validation of the calculation method and justification to continue to utilize it for predictive thermal performance of Designs C, D, & E.

Designs C, D, & E Results

Design C-E consisted of a 47"x23" VIP in a 48"X24"x3" VISE. This design only has one VIP per VISE and the protective EPS edge cover was further reduced compared to the previous designs. Only calculations were performed on these designs (no physical testing), and they were calculated with and without batt insulation within the stud cavity. The results, U-Factor and R-Value, are indicated in **Tables 4 – 6.**

Design C	W/m2K	BTU•in /(h•ft2•°F)	(h•ft2•°F)/BTU•in
Core Layer (Layer 2)	U-0.42	U-0.07	R-13.59
Calculated Wall Assembly	U-0.23	U-0.04	R-24.33
Calculated Wall Assembly with batt	U-0.19	U-0.03	R-30.12

Table 4: Design C (3/4" Thick VIP) Results

Design D	W/m2K	BTU•in /(h•ft2•°F)	(h•ft2•°F)/BTU•in
Core Layer (Layer 2)	U-0.31	U-0.06	R-18.12
Calculated Wall Assembly	U-0.20	U-0.04	R-27.93
Calculated Wall Assembly with batt	U-0.17	U-0.03	R-33.67

Table 5: Design D (1" Thick VIP)

Design E	W/m2K	BTU•in /(h•ft2•°F)	(h•ft2•°F)/BTU•in
Core Layer (Layer 2)	U-0.21	U-0.04	R-27.18
Calculated Wall Assembly	U-0.16	U-0.03	R-35.09
Calculated Wall Assembly with batt	U-0.14	U-0.03	R-40.82

Table 6: Design E (1 ½ " Thick VIP):

Designs C, D, & E Conclusions

The results of the varied thickness of the VIP's were evaluated to determine if increasing the VIP thickness is a more effective method of producing better overall thermal performance or if reduction of thermal bridging is more effective. When comparing Designs A and C, Design C utilized a VIP that was 25% thinner than Design A, but the total product thermal performance was better. The only other variable that could influence this result was that Design A had considerably more thermal bridges than Design C. Design A had approximately 340" of foil envelope thermal bridges and Design C had approximately 140" (60% less). This concludes that a reduction of thermal bridging is an effective way of producing better overall thermal performance. As expected, Designs D and E produced the highest thermal performance of all designs. This can be attributed to the highest level of thermal bridging reduction compared to the other designs, and an increase in the VIP thickness in Design E.

The difference in thermal bridging between Designs A and B also resulted in an increased total product thermal performance (approximately R- 6.75). However, the amount of thermal bridging reduction does reach a diminishing return. When comparing Design B and D, both have 1" thick VIP but have different amounts of foil envelope thermal bridging. The difference in the amount of thermal bridging is approximately 45", with Design B having 186" and Design D with 140". This is approximately 25% less and only improved the total product performance by R-1.26. The limiting factors of how much additional thermal bridge reduction can be achieved are manufacturing capabilities and usable size.

Design A-E Summary

As indicated in **Table 7**, the reduction of thermal bridging through the VIP layer of the VISE proved to be the most effective way to increase the overall thermal performance. The results from this study suggest that an alternate material to the MF-3 foil and/or protective EPS coverage, with lower conductivity, would need to be investigated in order to provide a significant increase in the thermal performance of the VISE.

Design	Batt Insulation	Core Thickness	U-factor W/m2K	U-factor BTU/(h•ft•°F)	R-Value	Tested R-Value
Typical EIFS	No	0	0.41	0.0714	14.00	
A	No	1"	0.28	0.0502	19.92	20.1
B	No	1"	0.22	0.0375	26.67	25.7
C	No	3/4"	0.23	0.0411	24.33	
D	No	1"	0.2	0.0358	27.93	
E	No	1 1/2"	0.16	0.0285	35.09	
Typical EIFS	Yes	0	0.28	0.05	20	
A	NA	NA	NA	NA	NA	NA
B	Yes	1"	0.18	0.0314	31.85	30.2
C	Yes	3/4"	0.19	0.0332	30.12	
D	Yes	1"	0.17	0.0297	33.67	
E	Yes	1 1/2"	0.14	0.0245	40.82	

Table 7: Results summary of tests and calculations.

Brunswick Test Installation

A building in Brunswick, Maine was selected to install an EIFS wall that incorporates VISE's of various designs [**Figure 24**]. This "in-situ" test was conducted in order to verify the constructability and viability of installing the product under real site conditions, and to act as a long term study model in which actual thermal performance data can be measured as it is exposed to in-service conditions. The installed system was similar to Design E, with the majority of the VISE's containing one 1 ½" VIP, and ¼" of EPS edge coverage. Eight different sizes of VISE's were used to maximize VIP coverage of the building. Some areas of the building could not fit a full VISE. At these locations a piece of EPS (cheater) of the same thickness as the VISE was used to fill the void. **Figure 25** indicates the locations of the eight VISE sizes (blue) and the cheaters (black) on each elevation. Temperature and RH sensors were installed at various locations within the wall assembly during the installation process in order to compare predicted performance to actual performance over time.

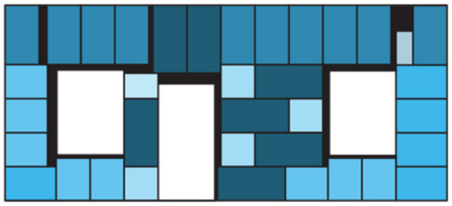
Figure 24: Completed Brunswick Installation

The performance of each of the eight VISE's was determined utilizing the parallel path method described previously. The sum of the area of each of the eight VISE sizes was then calculated as a percentage of the whole elevation. Similar to the parallel path method, the U-factor of each of the VISE and cheaters were then multiplied by their respective percentage of the elevation. The sum of these results was placed into a THERM© 5.2 wall section that included the existing wall conditions and the new EIFS assembly including the VISE's.

Table 8 indicates the calculated results for each elevation and a comparison to a typical EIFS of the same thickness. The typical EIFS wall assembly has an R-value of 16.8 without any VISE's included. The first method of comparison evaluates the area of each elevation that was covered by VISE panels only. The second compared the area covered by both VISE and Cheaters. Each elevation was then multiplied by percentage of total wall area it occupied to determine the total building performance.

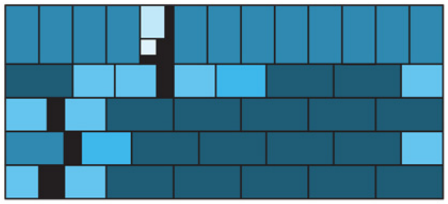
	Thermal performance of 3" VISE only	Performance Increase from Typical EIFS to VISE	Thermal performance of 3" VISE with cheaters	Performance Increase from Typical EIFS to VISE & Cheaters
North	R-32.3	R-15.5	R-30.2	R-13.4
South	R-32.3	R-15.5	R-31.2	R-14.4
East	R-32.2	R-15.4	R-30.7	R-13.9
West	R-32.4	R-15.6	R-30.9	R-14.1
Total Building	R-32.3	R-15.5	R-30.8	R-14.0

Table 8: Brunswick Comparative Results



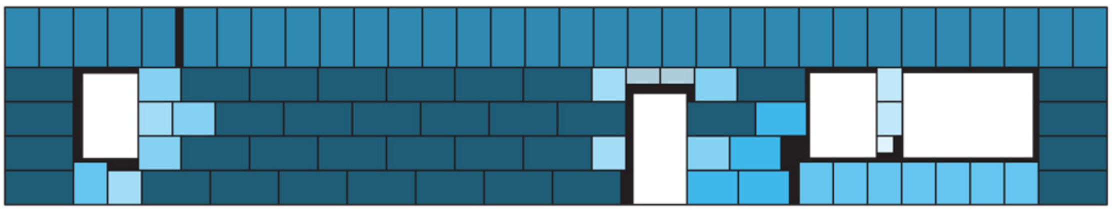
North Elevation VISE Layout

North Elevation Under Construction



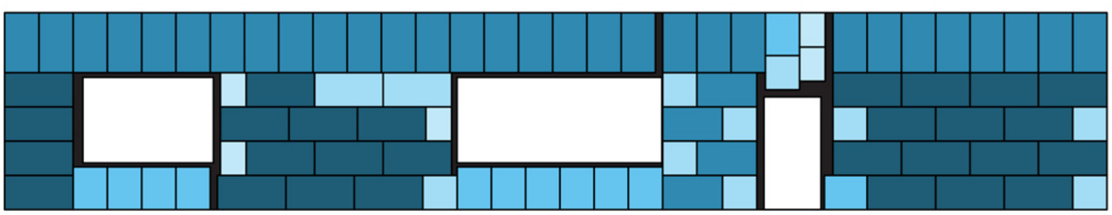
South Elevation VISE Layout

South Elevation Under Construction



East Elevation VISE Layout

East Elevation Under Construction



West Elevation VISE Layout

West Elevation Under Construction

Figure 25: Brunswick Installation Elevations and VISE Layouts

Condensation Risk Analysis

The risk of potential condensation at the thermal bridging within and around a VISE was evaluated. The risk of localized condensation was reviewed within the VISE at VIP to VIP joints and at the joints between two VISE's [**Figure 26**].

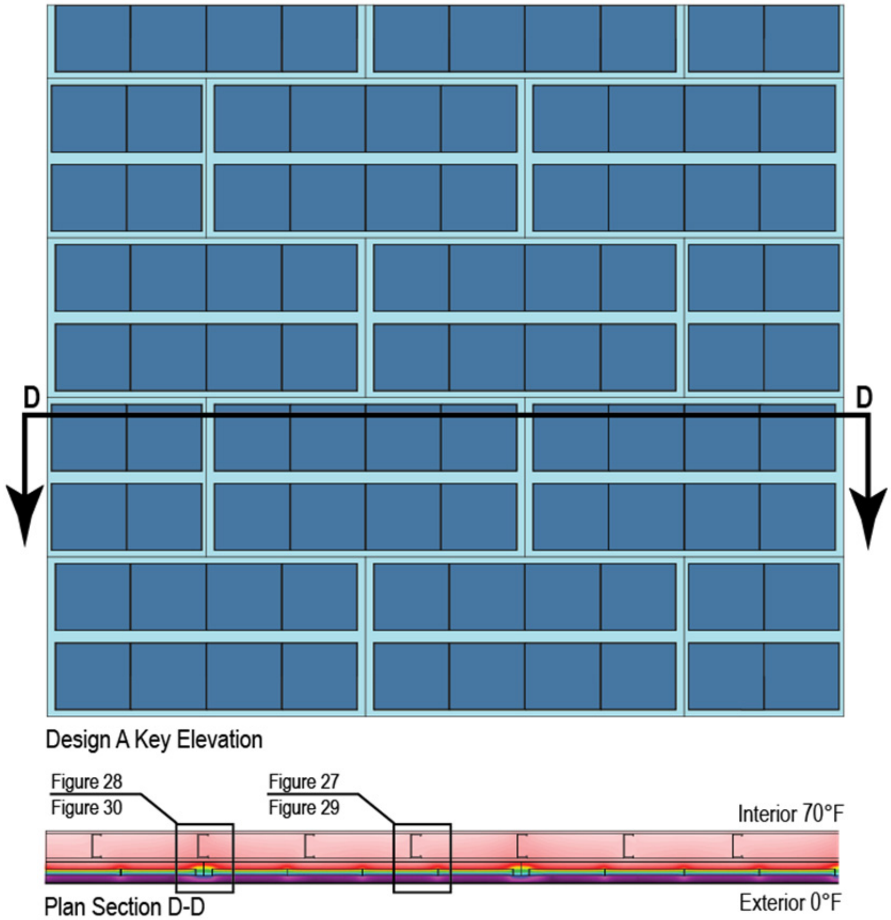


Figure 26: Location of Thermal Bridging

Vertical and horizontal sections of Design A were modeled in THERM© 5.2 to replicate the conditions of an installed VISE. The MF-3 foil was the key thermal bridge through the VISE's. However, the EPS edge protection was also causing thermal bridging. These areas may have a potential for condensation to occur as they are colder than the surrounding conditions. If enough moisture is present within the material at the cold point, there is potential for condensation to occur if the surfaces drop below the dewpoint temperature. A point of condensation can only occur if water can diffuse through the assembly from the interior and cool below the dew point temperature. The joints between the VIP's and VISE's are where this condition might occur.

A dew point curve was calculated with SGJJR proprietary software through the base EIFS wall assembly. The software uses the permeability and thermal conductivity of the materials within the assembly and calculates the change in temperature and water vapor pressure through each of the material layers. The areas of concern are located 1" into the EPS from the exterior as this is the coldest point at the thermal bridging conditions. The dew point at that point is calculated to be 17°F. This was compared to the temperature that was obtained in the THERM model.

As indicated in **Figures 27 and 28,** the temperature at the areas of concern are above the calculated dewpoint temperature. However, it is recommended to provide foil tape at the joints between VIP's to reduce the flow of water vapor.

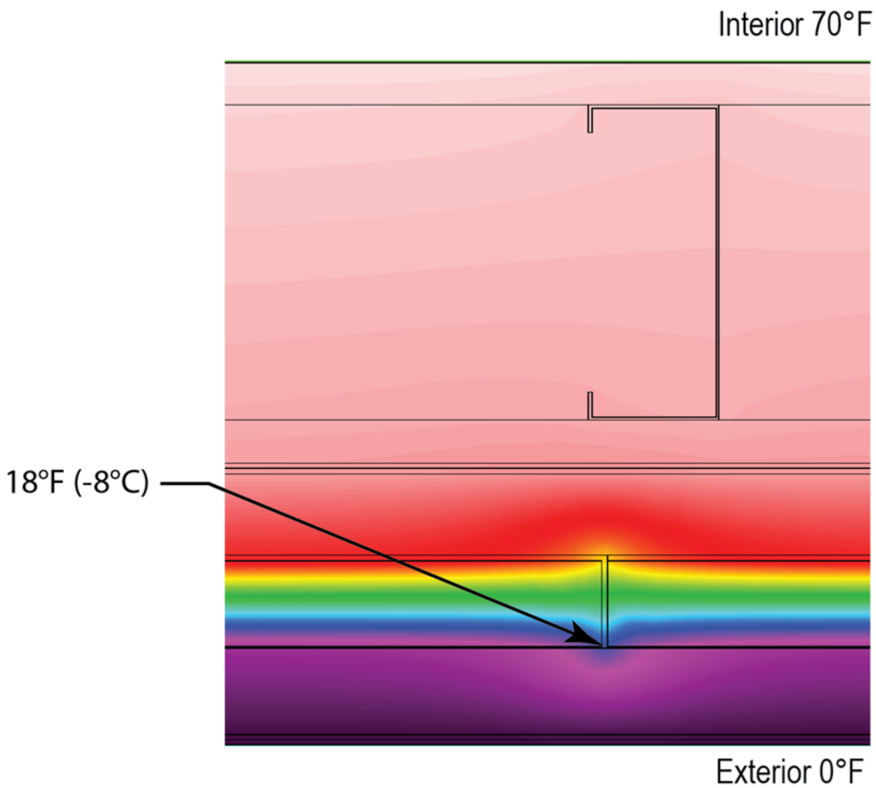


Figure 27: Plan detail at VIP to VIP Joint with Cold Point Temperature indicated.

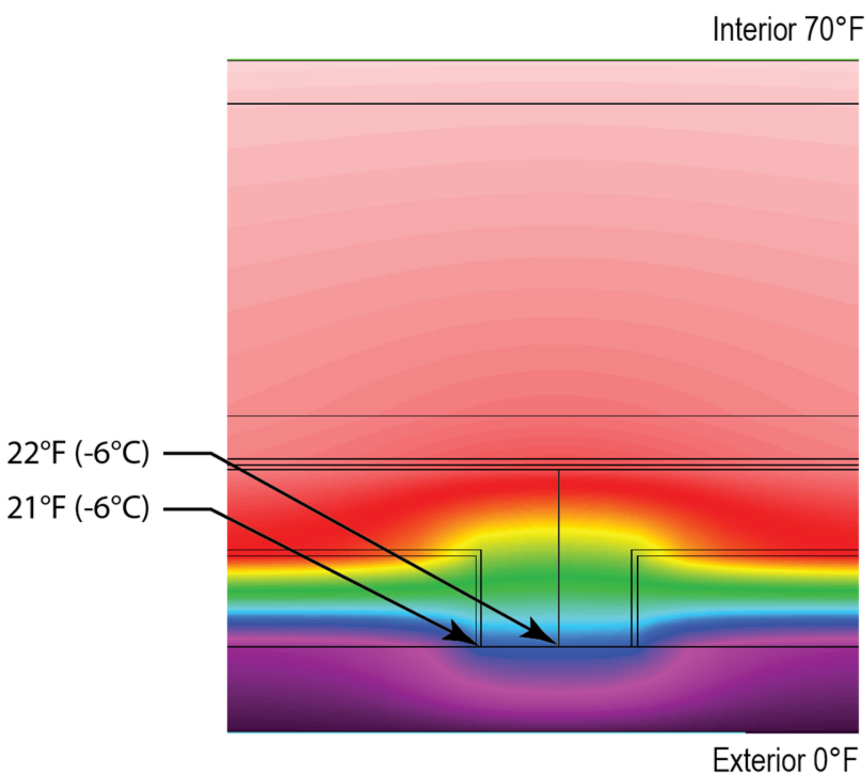


Figure 28: Plan Detailat VISE to VISE Joint with Cold Point Temperature indicated.

To further investigate the condensation risk, WUFI 2D was used to model the conditions. WUFI 2D is similar to WUFI 5.1, but it allows for two dimensional modeling. Two dimensional models can provide additional and more accurate data that can illustrate the internal interaction of material transitions within a wall and the climate that they are exposed to.

The areas of concern found in the preliminary calculations were modeled within the EIFS assembly and are indicated by the red dots in **Figure 29 and 30**. Material properties used in the simulation were the same as the WUFI 5.1. Minneapolis, MN was used for the exterior conditions as it is considered to be the worst case due to the cold winter months. Interior conditions ranged from 68°F to 72°F with a relative humidity of 40% to 60%. A three year simulation was performed.

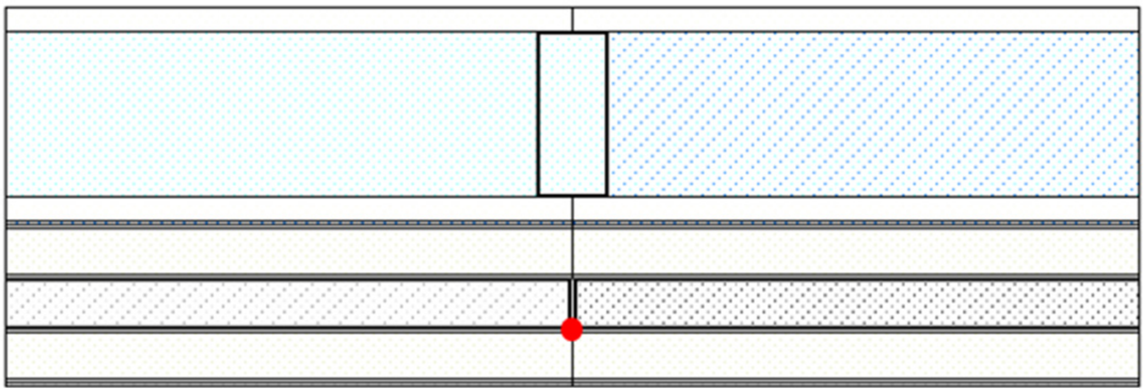


Figure 29: WUFI Plan Detail at VIP to VIP Joint.

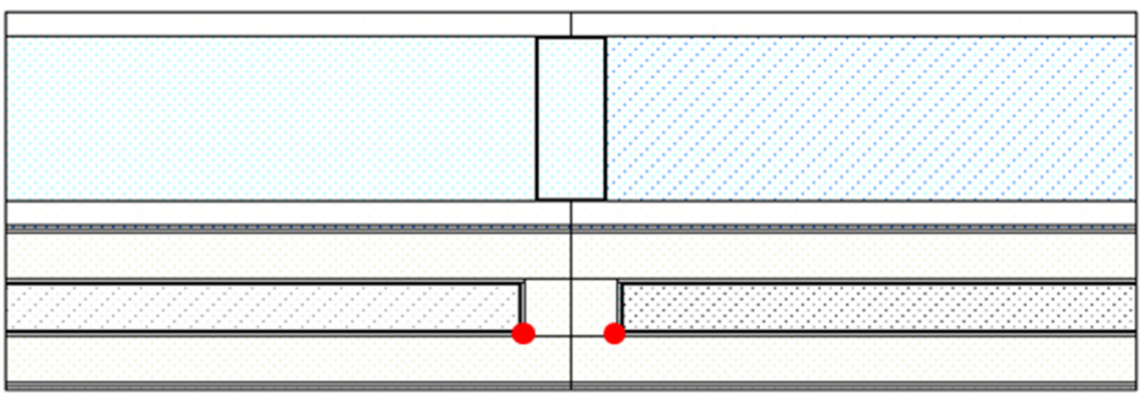


Figure 30: WUFI Plan Detail at VISE to VISE Joint.

The data was reviewed after the simulation was complete. Similar to WUFI 5.1, an animation and graphs were evaluated. In the animation, levels of water content are indicated throughout the entire model. As time progresses the total water content is represented by a stretching of the model in the Z axis indicated by the blue in **Figure 31**. When reviewing the animation, the user can determine areas in which the water content is increasing and require further investigation. Once a location is established a more detailed graph can be generated at the area of concern to determine if the water content accumulates or dries over time.

As predicted in earlier calculations, the data produced by WUFI 2D indicates that the water content does not accumulate throughout the three year simulation period at the areas of concern. The WUFI 2D results did however confirm the results of WUFI 5.1 in that the water content within the core material increases slightly over time [**Figure 32**]. This is occurring at the outer edge of the VIP and is illustrated by the blue in **Figure 31**.

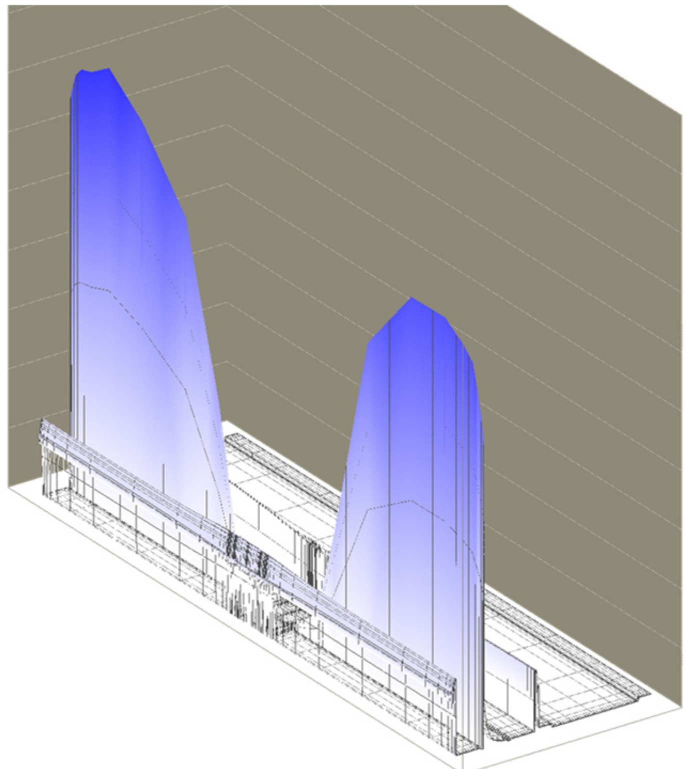


Figure 31: WUFI 2D Animation

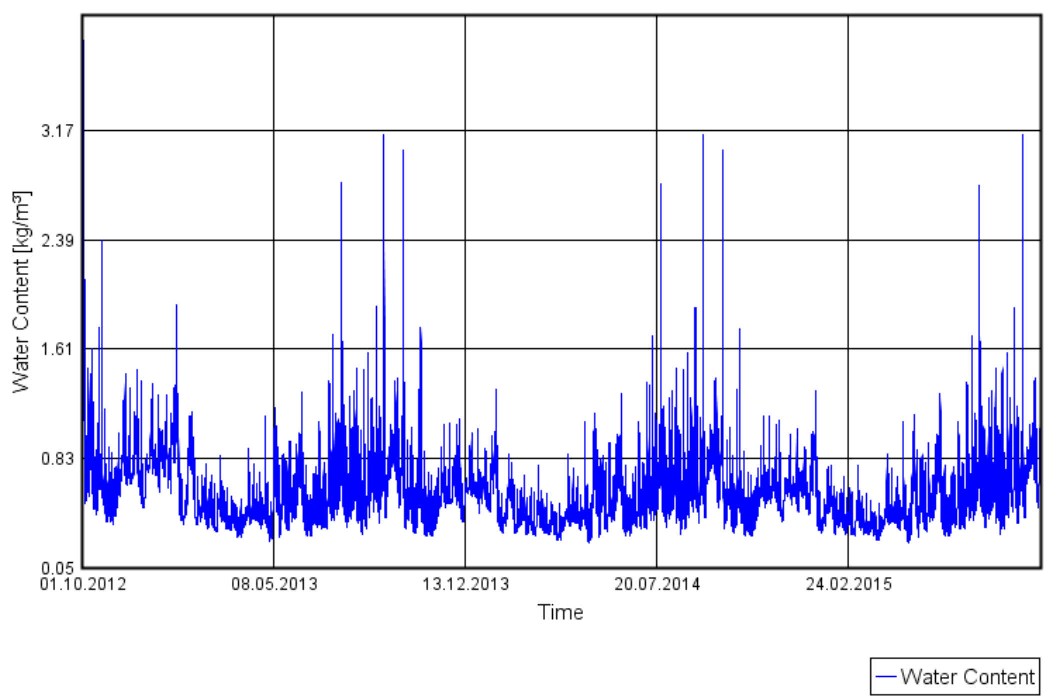


Figure 32: Water Content of VIP Core Material

Conclusions and Recommendations

As part of the evaluation process the transient hygrothermal performance, total product thermal performance, constructability, and condensation risk of the VIP and VISE were reviewed. The following summarizes the conclusions and recommendations developed from the evaluation.

Transient Hygrothermal Performance
The new wall assembly was evaluated to determine if there were any internal moisture migration concerns. Based on the ASHRAE 160 criteria and the interior conditions that were used in the simulations (50% RH / 70°F), there is not a concern of mold growth within the wall assembly throughout a 50 year simulation period for all locations with the exception of one condition. When including batt insulation in the stud cavity space in Minneapolis, MN the environmental conditions between VIP and interior layer of EPS do not conform to the criteria indicated in ASHRAE 160 and mold formation may be possible. This wall assembly is not recommended, as currently designed, when utilizing batt insulation.

This condition is primarily caused by the VIP becoming less effective and the addition of the batt insulation. The combination of these two, cause the surface to become colder with the same level of moisture content. The addition of the batt insulation increases the risks of mold formation when utilized in buildings with higher levels of interior RH. In this evaluation, there was not a method used to control the interior vapor flow when the batt insulation was added. Two methods could be utilized to potentially remediate this type of condition. The first would be to lower the interior RH level, and the second would be to utilize an interior vapor retarder to prevent the humidified air from entering the wall assembly. Note, the type and performance of the interior vapor retarder are critical as it can lead also lead to trapping moisture within the wall assembly. It is recommended to perform additional analysis if interior batt insulation and/or a vapor retarder are utilized in buildings with elevated interior RH. Additional evaluation is also recommended on a case by case basis when utilizing interior batt insulation in buildings located in colder climates that are humidified to higher levels that what was indicated in this evaluation.

Based on the results of the simulation, the VIP panel is the only material in the wall assembly that increases in moisture content over time. The moisture content at the end of the 50 year simulation is approximately 0.22 lbs/ft^3 or 2% MC. The increased moisture content decreases the thermal performance of the VIP over time. It is recommended to verify if the 2% MC will have any other detrimental effects on the VIP other than reducing its thermal performance.

Temperature and RH sensors were installed within the wall assembly at the Bruswick test installation. It is recommended to use the data produced from the sensors to compare against the data produced by the modeling process. The comparison can be used to further refine the modeling process or validate the results of the modeling.

Total Product Thermal Performance
The total product thermal performance of the five wall designs was calculated. The calculation includes the varying conductivities and sizes of all materials included in the assembly and the effects of thermal bridges within the assembly. Two of the five designs were also physically tested per ASTM C1363-11 "Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus". One of those two was also tested and calculated with and without batt insulation installed in the stud cavity of the wall assembly. The difference between the tested and calculated results was less than an R-1 for all three conditions. Based on the minimal difference, it was determined that the modeling process for predicting the performance of the other 3 designs was valid. However, additional testing is recommended to further validate the results of the additional designs.

By comparing the results of the various designs, it can be reasonably concluded that reducing the amount of thermal bridging can have a significant impact on the total product thermal performance of the assembly. In Designs C – E, further improvement was achieved by reducing the protective EPS edge cover around the VIP down to ¼” thick as compared to ½” thick for Design B and over 1” for Design A. However, this exposes the VIP to more risk of damage during installation. As the thickness of the edge protection is reduced, the risk of damage increases. It is recommended that additional test installations be performed to determine if this is an appropriate thickness of edge protection.

The amount of reduction of the thermal bridging of the EPS edge protection and MF-3 envelope does reach a diminishing return. At a certain point, the additional gain in performance becomes negligible as compared to the amount of thermal bridge reduction. Additionally, there are manufacturing and installation limitations that restrict further reduction. At that point, other methods to produce additional total product thermal performance are to increase the thickness of the VIP or decrease the conductivity of the thermal bridging components.

Constructability
As previously indicated, maximizing the VIP size and reducing the thermal bridging within the VISE are two primary methods of providing high thermal performance. This type of methodology necessitates a modular design of the wall assembly. In all designs, the typical panel size is 4’x2’x3”. The modularity of the assembly can impose design restrictions onto the building’s façade and must be accounted for when design openings and penetrations in a façade. Even when the modular design is incorporated, there may still be instances when “cheater” panels will be required to fill voids between the modular grid and an opening. Additionally, the VISE’s cannot be penetrated without damaging the VIP. When there are small penetrations required in a façade, a cheater panel will need to be used. Cheater panels are essentially the same as using the typical EIFS wall. When cheaters are used, transient hygrothermal evaluation of the typical EIFS wall must be performed to verify that it will not have any issues for the specific interior and exterior environmental exposures.

Condensation Risk
The typical joints between multiple VIP’s and between multiple VISE’s were analyzed as they were considered to be areas of concern. Based on two types of modeling procedures, condensation is not expected to occur in either condition with the interior and exterior conditions used in the modeling (Exterior Temperature = 0°F, Interior Temperature = 70°F, Interior RH = 50%). Even though the analysis indicates that condensation is not likely to occur at VIP joints, it is recommended to seal the joints. This will prevent free flow of water vapor from the warm side of the joint to the cold side and further reduce the risk of condensation.

This evaluation did not analyze the condensation risk of wall designs that include batt insulation in the stud cavity. Similar to the results of the transient hygrothermal analysis, the risk of condensation at the VIP and VISE joints is higher when batt insulation is included. The batt insulation causes the areas of concern to be colder than they would be without the batt. Additional modeling and analysis of these conditions is recommended.

Conclusion
While additional analysis and testing is recommended, the results of this evaluation indicate that the product does not exhibit any significant concerns or issues with the transient hygrothermal performance or the condensation risk within the assembly. The total product thermal performance proved to be much higher than similar industry standard wall assemblies. Although there are a few constructability limitations that exist, additional installations are required to determine if this is a viable product for the construction industry.

Resources

1. Oak Ridge National Laboratory (ORNL) and Fraunhofer Institute for Building Physics (IBP) WUFI PRO Websites
   - www.wufi-pro.com
   - www.ornl.gov/sci/btc/apps/moisture/index.html
   - http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=362/pagename_submenu=envelope_systems/pagename_menu=materials_components/pagename=subjects

1. THERM© 5.2, Software available from Lawrence Berkeley National Lab from Website http://windows.lbl.gov/software/therm/therm.html , viewed January 12, 2012

2. WINDOW© 5.2 Software available from Lawrence Berkeley National Lab from Website http://windows.lbl.gov/software/window/window.html , viewed January 12, 2012

3. ASHRAE Standard 90.1 - 2007 - Energy Standard for Buildings Except Low-Rise Residential Buildings

4. Tenpierik, M., Cauberg, H - *Analytical Models for Calculating Thermal Bridge Effects Caused by Thin High Barrier Envelopes Around Vacuum Insulation Panels*

5. Wegger, Jelle, Sveipe, Grynning, Baetens,& Thue - *Effect of Ageing on Service life of Vacuum Insulation Panels*

6. Smith, Wallace, Martinez, & Keller - *Accelerated Lifetime Testing of Vacuum Insulation Panels*

7. Fricke, Jochen - *From Dewars to VIP's- One Century of Progress in Vacuum Insulation Technology*

8. Heinemann, Ulrich - *Influence of Water on the Total Heat Transfer in 'Evacuated' Insulations*

9. Simmler, Hans - *Ageing and Service Life of VIP in Buildings*

10. Brunner, Tharian, Simmler, & Wakili - *Focused Ion Beam (FIB) Etching to Investigate Aluminum-Coated Polymer Laminates Subjected to Heat and Moisture Loads*

11. Buxbaum, Gallent, Kircher, Pankratz, Seiler - *Thermal Rehabilitation of Existing Building Enclosures by Using VIP (Vacuum Insulation Panel) Sandwich and Timber Based Panels*

12. Haavi, Jelle, Gustavsen, Grynning, Uvslokk, Baetens, & Caps - *Vacuum Insulation Panels in Wood Frame Wall constructions- Hot Box Measurements and Numerical Simulations*

ORNL/TM-2012/438

Steady-State Thermal Performance Evaluation of Steel-Framed Walls with 94% Coverage of Vacuum Insulated Panels Encapsulated Within an Exterior Insulation and Finish System

October 2012

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Energy and Transportation Science Division

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ABSTRACT

In February 2012, members of Dow Corning and Dryvit built a prototype Exterior Insulation Finish System (EIFS) wall with encapsulated Vacuum Insulated Panels (VIP) that was tested in a Rotatable Guarded Hot Box (RGHB) at Oak Ridge National Laboratory (ORNL). The exterior insulation consisted of 7.6 cm (3-inch) thick expanded polystyrene (EPS) foam blocks containing the VIPs. Improvements in the wall design based on analysis of a previous prototype wall and smaller VIP/EPS composites had been made. This improved wall showed a 24% higher thermal resistance than the previous wall. The EIFS/VIP wall was tested in the RGHB according to the ASTM C 1363 standard test method.

BACKGROUND AND TEST WALL DETAILS

During January 2011, members of Dryvit and Dow Corning built an Exterior Insulation Finish System (EIFS) wall with steel framing in the Building Technologies Research and Integration Center (BTRIC) at Oak Ridge National Laboratory (ORNL). This EIFS wall also contained Vacuum Insulated Panels (VIP) encapsulated within expanded polystyrene (EPS) blocks. This wall was tested in the Rotatable Guarded Hot Box (RGHB) and the results were reported to the sponsor (Biswas et al., 2011). The previous report included complete construction details of the test wall (Biswas et al., 2011).

Further, during 2011 and 2012, several configurations of small-scale (approximately 0.6 m or 2-ft square) composites containing VIPs enclosed in closed-cell foam were tested in a special purpose heat flow meter apparatus at ORNL. These tests were focused on the impact of vacuum panel size, the type of foam used to encase the vacuum panels, the thickness and shape of the foam sections between panels, and adhesives on the thermal performance of the VIP-foam composites. The heat flow meter measurements were mapped to full-scale wall designs to estimate their thermal performance. A finite-difference heat transfer model was developed to evaluate alternate design configurations using the heat flow measurements. The findings of the heat flow meter tests and the heat transfer model, and design recommendations based on those findings, have been reported by Childs et al. (2012).

In February 2012, a second EIFS/VIP wall was built for testing. The primary difference between the two test walls was the construction of the VIP/EPS composites. Figure 1 shows the layout of the VIP/EPS composites in the newer test wall. The lateral VIP dimensions were 0.58 m x 0.58 m (23-in x 23-in) or 0.58 m x 0.61 m (24-in x 23-in), except the for the composites in the top row where smaller VIPs were needed to fit the test frame. This resulted in 94% of the wall area being covered by the VIPs. In the previous wall, 25.4 cm x 28.6 cm (10-in x 11.25-in) VIPs were used, yielding a 78%VIP coverage.

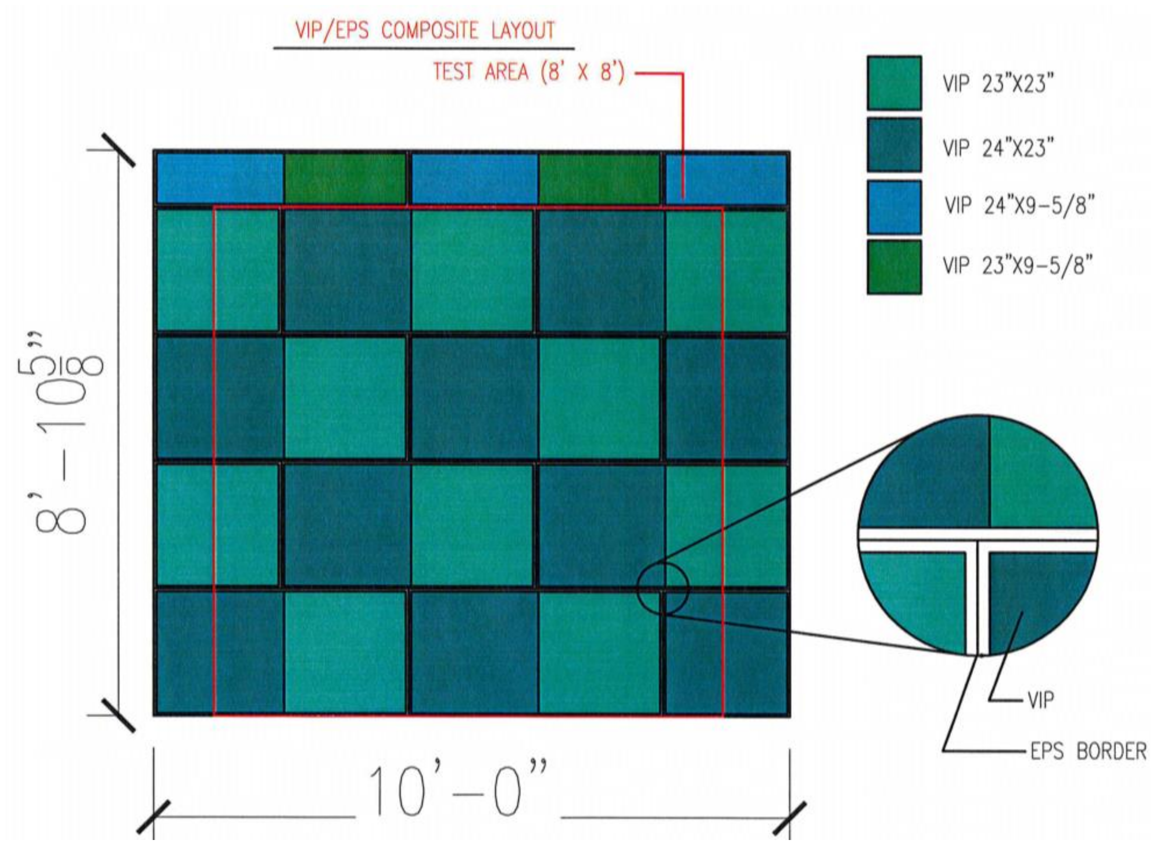

Figure 1. VIP/EPS composite layout in the test wall.

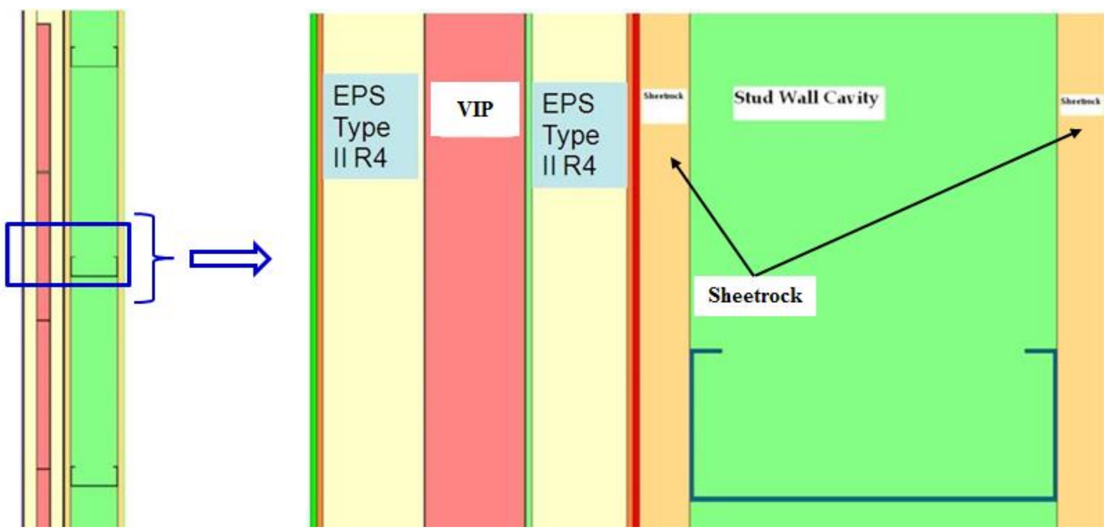

Figure 2. VIP/EPS test wall cross-section.

Figure 2 shows the cross-section of the test wall. The VIP/EPS composite is 7.6 cm (3-in) thick, with a 2.5 cm (1-in) VIP sandwiched by two 2.5 cm (1-in) EPS foam sheets. For edge protection, 1.3 cm (0.5-in) EPS foam strips were used as borders around the VIPs. Another difference from the 2011 test wall is that Type II EPS (ASTM C578-11, 2011) was used in the current wall as opposed to the Type I EPS (ASTM C578-11, 2011) used in the first wall. This stronger class of foam enabled the change to thinner border strips. Tests were done with and without R-1.9 m^2-K/W (11 hr-ft^2-°F/Btu) fiberglass cavity insulation.

TEST APPARATUS AND INSTRUMENTATION

Figure 3. ORNL Rotatable Guarded Hot Box.

ORNL operates and maintains a guarded hot-box that is used to measure the thermal resistance (R-Value) and thermal transmittance (U-Factor) of full size wall and window assemblies. The box operates under the requirements of ASTM C 1363. A photograph of the RGHB is shown in Figure 3. Test assemblies are installed in a specimen frame mounted on a moveable dolly. The specimen frame has an aperture of 4 m (13-ft.) wide by 3 m (10-ft.) high. The specimen frame/test assembly is inserted between two “clam-shell” chambers of identical cross-section. The placement of the test wall assembly between the chambers allows the chamber temperatures to be independently controlled, thus creating a temperature difference across the specimen. The chambers are designated as the climate (cold) and metering/guard (hot) chambers. Figure 4 shows a typical wall specimen installed in the test frame. The central 2.4 m x 2.4 m (8-ft x 8-ft) wall section, which aligns with the metering chamber boundary, is used for the actual test.

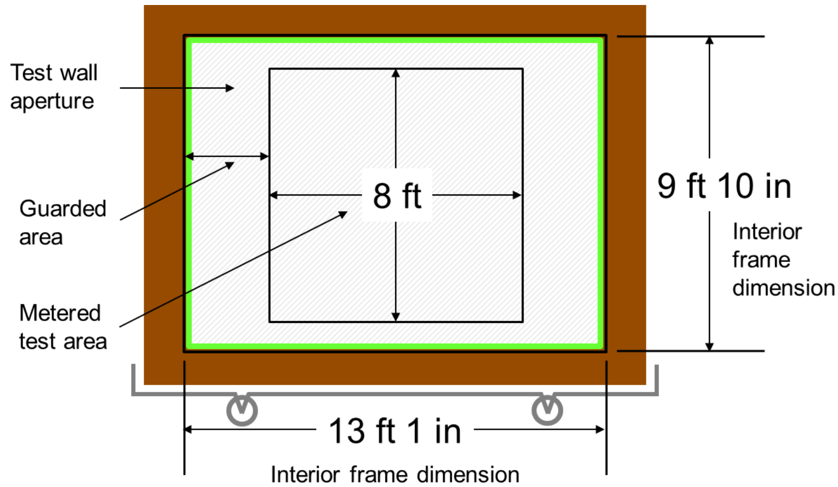

Figure 4. Schematic of a typical test wall within the hot-box test frame.

The climate chamber (cold side) is equipped with blowers and an air-conditioning system capable of producing stable environmental conditions to the extremes of -12.2°C (10°F) and 6.7 m/s (15 mph) wind velocities. Five centrifugal squirrel cage air blowers, installed behind a baffle, are used to circulate the air through the airspace between the baffle and test specimen assembly. Five hot-wire anemometers, located in the center of the air stream produced by each of the five squirrel cage blowers, continuously measure the wind speed across the baffle surface. Temperature measurement of the baffle and air is accomplished by a series of thermocouples distributed evenly over the baffle surface. The thermocouples are distributed such that the average air and surface temperature of the center 2.4 x 2.4 m^2 (8-ft. x 8-ft.) area, which is utilized for the actual test, facing the test specimen can also be obtained. A relative humidity probe is located inside the climate chamber to monitor the relative humidity. The baffle surface facing the test specimen is covered with a black coating with an emittance of 0.9.

The hot side consists of two similarly shaped chambers; a guard chamber surrounding the smaller metering chamber. The metering chamber has heaters and fans capable of producing stable environmental conditions to the extremes of 37.8°C (100°F) and 0.9 m/s (2.0 mph) wind velocities. The metering chamber is approximately 2.4 m (8-ft.) square by 0.4 m (1.3-ft.) deep and is suspended from the inside of the guard chamber by spring loaded brackets, which constantly push the open face of the metering chamber up against the warm side of the test specimen. The guard chamber and the climate chamber are then sealed against each side of the test frame with separate inflatable gaskets. The walls of the metering chamber are constructed with 7.6 cm (3-inch) thick aged extruded polystyrene foam having an approximate thermal resistance, R_{mb}, of 2.6 m^2-K/W (15 hr-ft^2-°F/Btu) at 23.9°C (75°F). A baffle is mounted inside the metering box, 15.2 cm (6-inch) from the exposed edge of the gasket. Behind the baffle, an array of eight fans and four electric resistance heaters force air upward between the baffle, through the resistance heaters, and then downward through the airspace between the baffle and test assembly. A relative humidity probe is mounted on the baffle surface inside the metering box. The average baffle air and surface temperature of the meter baffle is measured by equally spaced thermocouples attached to the surface and in the air space 7.6 cm (3-inch) away from the surface. There are four warm side hot-wire anemometer velocity probes on the baffle surface and an absolute pressure tap located on the baffle surface near the geometric center of the baffle.

A 92 junction (46 pair) differential thermopile is applied on the interior and exterior walls of the metering chamber to sense the temperature imbalance between the metering and guard chambers. Each thermopile junction is mounted in the center of one of the 48 equal areas into which the metering chamber is divided. The interior thermopile junction is mounted directly opposite the corresponding exterior junction. Additional arrays of temperature sensors are affixed to both the meter-side and climate-side surfaces of the foam panel surrounding the test specimen in the area covered by the guard chamber. Three differential pressure transducers are installed in the RGHB. Two of the transducers, P1 and P2, measure the pressure difference across the test assembly. The third transducer, P3, monitors the pressure difference between the metering and guard chambers.

The guard box has four heaters and six fans that heat and circulate the air in the guard space surrounding the metering box. The heaters are controlled by a PID controller that senses the surface temperature difference across the metering box walls measured by the metering box wall thermopile. The guard chamber also contains a relative humidity probe.

During operation, the temperatures of the climate and metering chambers are set at the desired level. Separate programmable D.C. power supplies in conjunction with a temperature controller are used to energize and control the metering chamber heaters and fans. The power to the fans is adjusted to set the desired wind speed in the airspace between the baffle and the test wall assembly. Anemometers are used to monitor this wind speed. The output of the differential thermopile controls the guard chamber heaters through a differential temperature controller. By this technique, the temperature difference across the metering box walls is minimized, thereby essentially eliminating the heat flow between the metering and guard chambers.

All temperature measurements are performed using Type T copper/constantan thermocouples calibrated to the special limits of error specified in ASTM E 230, "Temperature-Electromotive Force (EMF) Tables for Standardized Thermocouples". All sensors inside the RGHB are connected to a data acquisition system capable of measuring either thermocouple output or raw voltage signals. The modules used to measure thermocouples have an internal electronic reference junction to accurately calculate the temperature from the raw thermocouple output. Once started, the data acquisition modules automatically collect data at 30 second intervals for all sensors except those used for measuring energy input into the metering chamber, which are on 12 second intervals. All the instrumentation and control equipment used in the RGHB are annually calibrated against NIST traceable standards at ORNL or they are returned to the instrument manufacturer for calibration.

The heat flow generated by the metering chamber heaters is calculated from the voltage and current measurements taken from a precision shunt resistor as well as a watt-transducer. The energy dissipated by the metering chamber fans is metered with a precision resistor network. Once steady-state conditions have been achieved, the test period is continued until at least five successive data acquisition runs of periods equal to the time constant of the RGHB are obtained. The test is considered complete when each datum obtained for each measured variable differs from its mean by no more than the uncertainty of that variable. In addition, the data must not vary monotonically with time.

Over the years, ORNL has performed many characterization tests to ensure that the RGHB meets the specifications in the annex of ASTM C 1363. The standard requires the determination of a system time constant as well as flanking losses and null offset. Although the results from these time constant and flanking loss tests are not presented here, it should be noted that test data have been compiled and analyzed to verify that the RGHB meets the requirements of ASTM C 1363.

CALCULATION METHODOLGY

The meter and climate side average surface temperatures are calculated in an appropriate area-weighted manner. The surface area of the wall used for the test was 6 m^2 (64-ft^2). The percentage of the total wall surface area that each individual wall component comprised was determined. The average temperatures were then computed by area-weighing the average cavity, stud, and track surface temperatures.

The energy exchange rate from the metering box to the guard chamber, Q_{mb} is calculated as:

$$Q_{mb} = \frac{A_{mb} \cdot \Delta T_{mb}}{R_{mb}} \quad (1)$$

where Q_{mb} = heat flow rate through metering box walls (W),
A_{mb} = surface area of the metering box (m^2),
ΔT_{mb} = temperature imbalance across the metering box walls (°C),
R_{mb} = thermal resistance of the metering box walls (m^2-K/W).

The total energy flow through the wall assembly, Q_{wall}, is calculated from

$$Q_{wall} = Q_h + Q_{fan} - Q_{mb} \quad (2)$$

where Q_{wall} = total energy flow rate through the wall assembly (W),
Q_h = energy input to the resistance heaters in the metering chamber (W),
Q_{fan} = energy input to the fans in the metering chamber (W).

The surface-to-surface thermal resistance of the wall assembly, R_{wall}, is calculated from

$$R_{wall} = \frac{A_{wall} \times (T_{ms} - T_{cs})}{Q_{wall}} \quad (3)$$

where R_{wall} = surface-to-surface thermal resistance of the wall assembly (m^2-K/W),
A_{wall} = area of wall (m^2),
T_{ms} = average metering-side surface temperature (°C),
T_{cs} = average climate-side surface temperature (°C).

The meter side and climate side air film coefficients, R_{ms} and R_{cs}, are calculated as

$$R_{ms\,air} = \frac{A_{wall} \times (T_{ma} - T_{ms})}{Q_{wall}} \tag{4}$$

$$R_{cs\,air} = \frac{A_{wall} \times (T_{cs} - T_{ca})}{Q_{wall}} \tag{5}$$

where $R_{ms\ air}$ = thermal resistance of the meter side air film (m^2-K/W),
$R_{cs\ air}$ = thermal resistance of the climate side air film (m^2-K/W),
T_{ma} = average meter-side air temperature (°C),
T_{ca} = average climate-side air temperature (°C).

The overall air-to-air thermal resistance of the wall assembly, $R_{u\ wall}$, is given by

$$R_{u\,wall} = \frac{A_{wall} \times (T_{ma} - T_{ca})}{Q_{wall}} \tag{6}$$

or,

$$R_{u\,wall} = R_{wall} + R_{ms\,air} + R_{cs\,air} \tag{7}$$

TEST CONDITIONS

The temperature conditions for these tests were 37.8°C (100°F) and 10.0°C (50°F) in the metering and climate chambers, respectively. The "exterior" (VIP/EPS) side of the wall was facing the climate chamber and the "interior" (stud and gypsum board) side of the wall was facing the metering chamber. Thermocouple arrays were installed on both the hot and cold sides of the test walls to monitor temperatures over the wall cavities, studs, and the top and bottom tracks, similar to the January 2011 test wall (Biswas et al, 2011). The temperatures of the hot and cold wall surfaces were determined by area-weighted averaging of the thermocouples attached to the individual components.

The area of the test frame surrounding the specimen wall was filled with insulation of the same thickness as the metal studs. The perimeter of the test wall and the joints were caulked and taped to prevent air leakage. Once the tests were started, it took between 40 and 60 hours to reach stable temperature and heat flow conditions. The tests ran for a total of about 150-180 hours and data from the final 15-25 hours were used for analysis.

TEST RESULTS

Temperatures, heat flows and R-values are presented in Table 1. (A nomenclature list follows the table.) Table 1 also summarizes the calculated R-values. **The surface-to-surface R-values (*R_{wall}*) are shown in bold**. Both R_{SI} (m^2-K/W) and R_{US} (hr-ft^2-°F/Btu) are provided. All quantities are specified in both SI units and the corresponding IP units (in parenthesis). Test 1 pertains to the wall with R_{SI}-1.9 m^2-K/W (R_{US}-11 hr-ft^2-°F/Btu) cavity insulation and test 2 is for the wall without cavity insulation. All quantities are averaged over the last 25 hours for test 1 and the last 15 hours for test 2.

The surface-to-surface R-value was 5.5 m^2-K/W (31.3 hr-ft^2-°F/Btu) with cavity insulation and 4.5 m^2-K/W (25.7 hr-ft^2-°F/Btu) without. The previously tested wall, with smaller VIPs, had a measured surface-to-surface R-value of 3.7 m^2-K/W (20.8 hr-ft^2-°F/Btu) without cavity insulation. Thus, the VIP/EPS composite design for the second test wall resulted in a 24% improvement in the wall thermal resistance.

Table 1. Hot-box test results for EIFS wall with encapsulated VIP.

	Test 1 (R-11 cavity insulation)	**Test 2 (No cavity insulation)**
C-CAV	10.0 (50.0)	10.0 (50.0)
C-STUD	10.0 (49.9)	9.9 (49.9)
C-TRACK	9.7 (49.5)	9.6 (49.3)
T_{cs}	10.0 (50.0)	10.0 (50.0)
M-CAV	37.9 (100.2)	37.8 (100.0)
M-STUD	37.3 (99.2)	37.7 (99.8)
M-TRACK	36.1 (97.0)	35.8 (96.5)
T_{ms}	37.8 (100.0)	37.7 (99.9)
T_{ma}	38.1 (100.5)	38.3 (100.9)
M-BAF-T	38.0 (100.4)	38.1 (100.6)
T_{ca}	9.6 (49.3)	9.6 (49.2)
C-BAF-T	9.8 (49.6)	9.7 (49.4)
M-AIR-VC	0.2 (0.5)	0.2 (0.5)
C-AIR-VC	0.8 (1.9)	0.9 (2.0)
TMP-DC	30.0 (102.3)	36.4 (124.2)
ΔT	27.8 (50.0)	27.8 (50.0)
T(mean)	23.9 (75.0)	23.9 (74.9)
$Q_{mb\ fl}$	0.0 (0.0)	0.0 (0.0)
Q_{wall}	30.0 (102.3)	36.4 (124.2)
R_{wall}	**5.5 (31.3)**	**4.5 (25.7)**
$R_{u\ wall}$	5.6 (32.0)	4.7 (26.6)
$R_{ms\ air}$	0.05 (0.3)	0.08 (0.5)
$R_{cs\ air}$	0.07 (0.4)	0.07 (0.4)

Nomenclature for Table 1:

C-CAV - Average surface temperatures over cavity (climate side) (°C)/(°F)
C-STUD - Average surface temperatures over stud (climate side) (°C)/(°F)

C-TRACK	- Average surface temperatures over track (climate side) (°C)/(°F)
T_{cs}	- Weighted average external surface temperature (climate side) (°C)/(°F)
M-CAV	- Average surface temperatures over cavity (meter side) (°C)/(°F)
M-STUD	- Average surface temperatures over stud (meter side) (°C)/(°F)
C-TRACK	- Average surface temperatures over track (meter side) (°C)/(°F)
T_{ms}	- Weighted average external surface temperature (meter side) (°C)/(°F)
T_{ma}	- Average of 36 air TC's, meter side (°C)/(°F)
M-BAF-T	- Average of 24 baffle TC's, meter side (°C)/(°F)
T_{ca}	- Average of 48 air TC's (climate side) (°C)/(°F)
C-BAF-T	- Average of 36 baffle TC's (climate side) (°C)/(°F)
M-AIR-VC	- Air velocity (meter side) (m/s)/(mph)
C-AIR-VC	- Air velocity (climate side) (m/s)/(mph)
TMP-DC	- Total measured power into meter box (W)/(Btu/hr)
ΔT	- Average temperature difference across wall surfaces (°C)/(°F)
T(mean)	- Average weighted exterior wall surface mean temperature (°C)/(°F)
$Q_{mb,fl}$	- Energy exchange rate through meter box walls (W)/(Btu/hr)
Q_{wall}	- Calculated energy flow rate through specimen wall (W)/(Btu/hr)
R_{wall}	- Surface to surface R-value of wall (m^2-K/W)/(hr-ft^2-°F/Btu)
$R_{u\ wall}$	- Overall R-value of sample wall (m^2-K/W)/(hr-ft^2-°F/Btu)
$R_{ms\ air}$	- Meter side air film resistance (m^2-K/W)/(hr-ft^2-°F/Btu)
$R_{cs\ air}$	- Climate side air film resistance (m^2-K/W)/(hr-ft^2-°F/Btu)

INFRARED THERMOGRAPHY

In addition to the whole-wall R-values tests, infrared (IR) thermographic images of the test wall were taken for qualitative assessment of the heat flow through the different wall components. For IR imaging, the test wall was clamped to the meter/guard chamber and the meter chamber heaters were turned on. The steel-framed side was facing the meter chamber and the IR images were taken from VIP/EPS side.

Figure 4 shows the visual and IR images of the lower right quadrant. For identification, the wall sections were divided into 4 quadrants using reflective aluminum tape. Some heat flow characteristics are easily identifiable from the apparent temperature map. The center of the VIP panels show uniform lower temperatures, with some thermal bridging occurring at the foam borders of the VIP/EPS composites (indicated by the relatively higher apparent surface temperatures). Further, there is some thermal bridging at the interface of the two VIPs within each composite, but is less severe than through the foam edges. Similar findings were reported by Childs et al. (2012), who used a heat transfer model to simulate the EIFS/VIP wall performance.

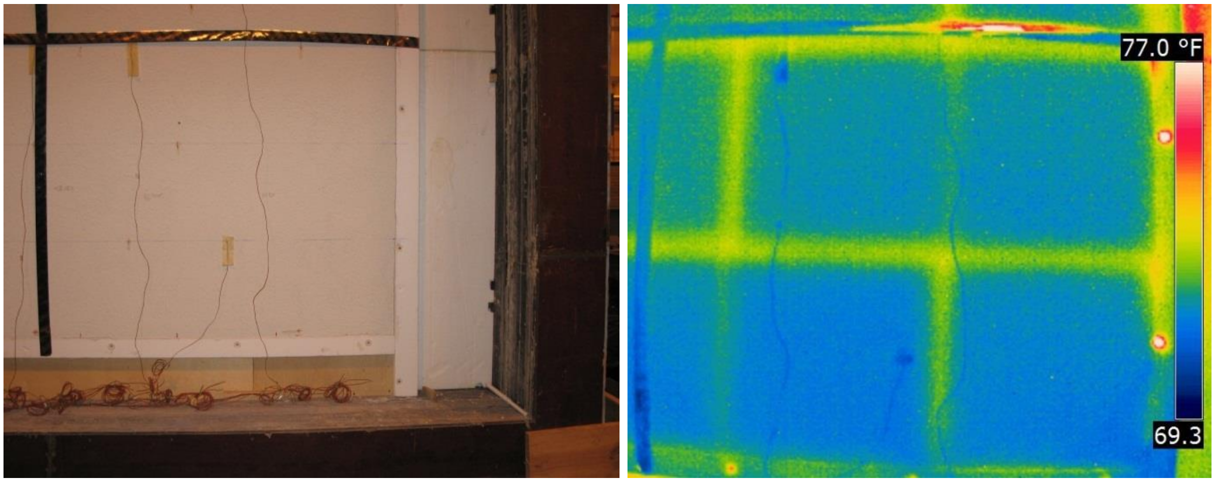

Figure 4. Visual and infrared image of the lower right quadrant of the wall.

Figure 5 also shows the visual and IR images of the lower right quadrant, but with one VIP punctured. The IR image was taken approximately 1 hour after the VIP was punctured. The failed VIP is clearly indicated in the IR image; however, it still appears to allow less heat flow than the foam borders.

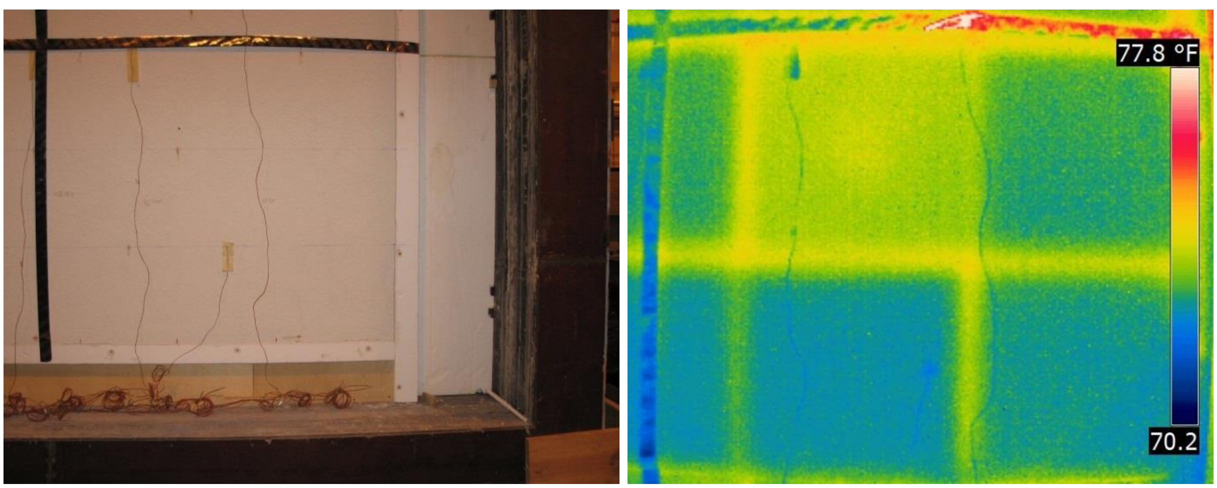

Figure 5. Visual and infrared image of the lower right quadrant of the wall, with one VIP punctured.

SUMMARY

In February, 2012, thermal performance testing of an enhanced prototype solution for encapsulated Vacuum Insulated Panels (VIP) within an Exterior Finish Insulation System (EIFS) wall was performed in Oak Ridge National Laboratory. The wall was built using metal studs at 40.6 cm (16-inch) on center (o.c.). The exterior insulation consisted of 7.6 cm (3-inch) thick expanded polystyrene (EPS) foam blocks containing the vacuum insulated panels, and was coated with an exterior stucco finish. The EIFS wall was tested in the Rotatable Guarded Hot

Box (RGHB) according to the ASTM C 1363 standard test method, with and without cavity insulation. With R_{SI}-1.9 m^2-K/W (R_{US}-11 hr-ft^2-°F/Btu) cavity insulation, the measured thermal resistance of the wall was 5.5 m^2-K/W (31.3 hr-ft^2-°F/Btu). Without cavity insulation, the measured thermal resistance was 4.5 m^2-K/W (25.7 hr-ft^2-°F/Btu), a 24% improvement over the previous prototype solution.

After the completion of the tests, infrared imaging the test wall was performed to qualitatively assess the heat flow characteristics. Thermal bridging through the foam was clearly identifiable. Infrared images taken about an hour after puncturing one VIP clearly showed the increased heat flow through the failed VIP, but it still appeared to be lower than the heat flows through the foam borders.

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ORNL/TM-2013/220

Transient Thermal Performance Evaluation of Steel-Framed Walls with 94% Coverage of Vacuum Insulated Panels Encapsulated Within an Exterior Insulation and Finish System in a Natural Exposure Test Facility

July 2013

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ORNL/TM-2013/220

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TABLE OF CONTENTS

ABSTRACT

This report presents the transient thermal performance evaluation of an exterior insulation and finish system (EIFS) wall incorporating encapsulated vacuum insulation panels (VIPs). The wall was built in Charleston, SC in May 2012 and exposed to natural weatherization for a period of about 12 months. The exterior insulation consisted of 7.6 cm (3-inch) thick expanded polystyrene (EPS) foam blocks containing the VIPs, which had 94% coverage of the entire wall area.

The test wall was instrumented with temperature, heat flux and relative humidity sensors, which were monitored remotely from Oak Ridge National Laboratory (ORNL) and downloaded into weekly data files. This report summarizes the findings of the field test.

1. INTRODUCTION

Dow Corning Corporation, a joint venture of Dow Chemical Company and Corning Inc., is working with the U.S. Department of Energy and Dryvit Systems, Inc. to develop a wall system that will provide a high thermal resistance in a relatively thin profile. The proposed wall system incorporates vacuum insulation panels (VIP) enclosed within closed-cell insulating foam in an exterior insulation and finish system (EIFS) application. In addition to providing some additional thermal resistance, the foam serves to protect the vacuum panels during construction and to provide a surface appropriate for an adhesive joint on both sides of the foam-VIP unit. Previously, the Rotatable Guarded Hot Box (RGHB) at Oak Ridge National Laboratory (ORNL) was used to test the steady-state thermal performance of two walls with different percentage coverage of VIPs of the wall area [1, 2]. The hot box testing was performed according to ASTM C1363 [3]. Further, a combined experimental and numerical study was performed to investigate the optimum thermal performance of the EIFS-VIP wall, by varying the vacuum panel size and coverage area, type and thickness of foam encapsulating the VIPs, thickness and shape of foam sections separating the VIPs, etc. [4].

This report presents a transient thermal performance evaluation of an EIFS-VIP wall that was tested in a Natural Exposure Test (NET) facility in Charleston, SC. NET facilities expose side-by-side roof/attic and wall assemblies to natural weathering in four different humid US climates. The data help industry develop products to avoid adverse moisture-related impacts in buildings, and are essential in validating hygrothermal and energy models. NET structures are located at ORNL, Charleston, SC, Tacoma, WA, and Syracuse, NY. Each is temperature and humidity controlled and instrumented to measure temperature, heat flux through walls and roofs, humidity, moisture content in materials, etc.

The testing in the Charleston NET facility was performed to evaluate the transient behavior of the EIFS/VIP wall under unsteady environmental conditions. This test complements the steady-state thermal performance tests conducted earlier in the ORNL hot-box following ASTM C1363. The hot-box tests provided the overall thermal resistance, or R-value, of the EIFS/VIP wall under steady conditions and can be used for comparison against R-values of other wall assemblies. However, ASTM C1363 only applies to steady-state testing and doesn't establish procedures or criteria for dynamic testing and analysis. Further, the C1363 test method doesn't permit intentional air or moisture transfer through the specimen, which can alter the net heat transfer through the wall under actual environmental conditions.

The test wall was monitored for a period of 12-months, covering the heating, cooling and shoulder (spring and fall) seasons. For analysis, temperature, heat flux and humidity data from the wall and weather data from an onsite weather station were collected on an hourly basis. The details of the test facility and test wall and data analysis are presented in the following sections.

2. TEST FACILITY AND TEST WALL DETAILS

Figure 1 shows the southeast wall of the Charleston NET facility, which houses multiple side-by-side test walls. Also shown is a weather station on the southwest gable end of the building.

Figure 1. Charleston, SC NET facility.

Figure 2 shows the interior and exterior sides of the test wall. The wall was built with steel frames and an exterior insulation and finish system (EIFS). The EIFS contained encapsulated vacuum insulated panels (VIPs).

Figure 2. EIFS-VIP wall interior and exterior views.

Figure 3 shows the cross-sectional details of the VIPs encapsulated by expanded polystyrene (EPS) foam boards. The EPS/VIP composite is 7.6 cm (3-in) thick, with a 2.5 cm (1-in) VIP sandwiched by two 2.5 cm (1-in) EPS foam sheets. For edge protection, 1.3 cm (0.5-in) EPS foam strips were used as borders around the VIPs. Type II EPS [5] was used for encapsulating the VIPs, compared to type I EPS used in the first prototype wall tested in the RGHB [1]. This stronger class of foam enabled the change to thinner border strips, resulting in a higher overall wall thermal resistance (R-value) under steady-state conditions [2, 3]. The framing was 9.2 cm (3.6-in) steel studs, with 1.3 cm (0.5-in) sheathing on either side of the steel studs. The wall cavities were filled with R_{SI}-2.3 m^2-K/W (R_{IP}-13 hr-ft^2-°F/Btu) fiberglass insulation.

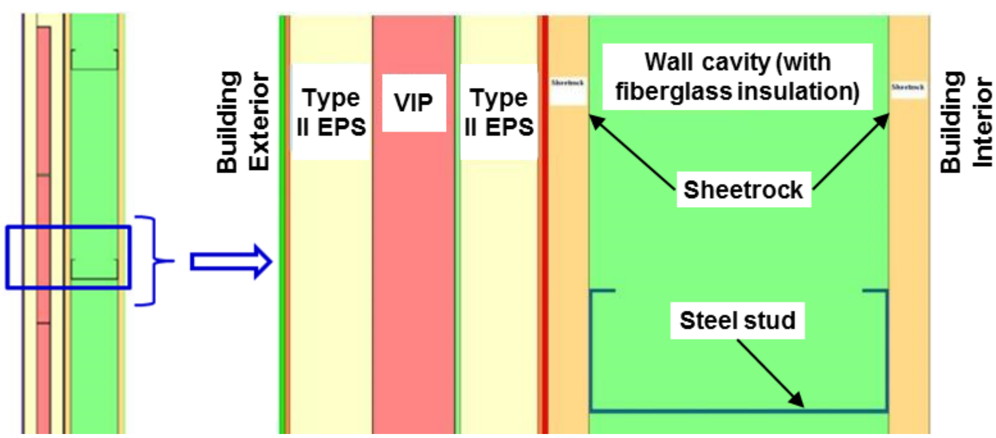


Figure 3. EPS/VIP test wall cross-section.

Figure 4 shows a schematic with the different wall layers and details (left) and the layout and dimensions of the EPS/VIP blocks (right). Three different types of EPS/VIP blocks (A, B & C) were used, with different dimensions and foam edge thicknesses. The wall contained two blocks each of types A, B and C. In type A and type C blocks, the VIPs were individually encapsulated within EPS sheets, including at the edges. Two VIPs were butted against each other within type

B blocks and then encapsulated by EPS sheets, except at their common edge. The actual VIP dimensions were: A – 57.8 cm and 77.5 cm, B – 59.1 cm and 57.8 cm, and C – 57.8 cm and 57.8 cm.

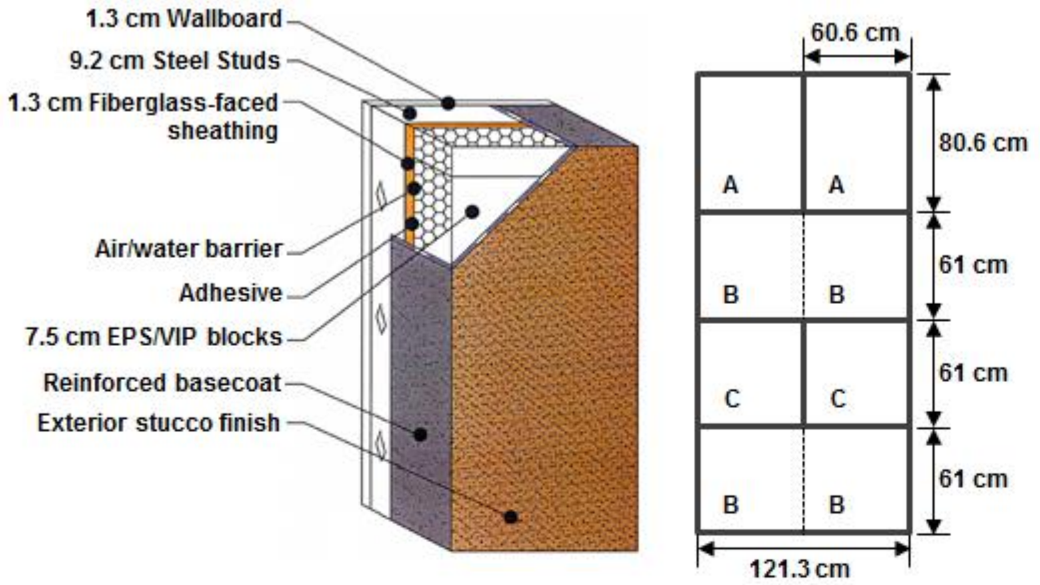


Figure 4. Left: Schematic showing wall construction details; Right: Layout of EPS/VIP blocks.

3. DATA ACQUISITION SYSTEM AND INSTRUMENTATION

The test wall contained several temperature (T), relative humidity (RH) and heat flux sensors. The sensors were installed within the EPS/VIP blocks and at the various interfaces between different cross-sectional layers of the wall. Figure 5 shows the locations of the array of T/RH sensors across the wall cross-section and the heat flux transducers (HFTs), with respect to the EPS/VIP layout. The cross-sectional T/RH sensor array was located along the clear cavity and VIP section of the wall, away from the studs and the VIP joints. The HFTs were located to measure the heat flows through the core of the VIP (A) and through the EPS foam at the joints between two VIPs (B/C). Figure 5 also shows the locations of pairs of thermistors to measure the temperatures across the VIPs (A, B and C). These thermistors are attached to the exterior and interior EPS-VIP interfaces.

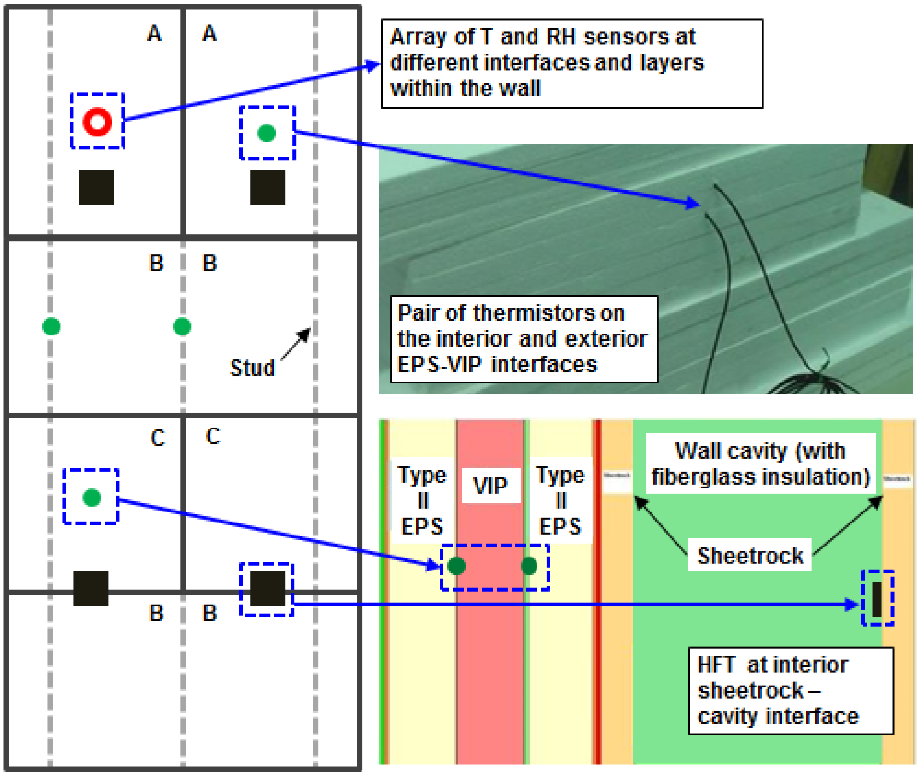


Figure 5. Sensors for measuring the temperatures across and heat flow through the EPS/VIP blocks. The empty red circle indicates and array of T and RH sensors installed along the cross-section of the wall, the green dot represents a pair of thermistors sandwiching the VIPs, and the black square represents the HFTs at the cavity-wallboard interface.

Figure 6 shows some sample locations of additional temperature and RH sensors located in the wall. In addition to the sensors attached to the test wall, the NET facility includes sensors and instruments to monitor the local weather conditions, including temperature, humidity, solar irradiance, wind conditions, etc. These sensors are controlled and monitored by Campbell Scientific (CSI) CR10X dataloggers and multiplexers (http://www.campbellsci.com/cr10x). Each sensor was scanned at five minute intervals and the data were averaged and stored at hourly intervals. The data files were downloaded on a weekly basis at ORNL using a dedicated computer and modem. Table 1 provides the sensor list for the NET facility and Table 2 lists all the sensor specifications.

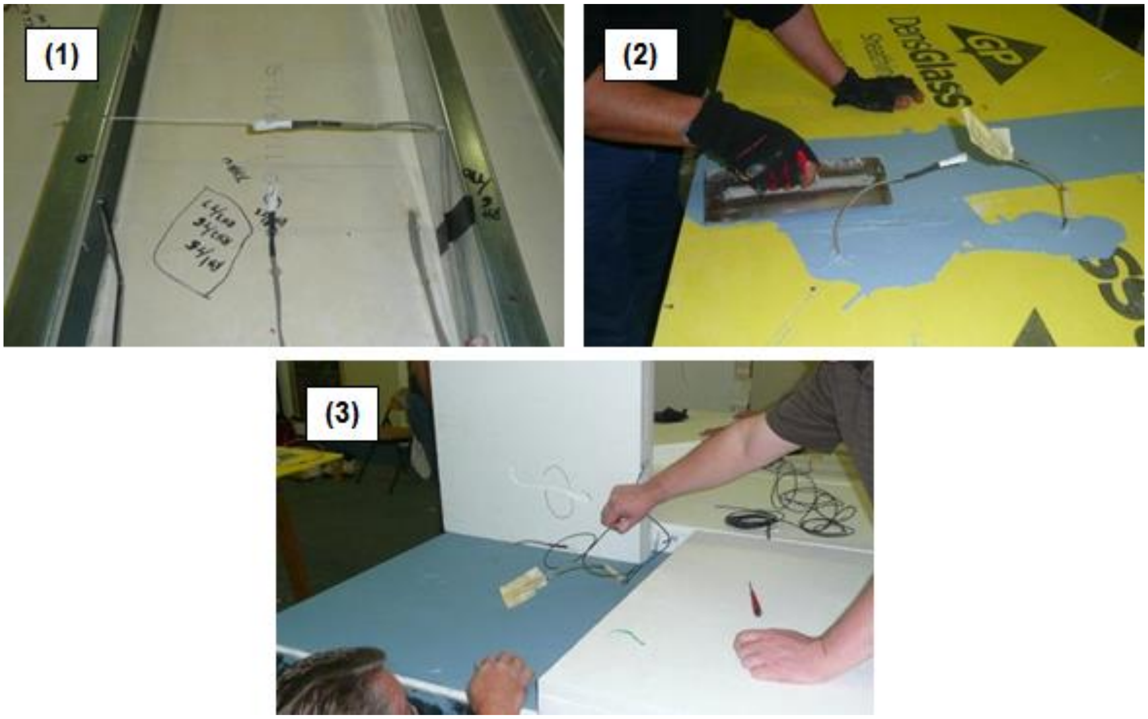


Figure 6. Temperature and relative humidity sensors at (1) interior sheetrock surface facing the cavity, (2) sheetrock-EPS interface, and (3) interior and exterior surfaces of the EPS/VIP blocks.

Table 1. Charleston NET facility sensor list.

Sensor	Location	Number
Outdoor temperature	Top of building exterior	1
Outdoor RH	Top of building exterior	1
Solar horizontal	Top of building exterior	1
Solar vertical	South center building exterior	1
Wind speed	Top of building exterior	1
Wind direction	Top of building exterior	1
Rainfall horizontal	Top of building exterior	1
Rainfall vertical south 1	South wall center	1
Rainfall vertical south 2	South wall east	1
Rainfall vertical north	North wall east	1
Indoor temperature Rm. 1	Room 1 high and low	2
Indoor RH Rm. 1	Room 1 high and low	2
Indoor temperature Rm. 2	Room 2 high and low	2
Indoor RH Rm. 2	Room 2 high and low	2
Test wall panel thermistors	17 per wall, 18 walls	306
Test wall panel RH sensors	6 per wall, 18 walls	108
Test wall panel moisture pin sets	8 per wall, 18 walls	144

Table 2. Installed sensor accuracy.

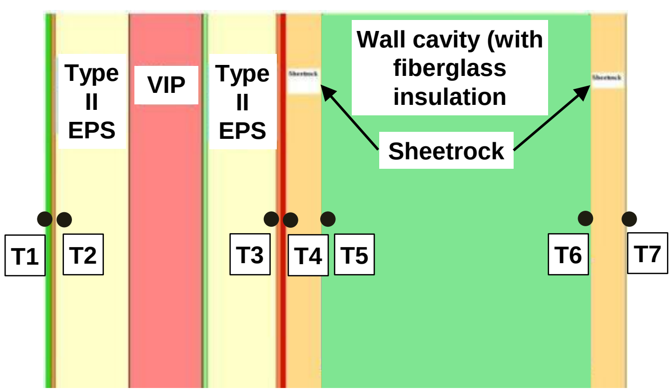
Sensor	Accuracy	Sensitivity	Repeatability	Supply Voltage
10K ohm thermistor	± 0.2%	-	± 0.2%	2.5 Vdc
Humidity Sensor	± 3.5%	-	± 0.5%	5 Vdc
Heat Flux Transducer	± 5%	5.7 $(W/m^2)/mV$	-	-
Outdoor RH	± 3%	-	-	12 Vdc
Wind Speed	± 0.4%	-	-	-
Wind Direction	± 3°	-	-	12 Vdc
Rainfall	± 1% @ 1"/hr	-	-	-
Solar pyranometer, vertical	± 3%	0.2 $(kW/m^2)/mV$	-	-
Solar pyranometer, horizontal	± 3%	$10\mu V/W^1/m^2$	-	-
Channel multiplexer	± 0.1% of full scale reading	-	-	12 Vdc

4. RESULTS AND DISCUSSION

This section shows some sample temperature, humidity and heat flux data, with the focus on some key findings. The data monitoring started around May 23, 2012, and since then they have been compiled into weekly files containing hourly data. The data collection is still ongoing at the time of writing this report. All data have been provided to the sponsor for further evaluation.

4.1. Temperature and Heat Flux Data

As mentioned earlier, thermistors were installed at several locations within the wall. Figure 7 shows the location of thermistors at the different interfaces/layers along the wall cross-section. The table next to Figure 7 describes the locations of thermistors. To differentiate between the two layers of sheetrock, the one on the exterior side of the wall cavity is called 'Densglass' and the interior sheetrock is called wallboard.



T1	Wall exterior
T2	EPS/VIP exterior
T3	EPS/VIP interior
T4	Densglass exterior
T5	Densglass interior
T6	Wallboard exterior
T7	Wallboard interior

Figure 7. Locations of temperature sensors along the wall cross-section.

Figure 8 and Figure 9 show some sample temperature distributions along the wall cross-section during three summer and three winter days, respectively. The outdoor temperatures measured using the onsite weather station are also shown. As expected, the outer thermistors (T1 and T2) showed the highest diurnal fluctuations in temperatures. The temperatures at locations inside the

EPS/VIP blocks exhibited much lower fluctuations, about 2-4°C during the summer and winter days shown in Figure 8 and Figure 9.

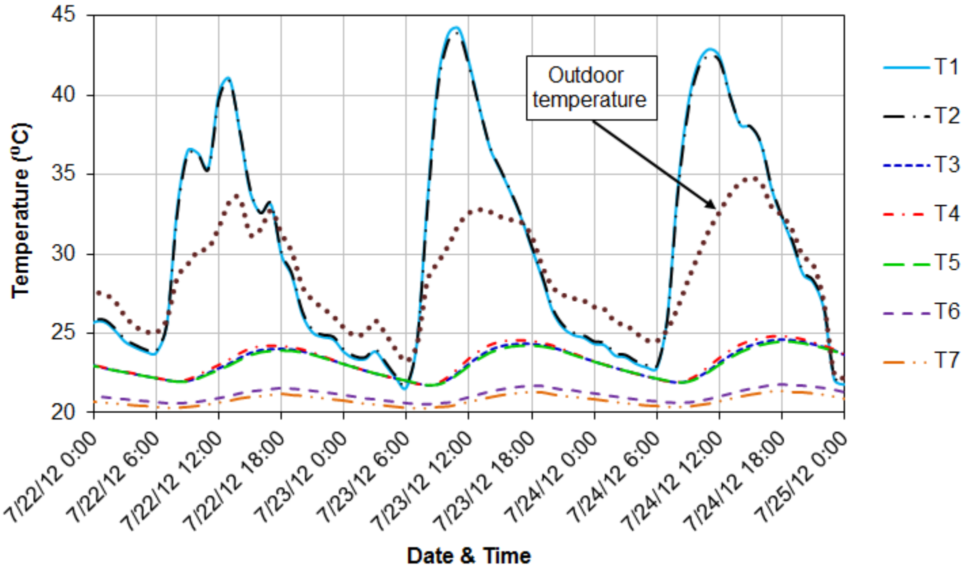


Figure 8. Temperature distribution along the wall cross-section during three summer days.

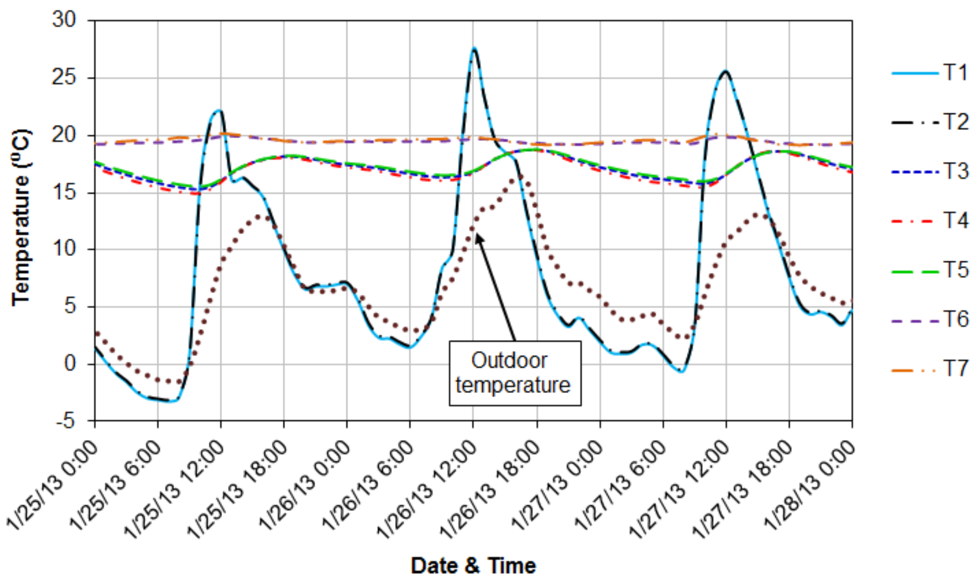


Figure 9. Temperature distribution along the wall cross-section during three winter days.

In addition to the thermistors attached at the different wall layers, four pairs of thermistors were embedded within the EPS/VIP blocks, at both the exterior and interior interfaces. Figure 10 shows the four pairs of thermistors and their locations, and the locations of the HFTs with respect to the EPS/VIP blocks.

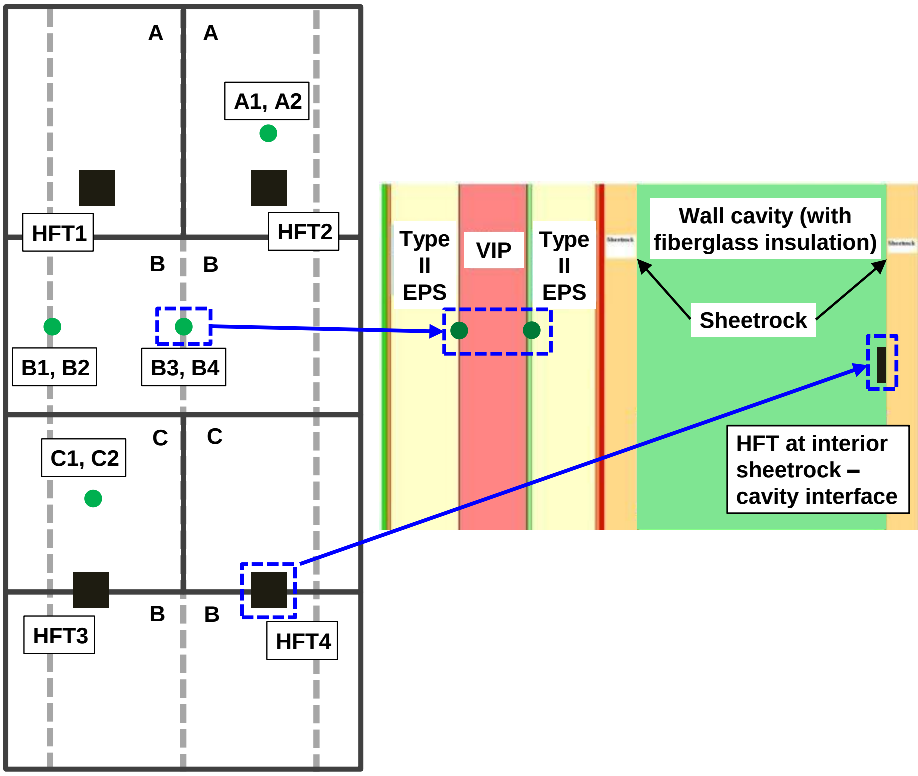


Figure 10. Locations of the thermistors at the EPS-VIP interfaces and the HFTs. Thermistors A1, B1, B3 and C1 were on the exterior EPS-VIP interface and A2, B2, B4 and C2 were on the interior interface.

Thermistors A1, B1, B3 and C1 were located on the EPS-VIP interface towards the wall exterior and A2, B2, B4 and C2 were on the interior interface. A1-A2 and C1-C2 were located in the clear wall and clear VIP sections, with no joints or thermal bridging from the studs. B1-B2 were located within the clear VIP section, but were aligned with a steel stud, and B3-B4 were aligned with a steel stud and the butt joint between two VIPs.

Figure 11 and Figure 12 show the temperature variations within the EPS/VIP blocks. The temperatures measured by C1-C2 thermistors were very close to A1-A2, and have not been shown to improve the clarity of the plots. The outer temperatures, A1 and B1, were similar. On the interior, B2 was closer to the room temperature compared to A2 at all times. B1-B2 were aligned with a steel stud, and thermal bridging from the steel stud is a possible reason for the proximity of B2 to the room temperature. B3-B4 were aligned with both a stud and the butt joint between two VIPs, and their magnitudes were discernibly different from A1-A2 and B1-B2.

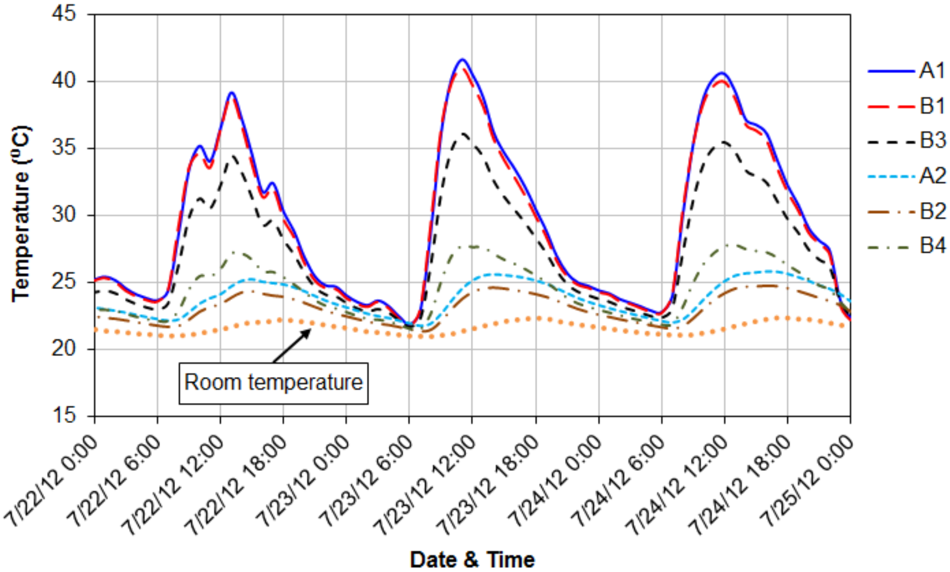


Figure 11. Temperatures within the EPS/VIP blocks during three summer days.

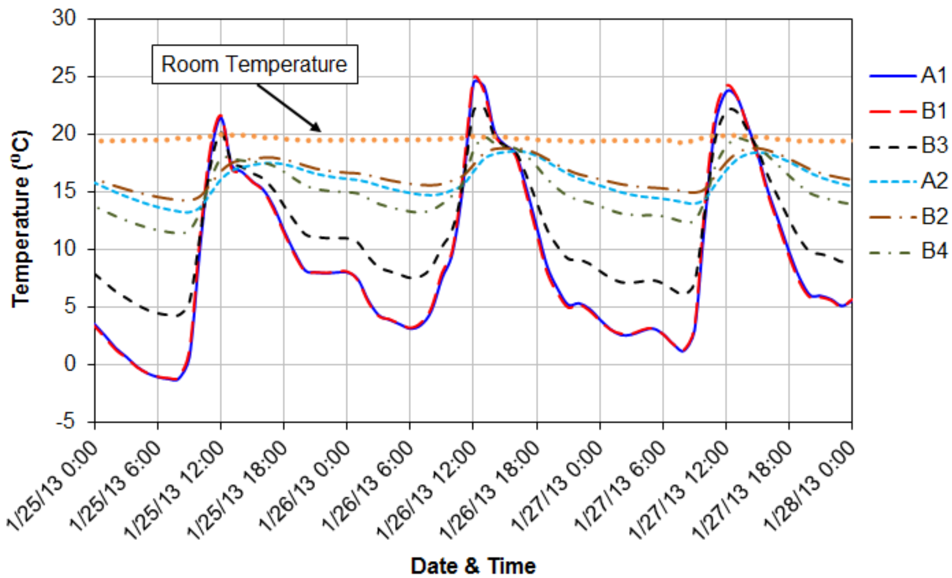


Figure 12. Temperatures within the EPS/VIP blocks during three winter days.

Figure 13 shows the heat flows through the different sections of the walls, as measured by the HFTs, during the summer days. Positive heat flows indicate heat addition to the building interior and negative heat flows indicate heat loss to the outside. The HFTs were located at the clear VIP sections (A) and at the EPS borders separating type B and type C VIPs (B/C). During summer, one of the clear VIP HFTs (HFT 2) reduced the peak heat fluxes compared to the HFTs at the EPS borders (HFTs 3 and 4); the peak reduction was about 10-20% during the three summer days shown. Further, peak heat flow through the clear VIP section was delayed by 5-6 hours compared the EPS border section. Such delays in peak heat flows (or summer cooling loads) benefit the utilities by reducing the loads at the peak demand times. Further, by shifting the peak heat flows by a few hours, the energy consumption by the air conditioning equipment may be lowered due to their higher operational efficiency at cooler ambient conditions [6]. The other clear VIP HFT (HFT 1), however, measured higher daytime heat flows than the EPS border VIPs, which was contrary to expectations.

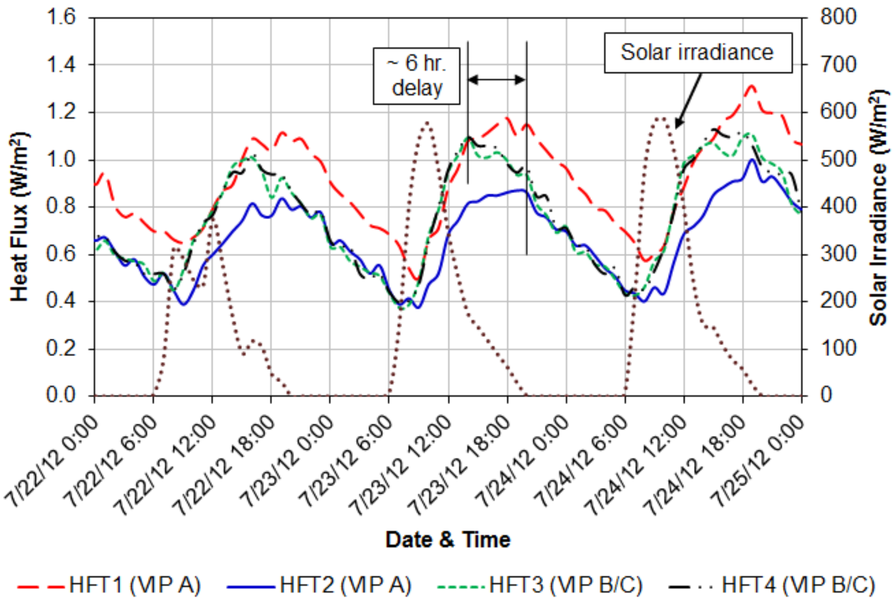


Figure 13. Heat flows through different wall sections during summer.

Figure 14 shows the heat flows through the different wall sections of the walls during winter days. Both HFTs located at the clear VIP sections measured lower heat losses to the surroundings compared to the EPS border HFTs, with reductions of about 10-15 % in peak nighttime heat losses.

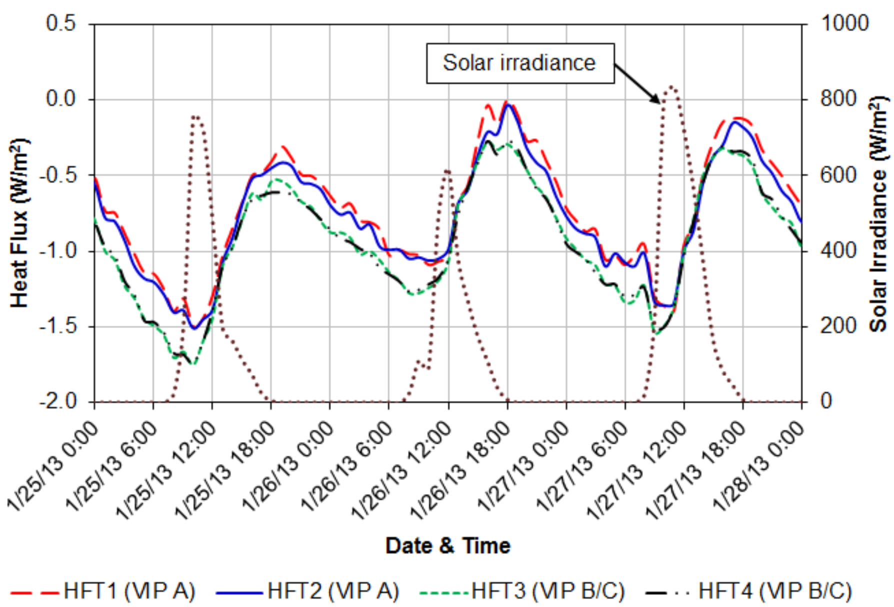


Figure 14. Heat flows through different wall sections during winter.

To further investigate the impact of the EPS vs. VIP wall sections, the heat flux data were integrated over 30-day winter and summer periods to determine the total heat gains and losses through the different sections. The respective 30-day periods were chosen based on the highest and lowest average outdoor temperatures. The integration was performed by a simple application of the trapezoidal rule (Romberg method):

$$Total\ Integrated\ Heat\ Flow\ [\frac{kJ}{m^2}] = \sum_{n=0}^{m} 0.5 * \Delta X_n * (Y_n + Y_{n+1}) \quad (1)$$

Where Y_n and Y_{n+1} correspond to the values during the current and future time steps, ΔX_n is the time step (one hour in this case), and the subscript 'm' denotes the final point in the series which varies depending on the summer or winter data sets. This integration represents a summation of the area under the curve of the heat flux. The positive and negative heat fluxes were integrated separately to determine the heat gains and losses measured by each HFT. The integrated or total heat gains and losses and the net heat transfer are shown in Table 3. The net heat transfer for each period was obtained by integrating the positive and negative heat fluxes together. The periods considered are listed in the tables, and these were selected based on the maximum and minimum 30-day average outside temperatures for the corresponding summer and winter periods, respectively.

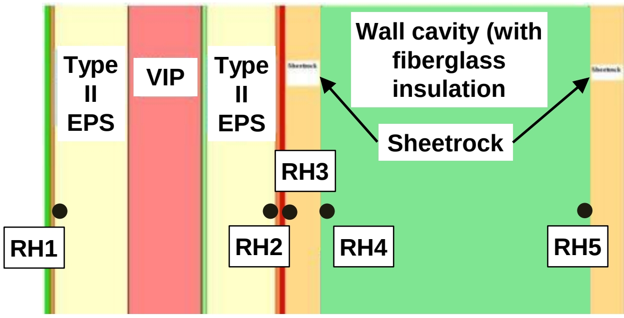
Table 3. Integrated heat flow into and out of the conditioned space during selected summer and winter periods.

	Summer 30-day period (Jun 29-Jul 28, 2012)				Winter 30-day period (Jan 22-Feb 20, 2012)			
	HFT1 (A)	HFT2 (A)	HFT3 (B/C)	HFT4 (B/C)	HFT1 (A)	HFT2 (A)	HFT3 (B/C)	HFT4 (B/C)
Gain (kJ/m^2)	2256.87	1640.19	1897.87	1873.65	55.71	15.98	21.16	21.40
Loss (kJ/m^2)	0.00	0.00	0.00	0.00	-1487.02	-1597.36	-1909.67	-1915.80
Net (kJ/m^2)	2256.87	1640.19	1897.87	1873.65	-1431.30	-1581.38	-1888.51	-1894.40

During the 30-day summer period, the integrated heat gain measured by clear VIP HFT2 was 13% less than the HFTs aligned with the EPS border (3 and 4). Contrary to expectations, HFT1 measured higher heat gains compared to HFTs 3 and 4, and needs further investigation. During winter, the heat flow was predominantly negative. Both clear VIP HFTs measured lower heat losses compared to the EPS border HFTs, with an average reduction of 19.4%.

4.2. Relative Humidity

Figure 15 shows the locations of the various RH sensors in the wall. The RH measurements during summer and winter days are shown in Figure 16 and Figure 17. The RH sensors at all locations, except the EPS/VIP exterior, measured low levels of humidity during both summer and winter. The EPS/VIP exterior RH sensor was, at times, saturated during the summer days, but measured relatively lower RH during winter.



RH1	EPS/VIP exterior
RH2	EPS/VIP interior
RH3	Densglass exterior
RH4	Densglass interior
RH5	Wallboard exterior

Figure 15. Locations of RH sensors along the wall cross-section.

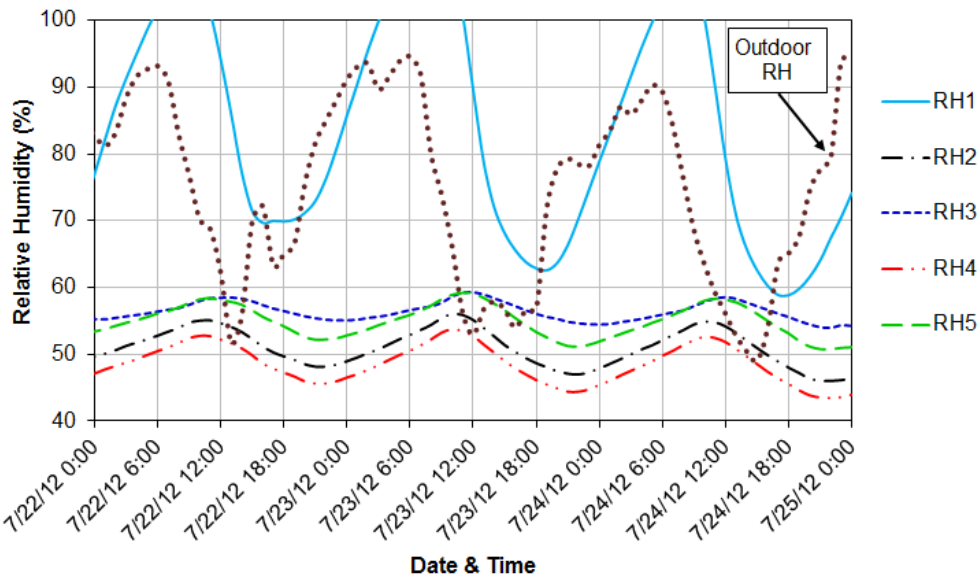


Figure 16. RH at different wall sections during summer.

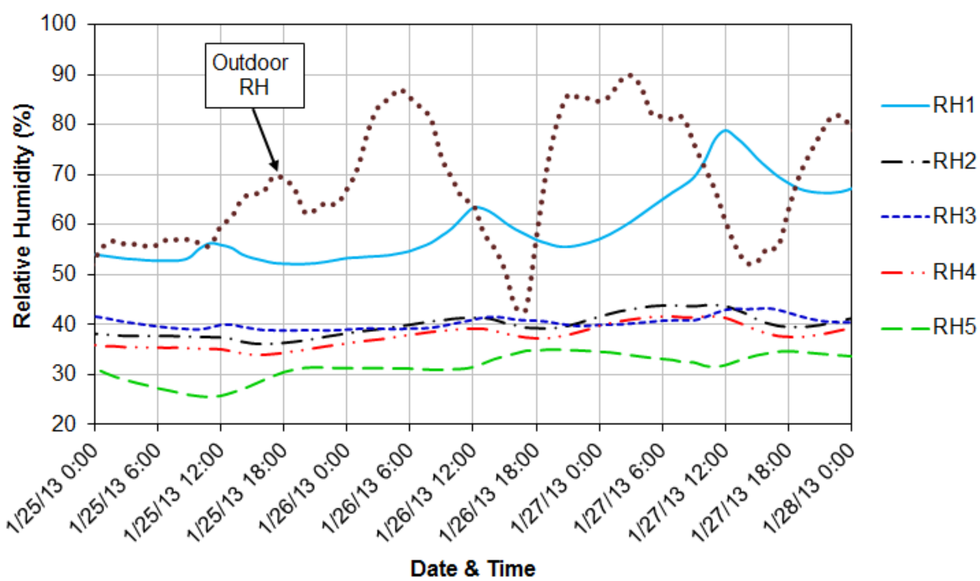


Figure 17. RH at different wall sections during winter.

Addendum A to ASHRAE standard 160 [7, 8] lists the following criterion for minimizing mold growth on building envelope surfaces: a 30-day running average surface RH < 80% when the 30-day running average surface temperature is between 5°C (41°F) and 40°C (104°F). The RH levels, at locations other than EPS/VIP exterior, predominantly remained below 70%, and on occasions when they exceeded 70%, the higher RH levels did not persist for more than a few hours (less than 24 hours). For further investigation, 30-day running averages of RH and corresponding temperatures were calculated and are shown in Figure 18 and Figure 19.

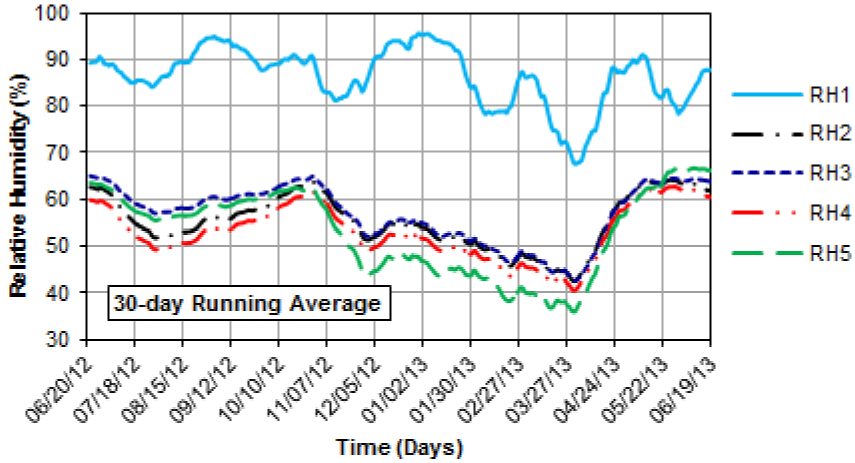


Figure 18. Running 30-day averages of relative humidity at the different wall layers.

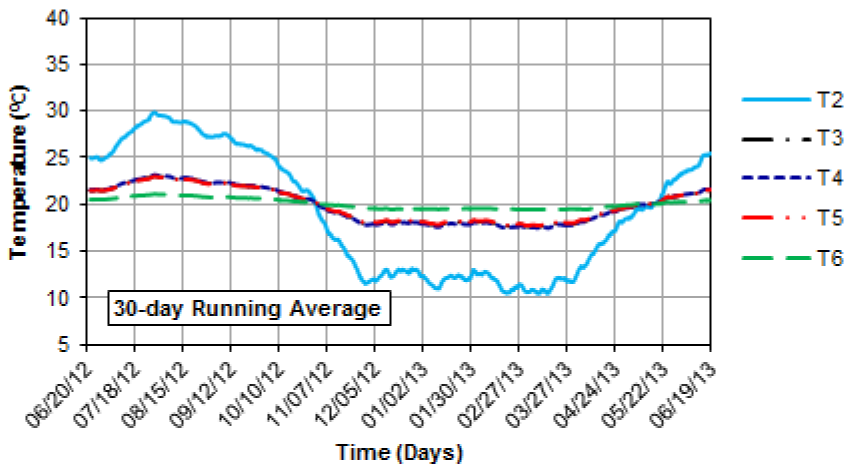


Figure 19. Running 30-day averages of temperature at the different wall layers.

The average temperatures were always between 5°C and 40°C. The average RH levels at the EPS/VIP exterior (RH1) were above 80% for major portions of the evaluation period. The high RH levels at the VIP/EPS exterior are expected as this location is just beneath the exterior stucco which gets saturated at times due rainfall and early morning condensation. The interior sections of the wall, especially near the two sheetrock wallboards, are the locations that are vulnerable to damage in case of high RH. The 30-day running average of RH at the interior locations always remained well below 80% and therefore, the current wall design is deemed satisfactory from the moisture perspective. Larger walls, however, will contain more joints between EPS/VIP blocks and probably more complicated design features, and it may require additional testing and analysis to predict their moisture behavior.

5. SUMMARY, CONCLUSIONS AND FUTURE WORK

This report presents field data and analyses results from the EIFS/VIP wall built in Charleston, SC and exposed to natural weatherization for a period of about 12 months. Temperature and local heat flow data from the wall were analyzed to examine the behavior of the VIP and EPS foam sections of the wall. HFT data indicated lower heat flows through the clear VIP sections compared to the EPS border sections at the VIP edges, and, hence, better overall thermal performance than a conventional EIFS wall with only exterior foam insulation.

Relative humidity sensors were also installed at different layers and interfaces within the wall. Except near the exterior wall surface, the RH levels at other locations within the wall were below the critical levels for mold growth, and the current design is deemed satisfactory from a moisture performance perspective. While it is difficult to ascertain the in-situ R-value of the test value based on the current heat flux and temperature data, they are valuable in comparing the performance of the different sections of the wall. Further, they are useful in validating models of EIFS/VIP walls, which can be used for whole-building energy modeling. By varying the insulation and wall-construction type, these models can be used to estimate equivalent thicknesses of rigid foam insulation that will allow the same levels of envelope-generated heating and cooling loads in different buildings and climate types.

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Fraunhofer USA

Center for Sustainable Energy Systems CSE

Whole House Testing and Analysis of a Building Retrofitted with VIP insulation and High Performance Windows – Project Final Report

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Disclaimer

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Acknowledgment

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1 Introduction

The objective of this project is to demonstrate the performance of a high efficiency wall insulation that is suitable for use in retrofit construction applications by incorporating vacuum insulation panels also known as vacuum insulated sandwich elements. In the near future, wall retrofit designs are expected to employ durable construction methods that are seamless and user friendly, minimize floor space loss with super-efficient thin VIP insulation, and preserve exterior architectural façade elements.

For wall insulation, Dow Corning Corporation fumed silica vacuum insulation panels (VIPs) were used. The VIP's are encapsulated within an EIFS system supplied by Dryvit Systems Inc. VIPs are able to achieve up to R-39 per inch at the center of the panel. The R-39 per inch is an increase of 6-10 times in thermal performance over current insulation technologies used in interior insulation. For comparison, thermal resistivity of conventional sheathing insulations ranges between R-4 and R-6.5 per inch and most common wall cavity fiber insulations achieve about R-3.5 per inch. The proposed solution utilizes a minimum of 2.5 to 3" for an EPS-foam-VIP sandwich as compared to about 8" necessary for a thermally equivalent conventional insulation technique. The demonstration aims to provide continuous opaque wall insulation of about R-30.

High performance windows were installed in the walls with VIP insulations and the combined improved efficiency was measured. High performance windows are highly insulating windows with a whole-window R-value of 5 (a U-factor of around 0.2), and are the top tier of energy-efficient windows for cold and mixed climates available today (an R-value or a U-factor is the measurement of heat loss through a window). For the proposed project, the Mathews Brothers Company offered their Clara Starrett series window – featuring EnergyCore™ technology. These windows qualify for the R-5 program when utilizing triple pane with Low-E glass and argon gas fill. A major project challenge is to integrate high-performance windows with VIP wall insulation in a way which will not create thermal shorts and long term durability problems.

The main project goal is to prove in field conditions that both of the above-mentioned technologies are capable of improving the energy performance of old wood-framed buildings in Northern U.S. climates, and to investigate the hygrothermal effects of the new wall technology over time.

2 Building Description

The building is typical construction from 1950 located in Brunswick, Maine. Building was used as vet clinic until summer of 2010. The location of the building can be seen in the Figure 1.

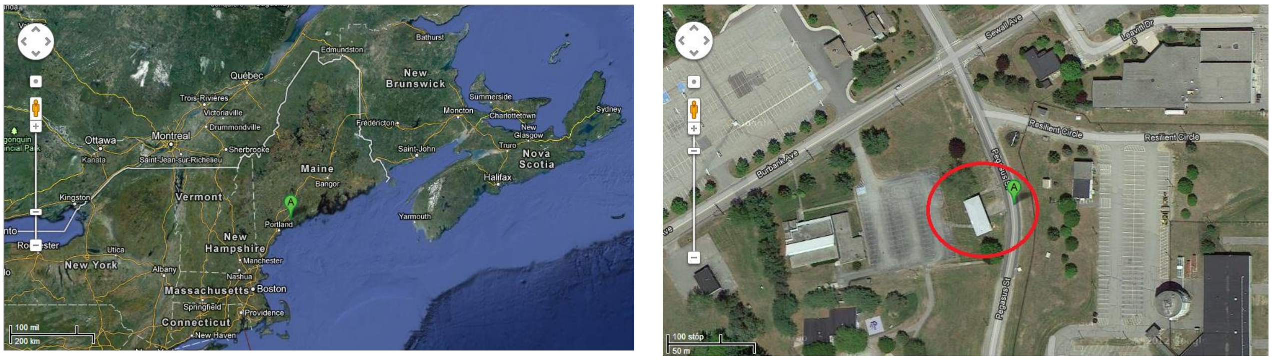


Figure 1: Building Location Map. Left – regional view of the building's location, Right - satellite view of site, with the building marked with a red circle [ref. Google maps]

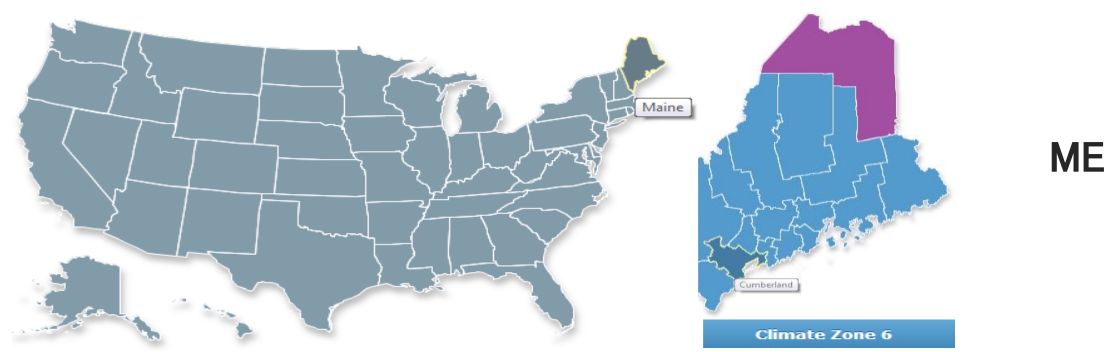


Figure 2 : Climate Zone Map. Brunswick ME falls under Zone 6 of the eight temperature-oriented climate zones of the United States [ref. 2009 IECC]

Site photographs are presented in the Figure 3.

Figure 3: Pictures taken at the site. Left: West façade before retrofit, Right: West façade after retrofit

3 Initial Building Structural Analysis (Pre-Retrofit Stage)

3.1 Introduction

The building in this study is a 1950's slab-on-grade, with 2x6 wood-frame construction, while the windows are single-glazed. Some of the windows contain additional storm windows. Except one room, all rooms of the building have a suspended ceiling. The suspended ceiling hangs approximately 5 ft. below the level of the cathedralized roof. Based on the recently-installed drop ceiling and modern doors, the building has likely gone through an interior renovation. Walls are constructed using conventional 2x6 wood framing with ½-in. solid wood paneling installed on both sides. Based on the examination of several holes made in the building envelope, insulation is sporadic in the walls and installed in most cavities up to 2 ft. above the floor. Pre-retrofit-wall-exterior-siding was made of asbestos-cement paneling. During retrofit stage, the exterior siding was removed and plywood sheathing installed before installation of the VIP-based insulation.

3.2 Assessment of wall structure

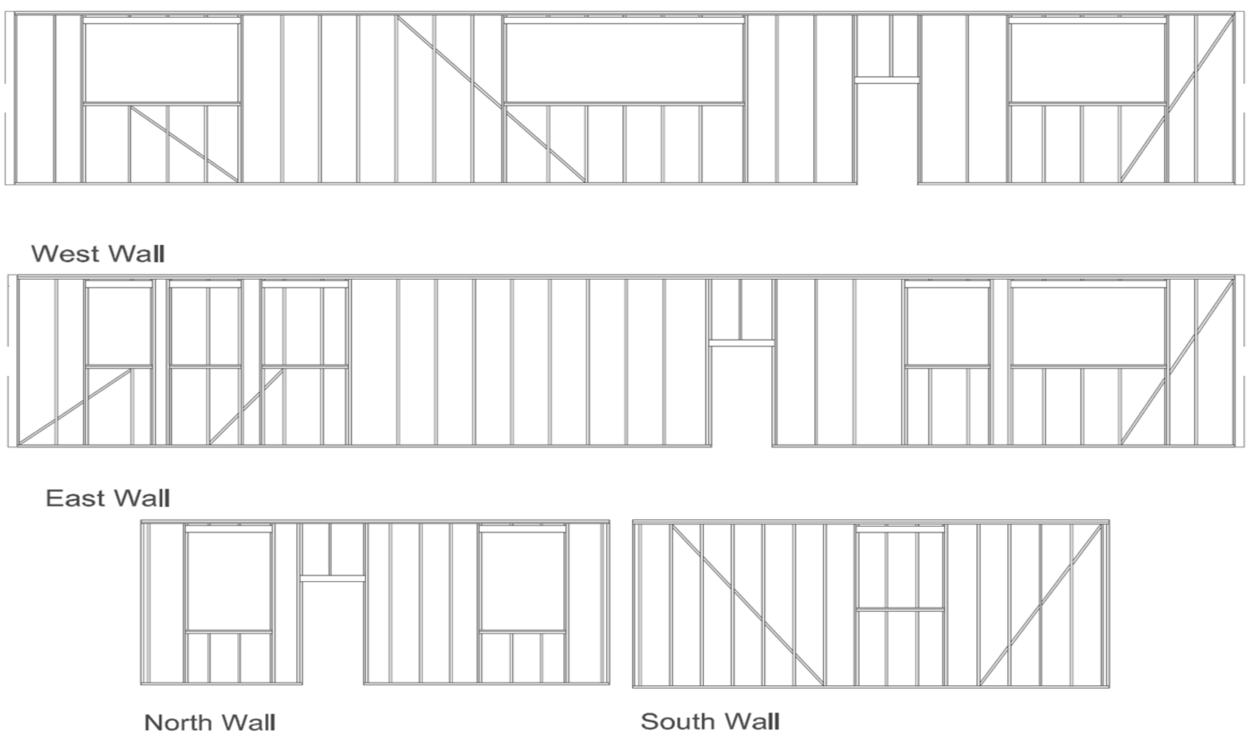


Figure 4: Estimated Existing Framing Elevations

Through infrared thermography and knowledge gained during the reframing of the windows, the estimated existing framing elevations were drawn in AutoCAD (Figure 4). Based on these drawings, the walls' framing factors ranged between 13.2– 15.5%, for a weighted average of 14.0%. The windows shown in the "existing" framing in Figure 4 are best estimates. During renovation, windows were lowered and one was removed. At Post-retrofit stage, shown in Figure 5, the framing factors ranged from 13.2– 15.2%, or a weighted average of 14.0%. Although the installation of the new windows changed the framing of the walls, the framing factors did not significantly change. All framing factors are shown in Table 1.

Figure 5: Framing Elevations after Reframing

During the reframing of the windows, insulation was found to be located along the bottom of the walls and only extending 2’ above the sole plate. Another test hole in a different wall indicated similar findings. Batt insulation was also discovered in an investigatory hole drilled through the ceiling, and was thought to be 6 ½” thick, approximately R-19.

Table 1: Framing Factors

	Existing Framing	*Renovated Framing*
North	15.47%	15.22%
East	14.19%	14.12%
South	14.76%	14.76%
West	13.22%	13.22%
Weighted Average	**14.09%**	**14.03%**

3.3 Assessment of roof structure

Because the ceiling had not been exposed during renovation, less is known about the framing of the roof. Based on the interview with the building administrator, an assumption was made that roof is made on scissor type structural wood trusses. Local inspection and thickness measurements confirmed that the roof is insulated using R-19 fiberglass batts. An approximate roof framing plan was developed, shown in Figure 6.

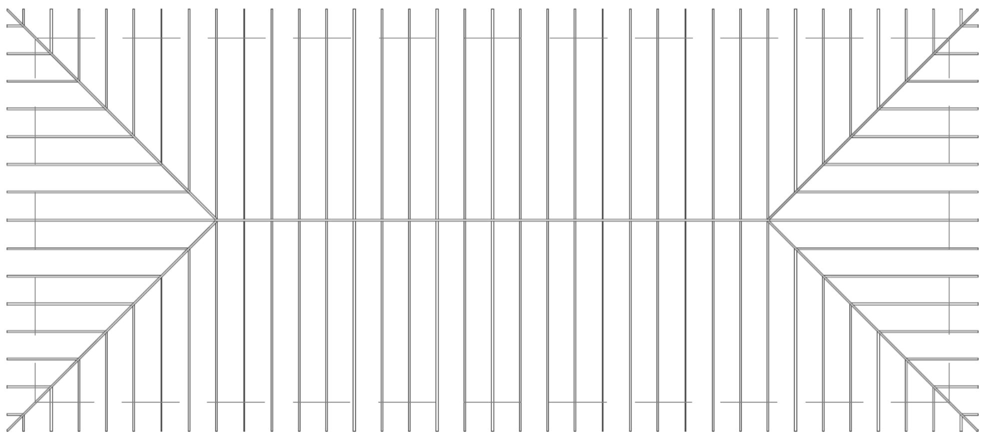


Figure 6: Roof Framing

4 Building IR Analysis (Pre- and Post- Retrofit Stages)

Infrared thermography is a useful tool in building diagnostics. Using the materials' emissivity, surface temperatures can be determined. By comparing temperatures of different locations, thermal losses are revealed.

Thermography was performed both before and after the building retrofit. Before retrofit walls were sporadically and poorly insulated and windows were single glazed. After the retrofit the wall insulations significantly improved with using VIP and single glazed windows were replaced with high efficient triple windows. Results were compared and spots causing heat loss were identified.

4.1 Task Scope

Thermographic images were taken on April 2012 for the before-renovation stage and on December 2012 for the after-renovation stage. Detailed information about the conditions during the investigation is listed in the Table 2.

Table 2: Detailed information regarding IR study

	Building Before Renovation	Building After Renovation
Date	April 19, 2012 (start at 8:30 PM) April 20, 2012 (start at 10 AM)	December 12, 2012 (start at 6 PM)
Temperature Outside Building	12°C / 54°F (April 19) 12°C / 54°F (April 20)	-3.5°C / 26°F
Temperature in Building	20°C / 68°F (April 19) 24°C / 75°F (April 20)	24°C / 75°F
Temperature Difference Across the Exterior Walls	8°C / 14°F (April 19) 12°C / 21°F (April 20)	27.5°C / 49°F

A Mikron 7800 IR camera was used in both experiments. The scene emissivity was set to 0.94 for exterior images, although later the emissivity was changed in post-processing for some images and calibrated against readings from temperature sensors located on the wall surfaces. Noise-cancelling features were also activated on the camera. The temperature range was set to -4°F – 212°F during the testing.

Post-processing of the images was done with MikroSpec 4.0 software. The temperature scales used for post-processing are listed in the Table 3.

Table 3: Temperature scales used for thermography images in post processing

	Building Before Renovation	Building After Renovation
Temperature Scale Range	4.4 -21°C / 40– 70°F (April 20) -3.8-20°C / 25–60°F (April 19)	-17.7-1.6°C / 0–35°F

No correction factors were applied in post-processing as comparisons between images with and without distance correction yielded few discernible differences.

4.2 IR Images

Below examples are the thermal images taken from walls before and after the renovation. Images A & B were taken before renovation and C & D were taken after renovation. The surface temperatures of the images before and after renovation should not be compared directly since the temperature scale of the images are different, and the temperature difference across the walls at the time the thermography was performed were not the same (see Table3).

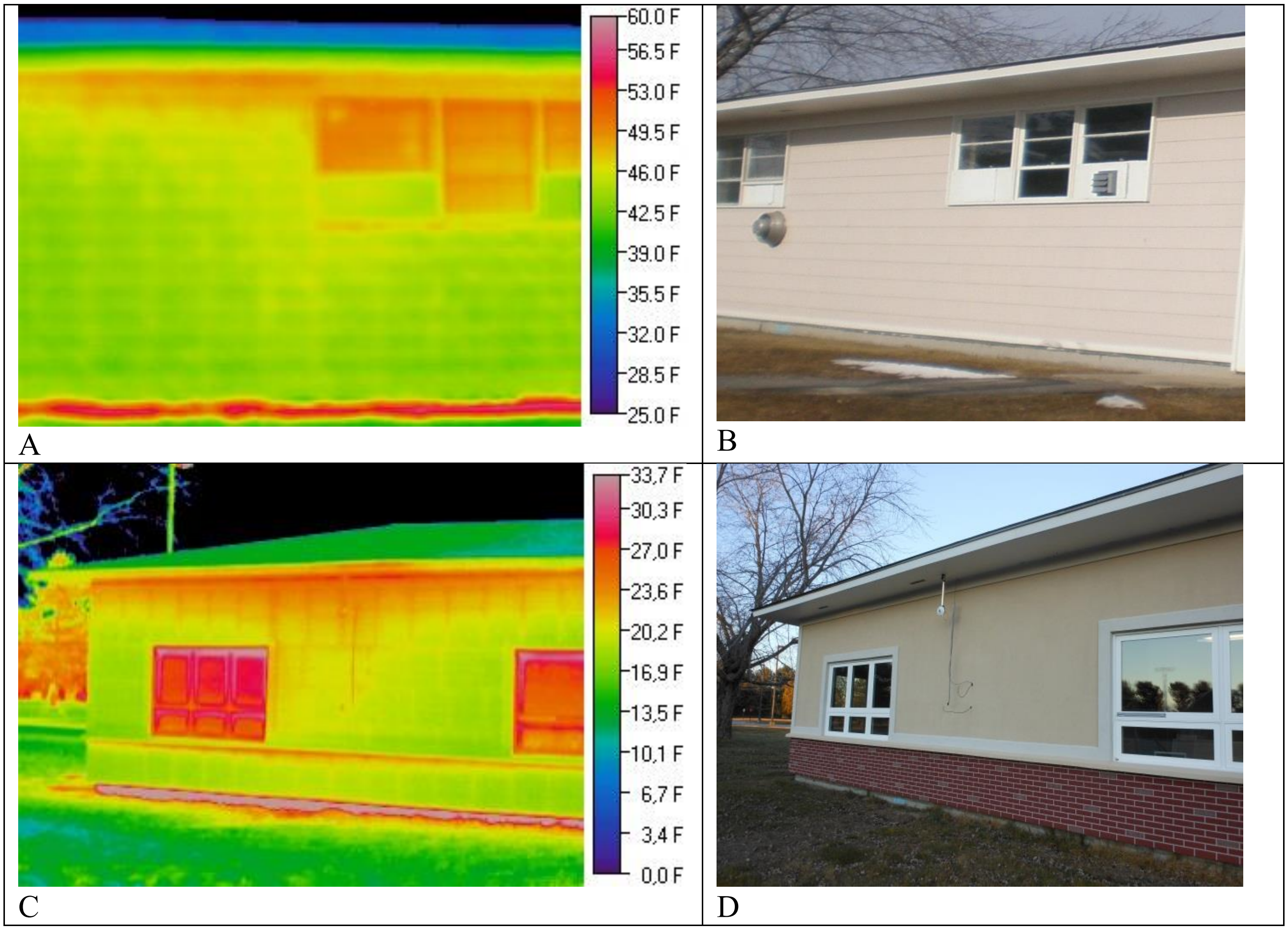


Figure 7: West Wall

Picture A: the structure is clearly visible and the façade temperature appears consistent. Losses from the single pane window, which surface is ~7°F warmer than the wall, are clear. The highest surface temperatures are visible in the concrete slab. Picture C: The wood building structure is not visible after renovation. However, thermal bridging effect on the edges of the VIP panels is visible. The window (especially the frames) present higher surface temperatures (~15°F), since their insulating capabilities are much lower than walls. Thermal bridging can also be observed on the roof-wall connection and the slab.

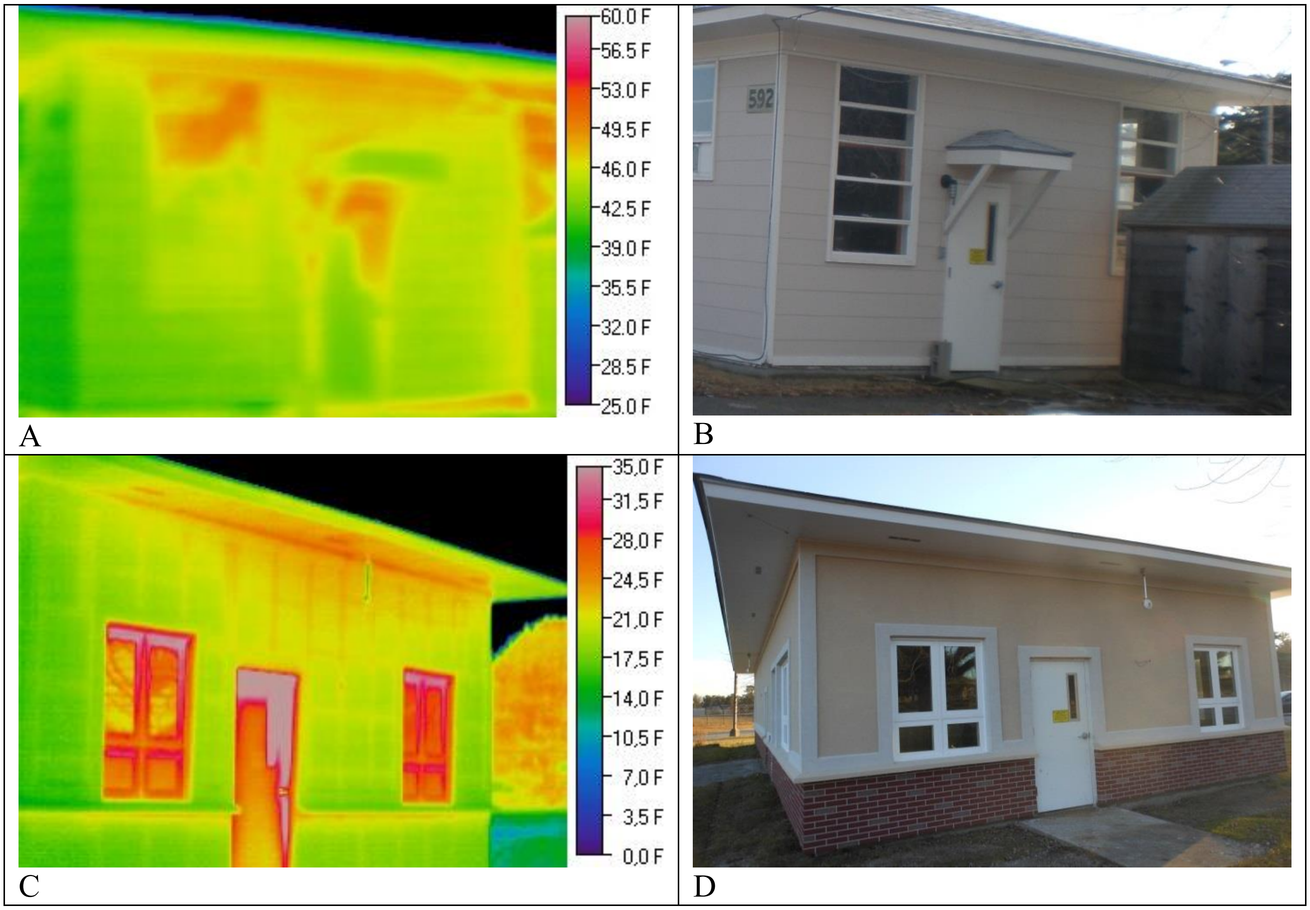


Figure 8: North Wall

Picture A: Heat loss is apparent from the intersection of wall and roof, from the window frames, and around the door. A small shed is present in the foreground at the right. Picture C: Door and window frames expose higher energy losses. The wall-roof intersection thermal bridging effect is still visible.

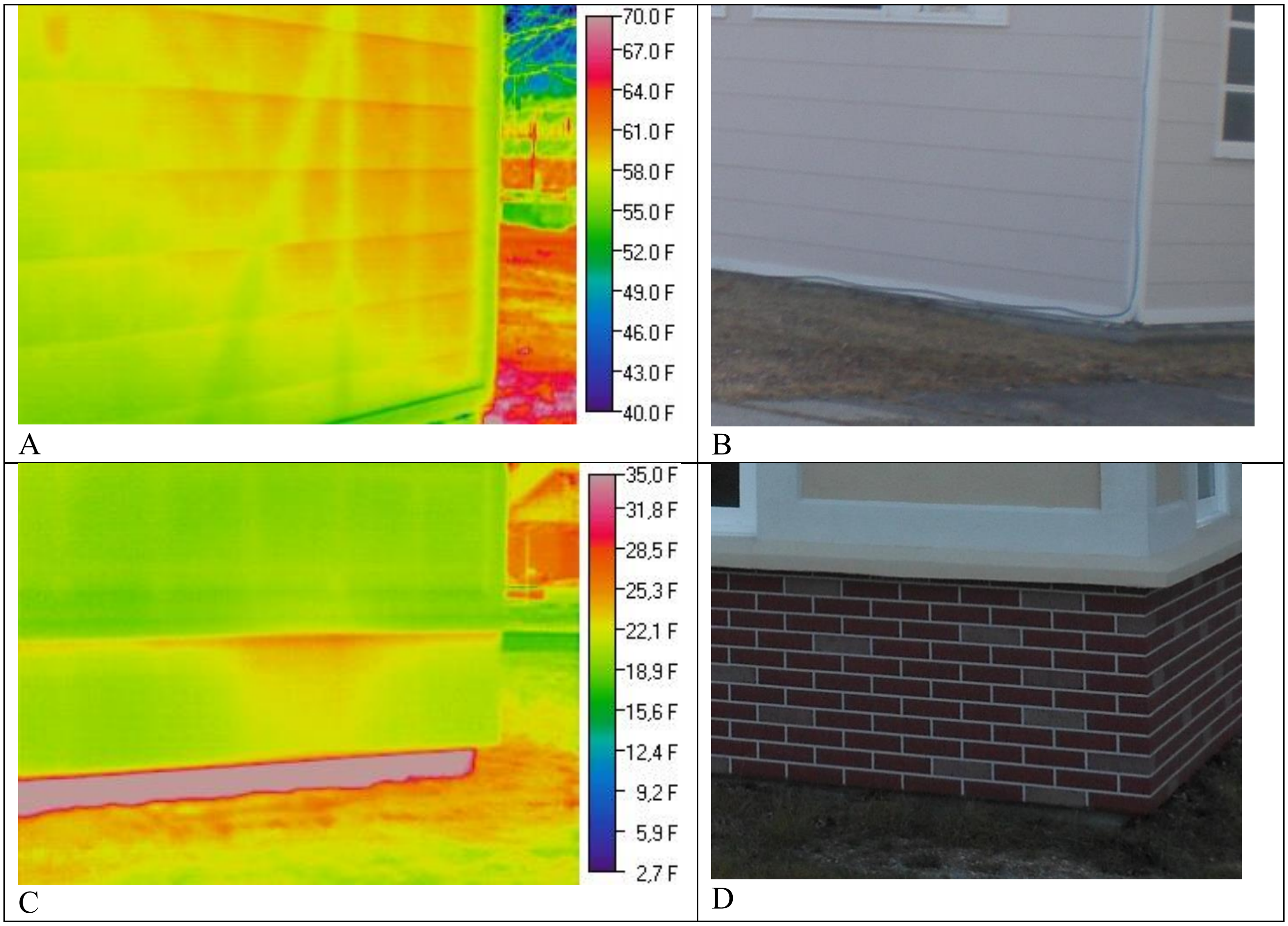


Figure 9: South-West Wall Corner

Picture A: This image was taken at early morning after keeping the interior at a raised temperature throughout the night. The bracing and wall studs are clearly seen. The effects of the sun are minimal, because the western wall is currently shaded. Picture C: Performance of the wall corner was improved – surface temperatures are even. Slab showing high energy loses.

4.3 Discussion

Thermographic images taken before the renovation clearly show the wooden structure of the building. The heat loss seems to be consistent throughout most of the façade, except for a small portion of the east wall. High heat loss is present at the intersection of the wall and roof. The high heat loss is likely unavoidable due to thermal bridging from the roof framing resting on the wall's top plates as well as air leakage due to this connection. Horizontal air leakage is present from the shingles around the entire building. The original single-glazed windows also contribute to the additional losses. Losses from the concrete slab can be attributed to thermal mass effects rather than conductive losses. Concerete thermal mass effect is due to concerete's high capacity to store heat during high solar radition and to release it gradually at a later time. Therefore, the high concrete slab temperature in IR image is mostly due to concrete gradual heat release rather than conduction losses. The thermographic study conducted after the building retrofit shows improvement in wall insulation, as the wooden structure is no longer visible. However, thermal bridging on VIP connection can be seen, which is caused by panel construction and spaces between panels being filled with EPS and foil. The study also shows that the wall-roof intersection and slab expose yields higher temperatures, thus causing thermal losses. Also, improvement of air leakage can be seen on walls.

The study focuses on identifying temperature difference between elements to describe thermal bridges, rather than taking actual temperature readings. The surface tempearatures of the images before and after renovations should not be compared.

5 Building Air Leakage Analysis (Pre- and Post-Retrofit Stages)

5.1 Task Scope

A series of blower door testings were conducted to estimate the airtightness of the Brunswick building both before and after the retrofit. In a typical blower door test, a building is depressurized with reference to the outside environment using a powerful, calibrated fan that is sealed into an exterior door. The depressurization causes outside air to infiltrate through the cracks and holes on the exterior envelope. The air leakage through the building envelope is characterized by measuring the air flow through the fan as a function of the pressure difference across the fan.

5.2 Pre-Retrofit Blower Door Test

Before the retrofit, a Minneapolis Blower Door™ system was used to measure the airtightness of the building with and without covering the windows. A series of pressure difference values between −60 to −15 Pa were generated by the fan and corresponding building air leakage was measured. A TECTITE software was used to control the fan and pressure gauge, collect the data and analyze the test results.

5.2.1 Discussion

Figure 10 shows the details of the blower door tests that were performed. First, the building was tested before any modifications. Figure 11 shows the building leakage as a function of building pressure for the building. Two separate tests were performed, and the test results are provided in Table 4. The average Air Changes Per Hour (ACH) from the two tests is determined to be 11.74 (building volume is 20214 ft^3). Next, all eight windows were covered and tightly sealed to the surrounding frame to investigate the effect of windows on the overall air leakage. The test results are shown in Figure 12 and Table 5. The average ACH from the two tests is determined to be 10.90. The test results suggest that although sealing off the windows improved the airtightness of the building, the air leakage through the windows only has a marginal impact on the overall ACH of the building. The large values of ACH and leakage areas also indicate that this building has a large number of pathways for air leakage through the building envelope.

(a) (b)

Figure 10: Blower door test at Brunswick building. (a) Blower door setup: a fan is temporarily installed on the exterior door that drives the air outside the building. Pressure difference across the fan is measured using a manometer with two channels to measure inside and outside temperature separately. A computer is used to control the fan speed and pressure, and for data acquisistion purpose. (b) All eight windows in the building are covered and sealed off with plastic sheets.

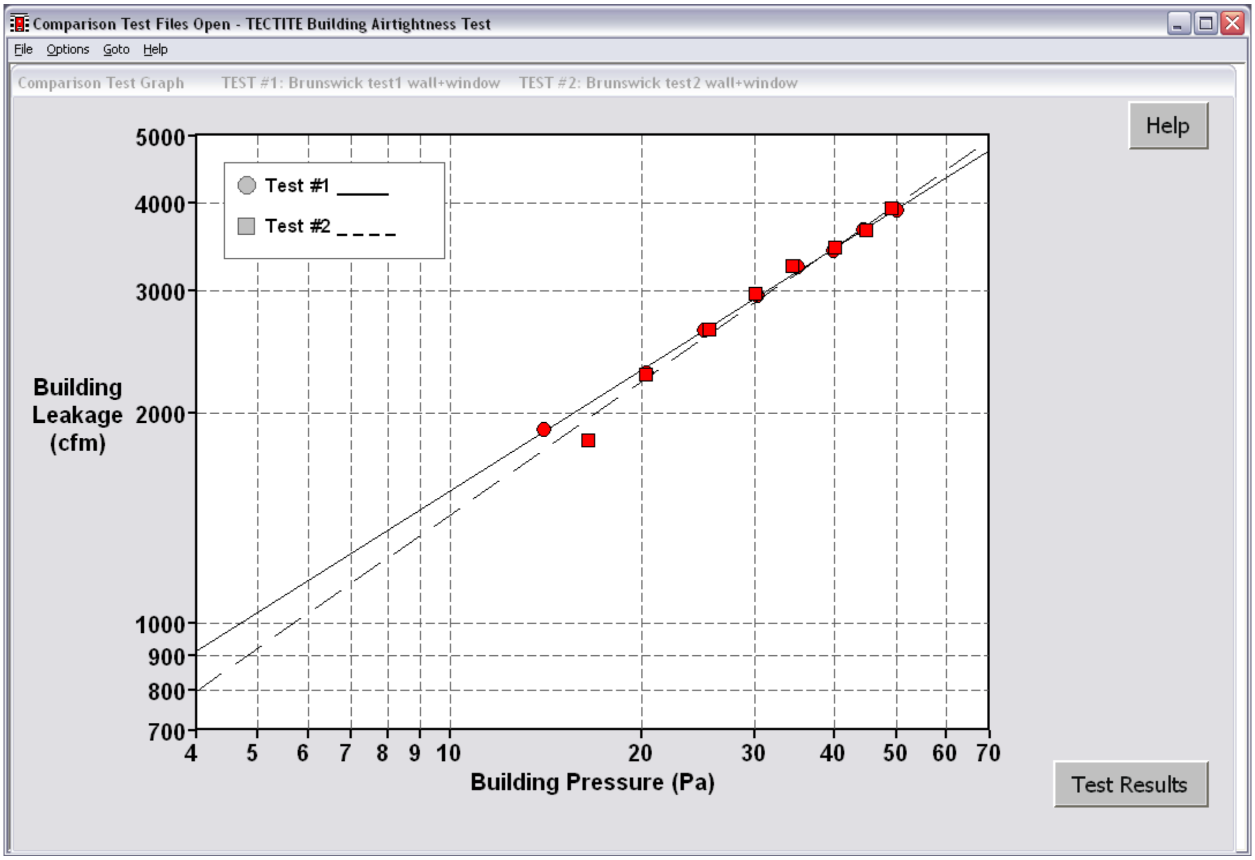


Figure 11: Blower door test data for the Brunswick building. Two tests were performed to measure building air leakage as a function of the building pressure. The two tests show very good repeatability except for the lowest pressure reading.

Table 4: Blower door test results for the Brunswick building.

	Test1	Test2
Airflow @50 Pa (cfm)	3922	3986
ACH	11.64	11.83
Leakage area		
Canadian EqLA@10 Pa (in^2)	455.3	420.8
LBL ELA@4Pa (in^2)	258.9	226.6
Building leakage curve		
Flow coefficient (C)	410.3	330.9
Exponent (n)	0.577	0.636
Correlation coefficient	0.99899	0.99276

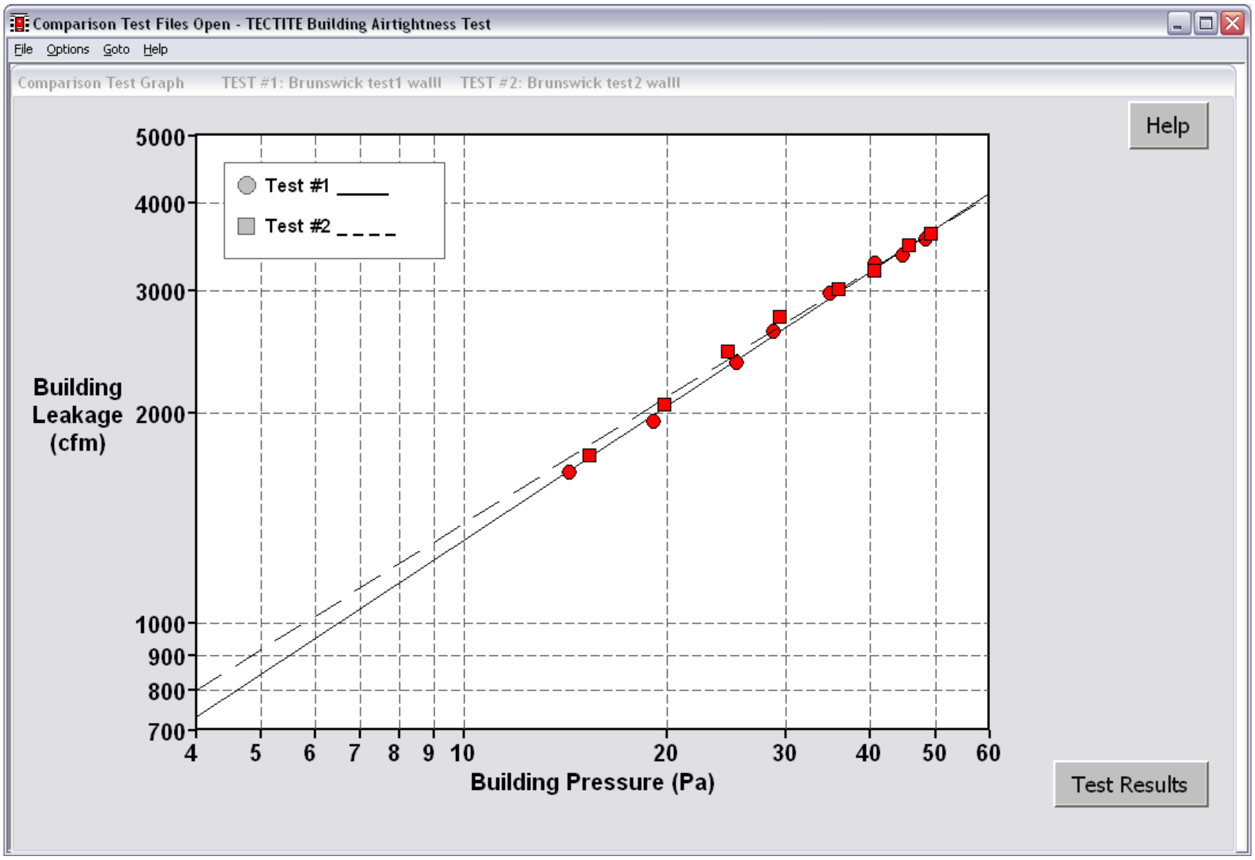


Figure 12: Blower door test data for the Brunswick building when the windows were tightly sealed off with plastic sheets. Two tests were performed to measure building air leakage as a function of the building pressure. The two tests show very good repeatability for the entire range of building pressures considered in the experiments.

Table 5: Blower door test results for the Brunswick building for the case where building windows are completely sealed off with plastic sheets

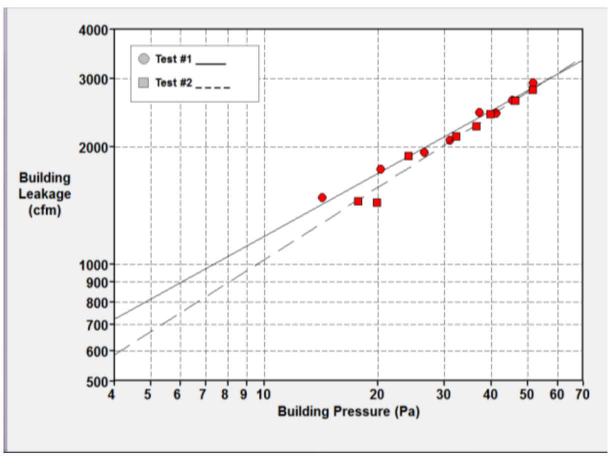
	Test1	Test2
Airflow @50 Pa (cfm)	3681	3664
ACH	10.93	10.87
Leakage area		
Canadian EqLA@10 (in^2)	387.6	408.4
LBL ELA@4Pa (in^2)	208.4	226.8
Building leakage curve		
Flow coefficient (C)	303.7	330.9
Exponent (n)	0.638	0.636
Correlation coefficient	0.99766	0.99636

5.3 Post-Retrofit Blower Door Test

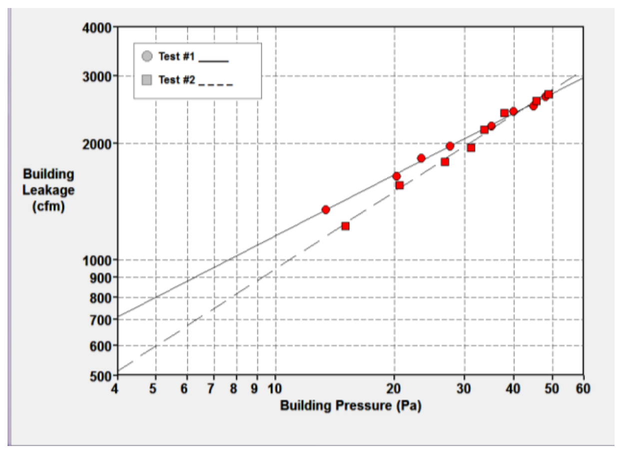
Two series of blower door air leakage test were performtmed after building renovation; once in Fall conditions and a second in early Winter conditions.

5.3.1 Fall Air Leakage Test

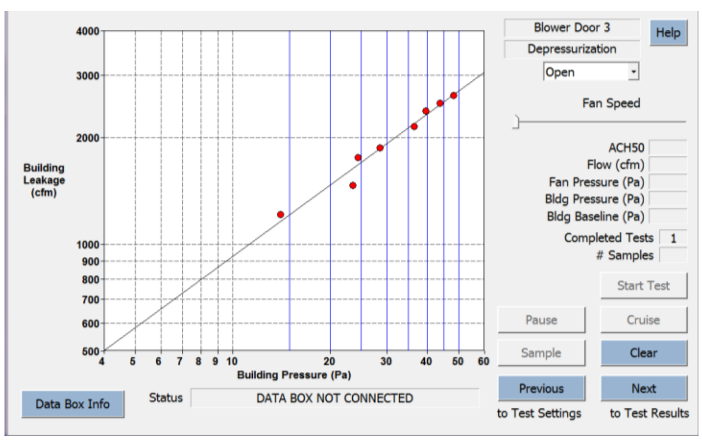
In this testing, two sets of measurements were performed: (i) building with untaped window, and (ii) building with taped window. The purpose of the second test was to estimate the air sealing effect of the new windows. Five separate test runs were conducted. Figure 13 and Table 6 show the building leakage as a function of building pressure for the Brunswick building without taping window. The average ACH @ 50 Pa from the five tests is determined to be 8.15. Next, all seven windows in the building were covered and tightly sealed off to investigate the effect of windows on the overall air leakage. The test results are provided in Figure 14 and Table 7. The average ACH @ 50 Pa from the two tests is determined to be 8.13. These results suggest that sealing off the windows has an insignificant effect on the air infiltration rate. The above results were compared to the corresponding tests performed before renovation.



A



B



C

Figure 13: Blower door test data for the Brunswick building performed on September 19th, 2012. Five tests were performed to measure building air leakage as a function of the building pressure. Figure A shows tests 1 and 2; B shows tests 3 and 4; and C shows test 5. The five tests show very good repeatability except for the lowest pressure reading.

Table 6: Blower door test results for the Brunswick building after renovations were completed

	Test1	Test2	Test3	Test4	Test5
Airflow @50 Pa (cfm)	2800	2762	2695	2757	2714
ACH	8.31	8.20	8.10	8.18	8.05
Leakage area					
Canadian EqLA@10 (in^2)	347.3	301.8	339.5	278.4	272.7
LBL ELA@4Pa (in^2)	205.0	165.8	202.2	146.2	142.8
Building leakage curve					
Flow coefficient (C)	343.9	249.4	343.8	205.4	199.9
Exponent (n)	0.536	0.615	0.526	0.664	0.667
Correlation coefficient	0.98918	0.98822	0.99830	0.99288	0.98587

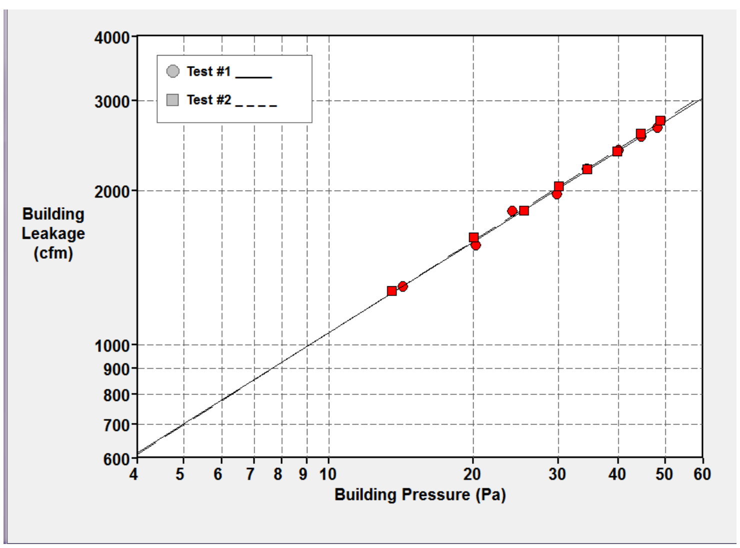


Figure 14: Blower door test data for the Brunswick building when the windows were tightly sealed off with plastic sheets. Two tests were performed to measure building air leakage as a function of the building pressure. The two tests show very good repeatability for the entire range of building pressures considered in the experiments.

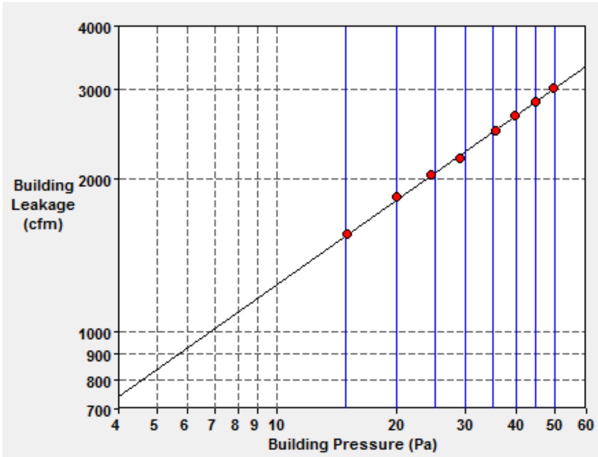
Table 7: Blower door test results for the Brunswick building for the case where building windows are completely sealed off with plastic sheets

	Test1	Test2
Airflow @50 Pa (cfm)	2727	2752
ACH	8.09	8.17
Leakage area		
Canadian EqLA@10 Pa (in^2)	310.8	310.4
LBL ELA@4Pa (in^2)	174.8	173.5
Building leakage curve		
Flow coefficient (C)	272.6	268.2
Exponent (n)	0.589	0.595
Correlation coefficient	0.99775	0.99938

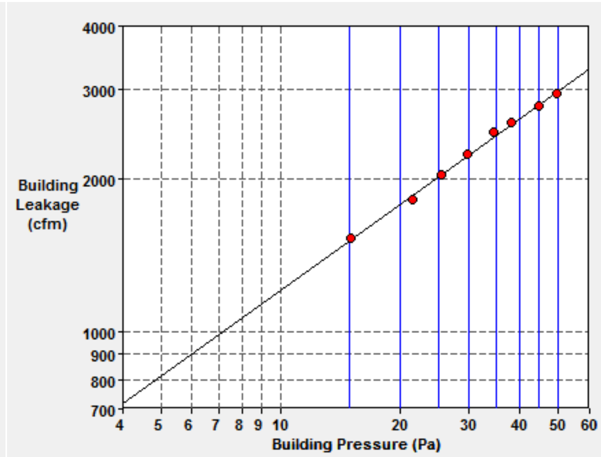
5.3.2 Early Winter Air Leakage Test

In addition, three separate blower door test runs were conducted on December 12, 2012 between 12:00-3:00 PM (see Figure 15). Figure 16 and Table 8 show the building leakage as a function of building pressure for the Brunswick building. The average ACH50 from the three tests was determined to be 8.96.

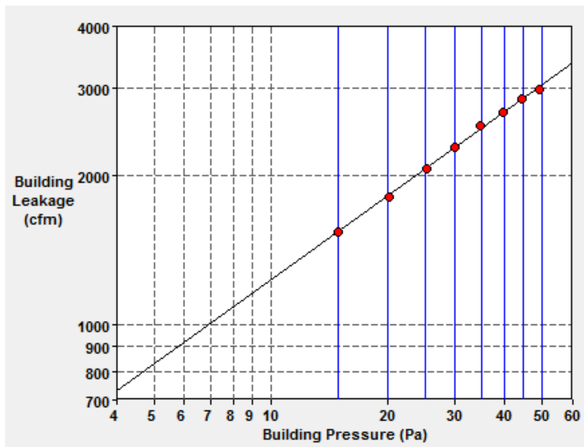
Figure 15: Blower door experimental setup at the Brunswick site performed on December 12, 2012. A blower fan is installed on the exterior door. The fan can generate pressure differences as high as 60 Pa. A computer is used to control the fan and data acquisition.



A



B



C

Figure 16: Blower door test data for the retrofitted Brunswick building during winter season. Three tests A, B and C were performed on December 12, 2012 to measure the building air leakage as a function of the building pressure. The three tests show very good repeatability and power law between building pressure and air leakage flow rate.

Table 8: Blower door test results for the retrofitted Brunswick building during winter season

	Test1	Test2	Test3
Airflow @50 Pa (cfm)	3023	2988	3049
ACH	8.97	8.87	9.05
Leakage area			
Canadian EqLA@10 (in^2)	363.8	354.6	361.3
LBL ELA@4Pa (in^2)	211.1	201.1	207.8
Building leakage curve			
Flow coefficient (C)	345	329.7	335.2
Exponent (n)	0.555	0.563	0.564
Correlation coefficient	0.99941	0.99819	0.99859

5.3.3 Discussion

An early winter air leakage test shows an increase of ~10% in ACH @ 50 Pa compared to the value that was measured in Fall immediately after the retrofit work and suggests that either the settling of the retrofit elements or the stack effect caused by the colder season (or a combination of both) is resulting in a higher leakage area in the building envelope (such as voids and cracks). On the other hand, the retrofit helped improve the overall airtightness of the building by 23% after retrofit was performed (from 11.74 to 8.96 ACH @ 50 Pa).

6 Instrumentation Design and Installation

6.1 Task Scope

Installation of instrumentation was completed on July 11th. The test building was instrumented to measure the energy performance of post-retrofitted walls and to evaluate the hygrothermal performance of wall assemblies. The sensors were imbedded in all four walls to measure temperature and heat flux. Instrumentation in the west wall and north wall additionally capture moisture contents of exterior sheathing. The west wall was instrumented more extensively than the other three walls. As shown in Figure 17-a, the temperature gradient across the retrofitted wall is measured using thermistors T1 to T7. Moisture pins MC1 and MC2 measure moisture content of the wood planks and plywood which act as exterior sheathing. Relative humidity and temperatures in the wall cavity are measured by a Hobo™ and the heat flux through the wall is recorded using a heat flux transducer HF1.

Figure 17-b illustrates the location of the sensors on the north wall. Temperature gradient and the moisture contents on the plywood and wood planks are measure by T1 to T3, Hobo^{TM}, and MC1& MC2. HF1 records the heat flux on the gypsum board.

On the other two walls (East and South) just the exterior, interior and cavity temperatures are measured, and a heat flux transducer measures incoming/outgoing heat flux (see Figure 18).

Thermistors were bonded to surfaces using epoxy resin to measure surface temperatures. The temperature sensors used for this experiment were 10K Ohm thermistors. The thermistors were acquired as leaded elements that were soldered to lengths of shielded twisted-pair two-conductor cables, and the tips were encapsulated with thermally conductive epoxy (Resinlab EP1200). The completed assembly was then calibrated using a Fluke 9171 Metrology Well and a Keithley 2700 Digital MultiMeter through seven temperature points.

The heat flux transducers are F series transducers by Concept Engineering. The heat flux sensors were calibrated between two pieces of gypsum in a Laser Comp Fox 304 heat flow meter. For each HF transducer, seven different temperature gradients were established across the heat flow meter. Once the systems reached equilibrium, the heat flow was measured by the meter, and the voltage was measured with a USB-TEMP 24-bit data acquisition unit (Measurement Computing). A linear relationship was determined, and a heat flux coefficient was generated.

Solar radiation intensity on all four orientations is measured using four distinct pyranometers (see Figure 19). The pyranometers are CMP6 and first class type from Kipp & Zonen.

A weather station (HOBO U30 Onset) was installed on a nearby light pole to measure outdoor thermal conditions. The weather station recorders wind speed and direction, rain fall, temperature, humidity and global radiation (Figure 19).

Each wall heat flux transducer was first installed on a 1’x1’ gypsum board panel, and then placed on the ceiling gypsum board. Shallow grooves were cut into the 1’x1’ gypsum panels to place the heat flow transducer and the wires to keep a flat contact surface between two gypsum boards without any air gap. After the grooves were cut the sensors were secured with epoxy. This method allowed good contact without damaging interior finishes of the building. The location of the heat flow transducers was close to the thermistor array.

The data acquisition units utilized were Campbell Scientific CR-1000, and were linked to the cellular modem (Ravan XT) to wirelessly transfer the recorded data (see Figure 20).

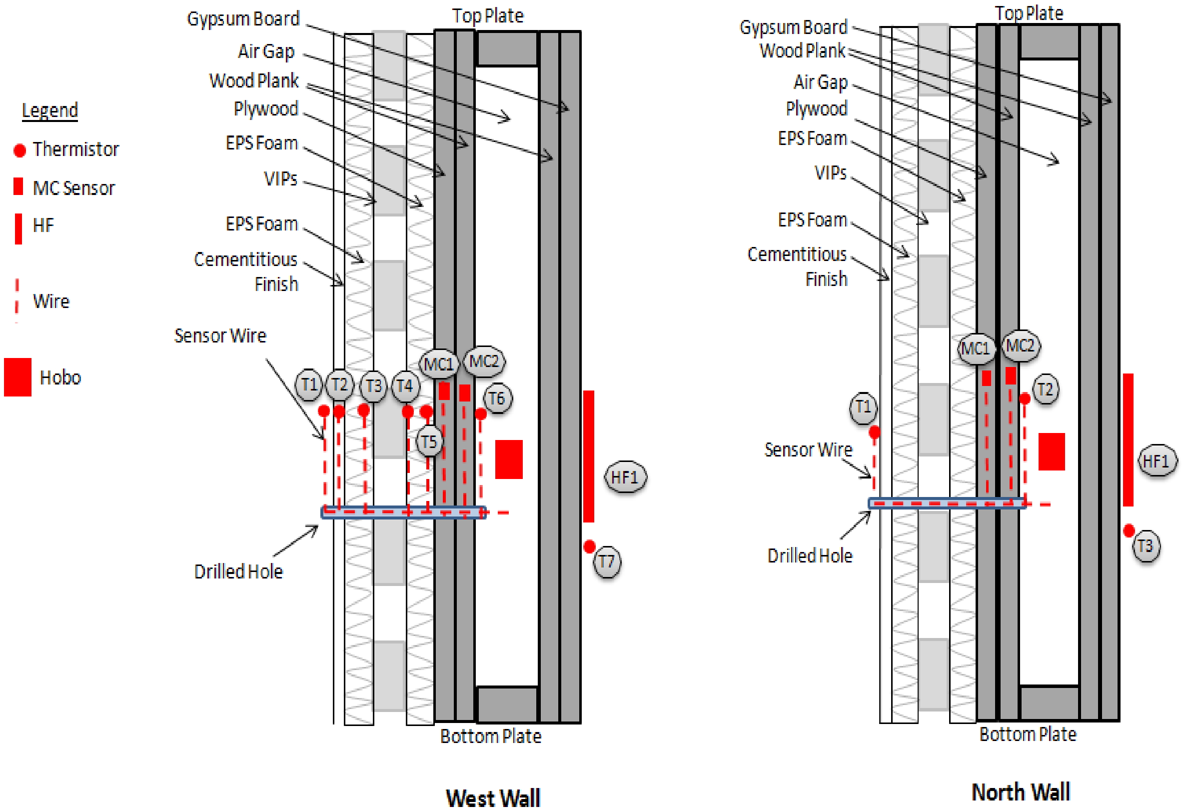


Figure 17: a) Section view of west wall sensor location, b) Section view of north wall sensor location

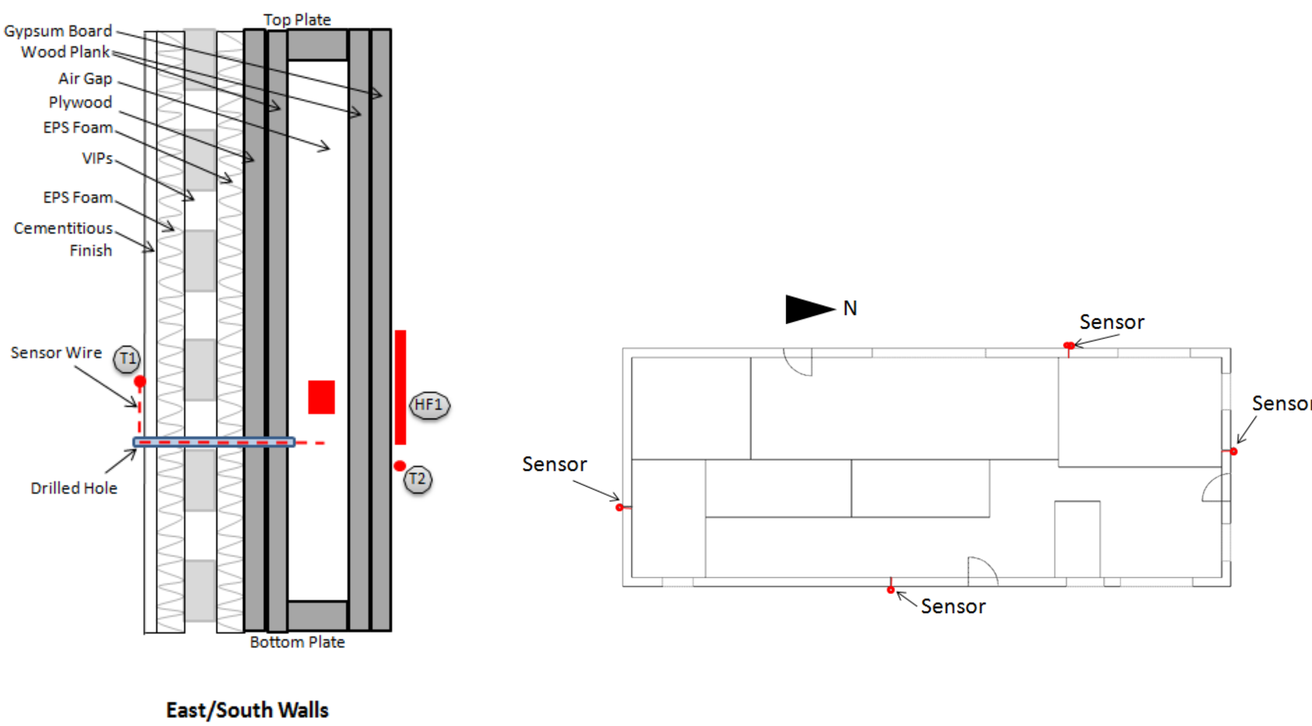


Figure 18: a) Section view of east/south wall sensor location, b) Plan view of sensor location

Figure 19: Pyronometer and weather station (top); Installed sensors in the west wall cavity and on the façade (bottom)

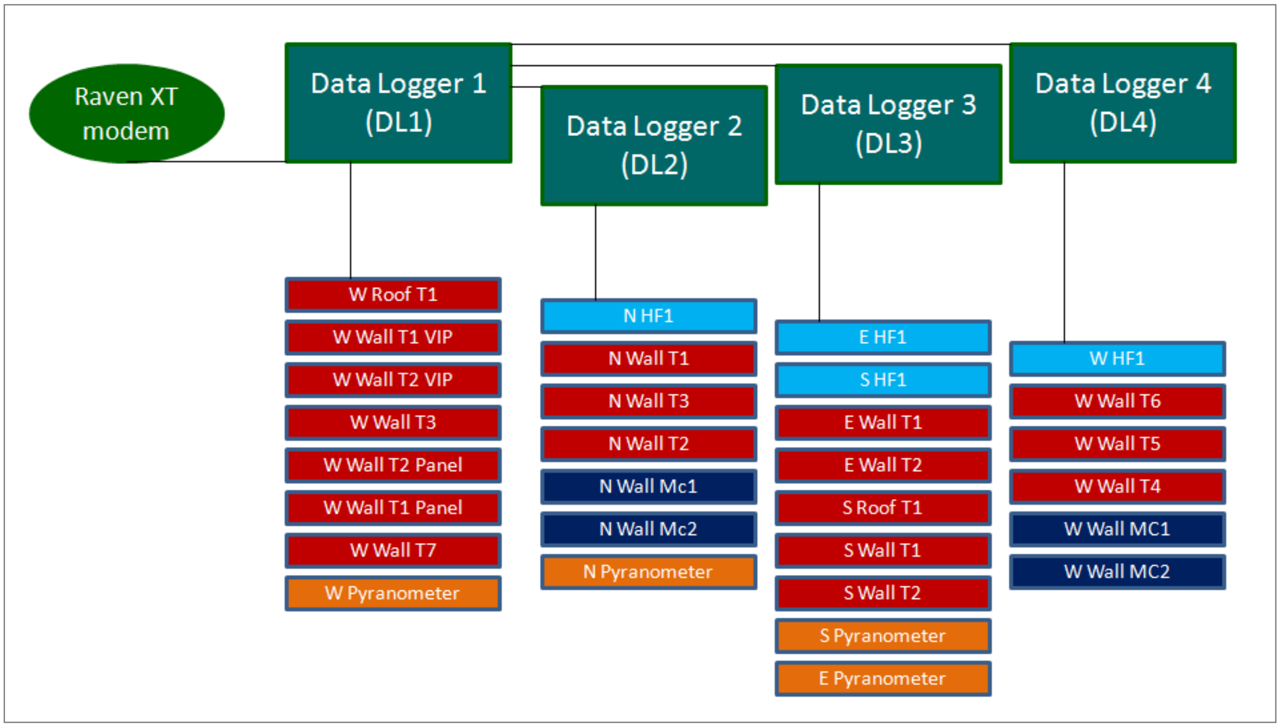


Figure 20: Schematics of DAQ system

7 Hygrothermal Model

7.1 Model Description

A hygrothermal model was developed using WUFI Pro 5.2 software to numerically evaluate the risk of moisture accumulation in the retrofitted wall of the Brunswick building. The developed model is a transient, one-dimensional heat and moisture transfer model capable of assessing the hygrothermal behavior of the wall assembly under actual climatic conditions found at the site of the building in Brunswick, ME during the field data collections. Both west and north walls were modeled hygrothermally and the results were compared with the measured data.

The initial WUFI model was developed by SmithGroup; however, that model required some corrections such as hygrothermal property and material layer thickness corrections and boundary condition adjustments which were performed by Fraunhofer CSE. The corrections were based on best available data at the time of writing this final report. Minor differences may be present between the corrected model by Fraunhofer and the actual material properties in the retrofitted wall.

7.2 Modeled Scenarios

Two models (A & B) were developed using WUFI software to evaluate the risk of moisture accumulation on the exterior sheathing of the wall assembly. The models represent the extreme moisture transfer scenarios in the wall assembly of the Brunswick building. One model predicts moisture accumulations in the exterior sheating when the moisture path is through fume silica VIP core as illustrated in Figure 21- Model A, and the other model when the moisture path is through EPS edge of the VIP sandwich as illustrated in Figure 21- Model B. Model A represents the majority of transfer path and model B is a minor moisture transfer path. In model B the ratio of the air gap on layer 2 is less than 0.02% of total wood plank surface area and the ratio of EPS edge on layer 9 is less than 8% of total encapsulated VIP area. The predictions of these two models establish an upper and a lower thresholds for moisture accumulation risk on the exterior sheathing of the wall assembly.

7.3 Model parameters and assumptions

Hygrothermal properties of modeled wall assemblies are listed in Table 9. Due to one dimensional model limitations, the layers (as shown in Figure 21) were assumed to be homogeneous and continuous and ignores the existence of air gap on the plane of wood planks (layers 2 & 4), studs on the plane of air gap (layer 3), adhesives on the plane of EPS (layers 8 & 12), the EPS protecting edge on the plane of fume silica core (layer 10) and the reinforcing mesh on the plane of cementitious basecoat (layer 13). Due to complexity of heat and hygrothermal processes on the edge of VIP sandwiches a two dimensional hygrothermal model is suggested to more accurately capture all these heat and moisture flow details. During retrofit stage and after replacement of the single glazed windows with the highly efficient ones, the intersection of window and wall was left open from inside. The opening caused unintentional air flow from indoor to the wall frame cavity. Although this airflow was very slight, it caused uncertainties both in measurements and in determining the right boundary conditions for WUFI model.

Table 9: Hygrothermal properties of wall materials used for WUFI modeling

Description	Thickness	Conductivity	Permeability	Source
Gypsum Board	½ inch	1.1 (Btu·in/h·ft^2·°F)	18.32 (perm-in)	WUFI database
Wood Plank	¾ inch	0.97 (Btu·in/h·ft^2·°F)	0.074 (perm-in)	WUFI database
2x6 Wood Frame Air Gap	5½ inch	6.0 (Btu·in/h·ft2·°F)	1431 (perm-in)	WUFI database
Air Gap	¾ inch	0.90 (Btu·in/h·ft2·°F)	0.0743 (perm-in)	WUFI database
Plywood	½ inch	0.58 (Btu·in/h·ft2·°F)	0.1195 (perm-in)	WUFI database
Vapor/Air retarder(Dryvit Backstop NT)	0.012 inch	negiligible	0.008 (perm-in)	Dryvit Excel sheet
Adhesive (Dryvit Genesis)	0.125 inch	negiligible	2.05 (perm-in)	Dryvit Excel sheet-average at MC-50%
EPS	½ inch, ½ inch	0.228 (Btu·in/h·ft^2·°F)	1.76 (perm-in)	Dryvit Excel sheet
Aluminum Foil	0.00047 inch	1111.1 (Btu·in/h·ft^2·°F)	2.2×10^{-5} (perm-in)	IEA-Annex39 report, Table 52 [average permeance taken as 2.72 (ng/Pa.s.m^2)]
Fume Silica VIP Core	1½ inch	0.025 (Btu·in/h·ft^2·°F)	10 (perm-in)	Dow Corning thermal conductivity and SmithGroup WUFI model
Cementitious Basecoat (Dryvit Genesis)	0.125 inch	negiligible	2.05 (perm-in)	Dryvit Excel sheet-average at MC-50%
Acrylic Finish (Dryvit)	0.125 inch	negiligible	2.40 (perm-in)	Dryvit Excel sheet-averaged at MC-50%

In the developed WUFI model, the outdoor climate condition came from a weather file data recorded during the course of field testing at the site of Brunswick, ME building. Similarly, the indoor temperature and RH were given to WUFI as a customized file from recorded HOBO data during the course of field testing at the site of the building.

Driving rain coefficients were set based on ASHRAE standard 160. The rain load calculation and the exterior surface heat transfer coefficients were wind dependent. Initial moisture content in different layers was assigned based on typical built-in material moisture at 68F. The calculation start up period was three years to establish an equilibrium state for moisture transfer.

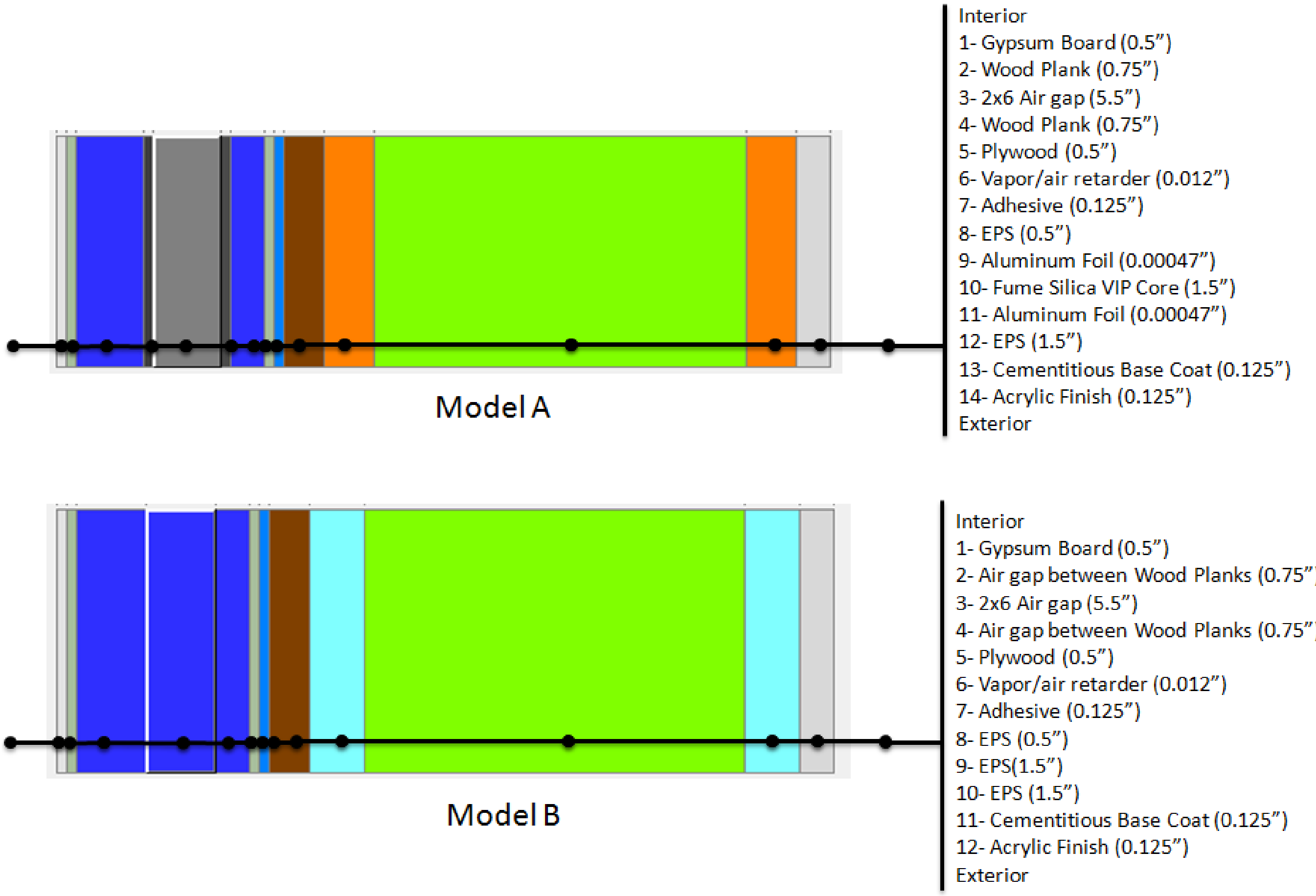


Figure 21: Modeled wall configurations in WUFI; Model A represents moisture transfer path through fume silica VIP core which is the major transport path and Model B represents a minor moisture transfer path which is through air gap between the wood planks and protective EPS edge instead of fume silica VIP core

7.4 Modeling Results

The modeling results of the two scenarios in WUFI, models A and B, representing two moisture paths through the wall assembly are shown in Figure 22. The moisture contents (by weight) are for north and west wall orientations for the plywood (layer 5) with a three year start-up period. As shown, the moisture content in none of the models exceeds 12%. Model B shows higher fluctuations of plywood moisture content; however, in model A, with the path through the VIP core, the moisture content variation is very mild over the year with maximum of 9%. Additionally, the north wall has slightly higher moisture content due to the north wall receiving less solar radiation intensity, which results in a lower surface temperature.

Figure 23 shows the modeled moisture content (by weight) of the wood plank and the plywood in WUFI (layers 4 & 5 in model A). The plotted results show that the moisture contents of neither wood plank nor plywood exceeds 10% (by weight) over time. Plywood which is adjacent to the vapor/air barrier layer has up to 2% higher moisture content than wood plank which is adjacent to the frame cavity. Figure 23 also compares the moisture content values of the WUFI model and the measurements. The modeled moisture content of the plywood by WUFI is close to measured data. This agreement is less seen in the case of plank wood and WUFI prediction seems to underestimate the moisture content. The error could be due to ignoring the air gaps between wood planks in model A and other assumption discussed in section 7.3.

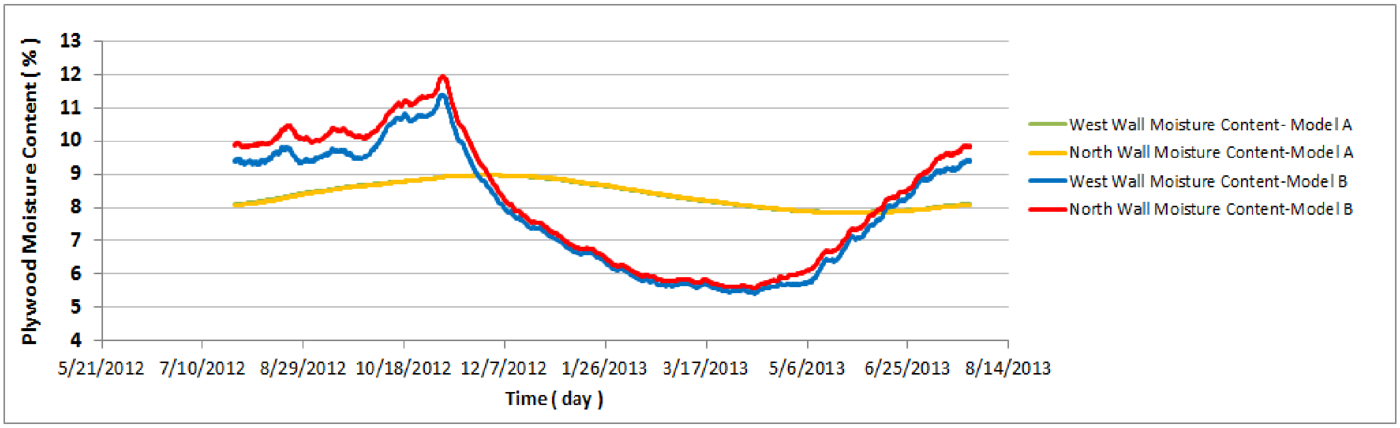


Figure 22: Modeled moisture contents of plywood by WUFI for the north and west walls of the Brunswick building. Moisture contents of the west and north walls in model A coincide (moisture content of north and west walls in Model A coincides)

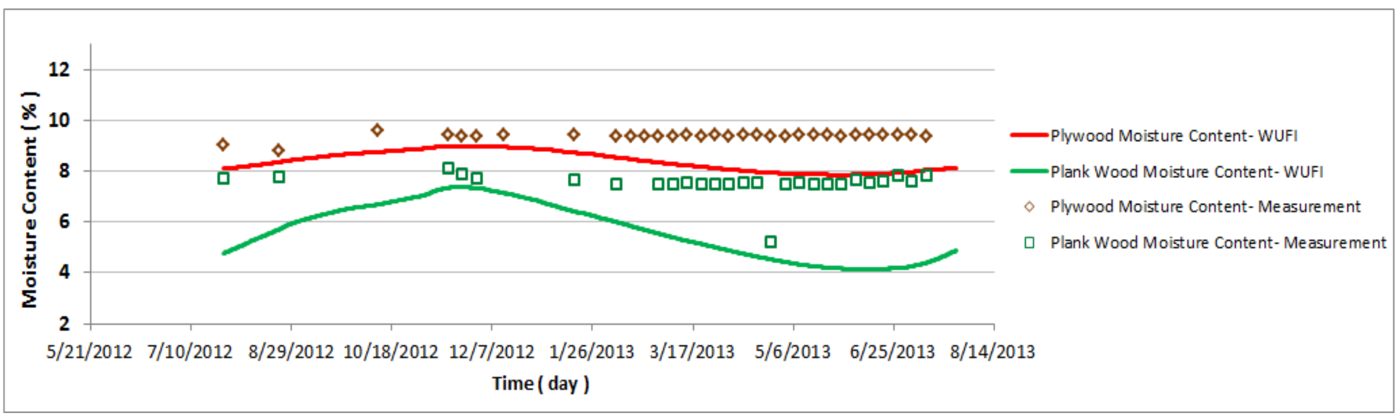


Figure 23: Modeled and measured moisture contents of north wall in Brunswick building

7.5 Discussion

Based on WUFI modeling results and the measurements, the risk of moisture accumulation in the VIP based EIFS of retrofitted wall in Brunswick building is low and moisture contents of plank wood and plywood remain below 12% and don't reach the critical threshold for wood deteriorations. The WUFI model was one dimensional and conservative scenarios were considered, but a two dimensional model would be able to better capture the actual moisture transfer through the wall assembly. Careful air and moisture sealing of the interior surface of the walls is recommended in the final stage of the building retrofit.

8 Energy Model

The energy modeling of the Brunswick building was performed by Fraunhofer CSE as a part of a report prepared for Oak Ridge National Lab (Fallahi et al, 2013). According to this report, to evaluate the energy performance of the VIP-based EIFS in conjunction with high efficient windows, an energy model was developed using EnergyPlus software which predicts gas consumption of the Brunswick building. The developed energy model was first calibrated against historical gas bill both from pre-retrofit (2008 and 2009) and post-retrofit (2012-13) stages and a good agreement between the two was found. Then, for performance comparisons, few different retrofit scenarios were modeled and compared. Annual gas consumption savings of retrofitted cases varies from 16% with installing just energy efficient windows to 49% with installing energy efficient windows and the VIP-based EIFS. The model also predicts additional annual gas consumption savings up to 70% when the retrofit strategies such as energy efficient windows and the VIP-based EIFS in Brunswick building are combined with improved air tightness strategies (Fallahi et al, 2013).

9 Conclusion

Thermographic images taken before the renovation clearly show the wooden structure of the building. High heat loss is present at the intersection of the wall and roof and air leakage is present from the shingles around the entire building. The original single-glazed windows also contribute to the additional losses. Losses from the concrete slab can be attributed to thermal mass effects rather than conductive losses. The thermographic study conducted after the building retrofit shows improvement in wall insulation, as the wooden structure is no longer visible. However, thermal bridging on VIP connection can be seen, which is caused by panel construction and spaces between panels being filled with EPS and foil. The study also shows that the wall-roof intersection and slab expose yields higher temperatures, thus causing thermal losses.

Improvement of air leakage was shown on the walls. Inference the Air Changes Per Hour (ACH) @ 50 Pa before the retrofit and immediately after the retrofit was measured to be 11.64 (section 5.2) and 8.96 (section 5.3.1), respectively. The retrofit helped improve the overall airtightness of the building by 23% after retrofit was performed.

The test building was instrumented to measure the energy performance of post-retrofitted walls and to evaluate the hygrothermal performance of wall assemblies. The sensors were imbedded in all four walls to measure temperature and heat flux. Instrumentation in the West wall and North wall additionally capture moisture contents of exterior sheathing.

Based on WUFI modeling results and the measurements, the risk of moisture accumulation in the VIP-based EIFS of the retrofitted wall in the Brunswick building is low and the moisture contents of the plank wood and plywood remain below 12% and don’t reach the critical threshold for wood deteriorations. The WUFI model was one dimensional and conservative scenarios were considered, but a two dimensional model would be able to better capture the actual moisture transfer through the wall assembly.

According to Fraunhofer CSE report prepared for Oak Ridge National Lab (Fallahi et al, 2013), an energy model of the Brunswick building using EnergyPlus software was developed to evaluate the energy performance of the VIP-based EIFS in conjunction with high efficient windows. Based on the developed model, annual gas consumption savings of 49% are achievable for retrofitted building with the energy efficient windows and the VIP-based EIFS compared to pre-retrofitted building with single glazed windows and asbestos-cement exterior siding. Additionally, the annual gas consumption savings can jump up to 70% if air tightness strategies are included in retrofit work.

References

ASHRAE Handbook of Fundamentals, 2009, Chapter 26

Fallahi, A. Misiopecki, C. Shukla, N. Watts, A., Kośny, J. 2013 "Window Testing in the VIP-Based EIFS Retrofitted Building - Brunswick, ME " Prepared for Oak Ridge National Laboratory (ORNL), Fraunhofer Center for Sustainable Energy Systems (CSE), Building Energy Efficiency Group, Boston

IEA/ECBCS Annex 39" High Performance Thermal Insulation Systems", http://www.ecbcs.org/annexes/annex39.htm

Architectural Testing

UNIFORM STATIC LOAD (ASTM E330) TEST REPORT

Report No.: C4306.01-550-44

Rendered to:

DRYVIT SYSTEMS, INC.
West Warwick, Rhode Island

PRODUCT TYPE: EIFS (wood studs)
SERIES/MODEL: VIP12PLY

Specimen	Uniform Static Load Test (Maximum/Ultimate Load)
1	-10.04 kPa (-209.72 psf)
2	-10.59 kPa (-221 psf)
3	-10.30 kPa (-215.02 psf)
4	+15.62 kPa (+326.04 psf)
5	+12.01 kPa (+250.64 psf)
6	+13.25 kPa (+276.64 psf)

Test Dates: 02/18/13
Through: 02/19/13
Report Date: 05/30/13
Test Record Retention End Date: 05/30/17

1701 Westfork Drive, Suite 106
Lithia Springs, Georgia 30122
phone: 770-941-6916
fax: 770-941-2930
www.archtest.com

1.0 Report Issued To: Dryvit Systems, Inc.
One Energy Way
West Warwick, Rhode Island 02893

2.0 Test Laboratory: Architectural Testing, Inc.
1701 Westfork Drive, Suite 105-106
Lithia Springs, Georgia 30122
(770) 941-6916

3.0 Project Summary:

3.1 Product Type: EIFS

3.2 Series/Model: VIP12PLY

3.3 Compliance Statement: Results obtained are tested values and were secured by using the designated test method(s). Test specimen description and results are reported herein.

3.4 Test Dates: 02/18/13 – 2/19/13

3.5 Test Record Retention End Date: All test records for this report will be retained until 05/30/17.

3.6 Test Location: Architectural Testing, Inc. test facility in Lithia Springs, Georgia

3.7 Test Sample Source: The test specimens were provided by the client. Representative samples of the test specimen(s) will be retained by Architectural Testing for a minimum of four years from the test completion date.

3.8 Drawing Reference: The test specimen drawings have been reviewed by Architectural Testing and are representative of the test specimen(s) reported herein. Test specimen construction was verified by Architectural Testing per the drawings located in Appendix A. Any deviations are documented herein or on the drawings.

3.9 List of Official Observers:

Name	Company
Beth Manteuffel	Dryvit Systems, Inc
Steve Altum	Dow Corning
Brent Doll	Dow Corning
Ian McKenzie	Architectural Testing, Inc.
José Colón	Architectural Testing, Inc.

4.0 Test Method(s):

ASTM E 330-02, *Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.*

5.0 Test Specimen Description:

5.1 Product Sizes:

Test Specimen #1 – 6:

Overall size	Width		Height	
	millimeters	**inches**	**millimeters**	**inches**
	1219	48	2438	96

The following descriptions apply to all specimens.

5.2 Frame and EIFS Components:

Name	Overall Cross Section	Description
Wood Stud Frame	2" x 4" Wood Studs	Wood stud wall frame with studs at 16" o.c.
Interior Sheathing	½" x 48" x 96"	ASTM C1396 Gypsum Wall Board
Exterior Sheathing	½" x 48" x 96"	APA Exposure 1 Plywood
Air/Water Resistant Barrier	n/a	Dryvit Backstop® NT
Adhesive	1/8" thick vertical ribbons	Dryvit Primus® Mixture (Note 1)
EPS VIP Panel	2-3/4" x 48" x 96"	VIP Panel Encapsulated in EPS Insulation Board
Base Coat	1/8" thick	Dryvit Primus® Mixture (Note 1)
Reinforcing Mesh	4.3 oz/yd^2	Dryvit Fiberglass Reinforcing Mesh
Finish	n/a	Dryvit Finish

Note 1: Mixed one-to-one by weight with Portland cement.

6.0 Installation:

The specimen was installed into a wood buck. The rough opening allowed for a 1/4" shim space.

Location	Anchor Description	Anchor Location
Wood Stud Frame	#10 x 2-1/2" deck screws	End Connections
Exterior Sheathing to Wood Studs	#6 x 1-1/4" self-drilling screws	6" o.c.

7.0 Test Results:

The temperature during testing was 18.8°C (66°F). The results are tabulated as follows:

Test Specimen #1:

Loads	Deflection @ Geometric Center	Permanent Set @ Geometric Center	Status
-718.5 Pa (-15 psf)	1.93mm (0.08")	0.30mm (0.01")	OK
-1.44 kPa (-30 psf)	4.83mm (0.19")	0.94mm (0.04")	OK
-2.16 kPa (-45 psf)	8.36mm (0.33")	1.70mm (0.07")	OK
-2.87 kPa (-60 psf)	12.50mm (0.49")	2.46mm (0.10")	OK
-3.59 kPa (-75 psf)	17.35mm (0.68")	3.63mm (0.14")	OK
-4.31 kPa (-90 psf)	22.28mm (0.88")	4.93mm (0.19")	OK
-10.04 kPa (-209.72 psf)	--	--	FAILURE LOAD

NOTES: *The screws attaching the unit to the test frame sheared.*

Test Specimen #2:

Loads	Deflection @ Geometric Center	Permanent Set @ Geometric Center	Status
-718.5 Pa (-15 psf)	2.46mm (0.10")	0.33mm (0.01")	OK
-1.44 kPa (-30 psf)	4.88mm (0.19")	0.66mm (0.03")	OK
-2.16 kPa (-45 psf)	8.03mm (0.32")	0.97mm (0.04")	OK
-2.87 kPa (-60 psf)	11.38mm (0.45")	1.19mm (0.05")	OK
-3.59 kPa (-75 psf)	14.88mm (0.59")	1.50mm (0.06")	OK
-4.31 kPa (-90 psf)	18.85mm (0.74")	1.93mm (0.08")	OK
-10.59 kPa (-221 psf)	--	--	MAXIMUM LOAD

NOTES: *We were not able to load the unit to a higher load. The face of the panel is bowed. There is separation between the EPS VIP Panel and the sheathing.*

Test Specimen #3:

Loads	Deflection @ Geometric Center	Permanent Set @ Geometric Center	Status
-718.5 Pa (-15 psf)	2.34mm (0.09")	0.31mm(0.01")	OK
-1.44 kPa (-30 psf)	5.10mm (0.20")	0.58mm (0.02")	OK
-2.16 kPa (-45 psf)	8.00mm (0.20")	0.86mm (0.03")	OK
-2.87 kPa (-60 psf)	11.35mm (0.45")	1.24mm (0.05")	OK
-3.59 kPa (-75 psf)	14.81mm (0.58")	1.63mm (0.06")	OK
-4.31 kPa (-90 psf)	18.11mm (0.71")	1.70mm (0.07")	OK
-10.30 kPa (-215.02 psf)	--	--	MAXIMUM LOAD

NOTES: *We were not able to load the unit to a higher load.*

Test Specimen #4:

Loads	Deflection @ Geometric Center	Permanent Set @ Geometric Center	Status
+718.5 Pa (+15 psf)	1.37mm (0.05")	0.20mm (0.01")	OK
+1.44 kPa (+30 psf)	2.97mm (0.12")	0.41mm (0.02"0	OK
+2.16 kPa (+45 psf)	4.77mm (0.19")	0.66mm (0.03")	OK
+2.87 kPa (+60 psf)	6.76mm (0.27")	1.04mm (0.04")	OK
+3.59 kPa (+75 psf)	8.69mm (0.34")	1.32mm (0.05")	OK
+4.31 kPa (+90 psf)	10.87mm (0.43")	1.63mm (0.06")	OK
+15.62 kPa (+326.04 psf)	--	--	FAILURE LOAD

NOTES: *The right jamb wood stud broke..*

Test Specimen #5:

Loads	Deflection @ Geometric Center	Permanent Set @ Geometric Center	Status
+718.5 Pa (+15 psf)	1.37mm (0.05")	0.25mm (0.01")	OK
+1.44 kPa (+30 psf)	4.93mm (0.19")	1.88mm (0.07")	OK
+2.16 kPa (+45 psf)	10.39mm (0.41")	3.53mm (0.14")	OK
+2.87 kPa (+60 psf)	12.92mm (0.51")	4.17mm (0.16")	OK
+3.59 kPa (+75 psf)	17.63mm (0.69")	5.03mm (0.20")	OK
+4.31 kPa (+90 psf)	20.88mm (0.82")	6.48mm (0.26")	OK
+12.01 kPa (+250.64 psf)	--	--	FAILURE LOAD

NOTES: *The screws attaching the unit to the test frame sheared.*

Test Specimen #6:

Loads	Deflection @ Geometric Center	Permanent Set @ Geometric Center	Status
+718.5 Pa (+15 psf)	1.37mm (0.05")	0.30mm (0.01")	OK
+1.44 kPa (+30 psf)	3.25mm (0.13")	0.69mm (0.03")	OK
+2.16 kPa (+45 psf)	5.16mm (0.20")	1.04mm (0.04")	OK
+2.87 kPa (+60 psf)	7.21mm (0.28")	1.42mm (0.06")	OK
+3.59 kPa (+75 psf)	9.40mm (0.37")	1.80mm (0.07")	OK
+4.31 kPa (+90 psf)	11.76mm (0.46")	2.21mm (0.09")	OK
+13.25 kPa (+276.64 psf)	--	--	MAXIMUM LOAD

NOTES: *We were not able to load the unit to a higher load.*

General Note: *All testing was performed in accordance with the referenced standard(s).*

Note 2: Loads were held for 10 seconds.

Note 3: Tape and film were used to seal against air leakage during structural testing. In our opinion, the tape and film did not influence the results of the test.

Architectural Testing will service this report for the entire test record retention period. Test records that are retained such as detailed drawings, datasheets, representative samples of test specimens, or other pertinent project documentation will be retained by Architectural Testing, Inc. for the entire test record retention period.

This report does not constitute certification of this product nor an opinion or endorsement by this laboratory. It is the exclusive property of the client so named herein and relates only to the specimen(s) tested. This report may not be reproduced, except in full, without the written approval of Architectural Testing, Inc.

For ARCHITECTURAL TESTING, Inc.

Digitally Signed for: Ian J. McKenzie by Jose E. Colon

Ian McKenzie
Technician

Digitally Signed by: Jose E. Colon

José E. Colón
Director – Regional Operations

Attachments (pages): This report is complete only when all attachments listed are included.
Appendix-A: Drawings (1)

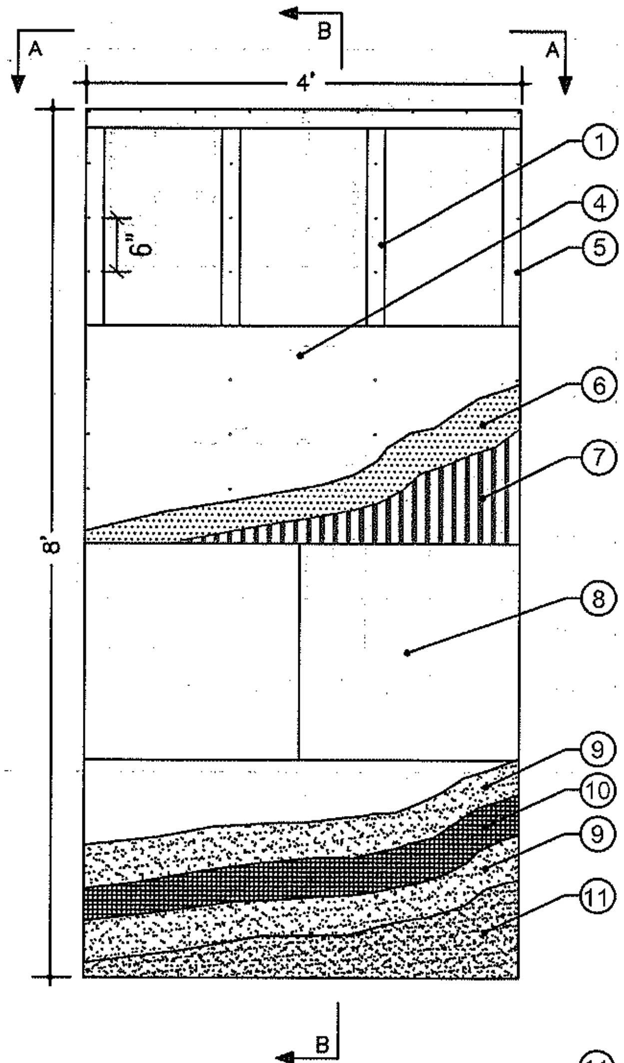
This report produced from controlled document template ATI 00479, issued 01/27/12.

Revision Log

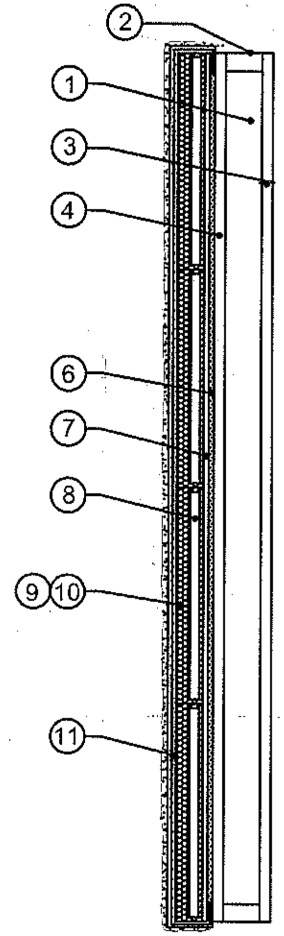
Rev. #	Date	Page(s)	Revision(s)
0	03/19/13	n/a	Original Report
1	05/30/13	Page 2 of 6	Description correction (Section 5.2)

Appendix A

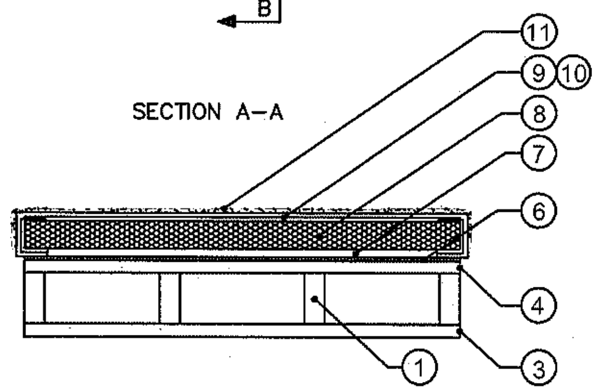
Drawings



SECTION B–B



SECTION A–A



MATERIAL LIST

1. 2" x 4" WOOD STUDS AT 16" O.C.
2. 2" x 4" WOOD STUD FRAMING
3. GYPSUM WALLBOARD ATTACHED WITH NO. 6 x 1¼" SELF DRILLING SCREWS SPACED AT 8" O.C.
4. ½" (NOMINAL) APA EXPOSURE 1 PLYWOOD
5. NO. 6 x 1¼" SELF DRILLING SCREWS SPACED AT 6" O.C.
6. DRYVIT BACKSTOP® NT
7. ADHERE THE EXPANDED POLYSTYRENE (EPS) ENCAPSULATED VIP PANEL WITH DRYVIT PRIMUS®. PRIMUS ADHESIVE IS APPLIED WITH A ⅜" X ½" NOTCHED TROWEL WITH NOTCHES SPACED A MAXIMUM OF 1½" O.C. THE ADHESIVE SHALL BE APPLIED TO THE BACKSIDE OF THE EPS IN A VERTICAL ORIENTATION.
8. VIP PANEL ENCAPSULATED IN EPS INSULATION BOARD
9. DRYVIT PRIMUS BASE COAT IS MIXED 1:1 BY WEIGHT WITH PORTLAND CEMENT AND WATER. PRIMUS IS A 100% POLYMER-BASED PRODUCT.
10. DRYVIT'S STANDARD REINFORCING MESH: 4.3 OZ/YD^2 FIBERGLASS REINFORCING MESH EMBEDDED IN DRYVIT BASE COAT. THE STANDARD REINFORCING MESH SHALL BE LAPPED A MINIMUM OF 2½" AT ALL EDGES.
11. DRYVIT FINISH: A 100% ACRYLIC BASED MATERIAL AVAILABLE IN VARIOUS TEXTURES.

Architectural Testing

Test sample complies with these details.
Deviations are noted.

Report #: C4306.01-550-44

Date: 3/19/13 Tech:

DRYVIT SYSTEMS, INC. One Energy Way West Warwick, Rhode Island		dryvit
DWG. NO.: VIP12PLY		
SHEET NO: 1 OF 1	ISSUE DATE: 2/1/2013	REV./DATE:
EPS ENCAPSULATED VIP OVER ½" (NOMINAL) PLYWOOD		

Architectural Testing

UNIFORM STATIC LOAD (ASTM E330) TEST REPORT

Report No.: C4306.02-550-44

Rendered to:

DRYVIT SYSTEMS, INC.
West Warwick, Rhode Island

PRODUCT TYPE: EIFS (over metal studs)
SERIES/MODEL: VIP12EXP358STUDS_

Specimen	Uniform Static Load Test (Maximum/Ultimate Load)
1	-9.04 kPa (-188.76 psf)
2	-5.75 kPa (-120 psf)
3	-8.64 kPa (-180.28 psf)
4	+16.09 kPa (+335.92 psf)
5	+14.27 kPa (+297.96 psf)
6	+13.80 kPa (+288.08 psf)

Test Dates: 02/18/13
Through: 02/19/13
Report Date: 05/30/13
Test Record Retention End Date: 05/30/17

1701 Westfork Drive, Suite 106
Lithia Springs, Georgia 30122
phone: 770-941-6916
fax: 770-941-2930
www.archtest.com

1.0 Report Issued To: Dryvit Systems, Inc.
One Energy Way
West Warwick, Rhode Island 02893

2.0 Test Laboratory: Architectural Testing, Inc.
1701 Westfork Drive, Suite 105-106
Lithia Springs, Georgia 30122
(770) 941-6916

3.0 Project Summary:

3.1 Product Type: EIFS (over metal studs)

3.2 Series/Model: VIP12EXP358STUDS

3.3 Compliance Statement: Results obtained are tested values and were secured by using the designated test method(s). Test specimen description and results are reported herein.

3.4 Test Dates: 02/18/13 – 2/19/13

3.5 Test Record Retention End Date: All test records for this report will be retained until 05/30/17.

3.6 Test Location: Architectural Testing, Inc. test facility in Lithia Springs, Georgia

3.7 Test Sample Source: The test specimens were provided by the client. Representative samples of the test specimen(s) will be retained by Architectural Testing for a minimum of four years from the test completion date.

3.8 Drawing Reference: The test specimen drawings have been reviewed by Architectural Testing and are representative of the test specimen(s) reported herein. Test specimen construction was verified by Architectural Testing per the drawings located in Appendix A. Any deviations are documented herein or on the drawings.

3.9 List of Official Observers:

Name	Company
Beth Manteuffel	Dryvit Systems, Inc
Steve Altum	Dow Corning
Brent Doll	Dow Corning
Ian McKenzie	Architectural Testing, Inc.
José Colón	Architectural Testing, Inc.

4.0 Test Method(s):

ASTM E 330-02, *Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.*

5.0 Test Specimen Description:

5.1 Product Sizes:

Test Specimen #1 – 6:

	Width		Height	
	millimeters	**inches**	**millimeters**	**inches**
Overall size	1219	48	2438	96

The following descriptions apply to all specimens.

5.2 Frame and EIFS Components:

Name	Overall Cross Section	Description
Metal Stud Frame and Track	3-5/8" x 18-Ga. Steel	Metal stud wall frame/track with studs at 16" o.c.
Interior Sheathing	½" x 48" x 96"	ASTM C1396 Gypsum Wall Board
Exterior Sheathing	½" x 48" x 96"	National Gypsum E^2XP
Air/Water Resistive Barrier	n/a	Dryvit Backstop® NT
Adhesive	1/8" thick vertical ribbons	Dryvit Primus® Mixture (Note 1)
EPS VIP Panel	2-3/4" x 48" x 96"	VIP Panel Encapsulated in EPS Insulation Board
Base Coat	1/8" thick	Dryvit Primus® Mixture (Note 1)
Reinforcing Mesh	4.3 oz/yd^2	Dryvit Fiberglass Reinforcing Mesh
Finish	n/a	Dryvit Finish

Note 1: Mixed one-to-one by weight with Portland Cement

6.0 Installation:

The specimen was installed into a wood buck. The rough opening allowed for a 1/4" shim space.

Location	Anchor Description	Anchor Location
Wood Stud Frame	#10 x 2-1/2" deck screws	End Connections
Exterior Sheathing to Wood Studs	#6 x 1-1/4" self-drilling screws	6" o.c. along verticals and 8" o.c. along tracks

7.0 Test Results:

The temperature during testing was 18.8°C (66°F). The results are tabulated as follows:

Test Specimen #1:

Loads	Deflection @ Geometric Center	Permanent Set @ Geometric Center	Status
-958 Pa (-20 psf)	2.44mm (0.10")	0.20mm (0.01")	OK
-1.92 kPa (-40 psf)	5.36mm (0.21")	0.61mm (0.02")	OK
-2.87 kPa (-60 psf)	8.18mm (0.32")	1.07mm (0.04")	OK
-3.83 kPa (-80 psf)	10.95mm (0.43")	1.50mm (0.06")	OK
-4.79 kPa (-100 psf)	13.90mm (0.55")	2.03mm (0.08")	OK
-5.75 kPa (-120 psf)	16.36mm (0.64")	2.31mm (0.09")	OK
-9.04 kPa (-188.76 psf)	--	--	FAILURE LOAD

NOTES: *The system pulled away from the left jamb stud (inside view)*

Test Specimen #2:

Loads	Deflection @ Geometric Center	Permanent Set @ Geometric Center	Status
-958 Pa (-20 psf)	2.51mm (0.10")	0.23mm (0.01")	OK
-1.92 kPa (-40 psf)	5.87mm (0.23")	0.61mm (0.02")	OK
-2.87 kPa (-60 psf)	9.42mm (0.37")	1.04mm (0.04")	OK
-3.83 kPa (-80 psf)	12.78mm (0.47")	1.55mm (0.06")	OK
-4.79 kPa (-100 psf)	16.31mm (0.64")	2.08mm (0.08")	OK
-5.75 kPa (-120 psf)	--	--	FAILURE LOAD

NOTES: *The exterior sheathing pulled away over the fasteners away from the metal studs.*

Test Specimen #3:

Loads	Deflection @ Geometric Center	Permanent Set @ Geometric Center	Status
-958 Pa (-20 psf)	2.49mm (0.10")	0.05mm (0.002")	OK
-1.92 kPa (-40 psf)	5.44mm (0.21")	0.51mm (0.02")	OK
-2.87 kPa (-60 psf)	8.94mm (0.35")	1.12mm (0.04")	OK
-3.83 kPa (-80 psf)	11.89mm (0.47")	1.63mm (0.06")	OK
-4.79 kPa (-100 psf)	14.86mm (0.59")	2.08mm (0.08"	OK
-5.75 kPa (-120 psf)	17.96mm (0.71")	2.72mm (0.11")	OK
-8.64 kPa (-180.28 psf)	--	--	FAILURE LOAD

Test Specimen #4:

Loads	Deflection @ Geometric Center	Permanent Set @ Geometric Center	Status
+958 Pa (+20 psf)	2.08mm (0.08")	0.25mm (0.01")	OK
+1.92 kPa (+40 psf)	3.81mm (0.15")	0.46mm (0.02")	OK
+2.87 kPa (+60 psf)	6.07mm (0.24")	0.74mm (0.03")	OK
+3.83 kPa (+80 psf)	8.69mm (0.34")	1.02mm (0.04")	OK
+4.79 kPa (+100 psf)	11.33mm (0.45")	1.42mm (0.06")	OK
+5.75 kPa (+120 psf)	14.53mm (0.57")	1.96mm (0.08")	OK
+16.09 kPa (+335.92 psf)	--	--	FAILURE LOAD

NOTES: *The middle two studs buckled..*

Test Specimen #5:

Loads	Deflection @ Geometric Center	Permanent Set @ Geometric Center	Status
+958 Pa (+20 psf)	1.67mm (0.07")	0.15mm (0.01")	OK
+1.92 kPa (+40 psf)	4.14mm (0.16")	0.43mm (0.02")	OK
+2.87 kPa (+60 psf)	6.07mm (0.24")	0.71mm (0.03")	OK
+3.83 kPa (+80 psf)	8.76mm (0.35")	1.14mm (0.05")	OK
+4.79 kPa (+100 psf)	11.73mm (0.46")	1.65mm (0.07")	OK
+5.75 kPa (+120 psf)	14.83mm (0.58")	2.18mm (0.09")	OK
+14.27 kPa (+297.96 psf)	--	--	FAILURE LOAD

NOTES: *The middle two studs buckled.*

Test Specimen #6:

Loads	Deflection @ Geometric Center	Permanent Set @ Geometric Center	Status
+958 Pa (+20 psf)	1.85mm (0.07")	0.33mm (0.01")	OK
+1.92 kPa (+40 psf)	4.06mm (0.16")	0.71mm (0.03")	OK
+2.87 kPa (+60 psf)	6.58mm (0.26")	1.24mm (0.05")	OK
+3.83 kPa (+80 psf)	9.27mm (0.37")	1.70mm (0.07")	OK
+4.79 kPa (+100 psf)	12.09mm (0.48")	2.21mm (0.09")	OK
+5.75 kPa (+120 psf)	14.99mm (0.59")	2.74mm (0.11")	OK
+13.80 kPa (+288.08 psf)	--	--	FAILURE LOAD

NOTES: *The middle two studs buckled.*

General Note: *All testing was performed in accordance with the referenced standard(s).*

Note 2: Loads were held for 10 seconds.

Note 3: Tape and film were used to seal against air leakage during structural testing. In our opinion, the tape and film did not influence the results of the test.

Architectural Testing will service this report for the entire test record retention period. Test records that are retained such as detailed drawings, datasheets, representative samples of test specimens, or other pertinent project documentation will be retained by Architectural Testing, Inc. for the entire test record retention period.

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For ARCHITECTURAL TESTING, Inc.

Digitally Signed for: Ian J. McKenzie by Jose E. Colon

Ian McKenzie
Technician

Digitally Signed by: Jose E. Colon

José E. Colón
Director – Regional Operations

Attachments (pages): This report is complete only when all attachments listed are included.
Appendix-A: Drawings (1)

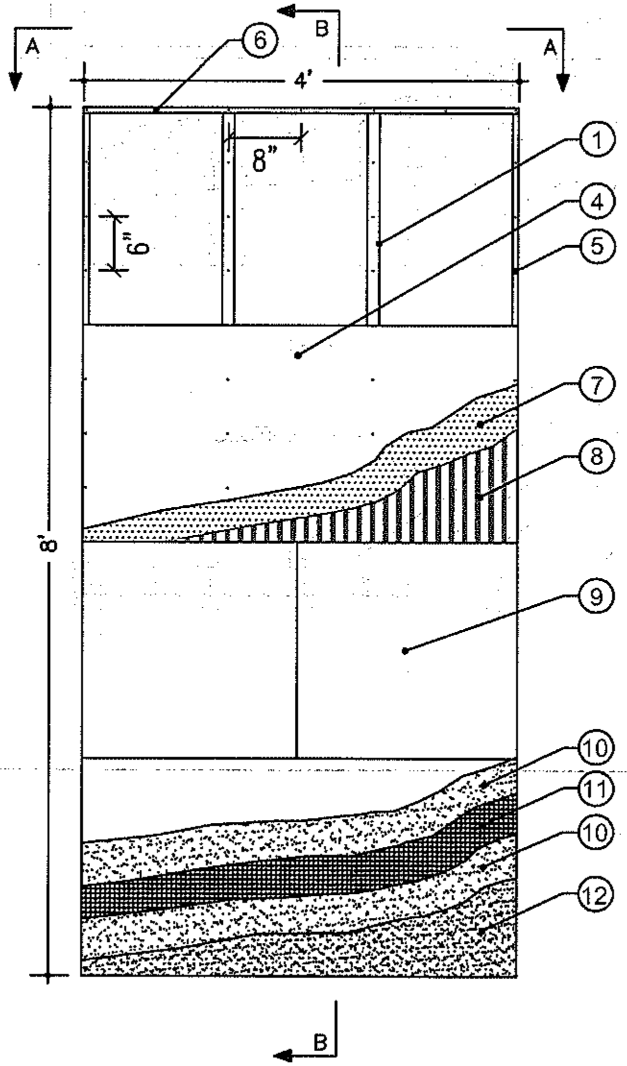
This report produced from controlled document template ATI 00479, issued 01/27/12.

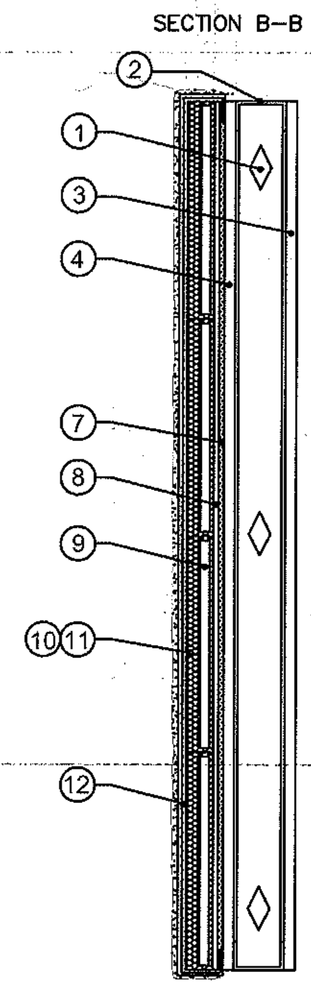
Revision Log

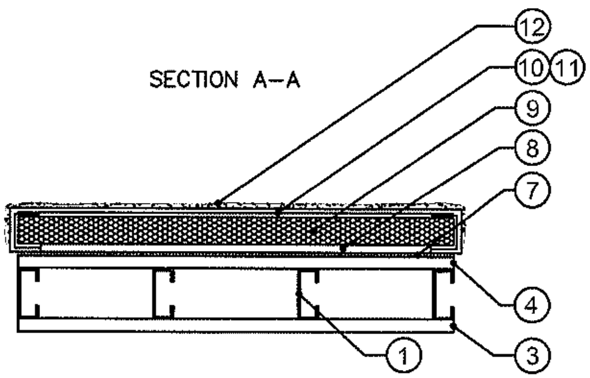
Rev. #	Date	Page(s)	Revision(s)
0	03/19/13	All	Original Report
1	05/30/13	Page 2 of 6	Description correction (section 5.2)

Appendix A

Drawings







MATERIAL LIST

1. 3⅝" x 18 GAUGE STEEL STUDS AT 16" O.C.
2. 3⅝" x 18 GAUGE STEEL TRACK
3. GYPSUM WALLBOARD ATTACHED WITH NO. 6 x 1¼" SELF DRILLING SCREWS SPACED AT 8" O.C.
4. ½" NATIONAL GYPSUM E^2XP
5. NO. 6 x 1¼" SELF DRILLING SCREWS SPACED AT 6" O.C.
6. NO. 6 x 1¼" SELF DRILLING SCREWS SPACED AT 8" O.C.
7. DRYVIT BACKSTOP® NT
8. ADHERE THE EXPANDED POLYSTYRENE (EPS) ENCAPSULATED VIP PANEL WITH DRYVIT PRIMUS®. PRIMUS ADHESIVE IS APPLIED WITH A ⅜" X ½" NOTCHED TROWEL WITH NOTCHES SPACED A MAXIMUM OF 1½" O.C. THE ADHESIVE SHALL BE APPLIED TO THE BACKSIDE OF THE EPS IN A VERTICAL ORIENTATION.
9. VIP PANEL ENCAPSULATED IN EPS INSULATION BOARD
10. DRYVIT PRIMUS BASE COAT IS MIXED 1:1 BY WEIGHT WITH PORTLAND CEMENT AND WATER. PRIMUS IS A 100% POLYMER-BASED PRODUCT.
11. DRYVIT'S STANDARD REINFORCING MESH: 4.3 OZ/YD^2 FIBERGLASS REINFORCING MESH EMBEDDED IN DRYVIT BASE COAT. THE STANDARD REINFORCING MESH SHALL BE LAPPED A MINIMUM OF 2½" AT ALL EDGES.
12. DRYVIT FINISH: A 100% ACRYLIC BASED MATERIAL AVAILABLE IN VARIOUS TEXTURES.

Architectural Testing

Test sample complies with these details.
Deviations are noted.

Report #: C4306.02-550-44

Date: 3/19/13 Tech: [signature]

DRYVIT SYSTEMS, INC. One Energy Way West Warwick, Rhode Island		dryvit
DWG. NO.: VIP12EXP358STUDS		
SHEET NO: 1 OF 1	ISSUE DATE: 2/1/2013	REV DATE: /
EPS ENCAPSULATED VIP OVER 3⅝" STUDS WITH ½" E^2XP		

TEST REPORT

Intertek

REPORT NUMBER: 100944630SAT-004A_Rev.1
ORIGINAL ISSUE DATE: February 28, 2013
REVISED DATE: March 28, 2013

EVALUATION CENTER
16015 Shady Falls Road
Elmendorf, TX 78112
Phone: (210) 635-8100
Fax: (210) 635-8101
www.intertek.com

RENDERED TO

Dryvit Systems, Inc.
One Energy Way
WEST WARWICK RI 02893

PRODUCT EVALUATED: Exterior Insulation and Finish System (EIFS) using 3-3/4" thick VIP Insulation Panels
EVALUATION PROPERTY: Fire Resistance

Report of Testing an Exterior Insulation and Finish System (EIFS) using 3-3/4" thick VIP Insulation Panels for compliance with the applicable requirements of the following criteria: *ASTM E119–12 Standard Test Methods for Fire Tests of Building Construction and Materials, January 2012 Edition.*

1 Table of Contents

2 Introduction

Intertek Testing Services NA, Inc. (Intertek) has conducted testing for Dryvit Systems, Inc., on their Exterior Insulation and Finish System (EIFS) using 3-3/4" thick VIP Insulation Panels, to evaluate its fire resistance. Testing was conducted in accordance with the applicable requirements of, and following the standard methods of, **ASTM E119–12 Standard Test Methods for Fire Tests of Building Construction and Materials, January 2012 Edition**. This evaluation took place on February 26, 2017.

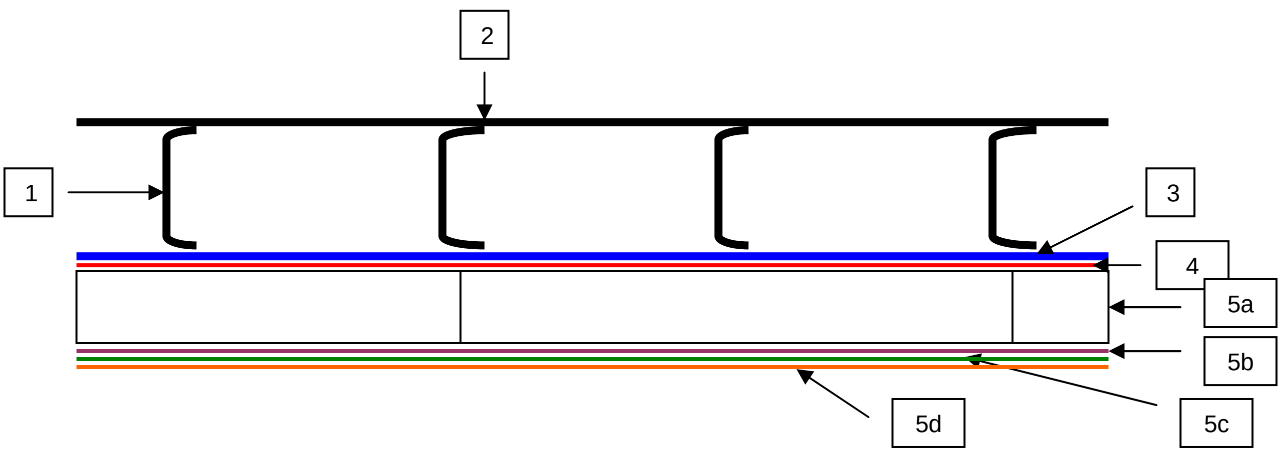
3 Test Samples

3.1. SAMPLE SELECTION

Samples were submitted to Intertek directly from the client. Samples were not independently selected for testing. Samples were received at the Evaluation Center on January 15, 2013 (San Antonio I.D. SAT1301151816-001 through SAT1301151816-008).

3.2. SAMPLE AND ASSEMBLY DESCRIPTION

An asymmetrical, 10' x 10' wall was constructed of steel studs, gypsum board, VIP Insulation panels, and a stucco exterior.



1. Framing –3-5/8" deep, 20 GA galvanized steel studs, 24" o.c., inserted (floated) into 20 GA top and bottom track.

2. Interior Sheathing – 4' x 10' x 5/8" thick, USG Sheetrock® Brand, Firecode® Core, Type X gypsum board, installed with the long edge parallel to the studs using #6 X 1-1/4" self drilling screws spaced 8" o.c. around the perimeter and 12" o.c. in the field; exposed joints and fasteners received a Level 2 finish.

3. Exterior Sheathing – 4' x 10' x 5/8" Gold Bond® Brand Fire-Shield Sheathing Type X gypsum board (National Gypsum), installed with the long edge parallel to the studs using #6 X 1-1/4" self drilling screws spaced 8" o.c. around the perimeter and 12" o.c. in the field; 4" Dryvit Grid Tape and then Backstop® NT Texture was installed over all sheathing joints.

4. Coating – Backstop® NT Texture was trowelled onto the entire wall by representative for Dryvit Systems, Inc.; the Backstop® NT Texture was applied over the exterior sheathing resulting in an approximate dry mil thickness of 12 mils; a strip of Dryvit Standard 4.3 oz/yd^2 mesh was installed around the edge of the wall, a nominal 4" embedded in the Backstop® NT Texture and nominal 8" protruding out from the edge, providing a backwrap system for the outer edges of the perimeter panels.

5. EIF System – Exterior Insulation and Finish System (EIFS) installed over the exterior sheathing by representatives of Dryvit Systems, Inc., on January 22 through 24, 2013:

    a. Primus® mixture (1:1 Primus® mixture of Primus® and Portland cement by weight) was applied to the back of the 3-3/4" thick insulation board (3-3/4" encapsulated VIP EPS composite) sections and to the outer edges of the peripheral sections, using 3/8" x 1/2" x 1-1/2" notched trowel; sections installed over the Backstop® NT Texture surface; the protruding mesh was wrapped around the peripheral panels and embedded in Primus® mixture.

    b. Primus® mixture applied over the entire insulation board surface and 4.3 oz/yd^2 mesh, applied horizontally, embedded with minimum 3" overlap at the joints, and smoothed over with additional Primus® mixture -- nominal thickness 1/16"

    c. The entire wall was covered with a skim coat of 1:1 Primus® / Portland cement mixture and allowed to dry

    d. Quarzputz® Pastel Base was applied over the entire exterior surface as the finish coat on January 24, 2013.

4 Testing and Evaluation Methods

4.1. INSTRUMENTATION

The assembly was instrumented with a total of eighteen (18) 24 GA, Type K, fiberglass jacketed thermocouples: TCs # 1 through 9 were evenly distributed across the unexposed surface; TCs' # 10 through 18 had been evenly distributed across the layer of Backstop® NT Texture prior to the installation of the VIP Insulation panels (see Appendix A). The output of the thermocouples and the furnace probes were monitored by a 100-channel Yokogawa, Inc., Darwin Data Acquisition Unit. The computer was programmed to scan and save data every 30 seconds. Following the test, the files were imported into MS Excel for tabular and graphical display (presented in Appendix B).

4.2. TEST STANDARD

Testing was conducted in accordance with the applicable requirements of, and following the standard methods of **ASTM E119–12 Standard Test Methods for Fire Tests of Building Construction and Materials, January 2012 Edition.**

The assembly was secured to the full scale vertical furnace, with the EIFS on the unexposed surface, and was tested to the standard time-temperature curve described in the E119 standard.

5 Testing and Evaluation Results

5.1. RESULTS AND OBSERVATIONS

The test was initiated on Tuesday, February 26, 2013. Bill Preston, Roland Serino, representing Dryvit Systems, Inc., Steve Altum, Brent Dull and Aaron Seitz, representing Dow Corning Corp., and Jesse Beitel, representing Hughes Associates, Inc., were present to witness the test. The ambient temperature and relative humidity at the time of the test was 52°F 40% R.H., respectively.

Observations made during the test are listed below:

Time (min:sec)	Observations
0:00	The test was initiated at 9:08 A.M.
2:15	There was discoloration of the unexposed surface
2:40	There was ignition of the gypsum board paper on the on the exposed surface
3:00	The gypsum board paper on the on the exposed had been consumed
19:00	The joint compound on the exposed surface was peeling
24:00	The joint compound and tape on the exposed surface was flaking
55:00	There was approximately 1/2" shrinkage at the gypsum board joints on the exposed surface
60:00	The burners were extinguished and the test was terminated

Immediately following the fire test, the assembly was removed from the furnace, and the exposed surface was subjected to the impact, cooling and erosion effects of the standard hose stream test. The water stream was applied from a distance of 20 feet, at an angle of 90°, at a pressure of 30 psig for 60 seconds, in compliance with the standard for a 1-hour test.

Time (min:sec)	Hose Stream Observations
0:00	The test was initiated
1:00	The test was terminated

The test assembly withstood the effects of the fire resistance test without passage of flame, of gases hot enough to ignite cotton waste, or with passage of water from the hose stream test through to the unexposed surface. Transmission of heat across the wall did not raise the average temperature on the unexposed surface more than 250°F above the average initial ambient temperature, or the temperature at any single thermocouple more than 325°F above the initial ambient temperature.

Assembly drawings, the test data and photographs documenting the test are located in the Appendices of this test report.

5.2. EXAMINATION OF RESULTS

5.2.1. Correction Factor for the Fire Endurance Test

In accordance with the E119 test standard, a calculation for any correction to the indicated fire resistance period was done. The correction factor was then mathematically added to the indicated fire resistance period, yielding the fire resistance period achieved by this specimen:

Correction Factor for the Fire Endurance Test

ITEM	DESCRIPTION	TEST VALUE
C	correction factor	-0.27 minutes -16 seconds
I	indicated fire-resistance period	60 minutes
A	area under the curve of indicated average furnace temperature for the first three fourths of the indicated period	57873 (°F•min)
As	area under the standard furnace curve for the same part of the indicated period	5829 (°F•min)
ITEM	**DESCRIPTION**	**TEST VALUE**
L	lag correction	3240
	FIRE RESISTANCE PERIOD ACHIEVED BY THIS SPECIMEN ==>	60 minutes

Note: The standard specifies that the fire resistance be determined to the nearest integral minute. Because the correction factor is less than 30 seconds, and the test specimen met the criteria for the full indicated fire resistance period, no correction is deemed necessary.

5.2.2. Surface Deflection

The deflection of the unexposed surface was measured at 3 equidistant locations, 30”, 60”, and 90” from left to right, across the horizontal midline, during the span of the test. The amount of that deflection is presented in the table below.

Time (min)	Position 1 (in)	Position 2 (in)	Position 3 (in)
0	0	0	0
32	5/8	7/8	5/8
42	5/8	7/8	5/8

6 Conclusion

Intertek Testing Services NA, Inc. (Intertek) has conducted testing for Dryvit Systems, Inc., on their Exterior Insulation and Finish System (EIFS) using 3-3/4" thick VIP Insulation Panels, to evaluate its fire resistance. Testing was conducted in accordance with the applicable requirements of, and following the standard methods of, **ASTM E119–12 Standard Test Methods for Fire Tests of Building Construction and Materials, January 2012 Edition**. This evaluation took place on February 26, 2017.

Based on the results of this test, the asymmetric assembly withstood the effects of the fire test and the hose stream test and achieved a fire resistance rating of 60 minutes with the Exterior Insulation and Finish System (EIFS) on the unexposed surface.

The conclusions of this test report may not be used as part of the requirements for Intertek product certification. Authority to Mark must be issued for a product to become certified.

INTERTEK TESTING SERVICES NA, INC.

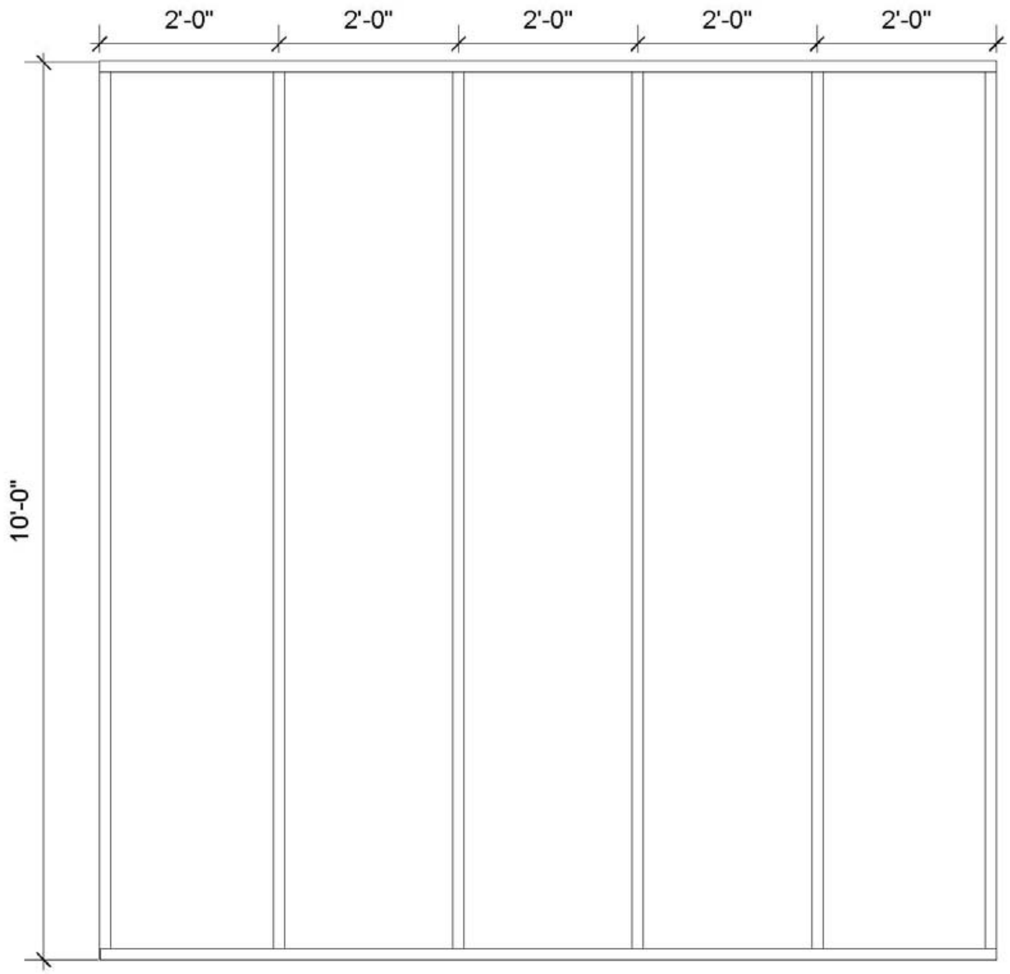
Tested by: ______________________
Joseph Zatopek
Test Engineer

Reported by: ______________________
Michael A Brown
Quality Supervisor / Technical Writer

Reviewed by: ______________________
Victor M. Burgos
Project Engineer, Fire Resistance

APPENDIX A

Assembly Drawings



ELEVATION VIEW

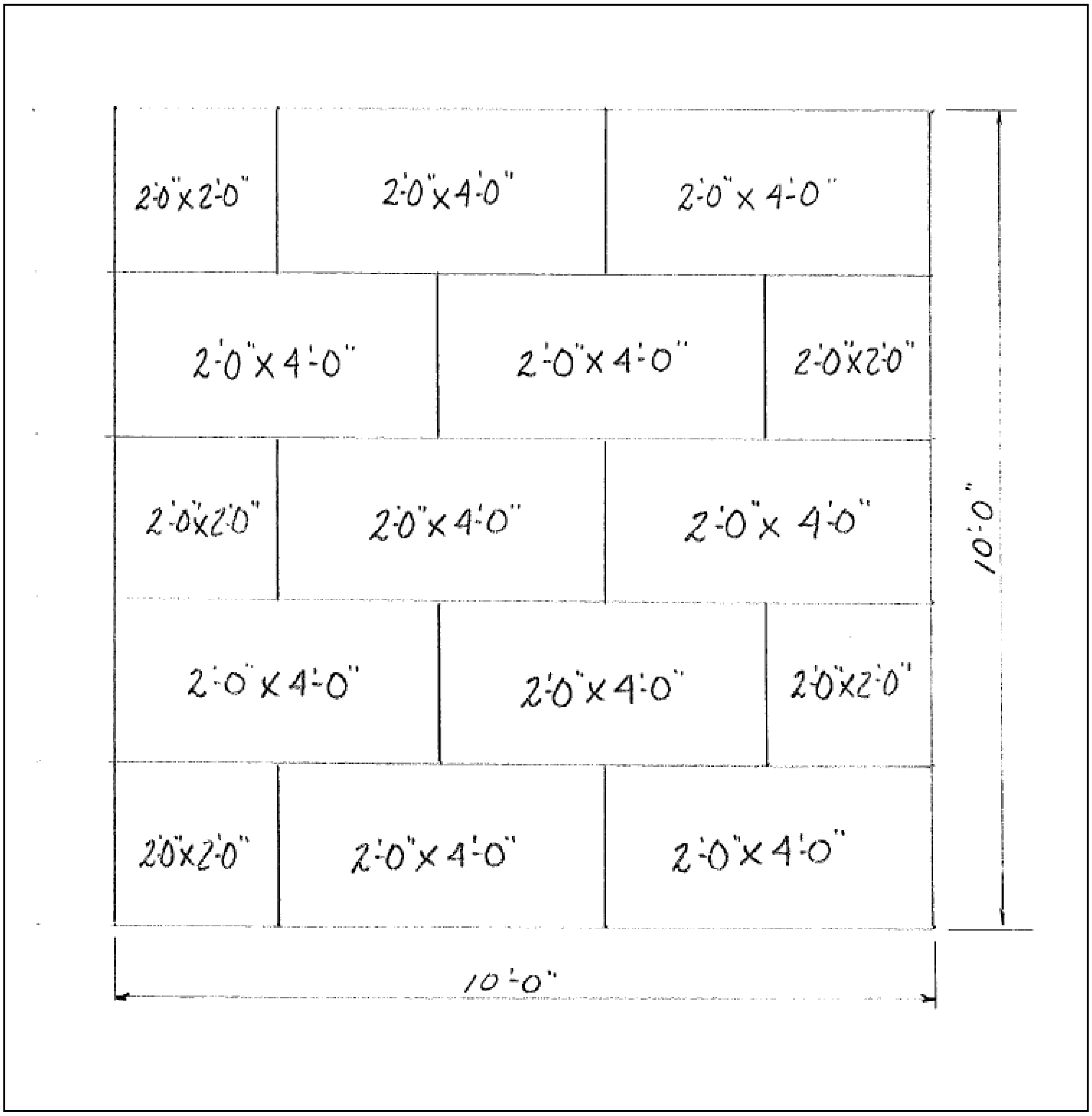
Note:

The framing consisted of 20 GA, 3-5/8 galvanized steel studs spaced 24" o.c. snapped into 20 GA track top and bottom. In the four corners, the studs were fastened to the track using #8 x 1/2" long lath head phillips self drilling screws on each side of the framing.

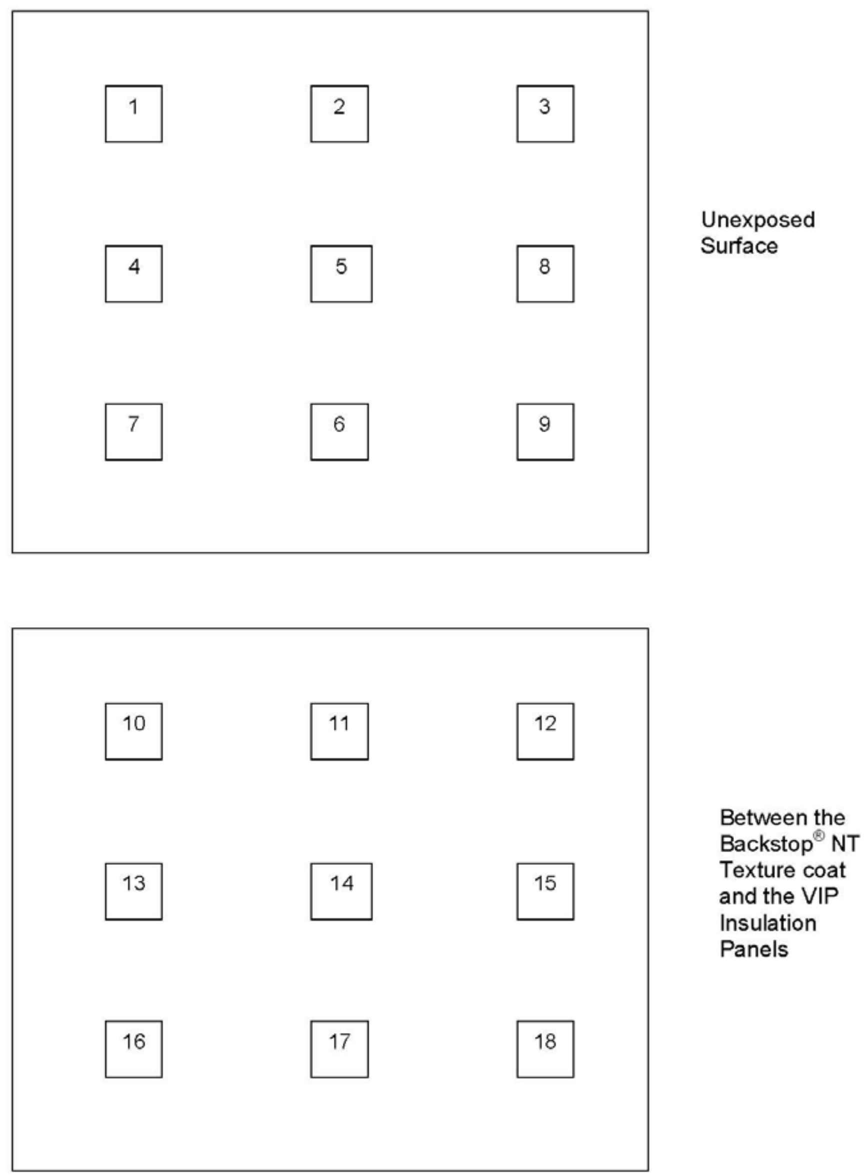
Intertek Testing Services NA, Inc. Project No. G100944630SAT-004A
Dryvit Systems, Inc.
Stud Layout

Scale = 1:20

Layout of VIP Insulation™ Blocks



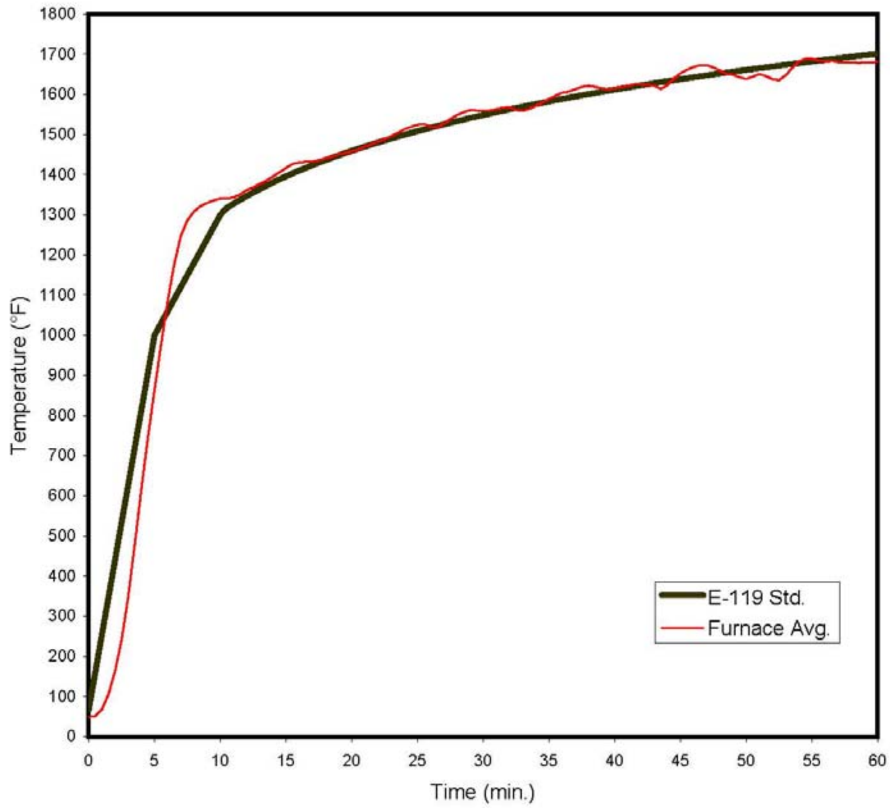
Wall Assembly:
Layout of Thermocouples

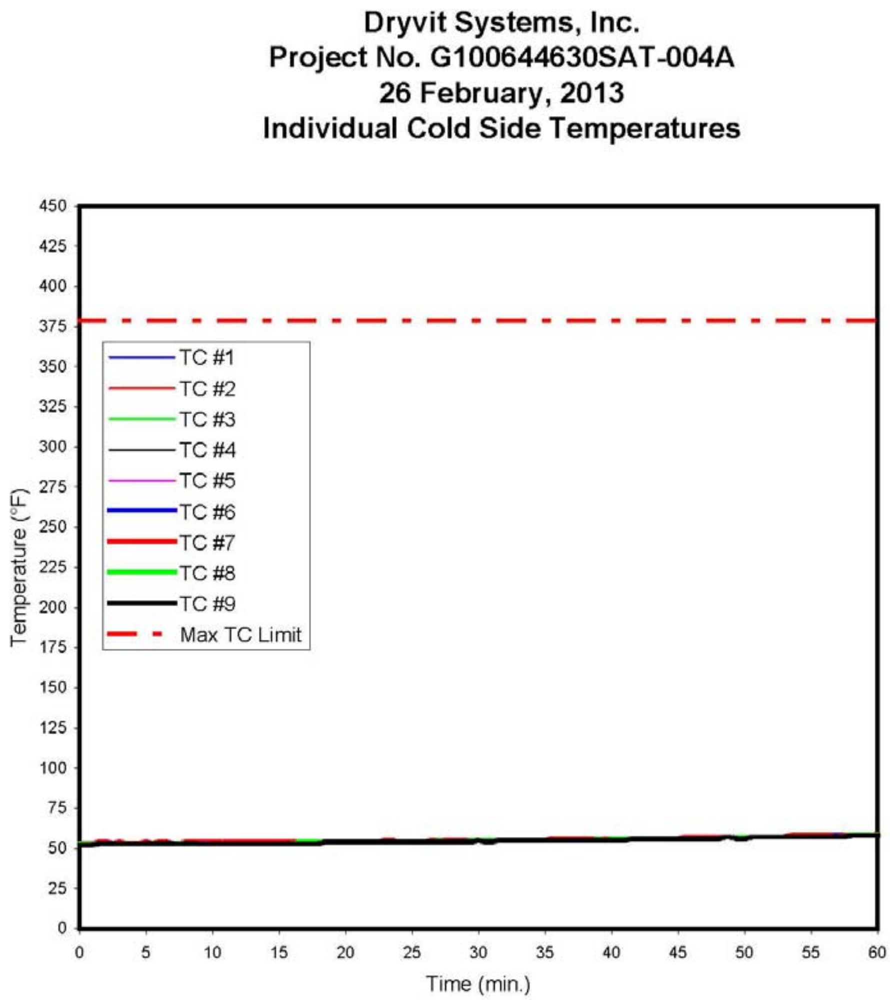


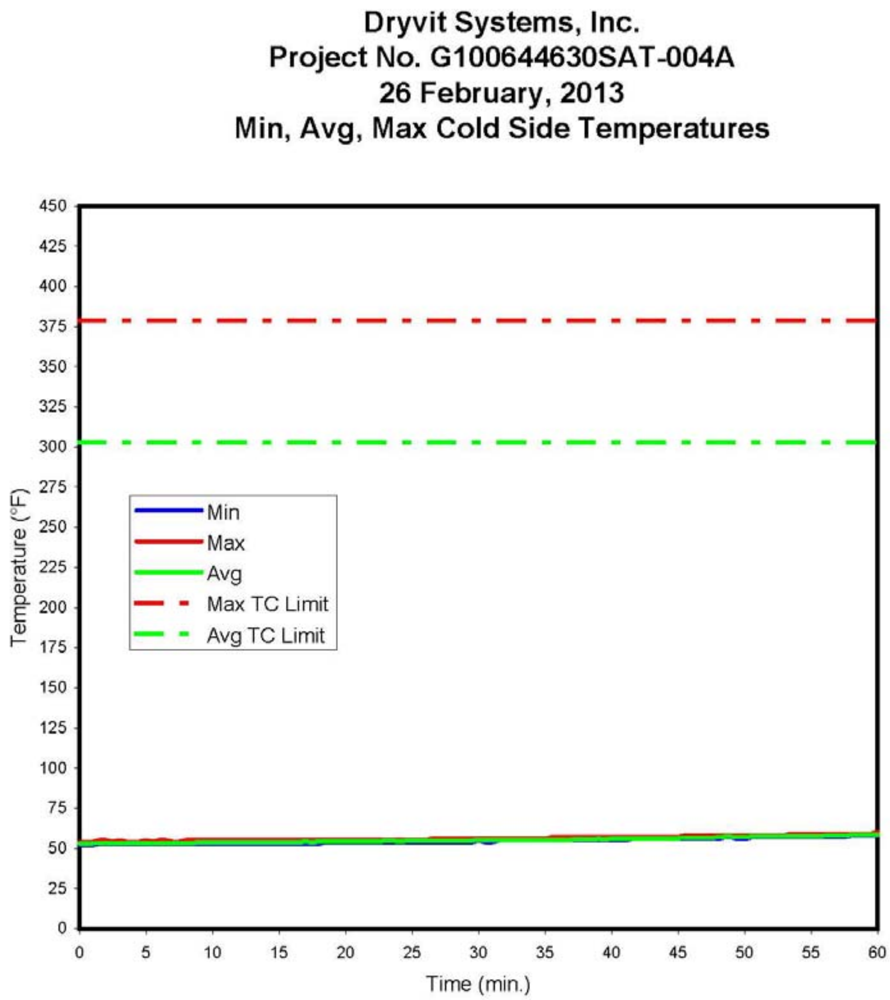
(Drawing not to scale)

APPENDIX B
Temperature Data

Dryvit Systems, Inc.
Project No. G100644630SAT-004A
26 February, 2013
Furnace Interior Temperatures




Dryvit Systems, Inc.
Project No. G100644630SAT-004A
26 February, 2013
Individual Cold Side Temperatures
Temperature (°F)
Time (min.)
TC #1
TC #2
TC #3
TC #4
TC #5
TC #6
TC #7
TC #8
TC #9
Max TC Limit
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
425
450
0
5
10
15
20
25
30
35
40
45
50
55
60


Dryvit Systems, Inc.
Project No. G100644630SAT-004A
26 February, 2013
Min, Avg, Max Cold Side Temperatures
Temperature (°F)
Time (min.)
Min
Max
Avg
Max TC Limit
Avg TC Limit
450
425
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
5
10
15
20
25
30
35
40
45
50
55
60

Time (min)	E119 Std Average (°F)	Furnace Average (°F)	Integration of Furnace Average (°F•min)	Integration of E119 Std Average (°F•min)	Error (%)	Furnace Probe #1 (°F)	Furnace Probe #2 (°F)	Furnace Probe #3 (°F)
0	68	49	0	0	0.00%	49	50	49
0.5	161	51	-9	23	-138.41%	53	54	50
1	254	68	-13	93	-114.06%	81	84	60
1.5	348	106	-4	210	-101.72%	139	143	89
2	441	164	30	373	-92.03%	221	227	138
2.5	534	242	97	583	-83.34%	323	332	207
3	627	348	211	839	-74.90%	461	475	305
3.5	720	479	383	1142	-66.42%	615	636	436
4	814	617	623	1491	-58.20%	765	785	583
4.5	907	746	930	1887	-50.72%	896	912	725
5	1000	863	1298	2330	-44.27%	1007	1016	849
5.5	1030	977	1725	2804	-38.48%	1112	1116	962
6	1060	1085	2206	3292	-32.98%	1206	1207	1068
6.5	1090	1177	2738	3796	-27.87%	1281	1279	1160
7	1120	1247	3310	4314	-23.28%	1330	1328	1232
7.5	1150	1287	3909	4848	-19.36%	1349	1344	1275
8	1180	1309	4524	5396	-16.16%	1355	1348	1301
8.5	1210	1322	5147	5960	-13.63%	1357	1347	1319
9	1240	1330	5776	6538	-11.65%	1356	1345	1330
9.5	1270	1336	6409	7132	-10.13%	1356	1343	1337
10	1300	1341	7044	7740	-8.99%	1355	1342	1343
10.5	1317	1341	7680	8360	-8.14%	1352	1340	1346
11	1328	1343	8317	8988	-7.46%	1353	1340	1349
11.5	1337	1351	8957	9620	-6.89%	1359	1347	1356
12	1347	1362	9601	10257	-6.40%	1369	1355	1365
12.5	1356	1368	10249	10898	-5.96%	1374	1362	1372
13	1364	1377	10901	11545	-5.57%	1381	1370	1381
13.5	1373	1385	11558	12195	-5.22%	1388	1378	1389
14	1381	1395	12219	12849	-4.91%	1398	1386	1397
14.5	1388	1406	12885	13507	-4.61%	1409	1395	1406
15	1396	1417	13557	14170	-4.32%	1419	1404	1416
15.5	1403	1427	14234	14835	-4.06%	1429	1411	1426
16	1410	1430	14914	15505	-3.81%	1432	1417	1434
16.5	1417	1432	15596	16177	-3.60%	1431	1418	1437
17	1424	1433	16278	16854	-3.42%	1430	1418	1439
17.5	1430	1436	16961	17533	-3.26%	1433	1420	1442
18	1436	1441	17646	18215	-3.13%	1438	1424	1447
18.5	1442	1445	18333	18901	-3.00%	1441	1427	1450
19	1448	1451	19023	19590	-2.89%	1448	1434	1456
19.5	1454	1454	19716	20281	-2.79%	1452	1437	1460
20	1459	1458	20410	20975	-2.70%	1456	1442	1465
20.5	1465	1463	21106	21672	-2.61%	1461	1448	1470
21	1470	1469	21805	22372	-2.53%	1468	1456	1476
21.5	1475	1476	22508	23074	-2.46%	1475	1462	1482
22	1480	1483	23213	23779	-2.38%	1481	1469	1488
22.5	1485	1489	23922	24487	-2.31%	1487	1475	1494
23	1490	1496	24634	25196	-2.23%	1494	1483	1501
23.5	1495	1505	25351	25909	-2.15%	1502	1494	1508
24	1499	1513	26071	26623	-2.07%	1510	1505	1516
24.5	1504	1519	26795	27340	-1.99%	1516	1512	1523
25	1508	1524	27522	28059	-1.92%	1521	1518	1528
25.5	1513	1526	28250	28781	-1.84%	1521	1519	1532
26	1517	1520	28978	29504	-1.78%	1513	1516	1529
26.5	1521	1518	29703	30230	-1.74%	1514	1515	1528
27	1525	1527	30431	30957	-1.70%	1524	1521	1535
27.5	1529	1539	31163	31687	-1.65%	1537	1532	1544
28	1533	1549	31901	32419	-1.60%	1546	1543	1551
28.5	1537	1556	32643	33153	-1.54%	1553	1545	1558
29	1541	1560	33388	33888	-1.48%	1556	1548	1562
29.5	1545	1560	34134	34626	-1.42%	1553	1548	1564
30	1549	1559	34880	35365	-1.37%	1551	1546	1563
30.5	1552	1560	35626	36106	-1.33%	1552	1546	1564
31	1556	1563	36373	36850	-1.29%	1555	1548	1567
31.5	1559	1567	37121	37594	-1.26%	1558	1551	1571
32	1563	1568	37871	38341	-1.23%	1558	1551	1573
32.5	1566	1561	38619	39089	-1.20%	1550	1549	1570

Time (min)	E119 Std Average (°F)	Furnace Average (°F)	Integration of Furnace Average (°F•min)	Integration of E119 Std Average (°F•min)	Error (%)	Furnace Probe #1 (°F)	Furnace Probe #2 (°F)	Furnace Probe #3 (°F)
33	1570	1559	39365	39839	-1.19%	1551	1549	1567
33.5	1573	1564	40112	40591	-1.18%	1559	1556	1571
34	1576	1572	40862	41344	-1.17%	1568	1565	1576
34.5	1579	1580	41616	42099	-1.15%	1577	1574	1582
35	1583	1589	42374	42856	-1.12%	1585	1583	1589
35.5	1586	1597	43137	43614	-1.09%	1592	1589	1596
36	1589	1604	43903	44373	-1.06%	1599	1597	1603
36.5	1592	1607	44672	45135	-1.03%	1601	1601	1607
37	1595	1613	45443	45897	-0.99%	1607	1608	1611
37.5	1598	1619	46217	46661	-0.95%	1613	1614	1616
38	1601	1622	46993	47427	-0.92%	1614	1614	1619
38.5	1604	1619	47769	48194	-0.88%	1608	1609	1618
39	1606	1615	48544	48963	-0.86%	1603	1604	1614
39.5	1609	1613	49317	49733	-0.84%	1602	1602	1612
40	1612	1616	50090	50504	-0.82%	1606	1602	1615
40.5	1615	1618	50864	51277	-0.80%	1610	1604	1619
41	1617	1622	51640	52051	-0.79%	1613	1606	1624
41.5	1620	1625	52418	52826	-0.77%	1615	1611	1626
42	1623	1625	53197	53603	-0.76%	1614	1612	1627
42.5	1625	1624	53975	54381	-0.75%	1613	1611	1627
43	1628	1622	54752	55160	-0.74%	1610	1607	1625
43.5	1631	1613	55527	55941	-0.74%	1602	1605	1621
44	1633	1623	56302	56723	-0.74%	1617	1618	1627
44.5	1636	1639	57084	57506	-0.73%	1637	1635	1637
45	1638	1653	57873	58290	-0.72%	1650	1647	1649
45.5	1640	1662	58668	59076	-0.69%	1657	1654	1656
46	1643	1668	59466	59863	-0.66%	1662	1659	1661
46.5	1645	1673	60268	60651	-0.63%	1665	1662	1666
47	1648	1673	61070	61440	-0.60%	1661	1659	1667
47.5	1650	1667	61871	62230	-0.58%	1652	1651	1664
48	1652	1659	62669	63022	-0.56%	1642	1642	1659
48.5	1655	1651	63462	63815	-0.55%	1636	1634	1628
49	1657	1649	64253	64608	-0.55%	1633	1629	1650
49.5	1659	1643	65042	65403	-0.55%	1626	1625	1646
50	1661	1639	65829	66199	-0.56%	1624	1623	1642
50.5	1663	1644	66616	66997	-0.57%	1632	1630	1645
51	1666	1650	67405	67795	-0.57%	1640	1638	1648
51.5	1668	1646	68195	68594	-0.58%	1634	1637	1649
52	1670	1638	68982	69394	-0.59%	1625	1632	1646
52.5	1672	1636	69767	70196	-0.61%	1623	1628	1647
53	1674	1648	70553	70998	-0.63%	1641	1642	1649
53.5	1676	1666	71348	71802	-0.63%	1664	1661	1662
54	1678	1682	72151	72607	-0.63%	1680	1676	1675
54.5	1680	1689	72960	73412	-0.62%	1682	1677	1682
55	1682	1689	73770	74219	-0.60%	1678	1675	1684
55.5	1684	1685	74580	75026	-0.60%	1671	1668	1685
56	1686	1684	75388	75835	-0.59%	1671	1667	1684
56.5	1688	1684	76196	76645	-0.59%	1671	1668	1684
57	1690	1681	77003	77455	-0.58%	1666	1666	1681
57.5	1692	1681	77809	78267	-0.58%	1667	1666	1679
58	1694	1681	78616	79079	-0.59%	1667	1666	1678
58.5	1696	1679	79422	79893	-0.59%	1664	1661	1679
59	1698	1680	80227	80707	-0.59%	1665	1662	1679
59.5	1700	1680	81033	81522	-0.60%	1667	1664	1678
60	1701	1681	81840	82338	-0.61%	1668	1667	1679

Time (min)	Furnace Probe #4 (°F)	Furnace Probe #5 (°F)	Furnace Probe #7 (°F)	Furnace Probe #8 (°F)	Furnace Probe #9 (°F)	Furnace Probe #10 (°F)	Furnace Probe #11 (°F)	Furnace Probe #12 (°F)
0	49	49	49	49	bad/probe	49	49	49
0.5	54	49	52	50	bad/probe	50	49	50
1	85	58	76	65	bad/probe	60	56	58
1.5	133	91	119	102	bad/probe	88	76	77
2	193	145	189	160	bad/probe	137	114	112
2.5	274	217	286	235	bad/probe	209	171	162
3	387	307	416	339	bad/probe	312	252	230
3.5	533	422	567	466	bad/probe	435	361	319
4	685	555	710	609	bad/probe	557	491	426
4.5	829	687	827	752	bad/probe	672	622	542
5	947	809	927	883	bad/probe	785	747	663
5.5	1047	924	1038	1000	bad/probe	914	878	783
6	1139	1030	1148	1104	bad/probe	1048	1005	896
6.5	1218	1124	1239	1193	bad/probe	1158	1116	999
7	1277	1202	1307	1261	bad/probe	1243	1204	1087
7.5	1306	1254	1343	1297	bad/probe	1291	1258	1149
8	1321	1286	1360	1318	bad/probe	1311	1292	1193
8.5	1329	1307	1370	1330	bad/probe	1324	1313	1224
9	1333	1323	1372	1339	bad/probe	1326	1324	1248
9.5	1336	1334	1377	1344	bad/probe	1334	1335	1265
10	1337	1343	1379	1349	bad/probe	1335	1343	1279
10.5	1335	1349	1371	1352	bad/probe	1329	1343	1288
11	1336	1354	1371	1356	bad/probe	1329	1345	1298
11.5	1342	1361	1379	1363	bad/probe	1339	1354	1309
12	1352	1370	1390	1373	bad/probe	1352	1366	1323
12.5	1359	1378	1394	1381	bad/probe	1355	1373	1333
13	1367	1387	1403	1391	bad/probe	1363	1383	1344
13.5	1374	1396	1410	1401	bad/probe	1369	1391	1354
14	1383	1405	1422	1409	bad/probe	1383	1404	1364
14.5	1393	1415	1434	1420	bad/probe	1394	1418	1375
15	1403	1424	1447	1429	bad/probe	1407	1432	1386
15.5	1413	1434	1458	1439	bad/probe	1418	1443	1396
16	1420	1442	1460	1445	1412	1419	1448	1405
16.5	1421	1448	1457	1450	1414	1416	1448	1412
17	1420	1450	1456	1450	1415	1415	1449	1418
17.5	1422	1453	1461	1452	1417	1420	1453	1424
18	1426	1456	1466	1455	1421	1425	1459	1430
18.5	1429	1459	1472	1457	1425	1431	1465	1435
19	1434	1463	1479	1464	1431	1439	1472	1443
19.5	1438	1467	1480	1468	1434	1438	1475	1448
20	1443	1471	1484	1469	1438	1442	1478	1452
20.5	1446	1475	1488	1475	1442	1447	1482	1455
21	1452	1482	1495	1483	1449	1454	1488	1461
21.5	1459	1488	1503	1488	1456	1464	1496	1467
22	1465	1493	1510	1493	1463	1471	1503	1474
22.5	1471	1500	1514	1501	1469	1475	1508	1481
23	1477	1507	1522	1508	1477	1484	1517	1488
23.5	1485	1515	1531	1516	1485	1494	1526	1495
24	1493	1524	1539	1523	1493	1503	1535	1502
24.5	1500	1531	1544	1530	1500	1508	1540	1507
25	1504	1537	1550	1535	1504	1514	1545	1512
25.5	1509	1542	1548	1537	1508	1512	1545	1514
26	1504	1542	1534	1534	1504	1498	1532	1511
26.5	1499	1541	1532	1536	1502	1497	1527	1511
27	1507	1546	1544	1545	1509	1511	1538	1518
27.5	1518	1554	1560	1555	1520	1528	1553	1528
28	1527	1562	1573	1559	1530	1543	1565	1535
28.5	1535	1568	1581	1565	1538	1551	1575	1542
29	1539	1572	1586	1570	1544	1557	1583	1548
29.5	1540	1574	1583	1570	1545	1551	1581	1550
30	1538	1574	1583	1568	1544	1552	1579	1552
30.5	1538	1574	1584	1569	1545	1554	1580	1554
31	1541	1576	1588	1574	1547	1557	1585	1559
31.5	1545	1579	1591	1579	1550	1560	1589	1564
32	1547	1581	1592	1580	1553	1559	1590	1567
32.5	1541	1579	1575	1574	1548	1544	1576	1561

Time (min)	Furnace Probe #4 (°F)	Furnace Probe #5 (°F)	Furnace Probe #7 (°F)	Furnace Probe #8 (°F)	Furnace Probe #9 (°F)	Furnace Probe #10 (°F)	Furnace Probe #11 (°F)	Furnace Probe #12 (°F)
33	1537	1578	1573	1574	1545	1543	1571	1558
33.5	1542	1581	1580	1579	1549	1549	1576	1561
34	1549	1586	1591	1587	1555	1561	1586	1566
34.5	1556	1593	1602	1594	1562	1572	1597	1572
35	1564	1600	1613	1602	1571	1585	1609	1579
35.5	1572	1607	1622	1608	1580	1596	1619	1586
36	1580	1614	1630	1615	1587	1602	1627	1593
36.5	1584	1619	1630	1619	1592	1601	1628	1597
37	1588	1625	1637	1624	1596	1608	1635	1603
37.5	1594	1630	1644	1630	1601	1618	1642	1608
38	1598	1633	1646	1632	1605	1618	1646	1613
38.5	1595	1633	1643	1627	1604	1617	1644	1613
39	1590	1629	1639	1622	1600	1613	1640	1611
39.5	1587	1627	1638	1620	1597	1613	1639	1609
40	1590	1628	1641	1624	1598	1614	1640	1613
40.5	1593	1630	1641	1629	1601	1613	1643	1618
41	1597	1632	1645	1633	1604	1617	1647	1622
41.5	1600	1636	1648	1638	1607	1619	1652	1625
42	1601	1638	1646	1639	1608	1615	1651	1626
42.5	1600	1638	1644	1637	1608	1613	1646	1625
43	1599	1637	1642	1634	1607	1612	1644	1623
43.5	1592	1633	1626	1629	1600	1595	1630	1615
44	1597	1638	1641	1642	1605	1612	1639	1621
44.5	1611	1650	1663	1656	1620	1637	1656	1632
45	1627	1661	1679	1668	1635	1652	1669	1644
45.5	1636	1669	1689	1675	1644	1664	1681	1653
46	1642	1676	1697	1680	1652	1674	1690	1659
46.5	1647	1681	1703	1683	1656	1680	1697	1664
47	1647	1683	1702	1681	1658	1679	1698	1666
47.5	1642	1680	1694	1675	1653	1669	1693	1665
48	1634	1674	1683	1669	1645	1657	1686	1663
48.5	1626	1668	1676	1662	1639	1652	1680	1658
49	1622	1663	1673	1658	1635	1647	1676	1654
49.5	1618	1658	1663	1653	1630	1636	1667	1648
50	1612	1654	1657	1652	1626	1631	1662	1645
50.5	1616	1656	1666	1656	1630	1643	1667	1647
51	1622	1660	1675	1659	1636	1653	1674	1650
51.5	1622	1661	1663	1657	1634	1637	1663	1645
52	1617	1658	1650	1652	1628	1621	1652	1637
52.5	1613	1655	1647	1652	1624	1620	1648	1635
53	1619	1661	1665	1665	1632	1644	1664	1644
53.5	1635	1675	1690	1682	1648	1669	1685	1658
54	1652	1689	1709	1697	1662	1690	1704	1672
54.5	1661	1696	1717	1699	1671	1697	1712	1680
55	1662	1698	1717	1698	1673	1696	1714	1682
55.5	1660	1696	1710	1694	1672	1686	1707	1681
56	1659	1694	1710	1693	1671	1686	1708	1682
56.5	1658	1694	1710	1692	1670	1686	1709	1684
57	1655	1692	1705	1690	1666	1680	1704	1681
57.5	1653	1691	1706	1689	1666	1684	1705	1681
58	1653	1691	1707	1688	1667	1686	1706	1680
58.5	1652	1690	1704	1688	1666	1681	1704	1680
59	1652	1689	1704	1690	1666	1683	1705	1681
59.5	1651	1689	1705	1690	1667	1686	1706	1681
60	1653	1690	1707	1688	1669	1688	1707	1680

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Time (min)	Cold Side Min (°F)	Cold Side Avg (°F)	Cold Side Max (°F)	Cold Side TC #1 (°F)	Cold Side TC #2 (°F)	Cold Side TC #3 (°F)	Cold Side TC #4 (°F)	Cold Side TC #5 (°F)	Cold Side TC #6 (°F)	Cold Side TC #7 (°F)	Cold Side TC #8 (°F)	Cold Side TC #9 (°F)
0	52	53	54	54	54	53	53	53	53	53	53	52
0.5	52	53	54	54	54	53	53	53	53	53	53	52
1	52	53	54	54	54	53	53	53	53	53	53	52
1.5	53	53	55	54	55	53	54	53	53	53	53	53
2	53	53	55	54	55	53	54	53	53	53	53	53
2.5	53	53	54	54	54	53	54	53	53	53	53	53
3	53	53	55	54	55	53	53	53	53	53	53	53
3.5	53	53	54	54	54	53	53	53	53	53	53	53
4	53	53	54	54	54	53	53	53	53	53	53	53
4.5	53	53	54	54	54	53	53	53	53	53	53	53
5	53	54	55	54	55	54	54	53	53	53	53	53
5.5	53	53	54	54	54	54	54	53	53	53	53	53
6	53	54	55	54	55	54	54	53	53	53	53	53
6.5	53	54	55	54	55	54	54	53	53	53	53	53
7	53	53	54	54	54	54	54	53	53	53	53	53
7.5	53	53	54	54	54	54	53	53	53	53	53	53
8	53	54	55	54	55	54	54	53	53	53	53	53
8.5	53	54	55	54	55	54	54	53	53	53	53	53
9	53	54	55	54	55	54	54	54	53	53	53	53
9.5	53	54	55	54	55	54	54	54	53	53	53	53
10	53	54	55	54	55	54	54	54	53	53	53	53
10.5	53	54	55	54	55	54	54	54	53	54	53	53
11	53	54	55	54	55	54	54	54	53	53	53	53
11.5	53	54	55	54	55	54	54	54	53	54	53	53
12	53	54	55	54	55	54	54	54	53	54	53	53
12.5	53	54	55	54	55	54	54	54	53	54	53	53
13	53	54	55	54	55	54	54	54	53	54	53	53
13.5	53	54	55	55	55	54	54	54	53	54	53	53
14	53	54	55	55	55	54	54	54	53	54	53	53
14.5	53	54	55	55	55	54	54	54	53	54	53	53
15	53	54	55	54	55	54	54	54	53	54	53	53
15.5	53	54	55	55	55	54	54	54	53	54	53	53
16	53	54	55	55	55	54	54	54	53	54	53	53
16.5	53	54	55	55	55	54	54	54	53	54	54	53
17	53	54	55	55	55	54	54	54	54	54	54	53
17.5	53	54	55	55	55	54	54	54	53	54	54	53
18	53	54	55	55	55	54	54	54	54	54	54	53
18.5	54	54	55	55	55	54	54	54	54	54	54	54
19	54	54	55	55	55	54	54	54	54	54	54	54
19.5	54	54	55	55	55	55	54	54	54	54	54	54
20	54	54	55	55	55	54	54	54	54	54	54	54
20.5	54	54	55	55	55	55	54	54	54	54	54	54
21	54	54	55	55	55	55	54	54	54	54	54	54
21.5	54	54	55	55	55	55	54	54	54	54	54	54
22	54	54	55	55	55	55	54	54	54	54	54	54
22.5	54	54	55	55	55	55	54	54	54	54	54	54
23	54	55	55	55	55	55	55	55	54	55	54	54
23.5	54	55	55	55	55	55	55	55	54	55	54	54
24	54	54	55	55	55	55	54	54	54	54	54	54
24.5	54	55	55	55	55	55	55	55	54	54	54	54
25	54	55	55	55	55	55	55	55	54	54	54	54
25.5	54	55	55	55	55	55	55	55	54	54	54	54
26	54	55	55	55	55	55	55	55	54	54	54	54
26.5	54	55	56	55	56	55	55	55	54	55	54	54
27	54	55	56	55	56	55	55	55	54	55	55	54
27.5	54	55	56	55	56	55	55	55	54	55	54	54
28	54	55	56	55	56	55	55	55	54	55	54	54
28.5	54	55	56	55	56	55	55	55	54	55	54	54
29	54	55	56	55	56	55	55	55	54	55	54	54
29.5	54	55	56	55	56	55	55	55	54	55	55	54
30	55	55	56	56	56	55	55	55	55	55	55	55
30.5	54	55	56	55	56	55	55	55	55	55	55	54
31	54	55	56	55	56	55	55	55	55	55	55	54
31.5	55	55	56	56	56	55	55	55	55	55	55	55
32	55	55	56	56	56	55	55	55	55	55	55	55
32.5	55	55	56	56	56	55	55	55	55	55	55	55

Time (min)	Cold Side Min (°F)	Cold Side Avg (°F)	Cold Side Max (°F)	Cold Side TC #1 (°F)	Cold Side TC #2 (°F)	Cold Side TC #3 (°F)	Cold Side TC #4 (°F)	Cold Side TC #5 (°F)	Cold Side TC #6 (°F)	Cold Side TC #7 (°F)	Cold Side TC #8 (°F)	Cold Side TC #9 (°F)
33	55	55	56	56	56	56	55	55	55	55	55	55
33.5	55	55	56	56	56	56	55	55	55	55	55	55
34	55	55	56	56	56	55	55	55	55	55	55	55
34.5	55	55	56	56	56	56	55	55	55	55	55	55
35	55	55	56	56	56	56	55	55	55	55	55	55
35.5	55	55	57	56	57	56	55	55	55	55	55	55
36	55	55	57	56	57	56	55	55	55	55	55	55
36.5	55	55	57	56	57	56	55	55	55	55	55	55
37	55	55	57	56	57	56	55	55	55	55	55	55
37.5	55	56	57	56	57	56	56	56	55	55	55	55
38	55	56	57	56	57	56	56	56	55	55	55	55
38.5	55	56	57	56	57	56	56	56	55	55	55	55
39	55	56	57	56	57	56	56	56	56	56	56	55
39.5	55	56	57	56	57	56	56	56	55	55	55	55
40	55	56	57	57	57	56	56	56	56	56	56	55
40.5	55	56	57	57	57	56	56	56	56	56	56	55
41	55	56	57	57	57	56	56	56	56	56	56	55
41.5	56	56	57	57	57	57	56	56	56	56	56	56
42	56	56	57	57	57	57	56	56	56	56	56	56
42.5	56	56	57	57	57	57	56	56	56	56	56	56
43	56	56	57	57	57	57	56	56	56	56	56	56
43.5	56	56	57	57	57	57	56	56	56	56	56	56
44	56	56	57	57	57	57	56	56	56	56	56	56
44.5	56	56	57	57	57	57	56	56	56	56	56	56
45	56	56	57	57	57	57	56	56	56	56	56	56
45.5	56	57	58	57	58	57	56	57	56	56	56	56
46	56	57	58	57	58	57	57	57	56	56	56	56
46.5	56	57	58	57	58	57	57	57	56	56	56	56
47	56	57	58	57	58	57	57	57	56	56	56	56
47.5	56	57	58	57	58	57	57	57	56	57	56	56
48	56	57	58	57	58	57	57	57	57	57	56	56
48.5	57	57	58	58	58	58	57	57	57	57	57	57
49	57	57	58	58	58	58	57	57	57	57	57	57
49.5	56	57	58	58	58	57	57	57	57	57	57	56
50	56	57	58	58	58	58	57	57	57	57	57	56
50.5	57	57	58	58	58	58	57	57	57	57	57	57
51	57	57	58	58	58	58	57	57	57	57	57	57
51.5	57	57	58	58	58	58	57	57	57	57	57	57
52	57	57	58	58	58	58	57	57	57	57	57	57
52.5	57	57	58	58	58	58	57	57	57	57	57	57
53	57	57	58	58	58	58	57	57	57	57	57	57
53.5	57	58	59	58	59	58	57	58	57	57	57	57
54	57	57	59	58	59	58	57	57	57	57	57	57
54.5	57	58	59	58	59	58	57	58	57	57	57	57
55	57	58	59	58	59	58	57	58	57	57	57	57
55.5	57	58	59	58	59	58	58	58	57	57	57	57
56	57	58	59	59	59	58	58	58	57	57	57	57
56.5	57	58	59	59	59	58	58	58	57	57	57	57
57	57	58	59	59	59	58	58	58	58	57	57	57
57.5	57	58	59	59	59	59	58	58	58	58	57	57
58	58	58	59	59	59	59	58	58	58	58	58	58
58.5	58	58	59	59	59	59	58	58	58	58	58	58
59	58	58	59	59	59	59	58	58	58	58	58	58
59.5	58	58	59	59	59	59	58	58	58	58	58	58
60	58	59	60	60	60	59	58	58	58	58	58	58
Max Temp	58	59	60	60	60	59	58	58	58	58	58	58
Max Allowed	377	303	379	379	379	378	378	378	378	378	378	377

Time (min)	Eng Only TC #10 (°F)	Eng Only TC #11 (°F)	Eng Only TC #12 (°F)	Eng Only TC #13 (°F)	Eng Only TC #14 (°F)	Eng Only TC #15 (°F)	Eng Only TC #16 (°F)	Eng Only TC #17 (°F)	Eng Only TC #18 (°F)
0	50	50	50	50	50	50	50	50	50
0.5	50	50	50	50	50	50	50	50	50
1	50	50	50	50	50	50	50	50	50
1.5	50	50	50	50	50	50	50	50	50
2	50	50	50	50	50	50	50	50	50
2.5	50	50	50	50	50	50	50	50	50
3	50	50	50	50	50	50	50	50	50
3.5	50	50	50	50	50	50	50	50	50
4	51	51	51	51	51	50	50	50	50
4.5	52	52	53	52	52	52	51	51	51
5	56	55	56	54	55	55	52	53	52
5.5	60	59	60	57	60	59	55	55	55
6	66	63	65	62	66	64	58	59	58
6.5	73	69	71	67	72	69	62	63	62
7	80	75	78	73	79	76	67	68	68
7.5	88	82	85	79	87	82	72	73	73
8	96	89	93	85	94	89	78	79	78
8.5	104	96	101	92	102	96	83	84	84
9	112	104	108	99	109	103	89	90	89
9.5	119	111	115	105	116	110	95	96	95
10	126	117	122	112	122	116	100	101	100
10.5	133	124	128	118	128	122	106	106	105
11	139	129	134	123	132	128	111	111	110
11.5	144	135	139	128	137	133	116	116	115
12	149	140	144	133	142	138	120	121	119
12.5	153	145	149	138	146	142	125	125	123
13	157	149	153	142	149	147	129	129	127
13.5	161	153	156	146	153	150	133	134	131
14	164	157	160	150	156	154	137	138	135
14.5	167	160	163	153	159	158	141	141	139
15	170	163	166	157	162	161	144	145	143
15.5	172	166	169	160	165	164	148	148	146
16	175	169	171	163	167	167	151	152	150
16.5	177	172	174	166	170	170	154	155	153
17	179	174	176	168	172	172	157	158	156
17.5	181	177	178	171	175	175	160	161	159
18	183	179	180	173	177	177	163	164	162
18.5	184	180	182	176	179	179	166	167	165
19	186	182	184	177	181	182	168	169	168
19.5	187	184	185	180	183	184	171	172	171
20	188	186	186	182	185	185	173	174	173
20.5	189	188	187	183	187	187	176	177	176
21	191	190	189	186	190	190	178	180	179
21.5	192	192	191	188	192	192	181	183	182
22	194	195	193	190	195	194	183	186	185
22.5	196	197	195	192	197	196	186	188	187
23	198	200	197	195	200	199	188	191	190
23.5	200	202	199	197	202	201	191	194	193
24	203	204	201	200	203	203	193	197	195
24.5	205	205	203	202	205	205	196	201	199
25	206	206	205	204	205	206	199	203	201
25.5	207	206	205	205	206	207	202	205	203
26	207	207	206	206	206	207	204	206	204
26.5	208	208	207	207	207	208	205	207	206
27	209	208	207	208	208	208	206	207	207
27.5	209	208	208	208	208	209	207	208	207
28	209	209	208	209	208	209	208	208	208
28.5	209	209	208	209	208	209	208	209	208
29	209	209	208	209	208	208	208	209	208
29.5	209	209	208	209	207	208	208	209	209
30	209	209	209	209	208	209	208	209	209
30.5	209	209	209	209	207	209	208	209	209
31	209	209	209	209	207	209	209	210	209
31.5	209	209	209	209	207	209	209	210	209
32	209	210	209	208	207	209	209	210	209
32.5	209	210	209	208	208	209	209	210	209

Time (min)	Eng Only TC #10 (°F)	Eng Only TC #11 (°F)	Eng Only TC #12 (°F)	Eng Only TC #13 (°F)	Eng Only TC #14 (°F)	Eng Only TC #15 (°F)	Eng Only TC #16 (°F)	Eng Only TC #17 (°F)	Eng Only TC #18 (°F)
33	209	210	209	209	208	210	210	210	210
33.5	210	210	210	209	208	210	210	210	210
34	210	211	210	209	208	210	210	211	210
34.5	210	211	210	209	209	211	211	211	210
35	210	211	211	209	209	211	211	211	210
35.5	211	211	211	210	210	211	211	212	210
36	211	211	211	210	210	211	211	212	210
36.5	211	211	211	210	211	211	211	212	210
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37.5	211	211	211	210	213	212	211	212	210
38	211	211	212	210	214	212	212	212	210
38.5	211	212	212	211	216	213	212	212	210
39	212	212	212	210	217	213	212	211	210
39.5	212	212	212	211	218	213	211	211	211
40	212	212	213	211	221	215	211	212	211
40.5	213	212	213	211	223	216	211	212	211
41	214	212	214	212	225	218	211	213	212
41.5	215	212	215	213	227	220	211	214	213
42	217	213	216	214	230	222	211	216	215
42.5	219	213	217	215	232	224	212	218	217
43	221	214	219	217	234	227	213	220	219
43.5	224	216	220	219	236	229	214	222	221
44	226	218	222	221	238	231	215	225	224
44.5	229	220	224	224	240	234	217	227	226
45	231	223	226	227	242	236	219	229	229
45.5	234	225	229	228	244	238	222	231	231
46	235	227	231	230	245	240	224	233	233
46.5	235	228	233	232	245	241	227	235	235
47	236	229	235	233	246	242	228	236	237
47.5	237	230	236	235	247	244	229	238	239
48	239	231	238	237	247	245	230	239	241
48.5	240	233	238	238	248	246	232	241	242
49	242	234	239	239	248	248	234	242	244
49.5	244	235	240	241	249	249	236	244	245
50	245	237	241	242	250	250	238	245	246
50.5	247	239	242	243	252	251	240	246	247
51	248	240	243	245	253	253	242	248	248
51.5	250	242	245	246	256	254	244	249	249
52	251	244	246	248	259	256	245	251	250
52.5	253	245	247	249	262	257	247	252	250
53	255	247	249	251	266	259	249	254	251
53.5	257	249	250	252	269	261	250	256	252
54	259	251	252	254	273	263	252	258	252
54.5	261	253	254	256	278	264	253	260	254
55	264	256	255	258	287	266	254	263	255
55.5	267	258	257	260	299	269	256	265	256
56	270	261	259	263	310	273	258	268	257
56.5	273	263	260	265	320	280	260	270	258
57	276	266	262	268	329	290	262	274	259
57.5	280	269	265	271	336	302	264	279	262
58	286	272	269	274	346	313	266	287	265
58.5	296	277	275	279	363	324	268	298	270
59	306	282	283	286	380	334	272	308	277
59.5	315	291	292	295	396	344	276	318	286
60	326	299	302	303	413	357	279	328	295

APPENDIX C
Photographs


01/21/2013 09:45


01/21/2013 11:10


01/21/2013 12:22


01/21/2013 12:41


01/21/2013 12:42


01/21/2013 15:12


01/22/2013 16:56


01/22/2013 16:56

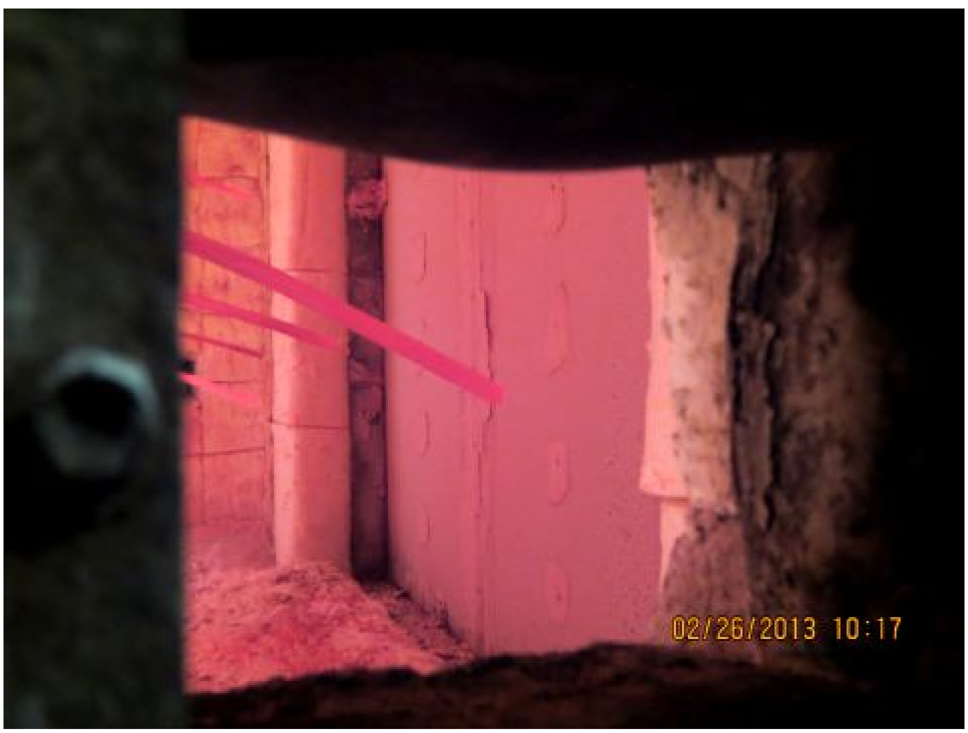

58
01/24/2013 11:27


02/25/2013 11:13


G100944630SAT-004A
02/26/2013 10:06


02/26/2013 10:11


02/26/2013 10:11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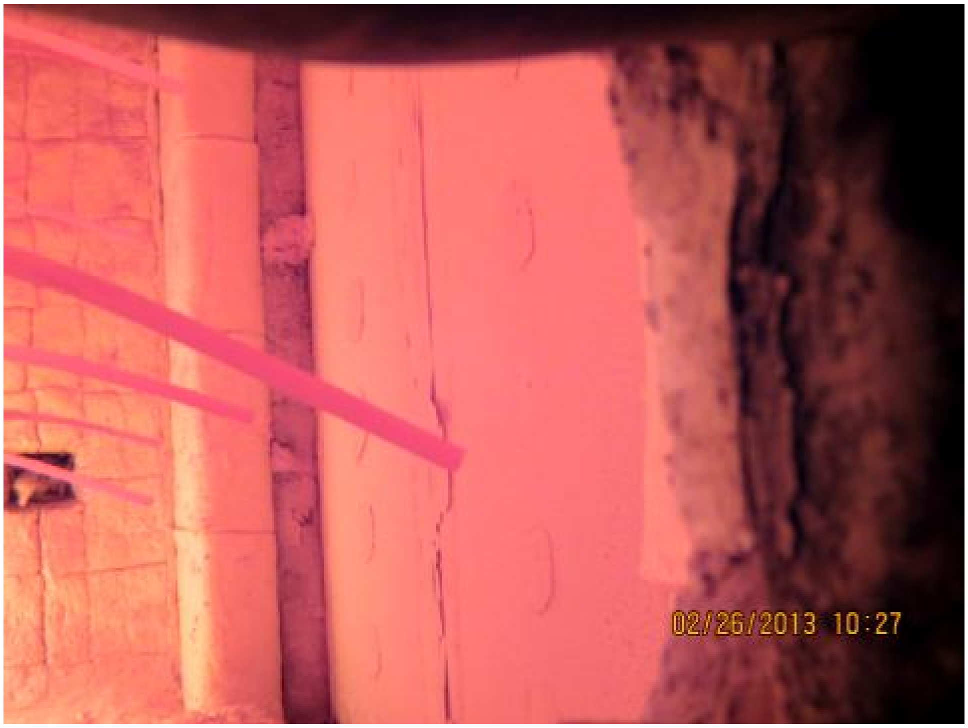
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02/26/2013 10:41


02/26/2013 10:50


G100944630SAT-004A
02/26/2013 11:03


02/26/2013 11:05


G100944630SAT-004A
02/26/2013 11:07


02/26/2013 11:09


02/26/2013 11:09


02/26/2013 11:10


02/26/2013 11:11


02/26/2013 11:11


02/26/2013 11:11


02/26/2013 11:12


G100944630SAT-004A
02/26/2013 11:12


02/26/2013 11:13

CALIBRATED INSTRUMENTATION USED FOR TESTING

Description	Serial No.	Calibration Due Date
Thermo-Hygrometer (Horizontal Furnace)	111901126	11/2/2013
100-Channel Data Acquisition System	99LE006	3/7/2013
Hose Gauge	06LE003	4/11/2013
Stop Watch	111765171	8/30/2013

REVISION SUMMARY

DATE	SUMMARY
February 28, 2013	Original Issue Date
March 28, 2013 MABrown VMBurgos	1) Inserted Revision Number and Date throughout 2) Revised “mesh” to Dryvit Grid Tape (pg 3) 3) Revised language in 3.2.4, to add “over the exterior sheathing” and revised coating thickness to approximately 12 mils dry thickness (pg 4) 4) Revised “imbedded” to “embedded”

TEST REPORT

Intertek

REPORT NUMBER: 100944630SAT-004B,D_Rev.1
ORIGINAL ISSUE DATE: February 28, 2013
REVISED DATE: April 9, 2013

EVALUATION CENTER
16015 Shady Falls Road
Elmendorf, TX 78112
Phone: (210) 635-8100
Fax: (210) 635-8101
www.intertek.com

RENDERED TO

Dryvit Systems, Inc.
One Energy Way
WEST WARWICK RI 02893

PRODUCT EVALUATED: Exterior Insulation and Finish System (EIFS) using 3" VIP Insulation Panels
EVALUATION PROPERTY: Fire Resistance

Report of Testing an Exterior Insulation and Finish System (EIFS) using 3" VIP Insulation Panels for compliance with the applicable requirements of the following criteria: *ASTM E119–12 Standard Test Methods for Fire Tests of Building Construction and Materials, January 2012 Edition.*

1 Table of Contents

2 Introduction

Intertek Testing Services NA, Inc. (Intertek) has conducted testing for Dryvit Systems, Inc., on their Exterior Insulation and Finish System (EIFS) using 3" VIP Insulation Panels, to evaluate its fire resistance. Testing was conducted in accordance with the applicable requirements of, and following the standard methods of, **ASTM E119–12 Standard Test Methods for Fire Tests of Building Construction and Materials, January 2012 Edition**. This evaluation began on February 26, and was completed on February 27, 2013.

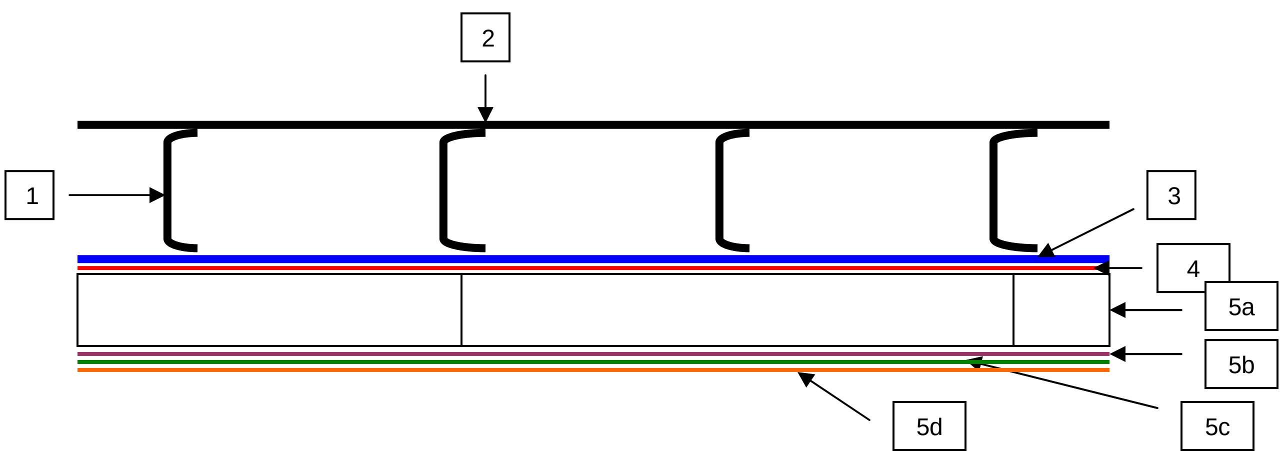
3 Test Samples

3.1. SAMPLE SELECTION

Samples were submitted to Intertek directly from the client. Samples were not independently selected for testing. Samples were received at the Evaluation Center on January 15, 2013 (San Antonio I.D. SAT1301151816-001 through SAT1301151816-008).

3.2. SAMPLE AND ASSEMBLY DESCRIPTION

An asymmetrical, 10' x 10' wall was constructed of steel studs, gypsum board, VIP Insulation panels, and a stucco exterior.



1. Framing –3-5/8" deep, 20 GA galvanized steel studs, 24" o.c., inserted (floated) into 20 GA top and bottom track.

2. Interior Sheathing – 4' x 10' x 5/8" thick, USG Sheetrock® Brand, Firecode® Core, Type X gypsum board, installed with the long edge parallel to the studs using #6 X 1-1/4" self drilling screws spaced 8" o.c. around the perimeter and 12" o.c. in the field; exposed joints and fasteners received a Level 2 finish.

3. Exterior Sheathing – 4' x 10' x 5/8" Gold Bond® Brand Fire-Shield Sheathing Type X gypsum board (National Gypsum), installed with the long edge parallel to the studs using #6 X 1-1/4" self drilling screws spaced 8" o.c. around the perimeter and 12" o.c. in the field; 4" Dryvit Grid Tape and then Backstop® NT Texture was installed over all sheathing joints.

4. Coating – Backstop® NT Texture was trowelled onto the entire wall by representatives of Dryvit Systems, Inc.; the Backstop® NT Texture was applied over the exterior sheathing resulting in an approximate dry mil thickness of 12 mils; a strip of Dryvit Standard 4.3 oz/yd^2 mesh was installed around the edge of the wall, a nominal 4" embedded in the Backstop® NT Texture and nominal 8" protruding out from the edge, providing a backwrap system for the outer edges of the perimeter panels.

5. EIF System – Exterior Insulation and Finish System (EIFS) installed over the exterior sheathing by representatives of Dryvit Systems, Inc.:

    a. Primus® mixture (1:1 Primus® mixture of Primus® and Portland cement by weight was applied to the back of the 3" thick insulation board (3" encapsulated VIP EPS composite) sections and to the outer edges of the peripheral sections, using 3/8" x 1/2" x 1-1/2" notched trowel; sections installed over the Backstop® NT Texture surface; the protruding mesh was wrapped around the peripheral panels and embedded in Primus® mixture.

    b. Primus® mixture applied over the entire insulation board surface and 4.3 oz/yd^2 mesh, applied horizontally**,** embedded with minimum 3" overlap at the joints, and smoothed over with additional Primus® mixture -- nominal thickness 1/16".

    c. The entire wall was covered with a skim coat of 1:1 Primus® / Portland cement mixture and allowed to dry.

    d. Quarzputz® Pastel Base was applied over the entire exterior surface as the finish coat on January 24, 2013.

4 Testing and Evaluation Methods

4.1. INSTRUMENTATION

The assembly was instrumented with a total of ten (10) 24 GA, Type K, fiberglass jacketed thermocouples: TCs # 1 through 9 were evenly distributed across the unexposed surface; TC #10 was positioned over a joint, over a stud. The output of the thermocouples and the furnace probes were monitored by a 100-channel Yokogawa, Inc., Darwin Data Acquisition Unit. The computer was programmed to scan and save data every 30 seconds. Following the test, the files were imported into MS Excel for tabular and graphical display (presented in Appendix B).

4.2. TEST STANDARD

Testing was conducted in accordance with the applicable requirements of, and following the standard methods of **ASTM E119–12 Standard Test Methods for Fire Tests of Building Construction and Materials, January 2012 Edition.**

The assembly was secured to the full scale vertical furnace, with the EIFS on the exposed surface, and was tested to the standard time-temperature curve described in the E119 standard.

5 Testing and Evaluation Results

5.1. RESULTS AND OBSERVATIONS

Test #1: Fire Test with the EIFS on the exposed surface: Project No. G100944630SAT-004B

The test was initiated on Tuesday, February 26, 2013. Bill Preston and Roland Serino, representing Dryvit Systems, Inc., Steve Altum, Brent Dull and Aaron Seitz, representing Dow Corning Corp., and Jesse Beitel, representing Hughes Associates, Inc., were present to witness the test. The ambient temperature and relative humidity at the time of the test was 66°F 30% R.H., respectively.

Observations made during the test are listed below:

Time (min:sec)	Observations
0:00	The test was initiated at 2:46 P.M.
2:30	There was heavy flaming on the exposed surface
4:30	There was deflecting of the exposed EIFS surface toward the furnace
9:00	Sections of the exposed surface fell from the wall; the exterior gypsum board was visible inside the furnace
38:00	There was approximately 1/4” shrinkage at the joints on the exposed surface
41:00	There was scorching of the screw heads on the unexposed surface
60:00	The burners were extinguished and the test was terminated

The test assembly withstood the fire test without passage of flame or gases hot enough to ignite cotton waste. Transmission of heat across the wall did not raise the average temperature on the unexposed surface more than 250°F above the average initial ambient temperature, or the temperature at any single thermocouple more than 325°F above the initial ambient temperature. There was no hose stream test.

Assembly drawings, the test data and photographs documenting the test are located in the Appendices of this test report.

Test #2: Hose Stream Re-Test: Project No. G100944630SAT-004D

The hose stream test was conducted on Wednesday, February 27, 2013, on a wall constructed identically to the original wall. Steve Altum, Brent Dull and Aaron Seitz, representing Dow Corning Corp., and Jesse Beitel, representing Hughes Associates, Inc., were present to witness the test. The ambient temperature and relative humidity at the time of the test was 66°F 30% R.H., respectively.

The hose stream retest requires a fire exposure of 1/2 the duration of the original wall, or 60 minutes, whichever is less. So, after 30 minutes of exposure, the assembly was removed from the furnace and the exposed (EIFS) surface was subjected to the impact, cooling and erosion effects of the standard hose stream test. The water stream was applied from a distance of 20 feet, at an angle of 90°, at a pressure of 30 psig for 60 seconds, in compliance with the standard.

Observations made during the test are listed below:

Time (min:sec)	Observations
0:00	The test was initiated at 2:36 P.M.
3:00	There was heavy flaming on the exposed surface
4:30	There was buckling of the exposed EIFS surface
13:30	The exposed surface fell from the wall; there was heavy flaming in the furnace
19:70	The gypsum board was visible inside the furnace
30:00	The burners were extinguished and the test was terminated

There was no penetration of the water stream through to the unexposed surface.

Assembly drawings, the test data and photographs documenting the test are located in the Appendices of this test report.

5.2. EXAMINATION OF RESULTS

5.2.1. Correction Factor for the Fire Endurance Test , Test #1

In accordance with the E119 test standard, a calculation for any correction to the indicated fire resistance period was done. The correction factor was then mathematically added to the indicated fire resistance period, yielding the fire resistance period achieved by this specimen:

Correction Factor for the Fire Endurance Test

ITEM	DESCRIPTION	TEST VALUE
C	correction factor	-0.24 minutes -15 seconds
I	indicated fire-resistance period	60 minutes
A	area under the curve of indicated average furnace temperature for the first three fourths of the indicated period	57918 (°F•min)
As	area under the standard furnace curve for the same part of the indicated period	58290 (°F•min)
ITEM	**DESCRIPTION**	**TEST VALUE**
L	lag correction	3240
	FIRE RESISTANCE PERIOD ACHIEVED BY THIS SPECIMEN ==>	60 minutes

Note: The standard specifies that the fire resistance be determined to the nearest integral minute. Because the correction factor is less than 30 seconds, and the test specimen met the criteria for the full indicated fire resistance period, no correction is deemed necessary.

5.2.2. Correction Factor for the Fire Endurance Test #2, Hose Stream Test

In accordance with the E119 test standard, a calculation for any correction to the indicated fire resistance period was done. The correction factor was then mathematically added to the indicated fire resistance period, yielding the fire resistance period achieved by this specimen:

Correction Factor for the Fire Endurance Test

ITEM	DESCRIPTION	TEST VALUE
C	correction factor	-0.34 minutes -20 seconds
I	indicated fire-resistance period	30 minutes
A	area under the curve of indicated average furnace temperature for the first three fourths of the indicated period	24020 (°F•min)
As	area under the standard furnace curve for the same part of the indicated period	24487 (°F•min)
ITEM	**DESCRIPTION**	**TEST VALUE**
L	lag correction	3240
	FIRE RESISTANCE PERIOD ACHIEVED BY THIS SPECIMEN ==>	30 minutes

Note: The standard specifies that the fire resistance be determined to the nearest integral minute. Because the correction factor is less than 30 seconds, and the test specimen met the criteria for the full indicated fire resistance period, no correction is deemed necessary.

5.2.3. Surface Deflection, Test #1

The deflection of the unexposed surface was measured at 3 equidistant locations, 30”, 60”, and 90” from left to right, across the horizontal midline, during the span of the test. The amount of that deflection is presented in the table below.

Time (min)	Position 1 (in)	Position 2 (in)	Position 3 (in)
0:00	0	0	0
21:00	3/8	3/8	3/8
39:00	1-5/8	1-7/8	1-5/8
58:00	1-1/8	1-1/2	1-5/8

6 Conclusion

Intertek Testing Services NA, Inc. (Intertek) has conducted testing for Dryvit Systems, Inc., on their Exterior Insulation and Finish System (EIFS) using 3" VIP Insulation Panels, to evaluate its fire resistance. Testing was conducted in accordance with the applicable requirements of, and following the standard methods of, **ASTM E119–12 Standard Test Methods for Fire Tests of Building Construction and Materials, January 2012 Edition**. This evaluation began on February 26, and was completed on February 27, 2013.

Based on the results of these tests, the asymmetric assembly withstood the effects of the fire test and the hose stream test with the 3" encapsulated VIP EPS composite exposed to the fire and achieved a fire resistance rating of 60 minutes.

The conclusions of this test report may not be used as part of the requirements for Intertek product certification. Authority to Mark must be issued for a product to become certified.

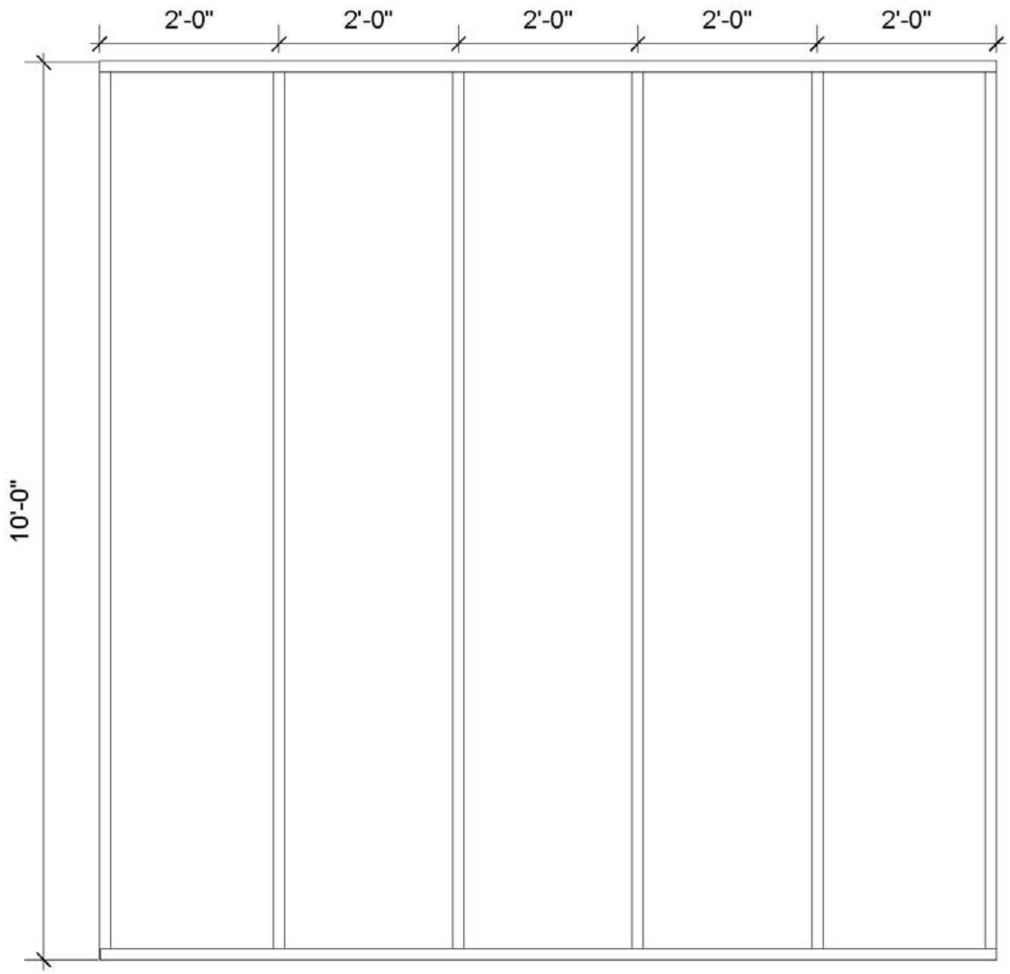
INTERTEK TESTING SERVICES NA, INC.

Tested by: ______________________
Joseph Zatopek
Test Engineer

Reported by: ______________________
Michael A Brown
Quality Supervisor / Technical Writer

Reviewed by: ______________________
Victor M. Burgos
Project Engineer, Fire Resistance

APPENDIX A
Assembly Drawings



ELEVATION VIEW

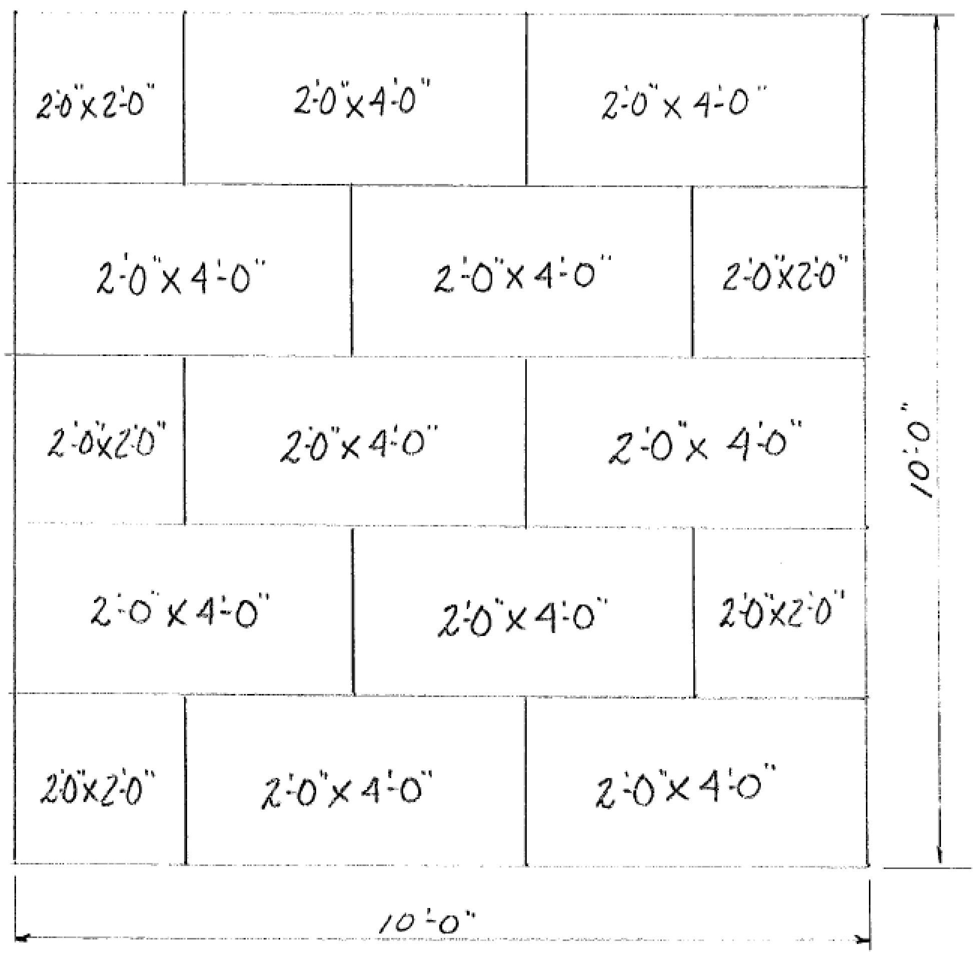
Note:

The framing consisted of 20 GA, 3-5/8 galvanized steel studs spaced 24" o.c. snapped into 20 GA track top and bottom. In the four corners, the studs were fastened to the track using #8 x 1/2" long lath head phillips self drilling screws on each side of the framing.

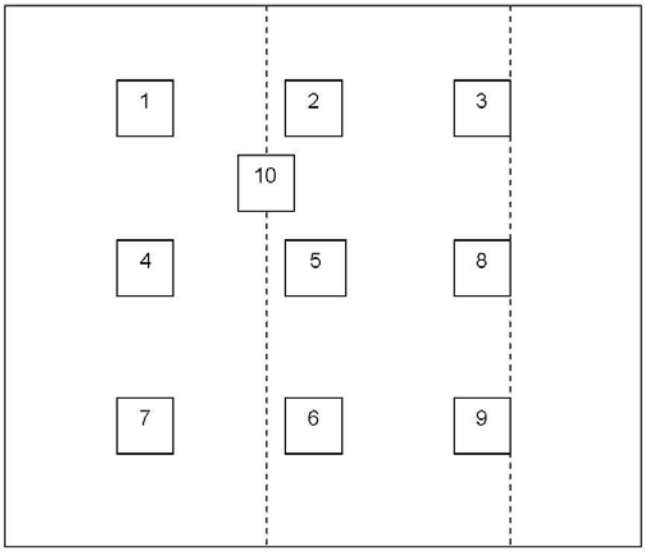
Intertek Testing Services NA, Inc. Project No. G100944630SAT-004B,D
Dryvit Systems, Inc.
Stud Layout

Scale = 1:20

Layout of VIP Insulation™ Blocks

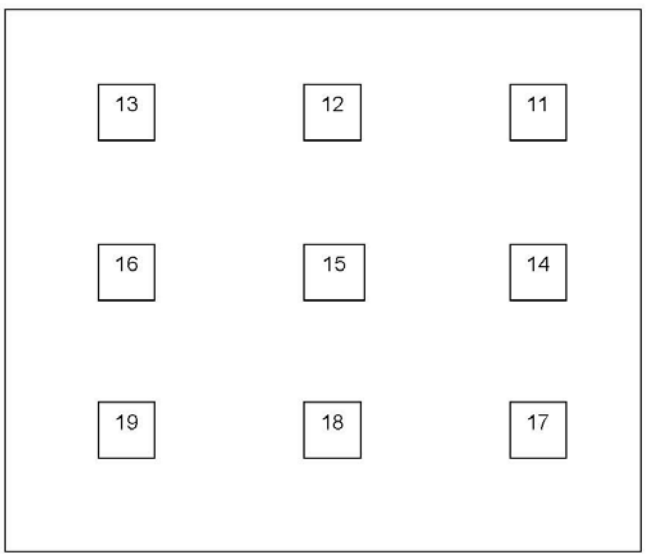


Wall Assembly:
Layout of Thermocouples



Unexposed Surface:

TC #10 located over a joint, over a stud

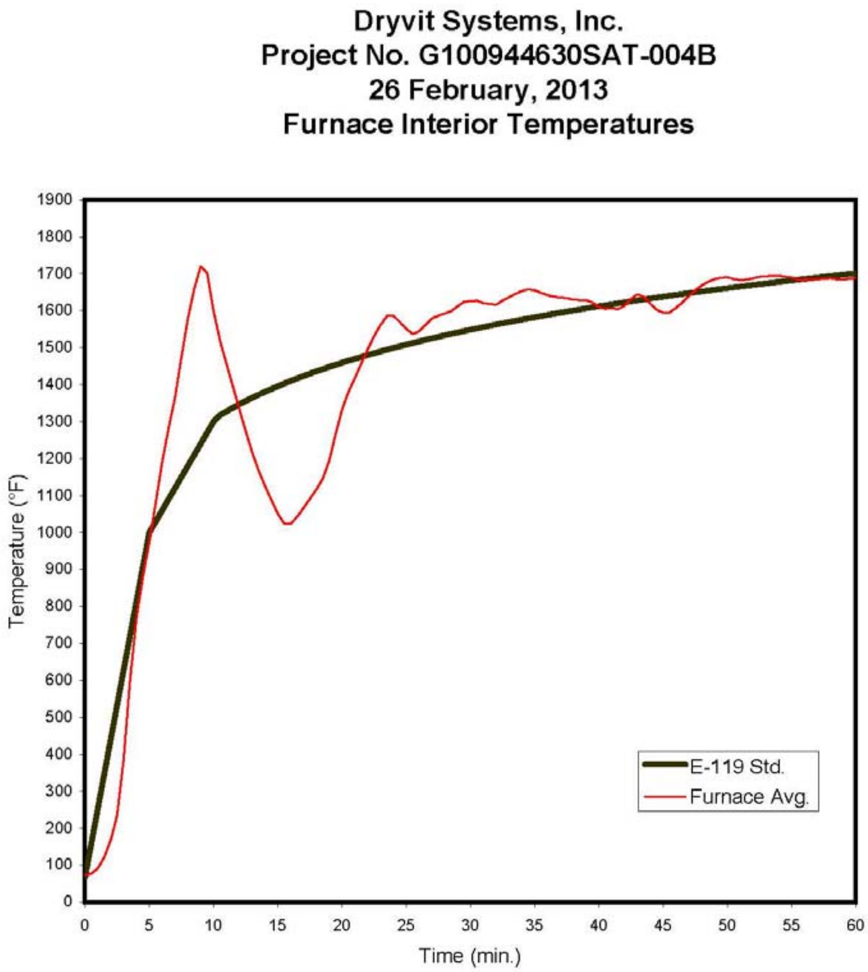


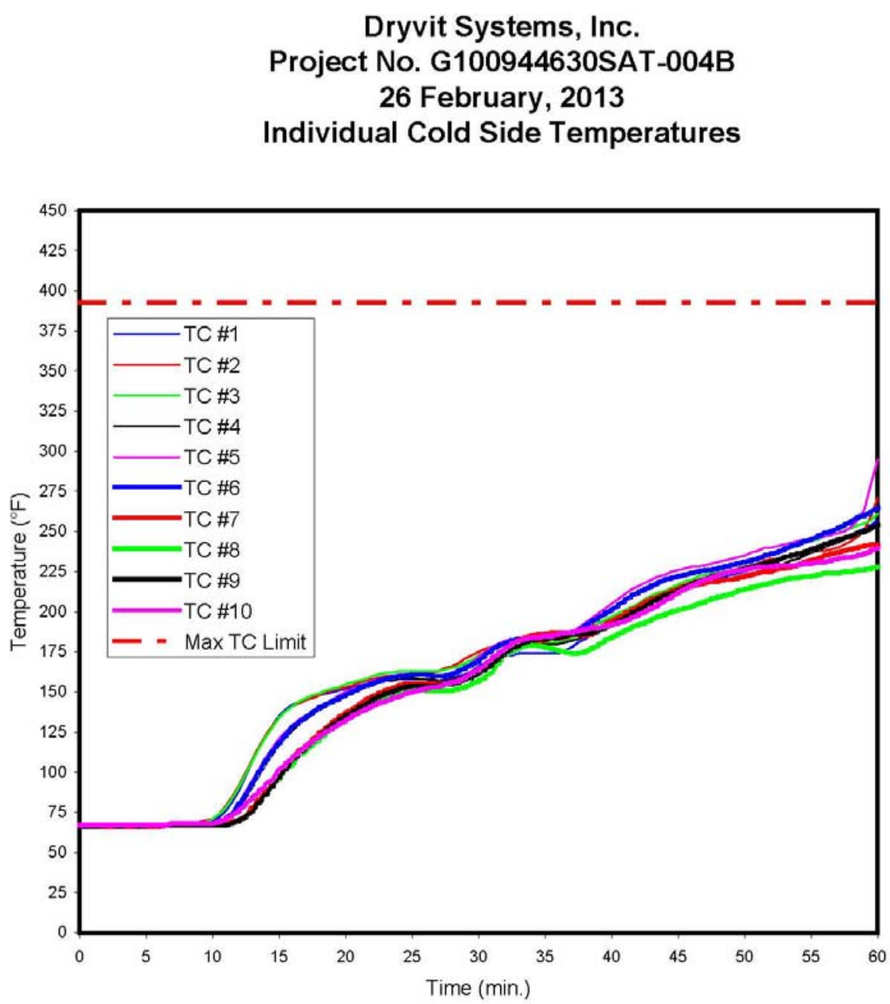
Between the Backstop® NT Texture coat and the VIP Insulation Panels

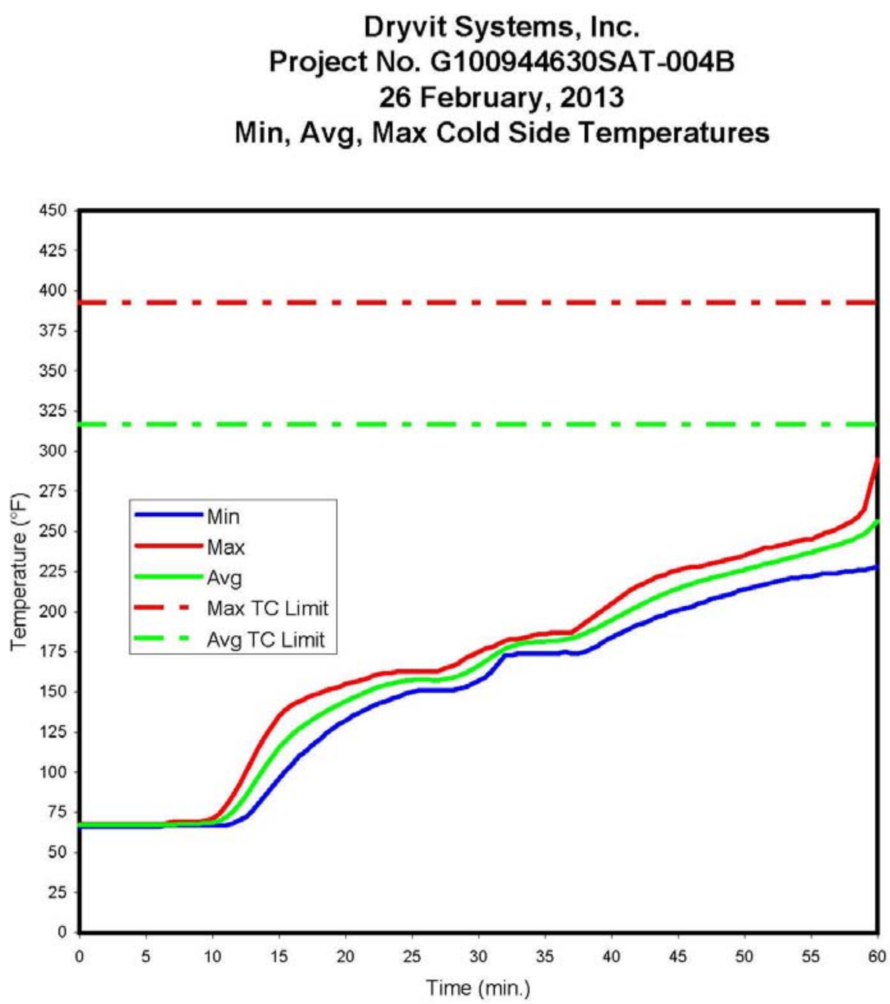
(Drawing not to scale)

APPENDIX B
Temperature Data

Test #1: G100944630SAT-004B




Dryvit Systems, Inc.
Project No. G100944630SAT-004B
26 February, 2013
Individual Cold Side Temperatures
Temperature (°F)
Time (min.)
TC #1
TC #2
TC #3
TC #4
TC #5
TC #6
TC #7
TC #8
TC #9
TC #10
Max TC Limit
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
425
450
0
5
10
15
20
25
30
35
40
45
50
55
60


Dryvit Systems, Inc.
Project No. G100944630SAT-004B
26 February, 2013
Min, Avg, Max Cold Side Temperatures
Temperature (°F)
Time (min.)
Min
Max
Avg
Max TC Limit
Avg TC Limit

Dryvit Systems, Inc. Project No. G100944630SAT-004B 26 February 2013

Time (min)	E119 Std Average (ºF)	Furnace Average (ºF)	Integration of Furnace Average (ºF•min)	Integration of E119 Std Average (ºF•min)	Error (%)	Furnace Probe #1 (ºF)	Furnace Probe #2 (ºF)	Furnace Probe #4 (ºF)
0	68	73	0	0	0.00%	74	74	74
0.5	161	77	4	23	-84.78%	78	78	81
1	254	92	12	93	-87.49%	101	98	112
1.5	348	122	31	210	-85.21%	149	139	146
2	441	168	69	373	-81.39%	218	201	201
2.5	534	236	136	583	-76.60%	318	294	282
3	627	385	258	839	-69.29%	548	522	439
3.5	720	600	470	1142	-58.86%	798	800	676
4	814	768	777	1491	-47.87%	960	979	844
4.5	907	880	1155	1887	-38.79%	1060	1077	945
5	1000	974	1585	2330	-31.99%	1176	1169	1028
5.5	1030	1081	2064	2804	-26.36%	1369	1284	1131
6	1060	1191	2598	3292	-21.07%	1544	1412	1242
6.5	1090	1282	3182	3796	-16.15%	1673	1499	1339
7	1120	1365	3810	4314	-11.68%	1749	1562	1449
7.5	1150	1474	4486	4848	-7.46%	1743	1622	1563
8	1180	1578	5215	5396	-3.36%	1741	1704	1634
8.5	1210	1660	5990	5960	0.51%	1743	1764	1679
9	1240	1720	6801	6538	4.02%	1759	1810	1716
9.5	1270	1702	7623	7132	6.89%	1749	1754	1730
10	1300	1600	8414	7740	8.71%	1630	1630	1655
10.5	1317	1520	9160	8360	9.56%	1556	1543	1571
11	1328	1457	9870	8988	9.82%	1490	1482	1508
11.5	1337	1396	10549	9620	9.66%	1428	1420	1443
12	1347	1335	11198	10257	9.18%	1370	1354	1381
12.5	1356	1275	11816	10898	8.42%	1311	1289	1320
13	1364	1218	12406	11545	7.46%	1256	1230	1262
13.5	1373	1168	12968	12195	6.34%	1211	1182	1210
14	1381	1126	13507	12849	5.12%	1172	1144	1165
14.5	1388	1088	14027	13507	3.85%	1137	1110	1125
15	1396	1051	14528	14170	2.53%	1102	1076	1088
15.5	1403	1025	15013	14835	1.19%	1077	1054	1058
16	1410	1024	15491	15505	-0.09%	1079	1059	1051
16.5	1417	1042	15973	16177	-1.26%	1098	1080	1067
17	1424	1066	16466	16854	-2.30%	1122	1107	1092
17.5	1430	1091	16972	17533	-3.20%	1147	1133	1118
18	1436	1117	17489	18215	-3.99%	1172	1159	1144
18.5	1442	1145	18021	18901	-4.66%	1199	1188	1170
19	1448	1194	18572	19590	-5.20%	1249	1241	1210
19.5	1454	1265	19152	20281	-5.56%	1322	1318	1271
20	1459	1332	19768	20975	-5.76%	1376	1381	1330
20.5	1465	1380	20412	21672	-5.82%	1417	1425	1378
21	1470	1418	21077	22372	-5.79%	1448	1457	1416
21.5	1475	1457	21762	23074	-5.69%	1481	1490	1451
22	1480	1496	22466	23779	-5.52%	1513	1521	1484
22.5	1485	1531	23189	24487	-5.30%	1539	1551	1514
23	1490	1562	23929	25196	-5.03%	1562	1576	1540

Time (min)	E119 Std Average (ºF)	Furnace Average (ºF)	Integration of Furnace Average (ºF•min)	Integration of E119 Std Average (ºF•min)	Error (%)	Furnace Probe #1 (ºF)	Furnace Probe #2 (ºF)	Furnace Probe #4 (ºF)
23.5	1495	1586	24681	25909	-4.74%	1579	1595	1562
24	1499	1587	25441	26623	-4.44%	1573	1584	1568
24.5	1504	1570	26196	27340	-4.19%	1552	1556	1552
25	1508	1551	26942	28059	-3.98%	1532	1528	1534
25.5	1513	1537	27680	28781	-3.82%	1517	1516	1519
26	1517	1544	28416	29504	-3.69%	1528	1526	1521
26.5	1521	1563	29159	30230	-3.54%	1547	1549	1536
27	1525	1579	29910	30957	-3.38%	1563	1569	1553
27.5	1529	1587	30668	31687	-3.22%	1570	1582	1563
28	1533	1593	31428	32419	-3.06%	1577	1590	1571
28.5	1537	1599	32192	33153	-2.90%	1584	1598	1578
29	1541	1612	32961	33888	-2.74%	1597	1611	1587
29.5	1545	1624	33736	34626	-2.57%	1608	1623	1598
30	1549	1626	34515	35365	-2.41%	1608	1624	1603
30.5	1552	1627	35294	36106	-2.25%	1609	1624	1604
31	1556	1620	36072	36850	-2.11%	1603	1618	1600
31.5	1559	1618	36847	37594	-1.99%	1602	1615	1597
32	1563	1616	37622	38341	-1.87%	1600	1613	1595
32.5	1566	1628	38399	39089	-1.77%	1614	1623	1602
33	1570	1636	39181	39839	-1.65%	1622	1631	1612
33.5	1573	1646	39967	40591	-1.54%	1630	1639	1620
34	1576	1653	40758	41344	-1.42%	1636	1644	1627
34.5	1579	1658	41552	42099	-1.30%	1642	1647	1632
35	1583	1655	42346	42856	-1.19%	1638	1640	1632
35.5	1586	1648	43138	43614	-1.09%	1629	1632	1625
36	1589	1642	43926	44373	-1.01%	1623	1626	1618
36.5	1592	1638	44712	45135	-0.94%	1618	1625	1614
37	1595	1636	45496	45897	-0.87%	1618	1624	1611
37.5	1598	1634	46280	46661	-0.82%	1616	1625	1610
38	1601	1630	47062	47427	-0.77%	1611	1624	1606
38.5	1604	1629	47842	48194	-0.73%	1612	1622	1605
39	1606	1629	48623	48963	-0.69%	1611	1619	1604
39.5	1609	1622	49401	49733	-0.67%	1603	1614	1598
40	1612	1609	50175	50504	-0.65%	1590	1601	1585
40.5	1615	1605	50945	51277	-0.65%	1586	1594	1579
41	1617	1606	51714	52051	-0.65%	1591	1596	1581
41.5	1620	1605	52483	52826	-0.65%	1589	1598	1582
42	1623	1613	53253	53603	-0.65%	1601	1607	1588
42.5	1625	1632	54030	54381	-0.64%	1622	1625	1605
43	1628	1644	54815	55160	-0.63%	1632	1635	1619
43.5	1631	1637	55602	55941	-0.61%	1622	1629	1617
44	1633	1618	56382	56723	-0.60%	1601	1612	1598
44.5	1636	1602	57153	57506	-0.61%	1584	1599	1579
45	1638	1595	57918	58290	-0.64%	1579	1594	1571
45.5	1640	1595	58682	59076	-0.67%	1581	1598	1572
46	1643	1608	59448	59863	-0.69%	1596	1608	1582
46.5	1645	1622	60222	60651	-0.71%	1612	1620	1597

Time (min)	E119 Std Average (ºF)	Furnace Average (ºF)	Integration of Furnace Average (ºF•min)	Integration of E119 Std Average (ºF•min)	Error (%)	Furnace Probe #1 (ºF)	Furnace Probe #2 (ºF)	Furnace Probe #4 (ºF)
47	1648	1639	61003	61440	-0.71%	1628	1635	1612
47.5	1650	1656	61793	62230	-0.70%	1643	1649	1629
48	1652	1669	62590	63022	-0.69%	1653	1659	1641
48.5	1655	1679	63393	63815	-0.66%	1661	1667	1650
49	1657	1686	64200	64608	-0.63%	1668	1673	1658
49.5	1659	1689	65010	65403	-0.60%	1669	1675	1661
50	1661	1691	65821	66199	-0.57%	1671	1677	1664
50.5	1663	1686	66631	66997	-0.55%	1665	1674	1661
51	1666	1683	67439	67795	-0.52%	1661	1671	1656
51.5	1668	1684	68247	68594	-0.51%	1665	1672	1657
52	1670	1688	69056	69394	-0.49%	1665	1677	1659
52.5	1672	1692	69867	70196	-0.47%	1670	1680	1662
53	1674	1693	70679	70998	-0.45%	1672	1679	1665
53.5	1676	1695	71492	71802	-0.43%	1674	1679	1666
54	1678	1695	72305	72607	-0.41%	1674	1679	1667
54.5	1680	1692	73118	73412	-0.40%	1672	1675	1665
55	1682	1690	73930	74219	-0.39%	1670	1674	1663
55.5	1684	1684	74739	75026	-0.38%	1663	1669	1658
56	1686	1684	75547	75835	-0.38%	1664	1669	1656
56.5	1688	1685	76355	76645	-0.38%	1666	1670	1656
57	1690	1686	77164	77455	-0.38%	1666	1671	1657
57.5	1692	1687	77973	78267	-0.37%	1666	1671	1658
58	1694	1688	78783	79079	-0.37%	1667	1672	1659
58.5	1696	1685	79592	79893	-0.38%	1663	1671	1657
59	1698	1685	80401	80707	-0.38%	1662	1671	1655
59.5	1700	1687	81210	81522	-0.38%	1665	1673	1656
60	1701	1689	82020	82338	-0.39%	1667	1675	1658

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Time (min)	Furnace Probe #5 (°F)	Furnace Probe #6 (°F)	Furnace Probe #7 (°F)	Furnace Probe #8 (°F)	Furnace Probe #9 (°F)	Furnace Probe #10 (°F)	Furnace Probe #11 (°F)	Furnace Probe #12 (°F)
0	72	74	73	72	75	73	73	74
0.5	73	74	82	75	78	75	74	76
1	81	80	107	87	96	85	80	82
1.5	102	95	149	115	138	111	96	99
2	140	120	204	159	198	153	123	127
2.5	196	161	285	228	280	216	169	169
3	289	252	456	390	454	357	265	261
3.5	477	411	703	626	690	580	426	408
4	663	583	870	802	850	752	592	548
4.5	803	719	973	913	939	870	722	656
5	916	829	1059	1003	1004	961	825	746
5.5	1022	938	1143	1101	1079	1053	927	840
6	1133	1050	1234	1199	1162	1151	1030	942
6.5	1229	1146	1306	1274	1239	1237	1122	1034
7	1307	1227	1386	1343	1328	1335	1208	1119
7.5	1414	1327	1535	1465	1481	1520	1332	1212
8	1524	1443	1650	1596	1624	1677	1473	1290
8.5	1622	1571	1737	1702	1704	1764	1590	1379
9	1720	1667	1823	1757	1738	1824	1678	1430
9.5	1732	1659	1802	1682	1767	1776	1658	1416
10	1650	1586	1677	1565	1672	1605	1555	1370
10.5	1584	1527	1588	1484	1558	1507	1472	1325
11	1526	1475	1523	1429	1467	1436	1408	1283
11.5	1473	1424	1461	1370	1386	1367	1346	1239
12	1420	1376	1402	1306	1308	1292	1284	1193
12.5	1368	1326	1340	1244	1231	1222	1223	1148
13	1316	1278	1278	1185	1161	1153	1168	1106
13.5	1267	1235	1221	1136	1103	1094	1120	1068
14	1224	1197	1170	1110	1053	1045	1079	1032
14.5	1185	1162	1124	1074	1008	1001	1041	999
15	1147	1127	1080	1037	967	961	1005	968
15.5	1116	1099	1052	1011	939	941	979	947
16	1102	1086	1058	1012	935	963	975	944
16.5	1106	1087	1080	1032	959	1004	992	960
17	1119	1093	1103	1057	994	1038	1017	983
17.5	1137	1105	1126	1084	1028	1065	1046	1011
18	1157	1119	1150	1112	1059	1094	1077	1040
18.5	1179	1136	1177	1141	1093	1134	1111	1072
19	1213	1166	1230	1191	1141	1205	1166	1117
19.5	1269	1217	1307	1268	1215	1297	1250	1185
20	1329	1274	1369	1337	1296	1374	1331	1256
20.5	1373	1316	1412	1386	1354	1425	1391	1306
21	1410	1348	1451	1428	1396	1460	1436	1346
21.5	1448	1380	1493	1469	1441	1510	1481	1385
22	1486	1417	1533	1510	1485	1552	1524	1430
22.5	1522	1455	1569	1546	1523	1587	1563	1474
23	1556	1490	1597	1580	1555	1612	1596	1516

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Time (min)	Furnace Probe #5 (°F)	Furnace Probe #6 (°F)	Furnace Probe #7 (°F)	Furnace Probe #8 (°F)	Furnace Probe #9 (°F)	Furnace Probe #10 (°F)	Furnace Probe #11 (°F)	Furnace Probe #12 (°F)
23.5	1584	1521	1620	1604	1577	1631	1621	1552
24	1595	1533	1622	1601	1580	1620	1623	1555
24.5	1586	1527	1606	1582	1563	1593	1608	1543
25	1570	1514	1588	1564	1542	1570	1590	1529
25.5	1557	1504	1573	1552	1525	1550	1572	1518
26	1559	1507	1582	1562	1524	1566	1580	1528
26.5	1573	1521	1601	1582	1538	1592	1601	1548
27	1590	1537	1616	1599	1554	1604	1619	1567
27.5	1602	1550	1619	1608	1563	1599	1622	1577
28	1610	1559	1621	1615	1568	1598	1625	1585
28.5	1617	1566	1626	1622	1574	1600	1630	1593
29	1627	1577	1641	1634	1585	1624	1645	1605
29.5	1638	1589	1654	1645	1599	1640	1658	1616
30	1643	1593	1653	1645	1605	1633	1655	1619
30.5	1645	1595	1657	1645	1607	1637	1658	1620
31	1644	1593	1646	1638	1604	1619	1644	1613
31.5	1642	1592	1645	1635	1601	1618	1644	1612
32	1640	1592	1640	1635	1598	1613	1639	1611
32.5	1646	1598	1655	1646	1604	1637	1656	1623
33	1654	1605	1666	1654	1613	1645	1667	1631
33.5	1660	1613	1677	1663	1621	1660	1679	1639
34	1667	1619	1687	1668	1630	1671	1689	1644
34.5	1672	1623	1693	1672	1636	1676	1696	1648
35	1672	1622	1690	1667	1636	1668	1693	1646
35.5	1667	1619	1682	1660	1630	1656	1685	1643
36	1662	1615	1674	1655	1624	1647	1678	1638
36.5	1659	1612	1668	1651	1620	1643	1672	1633
37	1657	1608	1666	1648	1617	1642	1672	1631
37.5	1656	1607	1663	1648	1614	1638	1668	1631
38	1652	1606	1655	1646	1611	1627	1660	1629
38.5	1650	1604	1654	1643	1609	1628	1661	1627
39	1649	1603	1655	1642	1608	1633	1663	1627
39.5	1645	1599	1648	1635	1604	1623	1654	1620
40	1634	1590	1633	1621	1593	1608	1640	1609
40.5	1627	1585	1630	1618	1587	1608	1638	1606
41	1627	1584	1632	1620	1588	1608	1637	1604
41.5	1626	1584	1627	1621	1587	1602	1631	1603
42	1631	1589	1637	1631	1593	1617	1641	1612
42.5	1645	1602	1660	1649	1607	1645	1664	1629
43	1658	1613	1675	1659	1620	1658	1679	1639
43.5	1658	1612	1665	1652	1620	1639	1665	1630
44	1644	1601	1641	1634	1607	1612	1640	1613
44.5	1630	1588	1619	1619	1591	1592	1625	1597
45	1623	1580	1609	1615	1581	1582	1618	1592
45.5	1622	1580	1608	1618	1578	1581	1616	1592
46	1630	1587	1625	1630	1585	1605	1632	1605
46.5	1641	1597	1643	1644	1598	1625	1649	1620

Time (min)	Furnace Probe #5 (°F)	Furnace Probe #6 (°F)	Furnace Probe #7 (°F)	Furnace Probe #8 (°F)	Furnace Probe #9 (°F)	Furnace Probe #10 (°F)	Furnace Probe #11 (°F)	Furnace Probe #12 (°F)
47	1655	1611	1662	1661	1613	1647	1668	1638
47.5	1669	1624	1683	1677	1629	1670	1688	1653
48	1680	1635	1698	1688	1643	1687	1704	1666
48.5	1690	1645	1711	1697	1653	1698	1716	1676
49	1698	1652	1718	1702	1661	1704	1724	1684
49.5	1704	1658	1721	1706	1664	1704	1729	1691
50	1707	1661	1723	1706	1666	1701	1729	1692
50.5	1705	1660	1716	1703	1663	1689	1719	1688
51	1703	1659	1712	1701	1661	1687	1717	1686
51.5	1702	1657	1714	1700	1663	1691	1720	1687
52	1705	1660	1718	1702	1666	1698	1725	1691
52.5	1708	1664	1723	1706	1669	1706	1730	1694
53	1709	1667	1724	1708	1672	1704	1730	1697
53.5	1711	1668	1724	1710	1673	1704	1731	1700
54	1711	1669	1724	1711	1673	1702	1733	1702
54.5	1710	1667	1721	1708	1672	1697	1728	1699
55	1708	1664	1719	1704	1672	1696	1726	1695
55.5	1703	1661	1710	1700	1667	1684	1717	1690
56	1702	1661	1710	1700	1665	1688	1719	1690
56.5	1703	1660	1713	1699	1666	1692	1721	1689
57	1703	1660	1714	1699	1667	1693	1722	1690
57.5	1704	1661	1715	1700	1667	1695	1724	1692
58	1704	1662	1718	1702	1669	1700	1726	1692
58.5	1703	1661	1715	1700	1663	1693	1723	1691
59	1702	1661	1714	1701	1661	1691	1723	1693
59.5	1703	1661	1714	1703	1663	1692	1725	1697
60	1705	1664	1716	1704	1666	1696	1727	1697

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Time (min)	Cold Side Min (ºF)	Cold Side Avg (ºF)	Cold Side Max (ºF)	Cold Side TC #1 (ºF)	Cold Side TC #2 (ºF)	Cold Side TC #3 (ºF)	Cold Side TC #4 (ºF)	Cold Side TC #5 (ºF)	Cold Side TC #6 (ºF)	Cold Side TC #7 (ºF)	Cold Side TC #8 (ºF)	Cold Side TC #9 (ºF)	Cold Side TC #10 (ºF)
0	66	67	68	68	68	68	67	67	67	66	67	66	67
0.5	66	67	68	68	68	68	67	67	67	66	67	66	67
1	66	67	68	68	68	68	67	67	67	66	67	66	67
1.5	66	67	68	68	68	68	67	67	67	66	67	66	67
2	66	67	68	68	68	68	67	67	67	66	67	67	67
2.5	66	67	68	68	68	68	67	67	67	66	67	67	67
3	66	67	68	68	68	68	67	67	67	66	67	66	67
3.5	66	67	68	68	68	68	67	67	67	66	67	67	67
4	66	67	68	68	68	68	67	67	67	66	67	67	67
4.5	66	67	68	68	68	68	67	67	67	66	67	66	67
5	66	67	68	68	68	68	67	67	67	66	67	67	67
5.5	66	67	68	68	68	68	67	67	67	66	67	67	67
6	66	67	68	68	68	68	67	67	67	66	67	67	67
6.5	67	67	68	68	68	68	67	67	67	67	67	67	67
7	67	68	69	68	69	68	67	67	67	67	67	67	68
7.5	67	68	69	68	69	68	68	67	67	67	67	67	68
8	67	68	69	68	69	69	68	68	68	67	67	67	68
8.5	67	68	69	69	69	69	68	68	68	67	67	67	68
9	67	68	69	69	69	69	68	68	68	67	67	67	68
9.5	67	68	70	69	70	69	68	68	68	67	67	67	68
10	67	69	71	70	71	71	68	68	68	67	67	67	68
10.5	67	70	74	72	74	74	68	69	69	68	67	67	69
11	67	72	79	76	79	78	70	71	71	68	67	67	71
11.5	68	75	85	82	85	84	73	75	75	69	68	68	73
12	70	80	92	89	92	91	78	81	80	70	70	70	76
12.5	72	85	100	98	100	99	84	88	86	73	72	72	80
13	76	92	108	107	108	107	91	95	93	78	76	76	84
13.5	81	98	116	115	116	115	98	102	100	83	81	81	88
14	86	104	123	123	123	122	105	109	107	88	86	86	92
14.5	91	110	129	129	129	128	111	115	113	93	91	91	96
15	96	115	135	135	134	134	117	121	118	99	96	97	101
15.5	101	120	139	139	138	138	122	125	123	104	101	102	105
16	105	124	142	142	141	141	126	129	128	108	105	107	109
16.5	110	127	144	144	143	144	130	133	131	113	110	111	112
17	113	130	146	146	145	146	133	135	134	116	113	115	116
17.5	117	133	148	147	146	148	136	138	137	120	117	119	119
18	120	135	149	148	148	149	139	141	140	124	120	122	122
18.5	124	138	151	149	150	151	141	143	142	127	124	126	125
19	127	140	152	150	151	152	144	145	144	131	127	129	127
19.5	130	142	153	151	152	153	146	148	146	134	130	132	130
20	132	144	155	152	153	155	148	150	148	137	133	135	132
20.5	135	146	156	153	154	156	150	152	150	139	135	137	135
21	137	148	157	154	156	157	151	153	152	142	138	140	137
21.5	139	150	158	155	157	158	153	155	154	145	140	142	139
22	141	152	160	156	158	160	154	157	155	147	143	145	141
22.5	143	153	161	157	159	161	156	158	157	149	145	147	143
23	144	154	162	157	160	162	157	159	158	151	147	149	144

Time (min)	Cold Side Min (ºF)	Cold Side Avg (ºF)	Cold Side Max (ºF)	Cold Side TC #1 (ºF)	Cold Side TC #2 (ºF)	Cold Side TC #3 (ºF)	Cold Side TC #4 (ºF)	Cold Side TC #5 (ºF)	Cold Side TC #6 (ºF)	Cold Side TC #7 (ºF)	Cold Side TC #8 (ºF)	Cold Side TC #9 (ºF)	Cold Side TC #10 (ºF)
23.5	146	155	162	158	160	162	157	160	159	152	148	150	146
24	147	156	163	158	161	163	158	161	160	154	150	152	147
24.5	149	157	163	158	161	163	159	161	160	155	151	153	149
25	150	157	163	158	161	163	159	161	161	155	152	154	150
25.5	151	158	163	158	162	163	158	161	161	155	152	154	151
26	151	158	163	158	162	163	158	161	161	155	151	154	152
26.5	151	157	163	157	162	163	158	161	160	155	151	154	153
27	151	157	163	157	163	163	157	160	160	155	151	154	153
27.5	151	158	165	158	165	164	157	161	160	155	151	155	155
28	151	159	166	159	166	165	158	162	161	155	151	155	156
28.5	152	160	168	160	168	166	159	163	163	156	152	156	157
29	153	162	171	161	171	168	160	165	165	158	153	158	159
29.5	155	164	173	163	173	170	162	168	167	160	155	159	162
30	157	166	175	166	175	173	164	172	169	162	157	162	164
30.5	159	169	177	168	177	175	168	175	173	165	159	164	167
31	163	172	178	170	178	177	171	178	176	168	163	167	171
31.5	168	175	180	171	179	178	173	180	179	172	168	171	174
32	173	177	182	173	180	179	176	182	180	176	173	174	177
32.5	173	179	183	173	180	180	177	183	182	180	175	177	180
33	174	180	183	174	180	180	178	183	183	182	177	179	182
33.5	174	181	184	174	180	180	179	184	183	184	179	181	183
34	174	181	185	174	180	180	179	184	183	185	179	182	184
34.5	174	182	186	174	181	180	180	185	184	186	179	183	184
35	174	182	186	174	181	180	180	185	184	186	178	183	185
35.5	174	182	187	174	181	181	180	185	184	187	177	184	185
36	174	182	187	174	182	181	180	186	185	187	176	184	186
36.5	175	183	187	176	183	182	181	186	185	187	175	185	187
37	174	184	187	178	185	183	182	187	186	187	174	186	187
37.5	174	185	190	181	187	186	183	190	188	186	174	186	188
38	175	186	193	183	189	188	185	193	191	185	175	186	189
38.5	177	188	196	186	191	190	187	196	194	186	177	187	190
39	179	190	199	189	193	193	189	199	196	188	179	188	190
39.5	182	193	202	191	194	195	191	202	199	191	182	190	191
40	184	195	205	194	196	197	193	205	201	194	184	192	192
40.5	186	197	208	196	199	199	195	208	204	196	186	194	193
41	188	199	211	198	201	201	197	211	207	199	188	196	194
41.5	190	202	214	200	203	203	199	214	210	201	190	199	196
42	192	203	216	202	205	205	200	216	212	203	192	201	198
42.5	193	206	218	204	207	208	203	218	214	206	193	203	200
43	195	208	220	206	209	210	205	220	216	208	195	206	202
43.5	197	210	222	207	211	212	207	222	218	209	197	208	204
44	198	211	223	209	213	213	209	223	220	211	198	210	207
44.5	200	213	225	211	214	215	211	225	221	213	200	211	209
45	201	215	226	212	216	217	212	226	222	214	201	213	212
45.5	202	216	227	214	217	219	214	227	223	215	202	215	214
46	203	217	228	215	219	220	215	228	224	216	203	217	216
46.5	205	219	228	217	220	222	216	228	225	217	205	219	218

Time (min)	Cold Side Min (ºF)	Cold Side Avg (ºF)	Cold Side Max (ºF)	Cold Side TC #1 (ºF)	Cold Side TC #2 (ºF)	Cold Side TC #3 (ºF)	Cold Side TC #4 (ºF)	Cold Side TC #5 (ºF)	Cold Side TC #6 (ºF)	Cold Side TC #7 (ºF)	Cold Side TC #8 (ºF)	Cold Side TC #9 (ºF)	Cold Side TC #10 (ºF)
47	206	220	229	218	221	223	217	229	226	218	206	220	220
47.5	208	221	230	219	222	224	219	230	226	219	208	222	221
48	209	222	231	221	224	225	219	231	227	219	209	223	223
48.5	210	223	232	222	224	227	220	232	228	220	210	224	224
49	211	224	233	223	225	228	221	233	229	220	211	225	225
49.5	213	225	234	224	227	229	222	234	230	221	213	226	226
50	214	226	235	225	228	231	223	235	231	222	214	227	226
50.5	215	227	237	227	229	232	224	237	232	223	215	228	227
51	216	228	238	228	230	233	225	238	233	224	216	229	228
51.5	217	230	240	229	232	235	226	240	235	225	217	230	228
52	218	231	240	231	233	236	227	240	236	225	218	231	228
52.5	219	232	241	232	233	237	229	241	237	227	219	232	229
53	220	233	242	233	234	239	230	242	239	227	220	234	229
53.5	221	234	243	235	235	240	232	243	241	228	221	235	229
54	221	235	244	236	236	241	233	244	242	229	221	236	229
54.5	222	236	245	238	236	243	235	245	244	231	222	237	230
55	222	237	245	239	237	244	237	245	245	232	222	239	230
55.5	223	238	247	241	238	245	238	246	247	233	223	240	231
56	224	240	249	242	238	247	240	247	249	235	224	242	231
56.5	224	241	250	244	239	248	242	248	250	236	224	243	232
57	224	242	252	245	240	249	243	249	252	237	224	245	233
57.5	225	243	254	247	242	251	245	250	254	238	225	246	234
58	225	245	256	248	244	252	247	253	256	239	225	247	234
58.5	226	247	259	250	247	254	248	257	259	240	226	249	235
59	226	249	264	252	251	255	250	264	260	241	226	250	236
59.5	227	252	280	254	260	257	252	280	262	242	227	252	238
60	228	257	295	257	271	261	254	295	265	242	228	254	240
Max Temp	228	257	295	257	271	261	254	295	265	242	228	254	240
Max Allowed	391	317	393	393	393	393	392	392	392	391	392	391	392

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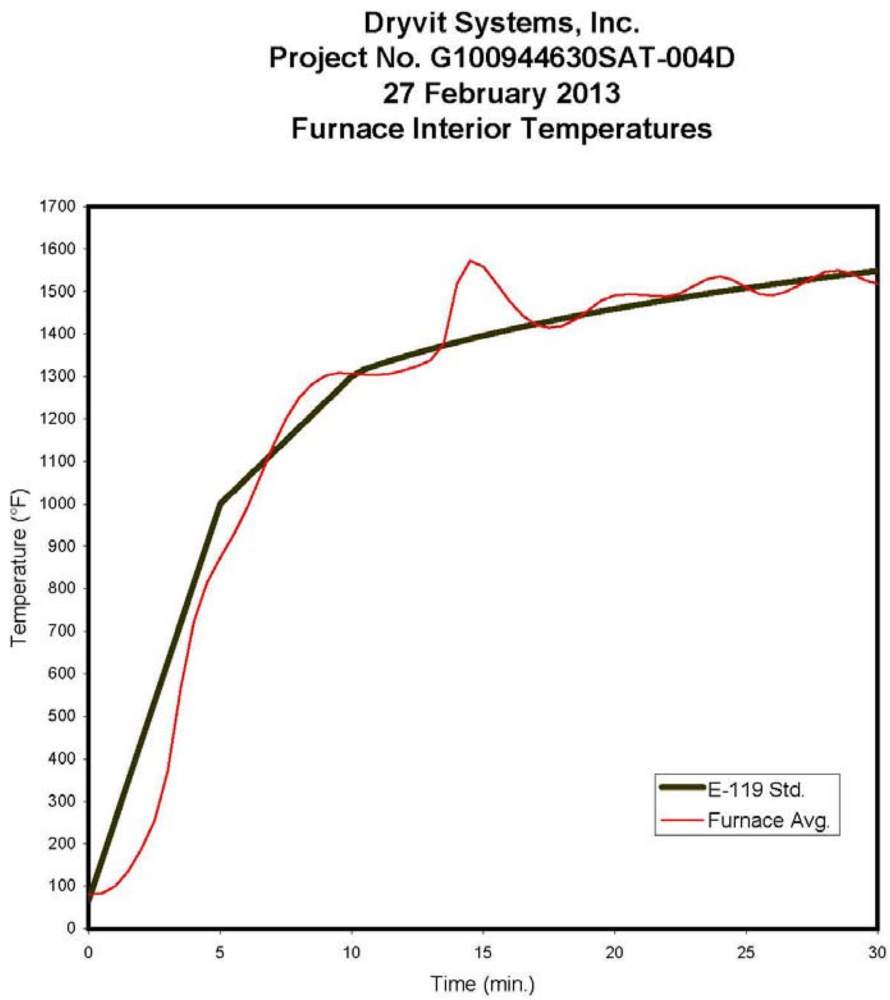
Time (min)	Eng Only TC #11 (ºF)	Eng Only TC #12 (ºF)	Eng Only TC #13 (ºF)	Eng Only TC #14 (ºF)	Eng Only TC #15 (ºF)	Eng Only TC #16 (ºF)	Eng Only TC #17 (ºF)	Eng Only TC #18 (ºF)	Eng Only TC #19 (ºF)
0	66	67	67	67	66	66	65	65	65
0.5	66	67	67	67	66	66	65	65	65
1	66	67	67	67	66	66	65	65	65
1.5	66	67	67	67	66	66	65	65	65
2	66	67	67	67	66	66	65	65	65
2.5	66	67	67	67	66	66	65	66	65
3	75	68	67	95	67	66	65	66	67
3.5	78	70	67	95	67	68	65	67	73
4	80	70	68	95	68	71	65	66	75
4.5	83	71	71	94	68	73	66	66	76
5	86	71	74	94	68	74	66	66	76
5.5	92	72	77	95	68	75	66	66	76
6	98	76	82	95	68	77	66	67	76
6.5	101	81	87	96	68	79	66	67	76
7	104	85	90	98	69	81	67	68	77
7.5	324	396	93	98	70	85	68	69	77
8	830	895	286	169	571	93	69	71	77
8.5	1423	1483	581	432	1162	381	173	179	225
9	1544	1539	865	1047	1347	689	474	1249	415
9.5	1358	1464	1579	1047	1325	1033	667	1259	653
10	1368	1463	1471	1202	1261	1175	778	1279	748
10.5	1427	1423	1485	1313	1283	1178	917	1283	833
11	1383	1386	1490	1269	1186	1132	1016	1252	911
11.5	1322	1375	1466	1061	1057	1227	1030	1196	1096
12	1310	1366	1458	954	946	1337	1049	1163	1266
12.5	1301	1362	1440	887	831	1335	909	977	1121
13	1271	1363	1439	833	771	1314	836	856	1063
13.5	1258	1364	1437	813	760	1220	820	779	1066
14	1240	1365	1436	810	717	1196	803	743	1051
14.5	1224	1366	1446	798	686	1185	774	679	1023
15	1206	1369	1443	780	961	1175	749	681	947
15.5	1191	1370	1423	898	1072	1175	870	816	970
16	1211	1370	1398	1108	1149	1188	1067	1156	1158
16.5	1249	1371	1390	1206	1186	1205	1174	1235	1267
17	1291	1377	1397	1254	1177	1228	1222	1175	1295
17.5	1322	1379	1404	1291	1262	1251	1256	1247	1310
18	1346	1382	1396	1320	1242	1273	1291	1261	1345
18.5	1363	1382	1396	1355	1363	1299	1347	1333	1367
19	1409	1380	1400	1433	1405	1329	1451	1426	1449
19.5	1469	1377	1412	1495	1666	1366	1525	1566	1535
20	1474	1375	1399	1487	1538	1402	1515	1526	1518
20.5	1477	1385	1410	1488	1411	1421	1529	1514	1537
21	1472	1362	1437	1504	1612	1435	1557	1556	1582
21.5	1476	1319	1501	1546	1618	1504	1589	1593	1656
22	1467	1313	1486	1547	1605	1497	1620	1612	1662
22.5	1437	1304	1441	1552	1596	1478	1652	1633	1664
23	1463	1378	1438	1593	1561	1481	1646	1615	1639

Time (min)	Eng Only TC #11 (°F)	Eng Only TC #12 (°F)	Eng Only TC #13 (°F)	Eng Only TC #14 (°F)	Eng Only TC #15 (°F)	Eng Only TC #16 (°F)	Eng Only TC #17 (°F)	Eng Only TC #18 (°F)	Eng Only TC #19 (°F)
23.5	1430	1401	1436	1593	1621	1485	1646	1629	1627
24	1499	1454	1448	1582	1624	1473	1584	1559	1577
24.5	1502	1475	1449	1554	1770	1459	1541	1524	1539
25	1508	1482	1447	1536	1866	1452	1510	1486	1515
25.5	1497	1496	1454	1527	1856	1474	1528	1531	1524
26	1506	1520	1461	1565	1857	1500	1584	1590	1558
26.5	1507	1529	1474	1589	1867	1514	1612	1613	1582
27	1529	1539	1473	1588	1724	1511	1599	1581	1575
27.5	1539	1536	1469	1576	1822	1506	1587	1559	1561
28	1548	1548	1476	1595	1799	1509	1599	1570	1561
28.5	1562	1571	1486	1624	1732	1516	1625	1601	1568
29	1616	1683	1501	1638	1741	1535	1667	1638	1594
29.5	1603	1603	1510	1609	1667	1535	1643	1590	1590
30	1608	1629	1513	1600	1654	1531	1635	1596	1582
30.5	1597	1578	1518	1587	1634	1528	1617	1570	1581
31	1605	1579	1523	1581	1623	1523	1617	1575	1571
31.5	1600	1569	1528	1574	1608	1523	1601	1554	1575
32	1613	1596	1536	1573	1639	1537	1631	1599	1592
32.5	1613	1612	1531	1577	1662	1552	1645	1620	1620
33	1626	1611	1549	1584	1657	1558	1649	1614	1628
33.5	1626	1630	1556	1581	1679	1572	1650	1629	1649
34	1623	1629	1569	1578	1679	1578	1640	1624	1656
34.5	1624	1626	1589	1578	1681	1584	1632	1620	1657
35	1623	1612	1613	1574	1690	1581	1621	1604	1646
35.5	1616	1596	1634	1572	1682	1577	1605	1586	1633
36	1618	1605	1648	1573	1678	1584	1614	1598	1637
36.5	1621	1601	1666	1574	1675	1588	1610	1594	1632
37	1624	1603	1679	1578	1673	1595	1613	1597	1635
37.5	1628	1589	1692	1576	1656	1599	1606	1574	1628
38	1629	1588	1702	1576	1653	1604	1606	1580	1621
38.5	1629	1590	1716	1574	1653	1609	1614	1586	1627
39	1625	1594	1731	1575	1650	1614	1619	1588	1630
39.5	1611	1575	1747	1564	1632	1611	1596	1559	1606
40	1610	1568	1789	1562	1622	1612	1595	1556	1596
40.5	1620	1578	1870	1568	1628	1622	1619	1573	1608
41	1609	1566	1883	1564	1613	1637	1592	1548	1619
41.5	1619	1571	1892	1571	1611	1628	1614	1559	1609
42	1649	1604	1872	1583	1636	1648	1676	1608	1646
42.5	1662	1626	1892	1591	1648	1667	1714	1630	1669
43	1641	1607	1891	1582	1632	1672	1681	1603	1668
43.5	1612	1579	1912	1567	1604	1676	1610	1556	1652
44	1599	1563	1901	1557	1590	1669	1582	1535	1627
44.5	1594	1554	1899	1551	1583	1670	1576	1528	1616
45	1595	1553	1911	1551	1583	1675	1587	1534	1617
45.5	1608	1562	1916	1562	1593	1680	1624	1563	1622
46	1622	1589	1918	1574	1611	1694	1662	1593	1642
46.5	1635	1603	1900	1588	1622	1710	1694	1611	1662

Time (min)	Eng Only TC #11 (°F)	Eng Only TC #12 (°F)	Eng Only TC #13 (°F)	Eng Only TC #14 (°F)	Eng Only TC #15 (°F)	Eng Only TC #16 (°F)	Eng Only TC #17 (°F)	Eng Only TC #18 (°F)	Eng Only TC #19 (°F)
47	1643	1622	1872	1602	1634	1725	1718	1628	1684
47.5	1646	1635	1870	1612	1643	1737	1729	1639	1700
48	1649	1639	1860	1620	1645	1748	1735	1640	1707
48.5	1641	1640	1862	1623	1644	1759	1724	1639	1712
49	1656	1639	1861	1640	1642	1765	1743	1640	1714
49.5	1649	1640	1843	1639	1643	1772	1732	1641	1716
50	1641	1616	1840	1646	1625	1767	1694	1611	1701
50.5	1632	1608	1834	1636	1616	1774	1685	1601	1698
51	1641	1623	1840	1644	1625	1781	1716	1624	1701
51.5	1648	1627	1852	1653	1625	1792	1725	1627	1707
52	1651	1632	1856	1659	1628	1798	1726	1632	1711
52.5	1648	1629	1865	1656	1624	1807	1725	1628	1715
53	1652	1625	1878	1663	1621	1811	1724	1625	1714
53.5	1656	1631	1865	1668	1626	1818	1728	1631	1716
54	1656	1626	1859	1670	1623	1820	1721	1627	1713
54.5	1648	1618	1858	1665	1619	1824	1713	1622	1711
55	1641	1603	1864	1661	1607	1822	1698	1606	1707
55.5	1647	1603	1871	1668	1606	1824	1708	1613	1702
56	1646	1603	1869	1668	1605	1832	1709	1613	1703
56.5	1639	1601	1868	1663	1602	1835	1697	1610	1703
57	1643	1602	1871	1668	1603	1842	1700	1612	1704
57.5	1649	1604	1862	1674	1604	1850	1707	1615	1706
58	1651	1604	1861	1676	1605	1857	1705	1618	1709
58.5	1655	1598	1861	1677	1600	1858	1697	1610	1700
59	1661	1597	1863	1681	1596	1862	1704	1610	1702
59.5	1664	1596	1863	1685	1594	1867	1705	1608	1706
60	1656	1595	1863	1680	1594	1870	1699	1607	1708

Test #1: G100944630SAT-004D



Time (min)	E119 Std Average (ºF)	Furnace Average (ºF)	Integration of Furnace Average (ºF•min)	Integration of E119 Std Average (ºF•min)	Error (%)	Furnace Probe #1 (ºF)	Furnace Probe #2 (ºF)	Furnace Probe #4 (ºF)	Furnace Probe #5 (ºF)
0	68	81	0	0	0.00%	79	81	79	78
0.5	161	84	7	23	-69.47%	82	85	83	78
1	254	100	19	93	-79.66%	107	106	108	82
1.5	348	135	44	210	-79.17%	157	152	159	97
2	441	188	90	373	-75.77%	226	216	227	134
2.5	534	254	167	583	-71.37%	311	297	309	188
3	627	370	289	839	-65.56%	478	453	434	267
3.5	720	567	489	1142	-57.14%	713	681	647	419
4	814	723	778	1491	-47.83%	867	855	796	587
4.5	907	815	1128	1887	-40.21%	949	944	876	709
5	1000	873	1516	2330	-34.92%	1007	997	922	793
5.5	1030	927	1932	2804	-31.07%	1071	1053	961	860
6	1060	988	2377	3292	-27.79%	1153	1132	1012	926
6.5	1090	1061	2855	3796	-24.77%	1242	1230	1076	1001
7	1120	1136	3370	4314	-21.87%	1326	1326	1144	1082
7.5	1150	1200	3920	4848	-19.12%	1401	1399	1205	1156
8	1180	1250	4499	5396	-16.62%	1461	1447	1250	1216
8.5	1210	1282	5098	5960	-14.45%	1501	1467	1281	1259
9	1240	1302	5710	6538	-12.66%	1504	1484	1300	1289
9.5	1270	1308	6329	7132	-11.26%	1486	1480	1309	1307
10	1300	1307	6949	7740	-10.22%	1464	1475	1310	1313
10.5	1317	1304	7567	8360	-9.48%	1439	1473	1305	1315
11	1328	1304	8186	8988	-8.92%	1418	1474	1300	1318
11.5	1337	1307	8804	9620	-8.48%	1405	1473	1298	1324
12	1347	1315	9426	10257	-8.10%	1399	1480	1301	1335
12.5	1356	1324	10051	10898	-7.77%	1399	1485	1307	1348
13	1364	1338	10683	11545	-7.46%	1405	1496	1316	1363
13.5	1373	1378	11328	12195	-7.11%	1466	1559	1343	1389
14	1381	1518	12018	12849	-6.47%	1598	1670	1473	1508
14.5	1388	1572	12757	13507	-5.56%	1611	1671	1544	1574
15	1396	1559	13505	14170	-4.69%	1573	1618	1540	1575
15.5	1403	1520	14241	14835	-4.01%	1525	1562	1508	1545
16	1410	1477	14956	15505	-3.54%	1475	1504	1464	1508
16.5	1417	1443	15653	16177	-3.24%	1435	1459	1423	1474
17	1424	1422	16335	16854	-3.08%	1410	1430	1393	1450
17.5	1430	1415	17010	17533	-2.98%	1402	1421	1376	1439
18	1436	1419	17685	18215	-2.91%	1407	1425	1376	1440
18.5	1442	1434	18364	18901	-2.84%	1427	1443	1390	1452
19	1448	1456	19052	19590	-2.74%	1453	1469	1411	1472
19.5	1454	1479	19752	20281	-2.61%	1478	1495	1432	1496
20	1459	1491	20461	20975	-2.45%	1489	1505	1446	1511
20.5	1465	1493	21173	21672	-2.30%	1490	1505	1452	1516
21	1470	1493	21885	22372	-2.17%	1488	1503	1452	1518
21.5	1475	1490	22597	23074	-2.07%	1488	1499	1454	1517
22	1480	1489	23308	23779	-1.98%	1490	1497	1458	1516
22.5	1485	1496	24020	24487	-1.91%	1501	1506	1469	1521
23	1490	1513	24738	25196	-1.82%	1521	1527	1487	1536

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Time (min)	E119 Std Average (°F)	Furnace Average (°F)	Integration of Furnace Average (°F•min)	Integration of E119 Std Average (°F•min)	Error (%)	Furnace Probe #1 (°F)	Furnace Probe #2 (°F)	Furnace Probe #4 (°F)	Furnace Probe #5 (°F)
23.5	1495	1529	25465	25909	-1.71%	1538	1546	1502	1553
24	1499	1536	26197	26623	-1.60%	1542	1552	1507	1564
24.5	1504	1527	26928	27340	-1.51%	1529	1540	1496	1560
25	1508	1510	27654	28059	-1.45%	1509	1518	1480	1546
25.5	1513	1494	28371	28781	-1.42%	1492	1498	1465	1529
26	1517	1491	29083	29504	-1.43%	1492	1495	1461	1522
26.5	1521	1499	29797	30230	-1.43%	1505	1508	1471	1528
27	1525	1515	30516	30957	-1.43%	1524	1528	1488	1542
27.5	1529	1531	31244	31687	-1.40%	1543	1549	1505	1558
28	1533	1546	31979	32419	-1.36%	1558	1567	1519	1574
28.5	1537	1550	32719	33153	-1.31%	1558	1571	1520	1581
29	1541	1542	33458	33888	-1.27%	1547	1561	1511	1577
29.5	1545	1527	34191	34626	-1.25%	1529	1541	1497	1563
30	1549	1519	34919	35365	-1.26%	1522	1532	1489	1553

Time (min)	Furnace Probe #6 (°F)	Furnace Probe #7 (°F)	Furnace Probe #8 (°F)	Furnace Probe #9 (°F)	Furnace Probe #10 (°F)	Furnace Probe #11 (°F)	Furnace Probe #12 (°F)
0	84	78	81	85	81	79	85
0.5	85	82	84	89	83	81	87
1	92	98	103	108	98	95	101
1.5	110	130	144	149	133	127	128
2	139	179	202	209	187	178	166
2.5	178	242	276	279	256	244	215
3	249	346	402	390	376	369	311
3.5	382	547	594	586	602	585	485
4	530	710	738	739	768	744	617
4.5	643	803	828	828	857	825	703
5	727	861	878	873	907	873	770
5.5	798	914	927	905	951	917	835
6	873	970	988	942	1003	970	899
6.5	961	1033	1063	989	1068	1036	971
7	1053	1099	1138	1043	1134	1103	1043
7.5	1135	1160	1203	1094	1190	1158	1104
8	1201	1207	1249	1138	1232	1201	1150
8.5	1243	1240	1279	1170	1256	1228	1183
9	1272	1260	1299	1191	1268	1245	1206
9.5	1289	1271	1308	1204	1269	1252	1217
10	1294	1273	1308	1205	1263	1251	1222
10.5	1298	1270	1307	1204	1257	1251	1229
11	1301	1269	1308	1204	1256	1256	1238
11.5	1308	1270	1312	1207	1261	1266	1250
12	1319	1278	1321	1215	1271	1278	1267
12.5	1331	1289	1332	1223	1281	1291	1283
13	1348	1303	1348	1233	1297	1308	1303
13.5	1381	1338	1381	1268	1341	1345	1342
14	1496	1483	1513	1412	1541	1555	1449
14.5	1558	1553	1562	1522	1610	1582	1510
15	1547	1554	1556	1541	1590	1554	1504
15.5	1503	1523	1518	1522	1551	1502	1456
16	1467	1485	1482	1490	1499	1449	1427
16.5	1437	1454	1451	1452	1465	1418	1410
17	1418	1432	1430	1430	1441	1402	1406
17.5	1410	1425	1422	1422	1433	1402	1411
18	1412	1428	1425	1427	1435	1412	1422
18.5	1425	1440	1440	1436	1447	1433	1441
19	1447	1460	1463	1447	1468	1462	1468
19.5	1470	1481	1487	1459	1489	1492	1494
20	1485	1493	1501	1462	1493	1505	1511
20.5	1490	1498	1506	1457	1489	1507	1516
21	1491	1500	1506	1451	1486	1505	1518
21.5	1491	1500	1504	1444	1481	1499	1514
22	1490	1500	1502	1440	1476	1494	1512
22.5	1496	1507	1509	1443	1482	1503	1520
23	1510	1523	1524	1455	1500	1523	1536

Dryvit Systems, Inc. Project No. G100944630SAT-004D 27 February 2013

Time (min)	Furnace Probe #6 (ºF)	Furnace Probe #7 (ºF)	Furnace Probe #8 (ºF)	Furnace Probe #9 (ºF)	Furnace Probe #10 (ºF)	Furnace Probe #11 (ºF)	Furnace Probe #12 (ºF)
23.5	1526	1537	1540	1467	1515	1541	1552
24	1535	1543	1548	1474	1519	1551	1558
24.5	1528	1534	1542	1472	1506	1541	1548
25	1514	1518	1526	1460	1486	1522	1533
25.5	1499	1504	1510	1445	1472	1503	1518
26	1495	1502	1505	1439	1471	1502	1515
26.5	1501	1510	1512	1442	1481	1512	1524
27	1514	1524	1526	1452	1497	1528	1538
27.5	1530	1540	1542	1466	1514	1545	1553
28	1544	1555	1557	1479	1529	1561	1566
28.5	1548	1558	1561	1486	1531	1563	1568
29	1542	1551	1555	1484	1522	1555	1560
29.5	1530	1536	1540	1473	1507	1536	1546
30	1521	1531	1531	1464	1499	1525	1538

APPENDIX C
Photographs


01/21/2013 09:45


01/21/2013 11:10


01/21/2013 12:22


01/21/2013 12:41


01/21/2013 12:42


01/21/2013 15:12


01/22/2013 16:56


01/22/2013 16:56

Test # 1: G100944630SAT-004B


02/26/2013 15:47


02/26/2013 15:49


02/26/2013 15:50


02/26/2013 15:51


02/26/2013 15:56


02/26/2013 16:03


02/26/2013 16:08

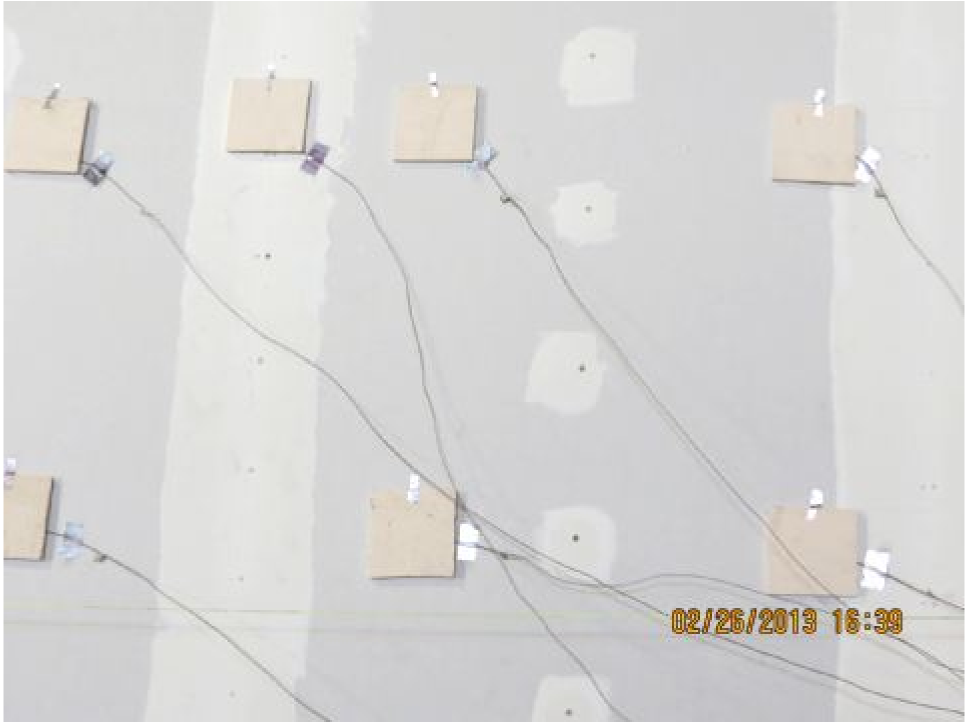

02/26/2013 16:09


02/26/2013 16:22


02/26/2013 16:29


02/26/2013 16:39


02/26/2013 16:39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Test # 2: G100944630SAT-004D


02/27/2013 15:39


02/27/2013 15:39


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02/27/2013 15:47


02/27/2013 15:55


02/27/2013 15:55


02/27/2013 15:56


02/27/2013 15:56


02/27/2013 15:57


02/27/2013 16:01


02/27/2013 16:02


02/27/2013 16:05


02/27/2013 16:05


02/27/2013 16:06


02/27/2013 16:07


02/27/2013 16:07


02/27/2013 16:08


02/27/2013 16:08


02/27/2013 16:09

CALIBRATED INSTRUMENTATION USED FOR TESTING

Description	Serial No.	Calibration Due Date
Thermo-Hygrometer (Horizontal Furnace)	111901126	11/2/2013
100-Channel Data Acquisition System	99LE006	3/7/2013
Hose Gauge	06LE003	4/11/2013
Stop Watch	111765171	8/30/2013

REVISION SUMMARY

DATE	SUMMARY
February 28, 2013	Original Issue Date
April 9, 2013 MABrown VMBurgos	1) Inserted Revision Number and Date throughout 2) Revised “mesh” to Dryvit Grid Tape (pg 3) 3) Revised language in 3.2.4, to add “over the exterior sheathing” and revised coating thickness to approximately 12 mils dry thickness (pg 4) 4) Revised “imbedded” to “embedded” throughout

TEST REPORT

Intertek

REPORT NUMBER: 100944630SAT-002_Rev.1
ORIGINAL ISSUE DATE: February 28, 2013
REVISED DATE: April 9, 2013

EVALUATION CENTER
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Elmendorf, TX 78112
Phone: (210) 635-8100
Fax: (210) 635-8101
www.intertek.com

RENDERED TO

Dryvit Systems, Inc.
One Energy Way
WEST WARWICK RI 02893

PRODUCT EVALUATED: Exterior Insulation and Finish System (EIFS) using VIP Insulation Panels
EVALUATION PROPERTY: Fire Resistance

Report of Testing an Exterior Insulation and Finish System (EIFS) using VIP Insulation Panels for compliance with the applicable requirements of the following criteria: *NFPA 285 Standard Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components, 2006 Edition.*

1 Table of Contents

2 Introduction

Intertek Testing Services NA, Inc. (Intertek) has conducted testing for Dryvit Systems, Inc., on their Exterior Insulation and Finish System (EIFS) using VIP Insulation Panels, to evaluate its fire resistance. Testing was conducted in accordance with the applicable requirements of **NFPA 285 Standard Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components, 2012 Edition**. This evaluation took place on February 26, 2013.

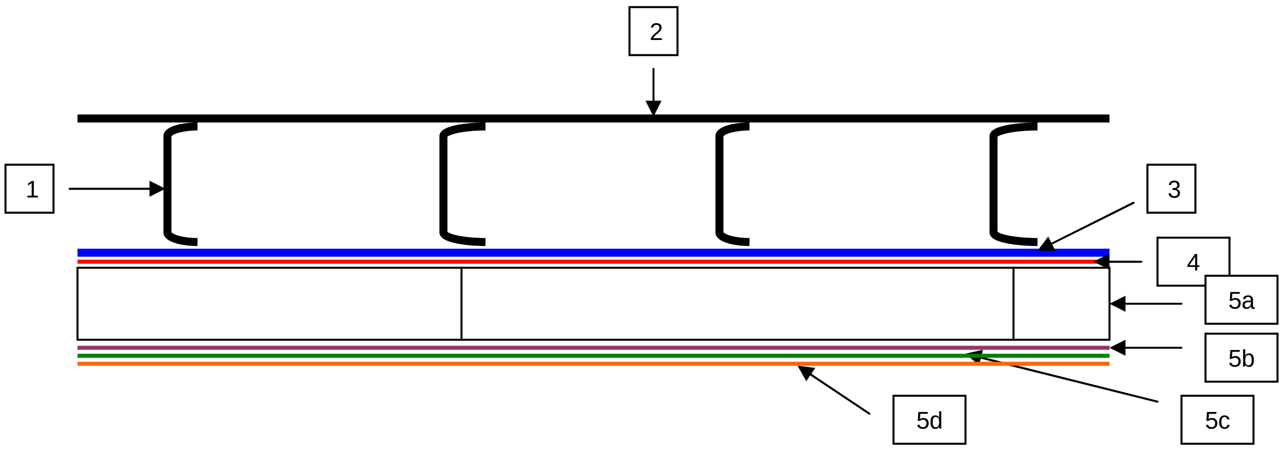
3 Test Samples

3.1. SAMPLE SELECTION

Samples were submitted to Intertek directly from the client. Samples were not independently selected for testing. Materials for the construction of the assembly were received at the Evaluation Center on January 15, 2013 (San Antonio I.D. SAT1301151816-001 through SAT1301151816-008).

3.2. SAMPLE AND ASSEMBLY DESCRIPTION

The 18' high X 14' ISMA test wall was constructed using steel studs, interior and exterior sheathing and the Dryvit EIFS System.



1. Framing –3-5/8" deep, 20 GA galvanized steel studs, 24" o.c., inserted into 20 GA at the top and bottom track; secured front and back with #8 x 1/2" long lath head screws to at each stud.

2. Interior Sheathing – 4' x 10' x 5/8" thick, USG Sheetrock® Brand, Firecode® Core Type X gypsum board (National Gypsum), installed with the long edge perpendicular to the studs using #6 X 1-1/4" self drilling screws spaced 8" o.c. around the perimeter and 12" o.c. in the field; exposed joints and fasteners received a Level 2 finish.

3. Exterior Sheathing – 4' x 8' x 1/2" DensGlass® Gold Exterior Sheathing (Georgia Pacific) installed over exterior side, with the long edge perpendicular to the studs; secured with #6 X 1-1/4" self drilling screws, spaced 8" o.c. around the perimeter and 12" o.c. in the field; 4" Dryvit Grid Tape and then Backstop® NT Texture was installed over all sheathing joints.

4. Coating – Backstop® NT Texture was trowelled onto the entire wall by representative for Dryvit Systems, Inc. The Backstop® NT Texture was applied over the exterior sheathing resulting in an approximate dry mil thickness of 12 mils; a strip of Dryvit Standard 4.3 oz/yd^2 mesh was installed around the edge of the window opening, a nominal 4" embedded in the Backstop® NT Texture.

5. EIF System – Exterior Insulation and Finish System (EIFS) installed over the exterior sheathing by representatives of Dryvit Systems, Inc., on January 22 through 24, 2013.

   a. Primus® mixture (1:1 Primus® mixture of Primus® and Portland cement by weight) was applied to the back of the 3-3/4" thick insulation board (3-3/4" encapsulated VIP EPS composite) sections and to the outer edges of the panels whose ends would be exposed, e.g., the expansion joint, wall perimeter, and window perimeter using 3/8" x 1/2" x 1-1/2" notched trowel; sections installed over the Backstop® NT Texture surface; the protruding mesh was wrapped around the peripheral panels and embedded in Primus® mixture.
   b. Primus® mixture applied over the entire insulation board surface and 4.3 oz/yd^2 mesh, applied horizontally, (starting at the top), embedded with minimum 3" overlap at the joints, and smoothed over with additional Primus® mixture -- nominal thickness 1/16"
   c. The entire wall was covered with a skim coat of 1:1 Primus® / Portland cement mixture and allowed to dry.
   d. Quarzputz® Pastel Base was applied over the entire exterior surface as the finish coat on January 24, 2013.
   e. 5/8" backer rod was installed in the expansion joint and recessed 3/8". Dow Corning ® 790 Silicone building Sealant was installed over the backer rod flush with the exterior of the wall (not shown).

4 Testing and Evaluation Methods

4.1. INSTRUMENTATION

Fifty-four (54) 24 GA, Type K, fiberglass jacketed thermocouples were installed in compliance with the standard (see Appendix A). The output of the thermocouples was monitored by a 100-channel Yokogawa, Inc., Darwin Data Acquisition Unit. The computer was programmed to scan and save data every 15 seconds. Following the test, those files were imported into MS Excel for tabular and graphical display (presented in Appendix B).

4.2. TEST STANDARD

Testing was conducted in accordance with the applicable requirements of, and following the standard methods of **NFPA 285 Standard Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components, 2012 Edition.**

The assembly was secured to the test laboratory's Intermediate-Scale, Multi-story Test Apparatus (ISMA), with ceramic fiber insulation installed between the assembly and the furnace to create an effective seal. The window burner was centered on the vertical centerline of the window, 9" below the top of the opening, and with the longitudinal centerline of the burner 3" from the plane of the exterior wall, consistent with the standard and the calibration of the test apparatus. The assembly was tested to the time-temperature curve described in the NFPA 285 standard, using commercial grade propane gas.

5 Testing and Evaluation Results

5.1. RESULTS AND OBSERVATIONS

The test was initiated on Tuesday, February 26, 2013. Bill Preston and Roland Serino, representing Dryvit Systems, Inc., Steve Altum, Brent Dull and Aaron Seitz, representing Dow Corning Corp., and Jesse Beitel, representing Hughes Associates, Inc., were present to witness the test. The ambient temperature at the time of the test was 63°F and humidity was 33% R.H. The Maximum TC Limits, established by the initial thermocouple temperatures and the test standard, are presented in the following table:

Location	TCs	Max TC Limit
Exterior Surface	11, 14 - 17	1000ºF
Core	18 – 19; 28, 31 - 40	750ºF rise
2nd floor Interior Surface	49 - 54	500ºF rise

Observations made during the test are listed below:

Time (min:sec)	Observation
0:00	The test was initiated at 11:35 A.M.
1:25	Ignition of exposed side gypsum board paper caused flames to projected out the window
1:56	The gypsum board paper was consumed, the flames receded into burn room
3:00	There were indentations in the exterior surface where the EPS was melting
5:00	The window burner was ignited
6:00	There was ignition of the exterior surface above the window
6:30	There was ignition of the surface above the window opening to the 7' mark, with flame reaching to 9'
7:00	Flames on the exterior surface receded to 5' above the window opening
8:00	The flames were back to the top of the window opening
10:00	There was no visible change
13:00	Flames continued along the header of the window opening
15:00	There was no visible change
17:00	There were indentations in the exterior surface around the flame plume and around the VIP panels; flames continued at the window header
20:00	There was no visible change

23:30	Exterior finish started flaking from the wall from 2' to 3'.
26:30	There was discoloration at the left side of the window opening at the 5' mark
28:00	Discoloration and smoke continued at the left side of the window opening
30:00	The burners were extinguished; the observation period began
35:00	Smoke continued at the sample
40:00	The observation period ended, the test was terminated; smoke continued to the end

Time (min:sec)	Observations from the 2nd Floor Room
3:45	There was light smoke at the center of the wall above the angle
6:30	There was light smoke from the lower angle
12:05	There was light smoke from the left side of the wall
13:28	There was steam at the top center of the wall at the ceiling
21:16	The amount of smoke had increased at the center of the wall at the angle
24:00	The amount of smoke had increased from the left side of the wall
26:21	There was moisture dripping from the top of the wall
33:00	The amount of moisture dripping from the ceiling had increased

Flames on the exterior panels were within the established limit during the test (10' above the top of the window, 5' beyond the side of the window); there were no flames that spread through the core components or infiltrated the second story room; none of the thermocouples exceeded their maximum limits.

Assembly drawings, the test data and photographs documenting the test are located in the Appendices of this test report.

6 Conclusion

Intertek Testing Services NA, Inc. (Intertek) has conducted testing for Dryvit Systems, Inc., on their Exterior Insulation and Finish System (EIFS) using VIP Insulation Panels, to evaluate its fire resistance. Testing was conducted in accordance with the applicable requirements of **NFPA 285 Standard Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components, 2012 Edition**. This evaluation took place on February 26, 2013.

Based on the results from this test, the assembly met the conditions of acceptance of the above mentioned standard.

.

The conclusions of this test report may not be used as part of the requirements for Intertek product certification. Authority to Mark must be issued for a product to become certified.

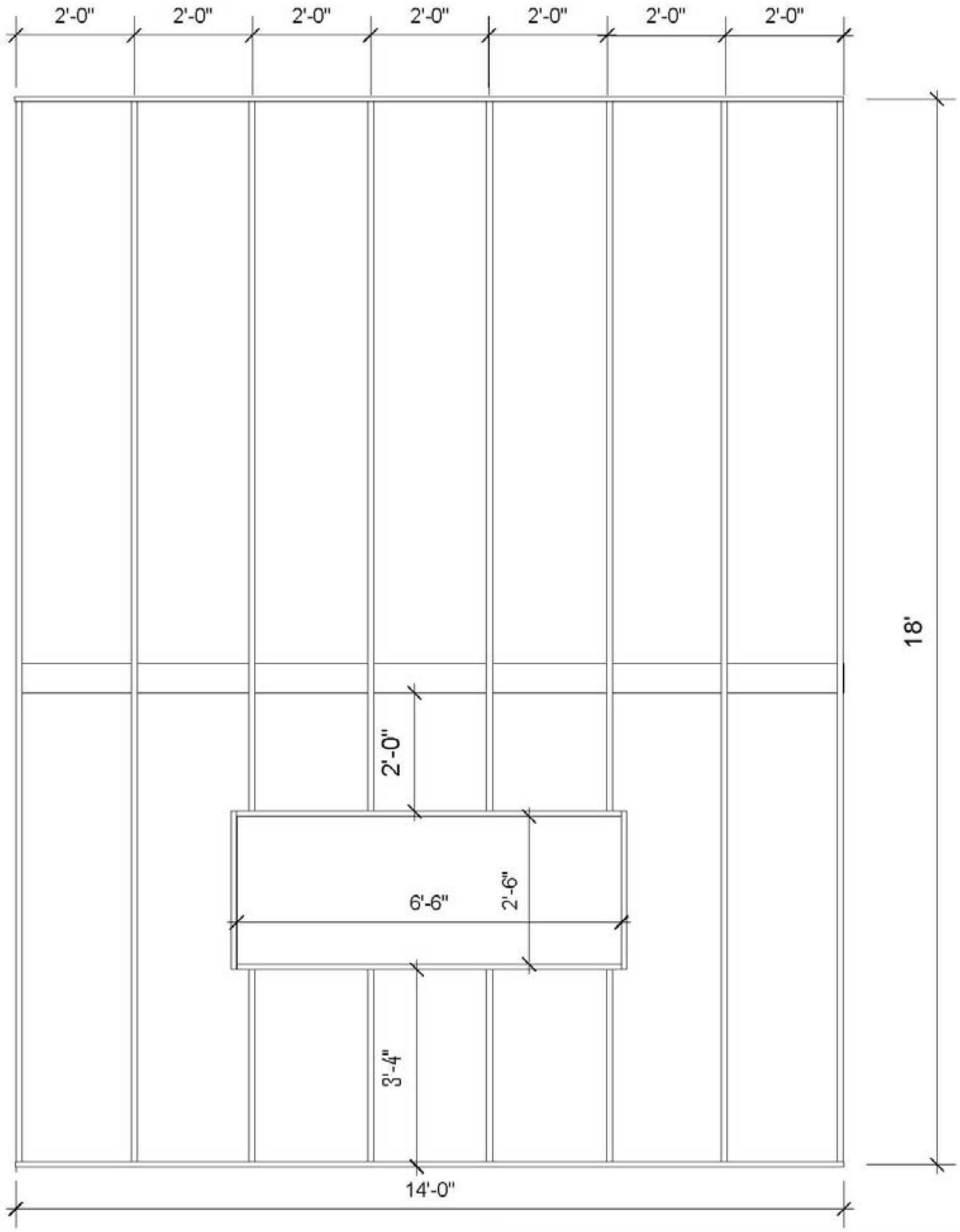
INTERTEK TESTING SERVICES NA, INC.

Tested by: ________________________
Joseph Zatopek
Test Engineer

Reported by: ________________________
Michael A Brown
Quality Supervisor / Technical Writer

Reviewed by: ________________________
Victor M. Burgos
Project Engineer, Fire Resistance

APPENDIX A
Assembly Drawings



Note:
The wall was framed using 3-5/8", 20GA galvanized steel studs spaced 24" o.c.; fastened to top and bottom 20GA galvanized steel track using #8 x 1/2" long lath head screws at each location.

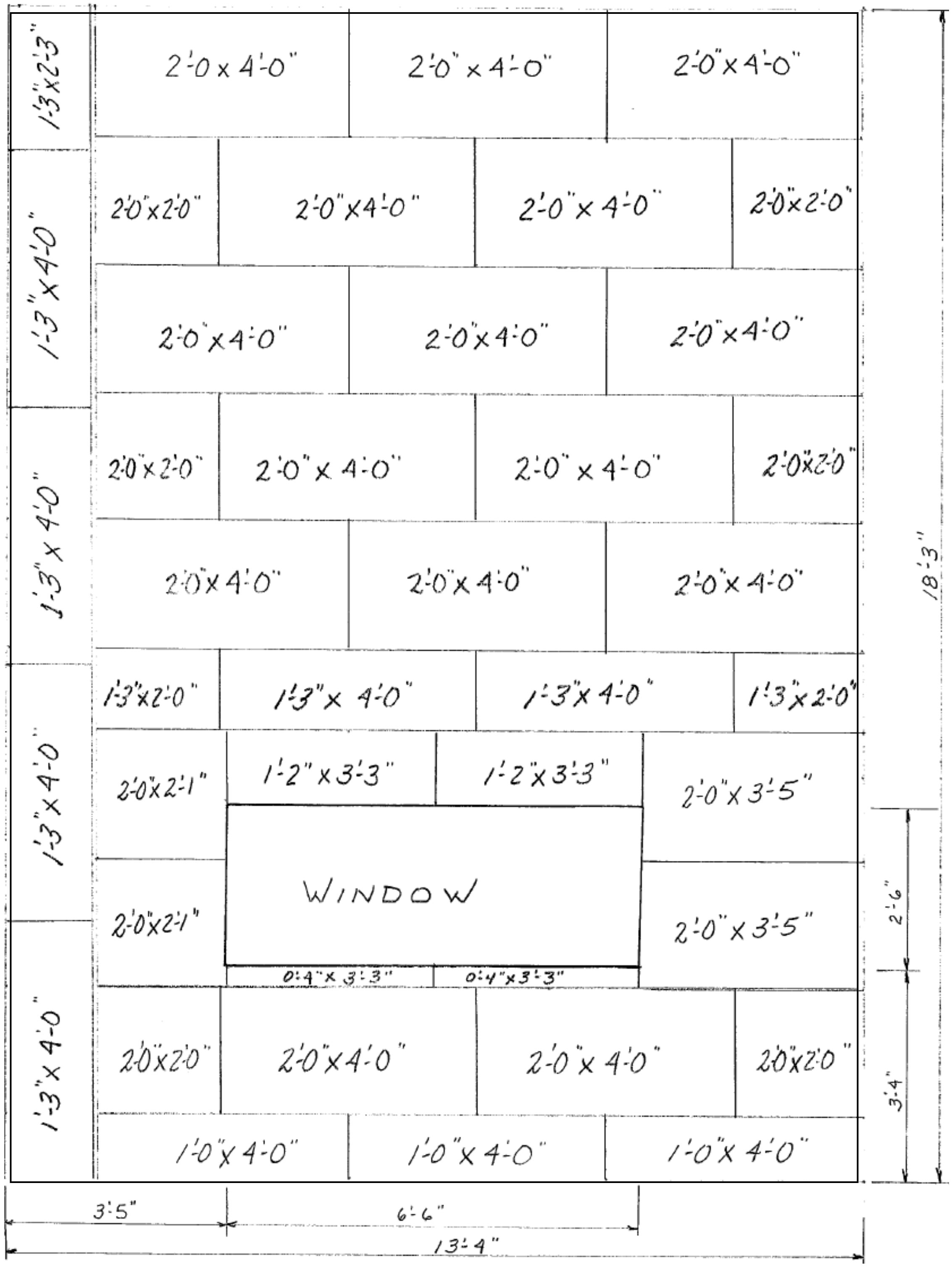
INTERTEK TESTING SERVICES NA, INC.

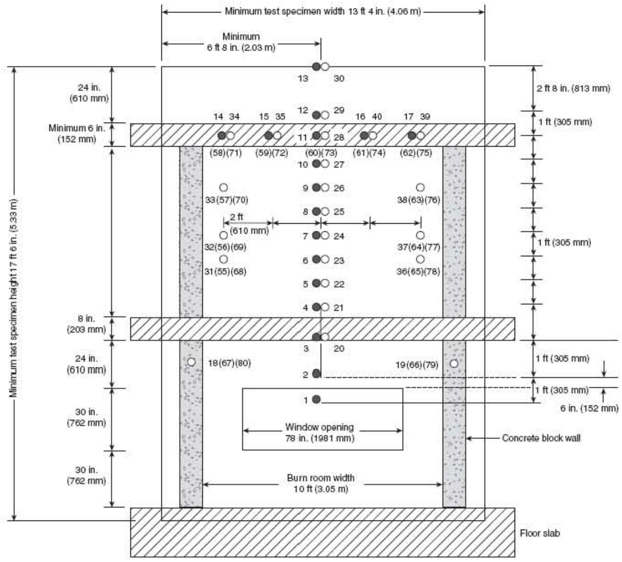
Project No. G100944630SAT-002

Dryvit Systems, Inc.

Steel Framing

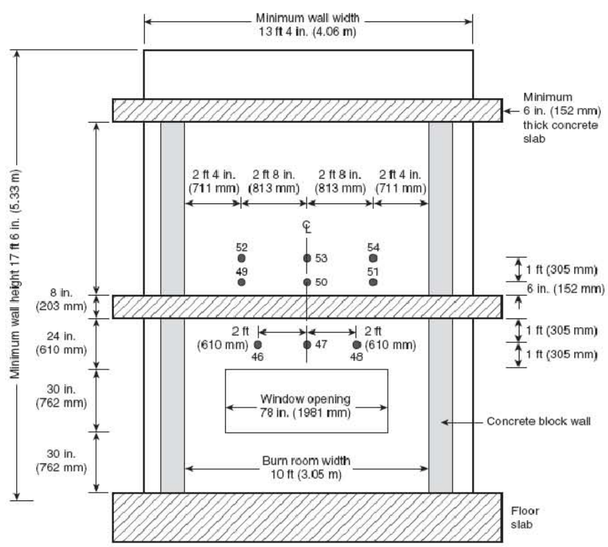
Insulation Panel Layout





● Thermocouples — 1 in. (25 mm) from exterior wall surface
○ Thermocouples — In the wall cavity air space or the insulation, or both, as shown in Figure 6.1(b) Details A through I.
( ) Thermocouples — Additional thermocouples in the insulation or the stud cavity, or both, where required for the test specimen construction being tested, as shown in Figure 6.1(b) Details C through I.

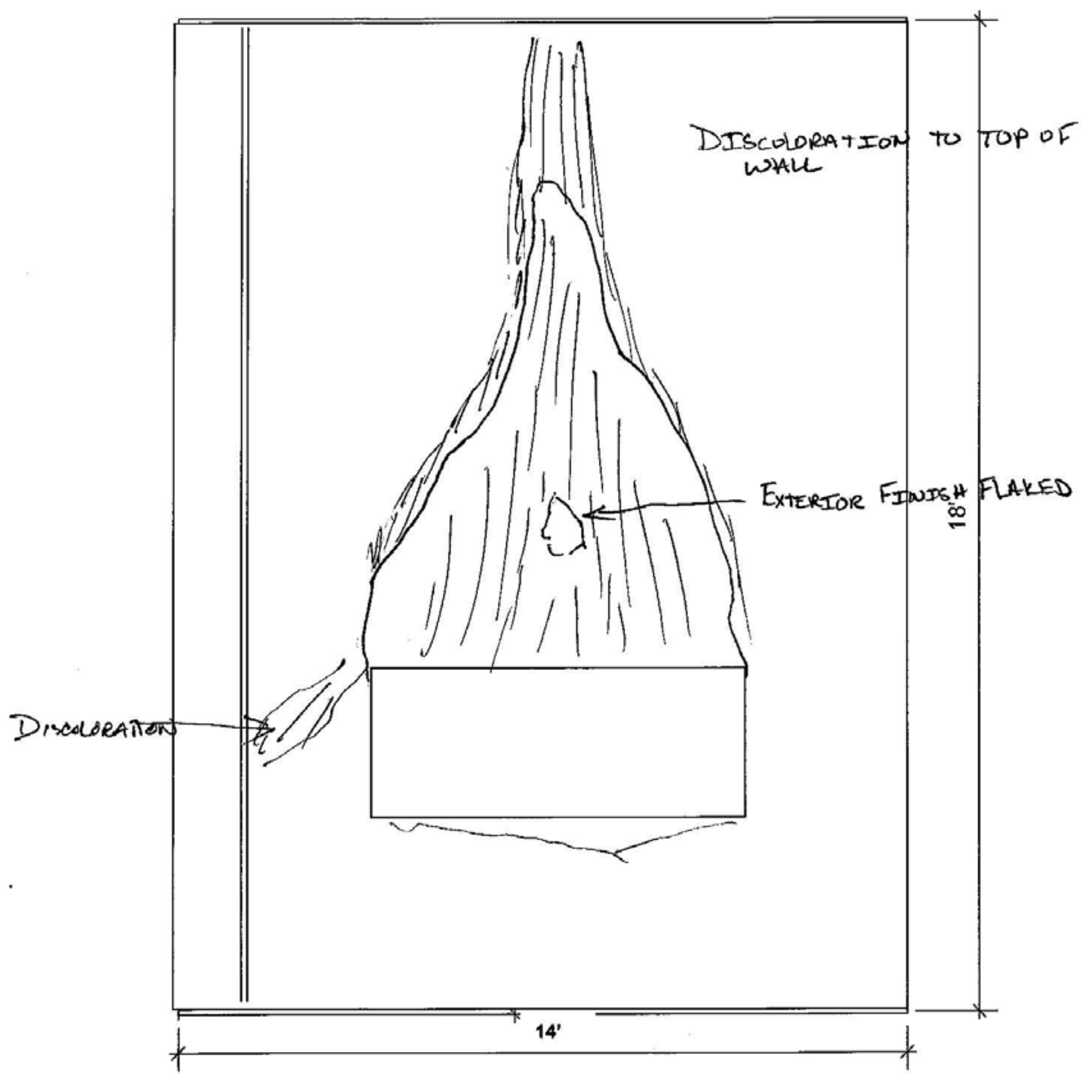
FIGURE 6.1(a) Front View of Test Specimen Superimposed over Test Apparatus Thermocouple Locations.



● Thermocouples — 1 in. (25 mm) from interior wall surface

FIGURE 6.1(c) Interior View of the Test Specimen. Instrumentation arrangement.

Source: NFPA 285 Standard Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components; 2012 Edition, Pgs 10, 14..



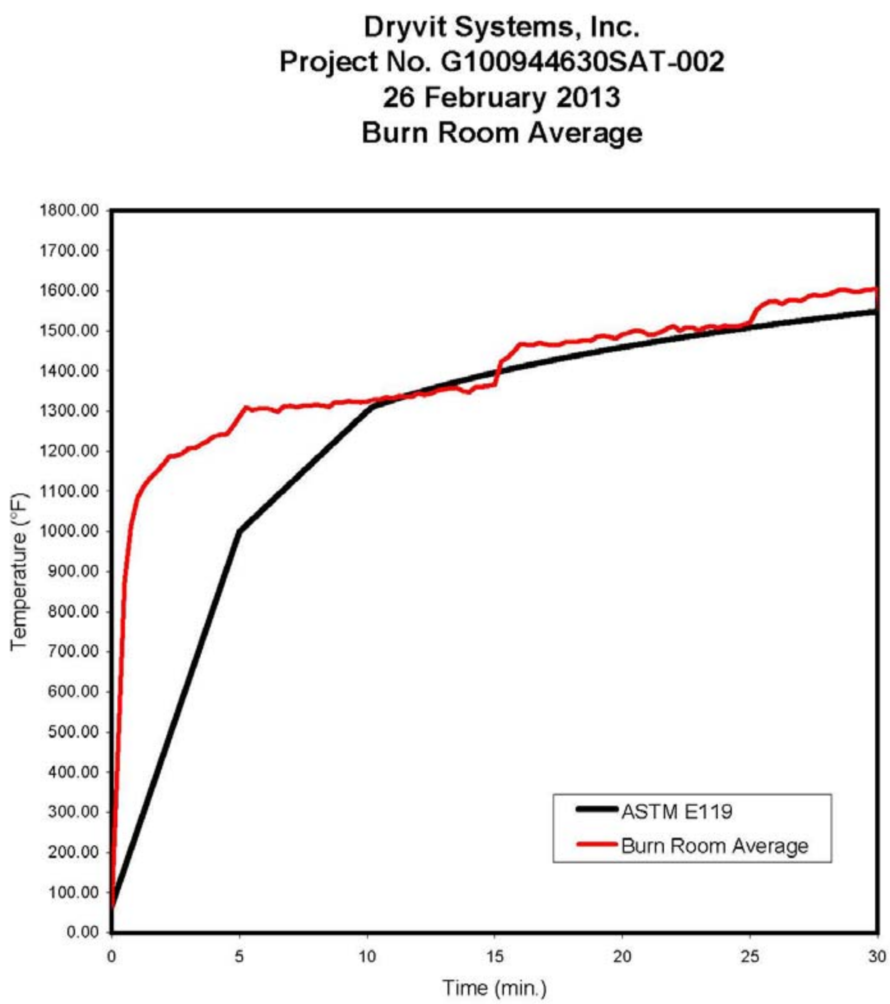
INTERTEK TESTING SERVICES INC., NA

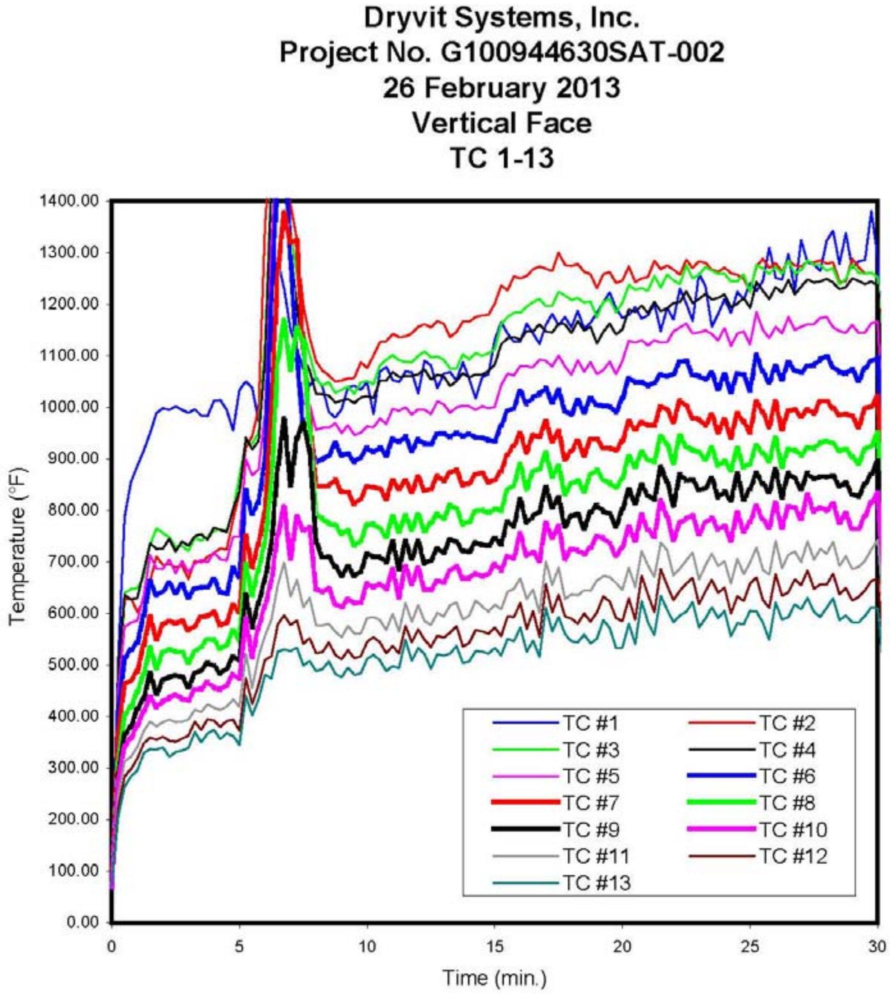
Project No G100944630SAT-002

Dryvit Systems, Inc.

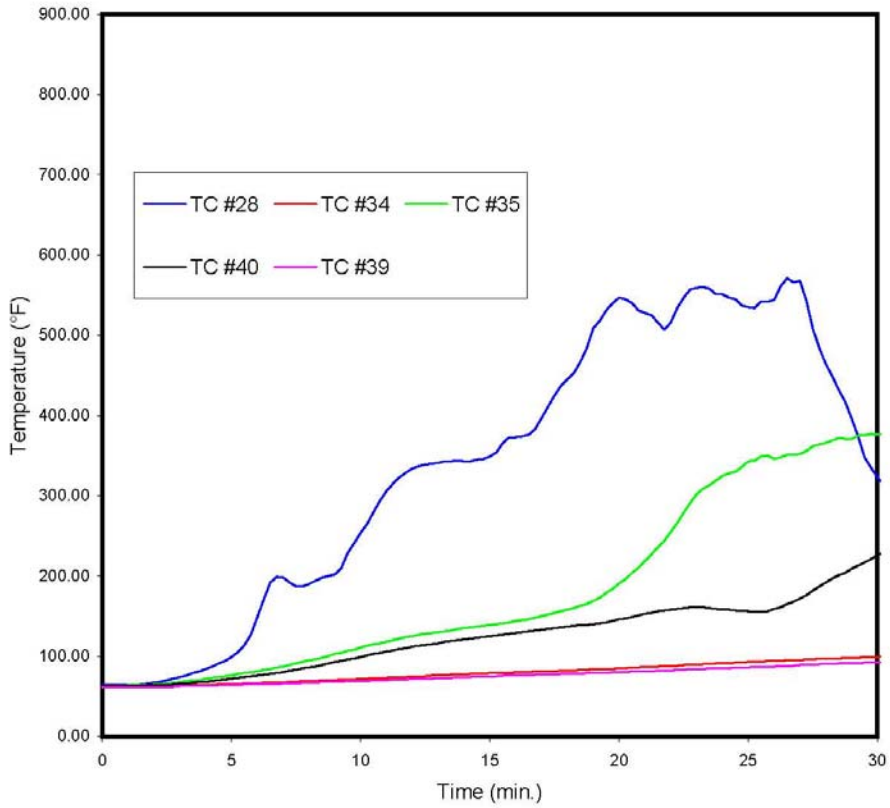
Damage Sketch

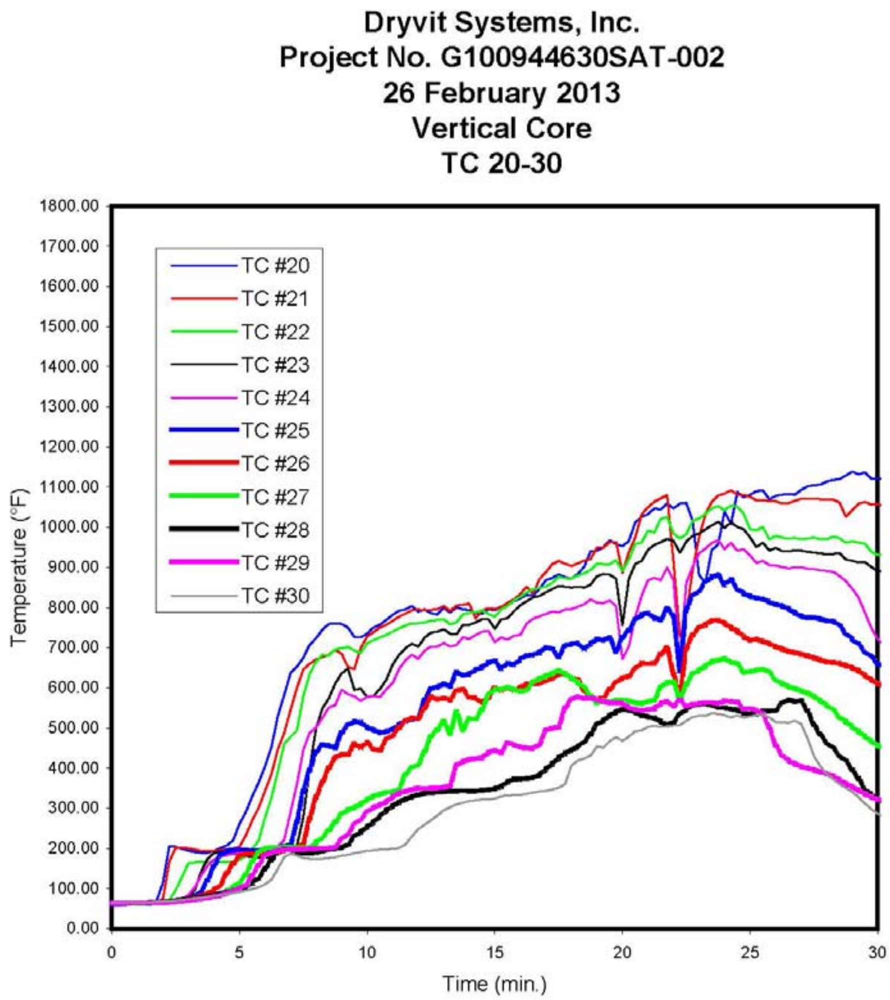
APPENDIX B
Temperature Data

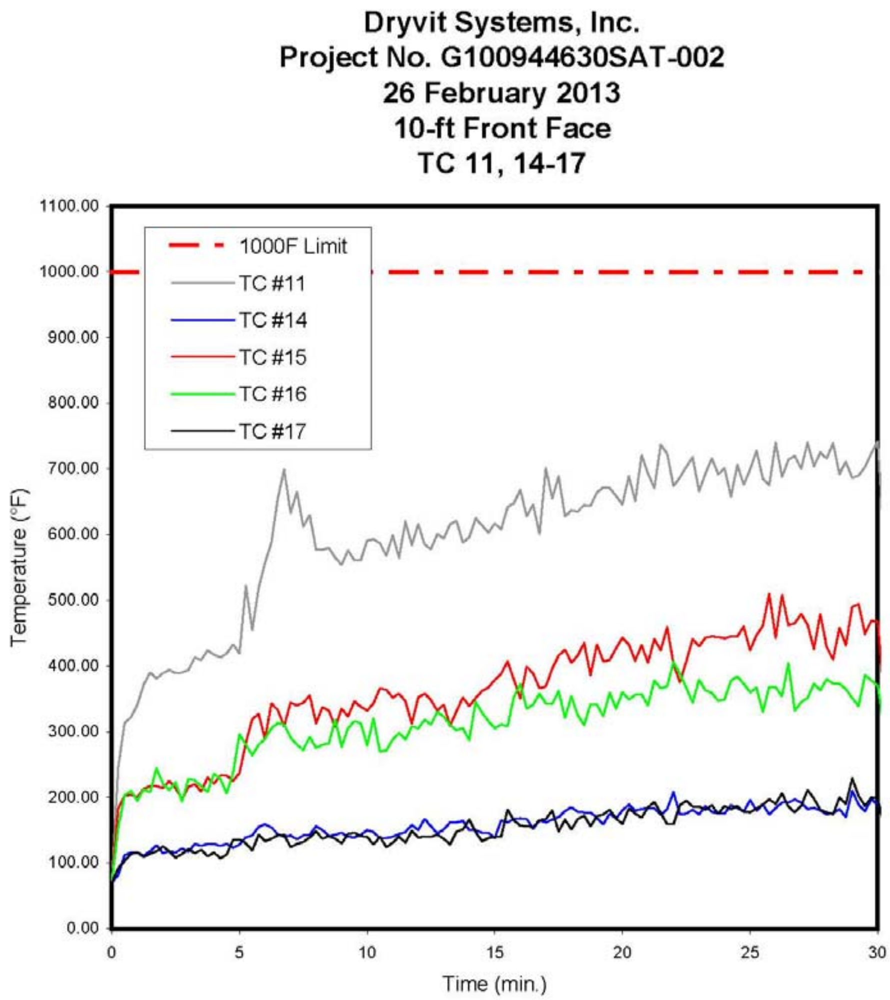

Dryvit Systems, Inc.
Project No. G100944630SAT-002
26 February 2013
Burn Room Average
Temperature (°F)
1800.00
1700.00
1600.00
1500.00
1400.00
1300.00
1200.00
1100.00
1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
0
5
10
15
20
25
30
Time (min.)
ASTM E119
Burn Room Average

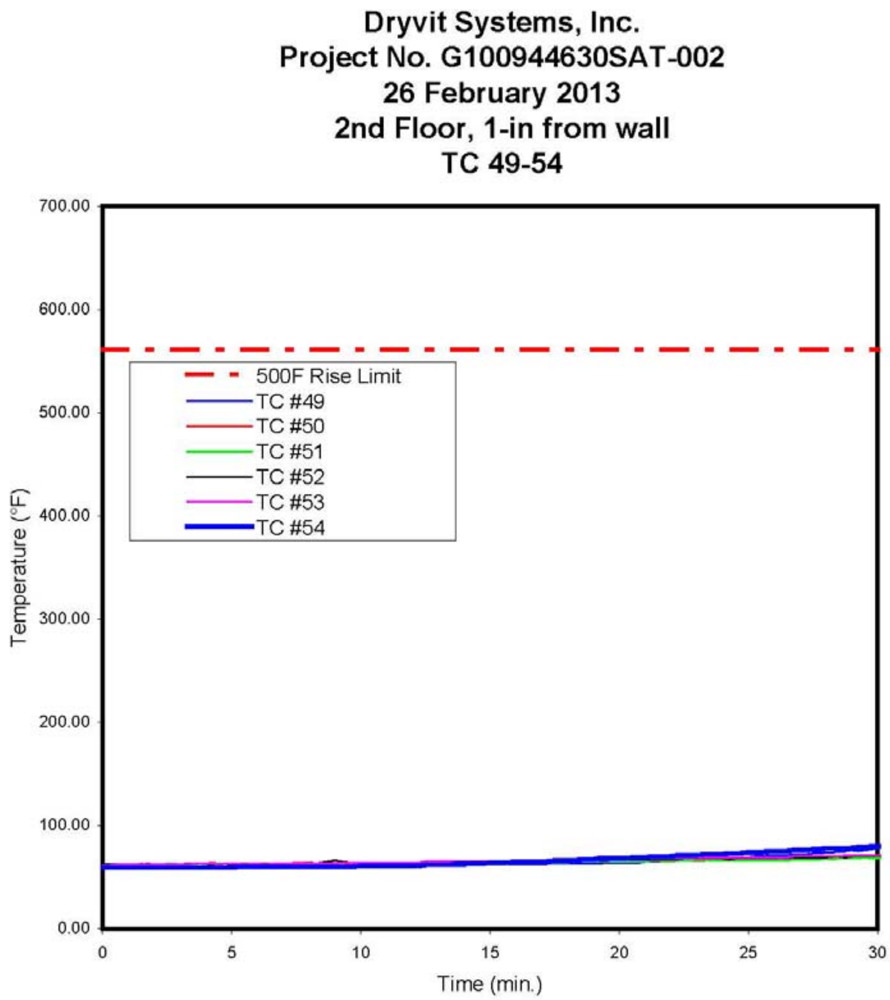

Dryvit Systems, Inc.
Project No. G100944630SAT-002
26 February 2013
Vertical Face
TC 1-13
Temperature (°F)
Time (min.)
0.00
100.00
200.00
300.00
400.00
500.00
600.00
700.00
800.00
900.00
1000.00
1100.00
1200.00
1300.00
1400.00
0
5
10
15
20
25
30
TC #1
TC #2
TC #3
TC #4
TC #5
TC #6
TC #7
TC #8
TC #9
TC #10
TC #11
TC #12
TC #13

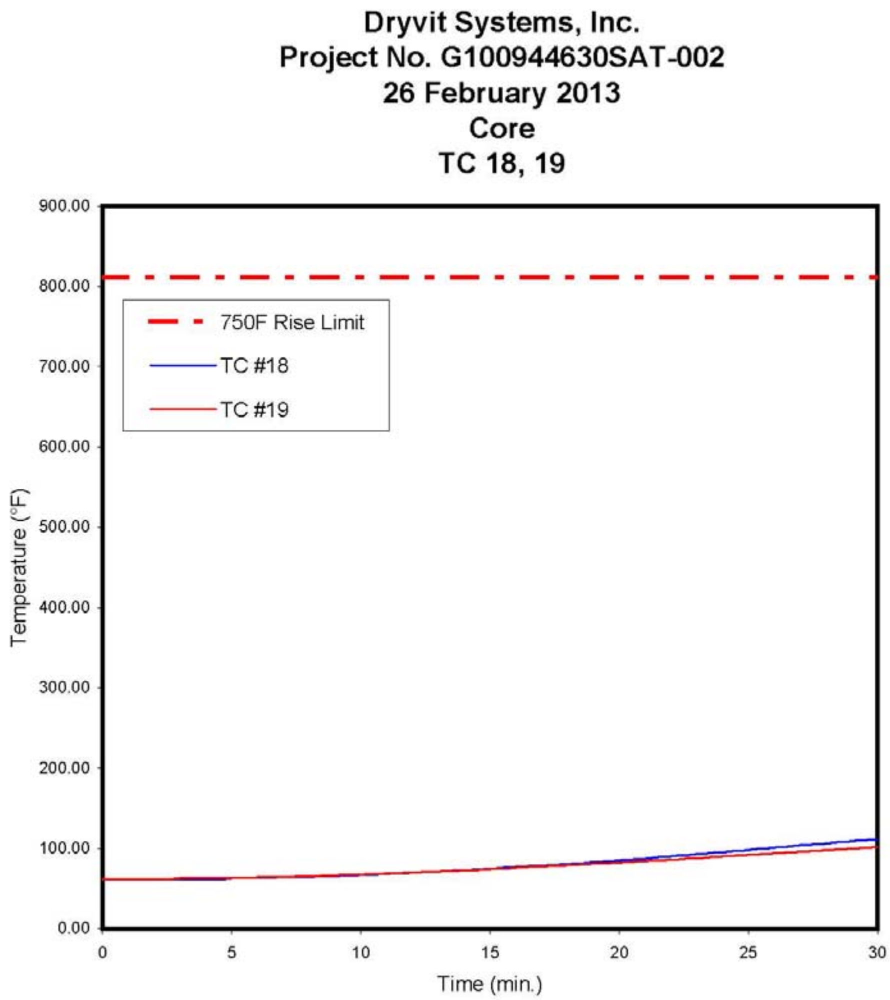
Dryvit Systems, Inc.
Project No. G100944630SAT-002
26 February 2013
10-ft Core
TC 28, 34, 35, 40, 39

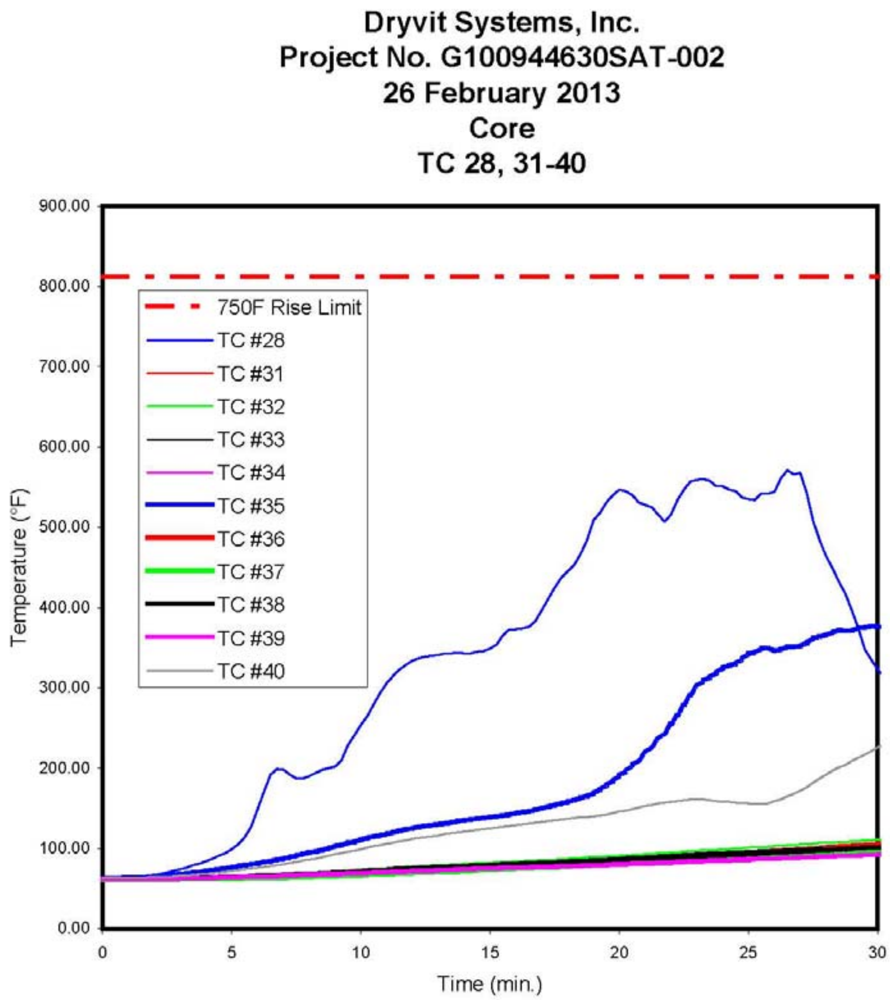



Dryvit Systems, Inc.
Project No. G100944630SAT-002
26 February 2013
Vertical Core
TC 20-30
Temperature (°F)
Time (min.)
TC #20
TC #21
TC #22
TC #23
TC #24
TC #25
TC #26
TC #27
TC #28
TC #29
TC #30
1800.00
1700.00
1600.00
1500.00
1400.00
1300.00
1200.00
1100.00
1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
0
5
10
15
20
25
30


Dryvit Systems, Inc.
Project No. G100944630SAT-002
26 February 2013
10-ft Front Face
TC 11, 14-17
1000F Limit
TC #11
TC #14
TC #15
TC #16
TC #17
Temperature (°F)
Time (min.)
1100.00
1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
0
5
10
15
20
25
30


Dryvit Systems, Inc.
Project No. G100944630SAT-002
26 February 2013
2nd Floor, 1-in from wall
TC 49-54
500F Rise Limit
TC #49
TC #50
TC #51
TC #52
TC #53
TC #54
Temperature (°F)
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
0
5
10
15
20
25
30
Time (min.)


Dryvit Systems, Inc.
Project No. G100944630SAT-002
26 February 2013
Core
TC 18, 19
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Temperature (°F)
750F Rise Limit
TC #18
TC #19
0
5
10
15
20
25
30
Time (min.)


Dryvit Systems, Inc.
Project No. G100944630SAT-002
26 February 2013
Core
TC 28, 31-40
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Temperature (°F)
750F Rise Limit
TC #28
TC #31
TC #32
TC #33
TC #34
TC #35
TC #36
TC #37
TC #38
TC #39
TC #40
0
5
10
15
20
25
30
Time (min.)

Time (min)	E119 Std Average (°F)	Burn Room (°F)	TC #1 (°F)	TC #2 (°F)	TC #3 (°F)	TC #4 (°F)	TC #5 (°F)	TC #6 (°F)	TC #7 (°F)	TC #8 (°F)	TC #9 (°F)	TC #10 (°F)	Pass/ Fail TC #11 (°F)	TC #12 (°F)	TC #13 (°F)
0	68	67	66	67	67	67	68	69	69	70	70	70	70	71	71
0.25	115	469	512	401	433	489	453	402	366	311	288	277	246	223	206
0.5	161	873	787	627	640	636	574	514	462	403	365	342	313	284	264
0.75	208	1014	855	629	647	627	582	530	471	419	380	358	322	298	284
1	254	1083	886	603	649	630	586	543	488	448	415	383	341	319	296
1.25	301	1113	916	625	671	682	635	596	539	482	435	410	372	348	329
1.5	348	1133	950	663	733	736	713	662	594	533	484	438	390	359	337
1.75	394	1149	989	710	765	725	687	635	550	494	444	419	381	355	336
2	441	1166	998	694	756	726	686	644	578	524	470	429	389	361	340
2.25	487	1186	995	696	748	745	705	659	586	531	477	436	394	353	322
2.5	534	1189	1002	689	729	720	678	640	580	526	480	443	389	351	331
2.75	581	1194	995	693	731	740	702	656	586	525	477	434	390	357	334
3	627	1207	989	667	721	731	680	631	567	505	457	432	394	363	339
3.25	674	1208	996	702	747	750	696	648	577	525	483	452	413	390	370
3.5	720	1217	984	699	741	754	704	651	593	537	491	454	409	374	350
3.75	767	1226	983	710	749	743	699	651	595	550	504	467	424	395	367
4	814	1237	1012	717	760	767	718	667	603	549	498	456	417	392	374
4.25	860	1241	1014	726	764	762	705	642	577	531	484	452	413	380	356
4.5	907	1243	995	724	760	758	703	638	583	540	494	462	419	391	368
4.75	953	1263	955	782	801	803	749	688	616	567	516	482	433	394	362
5	1000	1287	1034	834	866	837	749	671	602	549	510	473	419	372	345
5.25	1015	1309	1050	922	933	941	899	839	751	696	636	590	522	474	440
5.5	1030	1303	1038	944	929	918	868	793	690	635	574	515	455	424	402
5.75	1045	1306	973	998	951	935	879	816	735	685	620	573	518	462	434
6	1060	1308	1084	1351	1128	1096	989	895	796	737	665	614	557	510	481
6.25	1075	1304	1210	1536	1447	1435	1322	1200	989	847	732	661	588	517	474
6.5	1090	1298	1284	1498	1520	1591	1521	1452	1261	1089	881	751	655	579	526
6.75	1105	1313	1230	1459	1465	1588	1548	1525	1378	1169	978	808	699	596	530
7	1120	1313	1150	1393	1341	1302	1253	1291	1319	1073	849	706	633	578	527
7.25	1135	1310	1112	1325	1258	1198	1107	1097	1325	1154	941	788	665	586	534
7.5	1150	1314	1074	1199	1146	1095	1008	960	1117	1127	970	761	612	541	499
7.75	1165	1315	1042	1135	1102	1071	1005	940	974	950	917	767	630	552	508
8	1180	1315	1057	1089	1055	1026	956	894	847	792	739	648	577	523	488
8.25	1195	1315	1040	1071	1042	1025	960	899	847	784	709	641	577	525	492
8.5	1210	1311	991	1062	1049	1023	960	907	847	775	710	649	580	544	507
8.75	1225	1322	980	1050	1028	1009	969	930	859	771	691	619	565	520	483
9	1240	1321	996	1052	1034	1013	950	907	836	755	674	612	554	511	476
9.25	1255	1325	1039	1056	1040	1016	965	910	835	761	691	628	576	529	495
9.5	1270	1324	1042	1057	1026	1008	946	894	812	732	673	620	561	513	481
9.75	1285	1322	1034	1087	1048	1019	951	904	824	742	682	621	561	517	484
10	1300	1324	1049	1076	1051	1022	963	921	846	772	716	658	591	545	512
10.25	1312	1328	987	1100	1045	1018	961	912	845	774	710	650	593	554	520
10.5	1317	1328	1069	1126	1081	1052	978	922	841	764	710	658	587	544	509
10.75	1323	1335	1078	1128	1092	1052	968	907	823	749	700	647	568	523	488
11	1328	1332	1053	1142	1101	1068	997	939	858	788	739	685	599	537	498
11.25	1333	1338	1049	1136	1091	1059	993	932	841	759	687	631	565	522	494
11.5	1337	1336	1069	1137	1088	1060	1000	943	858	790	740	692	620	576	549
11.75	1342	1336	1068	1143	1087	1061	986	916	836	763	706	658	584	544	508
12	1347	1344	1027	1156	1100	1064	996	937	865	792	740	688	616	569	533
12.25	1351	1340	1090	1161	1108	1073	995	929	838	760	697	646	585	549	521
12.5	1356	1344	1081	1155	1097	1054	987	929	842	776	704	646	578	535	493
12.75	1360	1351	1037	1167	1098	1063	1011	948	866	793	726	663	601	557	521
13	1364	1354	1065	1162	1092	1060	1006	950	857	783	718	661	594	553	518
13.25	1369	1357	1068	1136	1075	1041	989	941	873	810	744	682	616	563	522
13.5	1373	1358	1052	1146	1075	1051	1000	951	878	803	738	692	621	576	537
13.75	1377	1350	1087	1166	1103	1066	1003	943	849	774	722	668	588	536	504
14	1381	1348	1055	1166	1092	1058	1002	949	853	778	720	668	596	543	507
14.25	1385	1360	1017	1175	1105	1064	995	941	869	799	738	679	625	568	527
14.5	1388	1361	1058	1178	1100	1063	1002	941	873	801	733	671	614	565	526

Time (min)	E119 Std Average (°F)	Burn Room (°F)	TC #1 (°F)	TC #2 (°F)	TC #3 (°F)	TC #4 (°F)	TC #5 (°F)	TC #6 (°F)	TC #7 (°F)	TC #8 (°F)	TC #9 (°F)	TC #10 (°F)	Pass/ Fail TC #11 (°F)	TC #12 (°F)	TC #13 (°F)
14.75	1392	1363	1064	1179	1104	1070	998	936	855	795	731	678	603	561	522
15	1396	1367	1131	1201	1113	1083	1001	934	860	803	747	696	617	573	533
15.25	1400	1424	1165	1236	1162	1122	1043	964	876	800	734	684	608	556	519
15.5	1403	1433	1143	1227	1175	1134	1065	992	908	839	778	711	642	594	551
15.75	1407	1449	1127	1254	1183	1136	1062	999	925	849	769	707	648	593	546
16	1410	1467	1127	1250	1183	1131	1080	1032	950	890	822	755	668	620	573
16.25	1414	1466	1162	1255	1195	1148	1079	1007	913	841	776	712	628	570	526
16.5	1417	1464	1143	1268	1204	1147	1078	1019	946	875	788	719	646	604	547
16.75	1420	1471	1123	1273	1210	1161	1092	1026	943	880	799	703	601	555	516
17	1424	1466	1160	1269	1196	1147	1090	1037	973	911	845	775	701	657	611
17.25	1427	1465	1181	1264	1197	1145	1079	1009	934	866	806	747	655	602	565
17.5	1430	1465	1159	1300	1224	1162	1100	1033	953	886	825	769	689	636	593
17.75	1433	1472	1175	1276	1217	1161	1079	993	899	832	769	706	628	594	560
18	1436	1473	1155	1274	1208	1144	1063	986	915	851	789	725	637	590	546
18.25	1439	1473	1187	1278	1212	1167	1091	1014	935	858	793	723	635	580	544
18.5	1442	1477	1152	1263	1203	1149	1069	991	907	837	765	715	645	600	559
18.75	1445	1475	1164	1258	1205	1156	1087	1018	938	868	797	728	644	584	542
19	1448	1485	1183	1231	1175	1124	1064	1005	938	878	810	749	664	602	551
19.25	1451	1488	1203	1258	1204	1146	1072	1003	921	860	798	747	672	633	587
19.5	1454	1485	1223	1262	1210	1162	1088	1002	921	853	793	735	671	623	572
19.75	1457	1481	1192	1241	1184	1141	1064	991	917	844	769	712	659	591	533
20	1459	1492	1173	1246	1203	1151	1090	1017	934	861	802	728	646	585	534
20.25	1462	1495	1179	1273	1237	1190	1129	1057	972	905	840	768	689	629	580
20.5	1465	1501	1194	1243	1228	1185	1125	1048	957	885	814	741	651	588	541
20.75	1467	1499	1172	1250	1231	1197	1130	1050	971	913	849	791	721	673	624
21	1470	1491	1178	1253	1226	1183	1120	1041	965	899	830	763	693	637	583
21.25	1473	1492	1201	1284	1255	1204	1130	1049	965	894	821	749	671	602	558
21.5	1475	1497	1148	1268	1232	1186	1125	1063	1002	944	884	819	737	686	634
21.75	1478	1506	1193	1275	1258	1192	1126	1060	995	929	856	789	723	654	607
22	1480	1512	1170	1267	1246	1202	1147	1065	972	892	810	743	674	626	583
22.25	1483	1501	1230	1257	1239	1204	1155	1088	1013	945	869	775	687	644	596
22.5	1485	1508	1201	1286	1275	1225	1162	1090	1002	924	858	784	703	658	603
22.75	1488	1508	1168	1270	1250	1202	1143	1063	980	917	860	790	718	669	622
23	1490	1502	1259	1283	1257	1210	1145	1061	977	912	840	754	666	618	573
23.25	1493	1509	1235	1280	1272	1220	1149	1054	965	899	843	775	693	643	590
23.5	1495	1513	1156	1267	1265	1209	1142	1067	986	921	863	786	716	665	612
23.75	1497	1507	1181	1263	1259	1212	1130	1035	952	887	826	763	692	640	591
24	1499	1513	1210	1271	1259	1219	1154	1064	976	895	836	770	701	650	605
24.25	1502	1511	1183	1260	1244	1193	1119	1030	942	878	820	742	658	600	556
24.5	1504	1511	1224	1257	1244	1201	1143	1065	988	921	871	796	706	633	581
24.75	1506	1516	1209	1249	1258	1212	1147	1063	972	884	821	759	676	624	579
25	1508	1520	1241	1226	1223	1193	1122	1033	951	891	841	777	699	658	605
25.25	1511	1552	1225	1273	1277	1243	1184	1101	1012	926	872	809	728	670	604
25.5	1513	1565	1245	1288	1269	1226	1150	1070	991	911	852	783	685	626	582
25.75	1515	1573	1310	1270	1259	1210	1134	1048	962	895	835	766	675	611	549
26	1517	1574	1251	1280	1272	1233	1156	1080	1011	941	880	815	740	676	621
26.25	1519	1568	1248	1263	1259	1222	1143	1054	957	885	826	766	688	634	588
26.5	1521	1576	1297	1285	1285	1247	1175	1087	993	919	872	808	714	641	593
26.75	1523	1576	1226	1275	1259	1219	1150	1072	995	917	861	805	720	666	618

Time (min)	E119 Std Average (°F)	Burn Room (°F)	TC #1 (°F)	TC #2 (°F)	TC #3 (°F)	TC #4 (°F)	TC #5 (°F)	TC #6 (°F)	TC #7 (°F)	TC #8 (°F)	TC #9 (°F)	TC #10 (°F)	Pass/ Fail TC #11 (°F)	TC #12 (°F)	TC #13 (°F)
27	1525	1575	1324	1273	1266	1234	1156	1067	982	907	841	783	700	655	608
27.25	1527	1585	1281	1282	1285	1248	1161	1080	996	921	872	830	740	683	630
27.5	1529	1590	1277	1281	1276	1242	1161	1081	988	920	860	798	704	648	603
27.75	1531	1587	1265	1285	1276	1244	1173	1093	1012	931	866	806	725	656	593
28	1533	1591	1323	1279	1265	1249	1175	1099	1012	935	865	800	716	656	611
28.25	1535	1595	1342	1281	1270	1242	1155	1079	998	929	867	813	739	677	629
28.5	1537	1603	1278	1243	1238	1229	1148	1068	985	916	847	776	692	637	587
28.75	1539	1603	1337	1244	1249	1233	1144	1065	987	919	853	794	711	649	596
29	1541	1598	1271	1288	1277	1250	1160	1074	982	904	832	764	686	625	583
29.25	1543	1597	1283	1272	1261	1245	1144	1051	961	891	827	764	690	632	582
29.5	1545	1602	1286	1259	1259	1239	1145	1076	997	918	851	789	703	645	595
29.75	1547	1604	1380	1261	1261	1244	1163	1089	1002	926	870	816	724	663	612
30	1549	1606	1290	1252	1252	1236	1166	1096	1021	950	896	833	742	667	610
30.25	1550	1451	948	1049	1025	994	923	843	786	736	670	622	584	524	480
30.5	1552	1203	674	806	792	772	721	673	638	589	529	489	476	430	400
30.75	1554	1090	596	707	706	682	650	617	586	540	491	456	434	395	372
31	1556	1007	541	649	651	615	590	555	529	492	447	416	393	358	335
31.25	1558	957	510	617	621	585	557	524	501	466	424	392	372	343	327
31.5	1559	912	480	583	582	549	519	493	469	442	403	380	355	329	314
31.75	1561	877	448	555	551	514	480	453	428	403	368	353	338	314	302
32	1563	843	439	529	527	483	444	417	399	377	352	336	310	290	279
32.25	1565	816	421	513	516	496	465	438	417	391	360	342	324	307	296
32.5	1566	788	400	492	495	469	440	417	394	374	349	328	310	289	277
32.75	1568	765	385	476	476	447	419	396	375	358	334	318	298	283	274
33	1570	743	370	464	466	432	404	383	365	346	321	302	283	266	258
33.25	1571	724	365	450	450	424	397	374	359	340	316	298	283	271	263
33.5	1573	706	348	433	434	408	384	363	345	325	306	289	272	258	248
33.75	1575	690	332	425	409	379	350	331	315	300	280	266	253	243	233
34	1576	674	330	413	409	380	354	336	322	307	288	272	258	249	243
34.25	1578	661	323	406	400	376	353	336	322	303	285	272	254	242	236
34.5	1579	646	318	394	393	375	351	332	315	294	274	255	241	232	226
34.75	1581	633	306	383	381	362	338	322	306	292	272	256	240	225	220
35	1583	620	301	380	375	353	328	309	295	280	262	249	235	226	219
35.25	1584	609	279	372	367	340	314	296	285	270	252	242	228	220	215
35.5	1586	598	289	362	357	332	313	298	285	274	259	248	233	223	218
35.75	1587	588	285	357	348	321	302	286	274	260	242	231	217	208	205
36	1589	578	276	354	336	304	283	266	254	243	228	218	209	205	201
36.25	1590	569	270	344	326	297	277	263	253	243	230	222	210	203	198
36.5	1592	559	251	335	314	292	269	251	238	230	217	208	200	193	190
36.75	1593	551	262	331	326	307	286	269	257	241	226	217	206	197	193
37	1595	542	250	324	315	298	281	265	252	239	227	219	208	198	191
37.25	1596	534	234	322	306	286	265	248	237	227	217	209	200	191	187
37.5	1598	525	241	318	312	299	278	263	251	239	228	219	210	200	195
37.75	1599	518	242	312	305	289	270	254	243	233	220	210	199	192	186
38	1601	510	235	312	294	270	250	233	221	214	204	198	189	182	177
38.25	1602	504	236	308	301	287	267	250	240	231	222	214	205	197	191
38.5	1604	497	235	301	296	283	266	250	240	230	217	208	197	188	183
38.75	1605	491	233	297	295	286	269	252	243	233	221	212	200	193	187
39	1606	484	231	292	287	277	260	247	236	228	216	206	199	191	184
39.25	1608	479	221	287	265	248	237	227	220	212	201	193	181	176	172
39.5	1609	472	226	284	275	260	244	231	223	213	203	195	184	176	173
39.75	1611	467	224	281	273	260	245	232	225	216	201	193	182	176	172
40	1612	461	220	277	271	259	243	230	220	211	199	190	179	172	169
Max Temp			1380	1536	1520	1591	1548	1525	1378	1169	978	833	742	686	634
Max Allowed													1000		

Time (min)	Pass/ Fail TC #14 (°F)	Pass/ Fail TC #15 (°F)	Pass/ Fail TC #16 (°F)	Pass/ Fail TC #17 (°F)	Pass/ Fail TC #18 (°F)	Pass/ Fail TC #19 (°F)	TC #20 (°F)	TC #21 (°F)	TC #22 (°F)	TC #23 (°F)	TC #24 (°F)	TC #25 (°F)	TC #26 (°F)	TC #27 (°F)
0	70	70	71	70	62	62	63	62	61	62	62	62	63	63
0.25	82	183	153	92	62	62	63	62	61	62	62	62	63	63
0.5	112	202	203	103	62	62	63	62	61	62	62	62	63	63
0.75	116	204	210	114	62	62	63	62	61	62	62	63	63	63
1	116	200	195	116	62	62	64	62	62	62	63	63	63	63
1.25	111	213	212	109	62	62	65	62	62	62	63	63	64	64
1.5	118	217	208	114	62	62	67	63	63	63	63	64	64	64
1.75	127	217	244	118	62	62	69	64	64	63	64	64	65	64
2	115	214	221	125	62	62	114	74	66	64	66	65	66	65
2.25	118	225	211	118	62	62	205	167	71	66	67	67	68	66
2.5	116	214	223	108	62	62	204	202	96	68	70	69	70	68
2.75	122	197	194	114	62	62	199	202	129	70	74	71	72	69
3	117	216	228	121	62	63	194	200	163	77	85	75	75	71
3.25	129	220	226	115	62	63	191	197	165	97	103	80	78	73
3.5	126	209	217	120	62	63	189	194	165	142	132	95	82	76
3.75	129	230	208	110	62	63	189	193	165	174	156	120	87	79
4	129	221	236	116	62	63	193	194	165	188	172	156	96	83
4.25	126	233	228	107	62	63	201	196	165	192	179	182	110	87
4.5	129	233	206	113	62	63	207	198	165	191	183	193	138	94
4.75	123	225	237	135	62	63	220	200	166	188	187	196	162	103
5	128	237	296	136	63	63	261	204	171	184	190	197	180	116
5.25	139	283	280	130	63	63	291	233	181	181	193	196	187	134
5.5	142	319	264	119	63	63	330	270	199	178	196	194	187	167
5.75	155	327	280	143	63	63	364	301	219	177	198	194	186	190
6	159	289	289	133	63	64	404	343	277	177	200	195	186	200
6.25	154	343	305	137	63	64	452	385	326	179	203	197	188	202
6.5	144	333	313	142	63	64	529	446	391	185	206	201	190	202
6.75	140	308	311	143	64	64	582	487	460	194	221	205	194	203
7	142	344	291	124	64	64	637	545	478	200	290	209	200	203
7.25	136	340	280	129	64	64	653	600	494	207	360	266	203	202
7.5	142	344	272	132	64	65	675	646	579	278	445	344	212	201
7.75	143	355	292	139	64	65	708	660	635	400	488	396	275	201
8	156	313	275	148	64	65	724	671	665	499	501	441	328	214
8.25	150	337	280	137	65	65	745	677	683	549	525	458	365	229
8.5	141	332	282	141	65	66	759	683	680	574	551	456	401	245
8.75	143	307	318	137	65	66	760	695	696	611	557	451	425	266
9	146	335	277	130	65	66	759	685	699	636	595	489	435	285
9.25	140	323	305	144	66	67	750	652	702	648	584	507	434	296
9.5	139	346	316	146	66	67	727	647	693	595	579	516	461	302
9.75	143	338	313	141	66	67	726	700	687	598	567	515	451	310
10	150	332	279	140	67	67	735	728	711	577	578	501	465	322
10.25	147	343	320	128	67	68	750	739	719	580	580	496	448	330
10.5	138	366	270	140	67	68	757	750	726	597	577	488	444	335
10.75	138	364	271	124	68	68	769	757	732	620	596	491	470	340
11	140	352	288	131	68	69	782	767	740	658	612	496	483	340
11.25	144	358	298	140	69	69	792	777	748	682	647	508	501	348
11.5	147	346	288	131	69	69	795	785	755	699	668	518	517	385
11.75	158	312	308	149	69	70	804	793	761	710	683	522	526	401
12	150	352	305	139	70	70	790	795	761	703	672	523	523	409
12.25	167	358	318	140	70	70	795	793	763	725	693	570	550	441
12.5	156	348	311	140	71	71	786	794	767	738	703	598	577	480
12.75	145	332	330	143	71	71	783	796	769	740	703	602	571	496
13	151	341	323	137	71	71	799	804	771	746	712	610	575	517
13.25	162	309	310	128	72	72	787	791	758	735	703	604	570	486
13.5	162	331	302	148	72	72	801	805	763	733	707	639	593	541
13.75	164	352	305	151	73	72	795	807	783	757	726	631	596	496
14	150	339	287	166	73	73	794	810	787	757	722	634	577	523
14.25	150	351	345	147	73	73	786	773	788	763	732	645	575	523
14.5	146	362	329	133	74	73	784	793	793	771	740	651	563	546

Time (min)	Pass/ Fail TC #14 (°F)	Pass/ Fail TC #15 (°F)	Pass/ Fail TC #16 (°F)	Pass/ Fail TC #17 (°F)	Pass/ Fail TC #18 (°F)	Pass/ Fail TC #19 (°F)	TC #20 (°F)	TC #21 (°F)	TC #22 (°F)	TC #23 (°F)	TC #24 (°F)	TC #25 (°F)	TC #26 (°F)	TC #27 (°F)
14.75	146	367	316	138	74	74	796	798	784	771	742	663	577	582
15	138	379	305	140	75	74	793	796	777	747	714	668	601	597
15.25	165	388	311	140	75	75	803	801	795	771	726	648	594	595
15.5	162	407	308	181	76	75	806	812	804	773	720	662	601	603
15.75	167	379	353	165	76	75	816	820	818	791	730	657	594	596
16	168	351	372	157	77	76	823	834	827	806	732	671	601	591
16.25	167	399	335	156	77	76	832	852	838	816	760	681	609	595
16.5	152	389	341	155	78	77	830	835	846	825	772	682	610	614
16.75	165	366	358	165	78	77	847	871	849	829	778	688	612	623
17	162	369	343	167	78	77	868	888	852	838	784	701	618	629
17.25	166	396	342	180	79	78	874	908	862	846	790	697	624	636
17.5	170	416	362	148	79	78	883	916	877	854	788	677	634	644
17.75	179	425	321	166	80	78	876	909	873	852	795	705	636	634
18	185	405	354	151	80	79	872	904	872	850	796	709	624	625
18.25	178	416	325	167	81	79	884	910	880	852	802	712	620	614
18.5	177	435	310	172	81	80	901	917	885	850	808	697	594	600
18.75	177	386	342	156	82	80	940	921	894	857	820	710	574	580
19	169	433	341	171	83	81	942	950	909	878	812	722	573	563
19.25	159	407	324	174	83	81	950	949	908	884	811	719	574	569
19.5	175	409	359	181	84	81	968	963	908	882	818	726	596	564
19.75	168	427	335	168	84	82	958	964	918	872	803	690	613	570
20	180	443	360	159	85	82	953	886	891	756	672	727	624	571
20.25	189	433	349	183	86	83	966	938	919	871	703	743	630	567
20.5	180	408	356	175	86	83	1012	975	958	909	776	769	647	563
20.75	182	432	357	169	87	84	1026	1032	962	916	829	782	662	561
21	184	405	340	185	87	84	1033	1050	992	944	868	787	660	566
21.25	183	441	378	193	88	85	1047	1064	987	956	874	774	662	570
21.5	173	424	366	176	89	85	1045	1072	1021	963	868	769	684	601
21.75	182	459	369	159	89	85	1060	1080	1026	971	900	798	701	613
22	208	403	406	159	90	86	1047	915	985	966	868	781	635	616
22.25	174	375	388	188	91	86	1059	728	972	937	669	643	577	569
22.5	175	407	367	195	91	87	1061	784	983	964	861	798	699	609
22.75	181	441	344	186	92	88	1016	893	1016	979	902	828	732	634
23	174	430	379	186	93	88	882	975	1022	985	935	843	749	644
23.25	187	443	363	181	93	88	861	1032	1034	995	947	862	757	654
23.5	178	445	359	188	94	89	944	1064	1047	1005	961	877	768	666
23.75	175	444	347	175	95	89	957	1079	1053	1014	968	881	769	669
24	175	442	349	187	95	90	1040	1084	1042	998	946	857	761	673
24.25	188	445	378	182	96	90	1008	1092	1055	1013	961	871	750	664
24.5	184	445	384	187	97	91	1088	1081	1051	1001	942	847	742	660
24.75	178	460	373	178	97	91	1075	1081	1034	995	945	835	728	639
25	196	424	360	177	98	92	1081	1076	995	975	930	828	719	640
25.25	180	447	367	183	99	92	1090	1067	993	951	911	824	721	644
25.5	189	461	330	189	100	93	1092	1067	1001	962	916	822	716	647
25.75	174	510	368	197	100	93	1070	1066	970	942	906	814	711	639
26	184	443	368	190	101	94	1078	1065	979	949	905	808	703	621
26.25	192	508	354	206	102	94	1081	1059	974	941	901	804	697	611
26.5	192	462	404	186	102	95	1083	1060	972	940	898	797	691	603
26.75	197	465	332	177	103	95	1081	1066	974	943	900	787	688	598

Time (min)	Pass/ Fail TC #14 (°F)	Pass/ Fail TC #15 (°F)	Pass/ Fail TC #16 (°F)	Pass/ Fail TC #17 (°F)	Pass/ Fail TC #18 (°F)	Pass/ Fail TC #19 (°F)	TC #20 (°F)	TC #21 (°F)	TC #22 (°F)	TC #23 (°F)	TC #24 (°F)	TC #25 (°F)	TC #26 (°F)	TC #27 (°F)
27	192	479	345	187	104	96	1093	1071	970	942	900	778	684	593
27.25	182	463	351	211	104	96	1102	1072	972	939	897	775	680	587
27.5	184	426	373	198	105	97	1105	1071	975	937	896	775	675	579
27.75	180	479	363	181	105	97	1106	1070	970	935	893	772	670	568
28	174	429	380	177	106	98	1114	1069	970	933	891	767	665	557
28.25	176	410	373	174	107	98	1118	1069	977	934	889	767	663	545
28.5	182	458	373	200	108	99	1120	1062	973	935	879	755	661	528
28.75	170	432	365	190	108	99	1129	1027	962	920	866	737	656	516
29	210	490	351	229	109	100	1139	1043	965	917	847	722	650	503
29.25	189	494	339	202	110	100	1132	1059	962	912	825	708	643	491
29.5	179	449	386	187	110	101	1137	1063	959	913	787	691	631	479
29.75	197	469	378	200	111	101	1121	1057	939	901	749	677	620	467
30	189	467	370	198	111	102	1122	1059	931	891	722	661	611	456
30.25	174	350	305	156	112	102	1121	1051	932	890	706	653	604	449
30.5	130	273	244	119	112	102	1082	958	868	855	688	642	597	441
30.75	121	251	212	108	113	103	1027	888	809	808	673	631	589	435
31	123	232	202	110	114	104	936	805	749	767	658	619	580	428
31.25	114	212	197	105	114	104	880	762	711	734	646	608	571	423
31.5	113	216	193	103	115	104	820	713	666	697	634	597	560	417
31.75	116	213	180	101	115	105	783	681	633	667	630	587	550	413
32	110	202	163	102	116	105	741	654	603	636	624	577	540	408
32.25	110	191	162	103	116	105	717	631	580	616	618	568	530	404
32.5	108	179	165	98	117	106	697	611	564	595	611	558	519	400
32.75	103	186	166	98	117	106	677	592	544	579	605	551	510	397
33	99	173	161	97	117	106	654	571	524	562	598	542	500	392
33.25	99	175	157	99	118	106	626	553	501	548	591	534	492	388
33.5	101	177	166	97	118	106	602	535	485	536	583	530	482	384
33.75	100	166	151	96	118	106	583	522	473	526	576	521	473	380
34	100	160	144	94	118	106	566	509	459	515	568	513	464	376
34.25	99	170	151	95	118	106	554	499	449	507	562	505	457	373
34.5	98	160	154	95	119	106	538	487	437	498	555	497	450	369
34.75	98	157	150	95	119	106	527	478	426	491	549	491	443	367
35	97	150	146	94	119	106	514	468	418	482	543	483	436	365
35.25	97	159	142	93	119	106	504	460	408	475	537	477	431	363
35.5	92	151	132	90	119	105	491	453	403	469	531	470	425	362
35.75	93	145	131	90	119	105	483	444	394	463	525	465	420	359
36	96	141	132	89	119	105	470	437	388	456	519	458	414	357
36.25	92	140	129	90	119	105	466	428	380	451	514	453	409	355
36.5	94	140	131	88	119	105	459	422	375	446	508	447	404	352
36.75	92	141	129	89	119	105	452	417	370	441	503	442	400	350
37	89	144	133	87	119	104	444	411	366	436	497	436	396	347
37.25	91	140	129	87	119	104	439	407	366	432	492	432	392	344
37.5	91	138	123	85	119	104	457	414	384	449	486	424	388	341
37.75	91	138	122	86	119	104	448	412	378	452	481	418	384	339
38	94	142	117	86	119	103	435	394	346	434	476	412	381	336
38.25	90	137	114	85	119	103	434	388	336	425	471	408	377	333
38.5	87	129	116	86	119	103	426	382	330	419	467	403	374	330
38.75	89	133	120	87	118	103	420	375	324	415	463	399	371	328
39	89	129	122	87	118	102	412	369	320	410	459	395	367	325
39.25	89	131	117	84	118	102	411	366	315	405	456	392	364	322
39.5	88	133	117	84	118	102	401	362	312	402	452	388	361	320
39.75	87	125	112	86	118	102	392	358	308	400	449	385	358	318
40	88	130	115	85	118	102	390	355	304	396	445	381	355	317
Max Temp	210	510	406	229	119	106	1139	1092	1055	1014	968	881	769	673
Max Allowed	1000	1000	1000	1000	812	812								

Dryvit Systems, Inc. Project No. G100944630SAT-002 26 February 2013

Time (min)	Pass/ Fail TC #28 (°F)	TC #29 (°F)	TC #30 (°F)	Pass/ Fail TC #31 (°F)	Pass/ Fail TC #32 (°F)	Pass/ Fail TC #33 (°F)	Pass/ Fail TC #34 (°F)	Pass/ Fail TC #35 (°F)	Pass/ Fail TC #36 (°F)	Pass/ Fail TC #37 (°F)	Pass/ Fail TC #38 (°F)	Pass/ Fail TC #39 (°F)	Pass/ Fail TC #40 (°F)	TC #41 (°F)
0	64	63	65	62	63	63	62	63	61	61	62	62	63	70
0.25	64	64	65	62	63	63	62	63	61	61	62	62	63	468
0.5	64	63	65	62	63	63	62	63	61	61	62	62	63	957
0.75	64	64	65	62	63	63	62	63	61	61	62	62	63	1090
1	64	64	65	62	63	63	63	64	62	61	63	62	63	1162
1.25	64	64	66	62	63	63	63	64	62	61	63	62	63	1187
1.5	65	64	66	62	63	63	62	64	61	61	62	62	63	1202
1.75	66	65	67	62	63	63	63	64	62	61	62	62	64	1225
2	67	65	68	62	63	63	63	65	62	61	63	62	64	1240
2.25	68	66	69	62	63	63	63	65	61	61	63	62	64	1259
2.5	70	68	70	62	63	63	63	66	61	61	63	62	64	1254
2.75	72	69	71	62	63	63	63	67	62	61	63	62	65	1245
3	74	71	73	62	64	64	63	68	62	62	63	63	66	1259
3.25	76	73	75	63	64	64	63	69	62	62	63	63	66	1260
3.5	79	75	77	63	64	64	64	70	62	62	63	63	67	1282
3.75	81	77	79	63	64	64	64	70	62	62	63	63	68	1289
4	84	80	81	63	65	65	64	72	62	62	64	63	68	1280
4.25	87	83	84	63	65	65	64	73	62	62	64	63	69	1284
4.5	91	88	86	63	65	65	65	74	62	62	64	64	70	1278
4.75	94	93	89	64	65	65	65	75	62	62	65	64	71	1325
5	99	100	92	64	66	66	65	76	62	62	65	64	72	1355
5.25	105	110	95	64	66	66	65	78	63	62	65	64	73	1364
5.5	114	132	99	65	66	66	66	79	63	63	65	65	74	1348
5.75	127	158	103	65	67	67	66	80	63	63	65	65	75	1347
6	149	181	111	65	67	67	66	81	63	63	66	65	76	1370
6.25	171	190	122	65	67	67	67	83	63	63	66	65	77	1350
6.5	192	195	149	65	68	68	67	84	63	63	66	65	78	1353
6.75	199	196	178	65	68	68	67	86	64	63	66	65	79	1361
7	198	198	187	66	68	68	67	87	64	63	67	66	80	1358
7.25	192	197	182	66	69	69	68	89	64	64	67	66	82	1384
7.5	187	198	176	67	69	69	68	91	64	64	68	66	83	1386
7.75	187	199	174	67	70	70	69	93	65	64	68	67	85	1398
8	190	200	173	67	70	70	69	95	65	64	68	67	86	1389
8.25	194	200	174	68	70	70	69	96	65	65	68	67	87	1397
8.5	198	200	176	68	71	71	70	98	65	65	69	68	89	1349
8.75	200	204	178	68	71	71	70	100	66	65	69	68	91	1367
9	202	222	182	69	72	72	70	103	66	65	70	68	93	1371
9.25	210	237	184	69	72	72	71	104	66	66	70	68	94	1377
9.5	229	259	188	70	73	72	71	107	66	66	70	69	96	1394
9.75	241	274	191	70	73	73	71	108	67	66	70	69	97	1358
10	254	290	194	70	74	73	72	111	67	66	71	69	99	1364
10.25	265	302	195	70	74	74	72	113	68	67	71	69	101	1355
10.5	280	308	197	71	75	75	73	115	68	68	72	70	103	1375
10.75	294	316	198	72	75	75	73	116	68	68	72	70	104	1418
11	306	328	199	72	75	75	73	118	69	68	72	70	106	1395
11.25	315	338	201	72	76	76	74	120	69	68	73	71	107	1375
11.5	323	342	210	73	76	76	74	122	69	69	73	71	109	1390
11.75	329	347	230	73	77	76	74	124	70	69	74	71	110	1404
12	334	350	248	73	77	77	75	125	70	69	74	72	112	1397
12.25	337	349	259	74	78	77	75	127	71	70	74	72	113	1412
12.5	339	350	270	74	78	77	75	128	71	70	75	72	114	1419
12.75	340	351	282	74	79	78	76	129	71	70	75	72	115	1423
13	341	352	295	75	79	78	76	130	71	71	76	73	116	1385
13.25	343	357	303	75	79	78	76	131	72	71	76	73	118	1409
13.5	343	407	310	76	80	79	77	132	72	71	76	73	119	1406
13.75	344	416	314	76	80	79	77	134	72	71	76	74	120	1399
14	343	422	318	76	81	79	77	135	73	72	77	74	121	1394
14.25	343	424	320	77	81	80	78	136	73	72	77	74	122	1388
14.5	345	425	322	77	82	80	78	137	74	73	78	75	123	1415

Time (min)	Pass/ Fail TC #28 (°F)	TC #29 (°F)	TC #30 (°F)	Pass/ Fail TC #31 (°F)	Pass/ Fail TC #32 (°F)	Pass/ Fail TC #33 (°F)	Pass/ Fail TC #34 (°F)	Pass/ Fail TC #35 (°F)	Pass/ Fail TC #36 (°F)	Pass/ Fail TC #37 (°F)	Pass/ Fail TC #38 (°F)	Pass/ Fail TC #39 (°F)	Pass/ Fail TC #40 (°F)	TC #41 (°F)
14.75	346	439	322	78	82	80	78	138	74	73	78	75	124	1432
15	349	445	324	78	82	81	79	139	74	73	78	75	125	1453
15.25	354	438	330	78	83	81	79	140	75	74	78	75	126	1525
15.5	366	463	332	79	83	82	79	141	75	74	79	76	127	1536
15.75	373	459	333	79	83	82	79	142	75	74	79	76	128	1524
16	373	452	334	80	84	82	80	144	76	75	79	76	129	1524
16.25	374	450	336	80	84	83	80	145	76	75	80	76	130	1536
16.5	376	449	339	80	85	83	80	146	76	75	80	76	131	1543
16.75	383	460	342	81	85	83	81	148	77	76	80	77	132	1547
17	397	494	343	81	86	84	81	150	77	76	81	77	133	1515
17.25	411	500	347	82	86	84	81	152	78	76	81	77	134	1527
17.5	425	502	351	82	86	84	81	154	78	76	81	77	135	1514
17.75	437	550	360	82	87	85	82	156	78	77	82	78	136	1535
18	445	571	406	83	87	85	82	158	79	77	82	78	137	1536
18.25	453	578	419	83	88	86	82	160	79	78	82	78	138	1543
18.5	467	573	424	84	88	86	83	163	80	78	83	78	139	1541
18.75	484	575	431	84	89	86	83	165	80	78	83	79	139	1550
19	509	571	454	85	89	87	84	169	81	79	84	79	140	1574
19.25	518	566	451	85	89	87	84	173	81	79	84	79	141	1572
19.5	531	563	467	86	90	87	84	179	81	80	84	79	142	1536
19.75	540	563	477	86	90	88	84	184	82	80	85	80	144	1540
20	547	562	468	87	91	88	85	191	82	80	85	80	146	1569
20.25	545	551	478	87	91	89	85	196	83	81	86	80	147	1574
20.5	540	546	492	87	92	89	86	204	83	81	86	81	149	1555
20.75	531	544	494	88	92	89	86	210	84	81	86	81	151	1566
21	528	546	503	88	93	90	87	219	84	82	87	81	153	1539
21.25	525	548	505	89	93	90	87	227	84	82	87	81	154	1531
21.5	516	561	503	89	94	91	87	236	85	83	87	82	156	1541
21.75	507	567	504	90	94	91	88	244	86	83	88	82	157	1589
22	516	554	506	91	95	92	88	255	86	83	88	82	158	1634
22.25	534	571	507	91	95	92	88	266	87	84	89	83	159	1565
22.5	547	554	518	92	96	93	89	279	87	84	89	83	160	1546
22.75	557	559	527	92	97	93	89	291	87	84	89	84	161	1551
23	559	560	531	93	97	94	89	302	88	85	90	84	161	1550
23.25	560	564	530	93	98	94	90	309	88	85	90	84	161	1556
23.5	558	564	537	94	98	95	90	313	89	86	91	85	160	1538
23.75	551	560	535	94	98	95	91	319	89	86	91	85	159	1563
24	551	568	532	95	99	95	91	325	90	86	91	85	158	1579
24.25	547	566	526	95	99	96	91	328	90	87	92	85	158	1582
24.5	545	564	532	96	100	96	92	330	91	87	92	86	157	1555
24.75	537	547	525	96	100	96	92	336	92	87	92	86	157	1556
25	535	549	529	97	101	97	93	343	92	88	93	86	156	1592
25.25	534	544	532	97	102	97	93	344	93	88	93	87	156	1625
25.5	542	535	533	98	102	98	93	349	93	89	94	87	156	1651
25.75	542	503	526	98	102	98	94	350	94	89	94	87	156	1643
26	544	457	515	99	103	98	94	346	94	89	95	87	159	1633
26.25	561	434	514	99	103	98	94	348	94	90	95	88	161	1616
26.5	571	419	513	100	104	99	95	351	95	90	95	88	165	1643
26.75	566	411	518	100	104	99	95	351	96	91	96	88	168	1625

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Time (min)	Pass/ Fail TC #28 (°F)	TC #29 (°F)	TC #30 (°F)	Pass/ Fail TC #31 (°F)	Pass/ Fail TC #32 (°F)	Pass/ Fail TC #33 (°F)	Pass/ Fail TC #34 (°F)	Pass/ Fail TC #35 (°F)	Pass/ Fail TC #36 (°F)	Pass/ Fail TC #37 (°F)	Pass/ Fail TC #38 (°F)	Pass/ Fail TC #39 (°F)	Pass/ Fail TC #40 (°F)	TC #41 (°F)
27	568	404	510	101	105	100	95	352	96	91	96	89	172	1619
27.25	543	400	474	101	105	100	96	356	97	92	97	89	176	1628
27.5	508	396	430	102	106	100	96	362	97	92	97	89	182	1634
27.75	484	391	405	102	107	101	97	364	98	93	98	90	187	1618
28	464	386	385	103	107	101	97	366	99	93	98	90	192	1631
28.25	449	381	373	103	107	102	97	369	99	93	98	90	197	1652
28.5	432	370	360	104	108	102	97	372	100	94	99	91	201	1692
28.75	417	362	351	104	108	102	98	371	100	94	99	91	204	1658
29	396	353	341	105	109	103	98	371	101	95	100	91	209	1644
29.25	374	345	328	105	109	103	98	375	102	95	100	91	213	1659
29.5	348	336	312	106	110	103	99	375	102	96	101	92	217	1633
29.75	335	328	298	106	110	104	99	377	103	96	101	92	221	1656
30	323	322	286	107	111	104	99	376	103	97	101	92	226	1648
30.25	314	318	279	107	111	104	100	376	104	97	102	93	230	1477
30.5	307	315	272	108	112	105	100	374	105	98	102	93	235	1222
30.75	301	312	267	108	112	105	100	368	105	98	103	93	240	1111
31	296	310	263	109	112	105	101	363	106	99	103	94	244	1033
31.25	291	308	260	109	113	106	101	361	107	99	103	94	246	981
31.5	287	306	259	110	113	106	101	355	107	100	104	94	247	935
31.75	283	305	258	110	113	106	102	349	108	100	104	95	247	900
32	280	303	257	110	113	107	102	343	108	101	104	95	246	864
32.25	277	301	257	111	114	107	102	339	109	101	105	95	244	836
32.5	275	300	257	111	114	107	102	334	109	101	105	96	239	807
32.75	273	299	256	111	114	107	102	329	109	102	105	96	237	785
33	270	298	256	111	114	107	102	324	109	102	105	96	237	762
33.25	268	296	256	111	114	107	102	321	109	102	105	96	238	744
33.5	266	295	256	111	113	107	102	316	109	103	105	96	240	723
33.75	265	294	255	111	113	107	102	311	109	103	105	96	242	708
34	263	292	255	111	113	106	102	306	109	103	104	96	244	692
34.25	262	291	255	111	113	106	102	302	109	103	104	96	244	679
34.5	260	290	254	111	113	106	102	298	109	103	104	96	243	664
34.75	259	289	254	111	112	106	102	296	109	103	104	96	246	651
35	258	288	253	111	112	106	102	292	109	103	103	96	252	638
35.25	257	287	253	110	112	106	101	287	109	103	103	96	253	625
35.5	255	286	253	110	111	105	101	284	108	103	103	96	253	614
35.75	254	285	252	110	111	105	101	280	108	103	103	96	251	604
36	253	284	251	110	111	105	101	277	108	103	102	96	248	593
36.25	252	283	251	109	110	104	100	273	108	103	102	96	247	584
36.5	252	282	250	109	110	104	100	268	108	103	102	95	243	573
36.75	251	281	250	109	110	104	100	265	107	103	101	95	242	564
37	250	280	249	109	109	104	100	263	107	103	101	95	241	555
37.25	250	280	248	108	109	103	100	260	107	103	100	95	238	547
37.5	249	279	248	108	109	103	100	257	107	103	100	95	251	538
37.75	248	278	247	108	108	103	99	255	106	103	100	95	246	530
38	247	277	246	107	108	102	99	252	106	103	99	95	243	523
38.25	247	276	245	107	107	102	99	248	105	102	99	95	241	516
38.5	246	275	244	107	107	102	99	246	105	102	99	94	239	509
38.75	245	273	244	106	107	102	99	242	105	102	98	94	237	503
39	244	272	243	106	107	101	98	240	105	102	98	94	235	496
39.25	244	270	242	106	106	101	98	238	104	102	98	94	233	490
39.5	243	269	241	105	106	101	98	234	104	102	98	94	231	483
39.75	242	268	240	105	105	100	98	231	103	102	97	94	229	477
40	242	267	240	105	105	100	98	229	103	101	97	94	227	471
Max Temp	571	578	537	111	114	107	102	377	109	103	105	96	253	1692
Max Allowed	814			812	813	813	812	813	811	811	812	812	813	

Time (min)	TC #42 (°F)	TC #43 (°F)	TC #44 (°F)	TC #45 (°F)	TC #46 (°F)	TC #47 (°F)	TC #48 (°F)	Pass/ Fail TC #49 (°F)	Pass/ Fail TC #50 (°F)	Pass/ Fail TC #51 (°F)	Pass/ Fail TC #52 (°F)	Pass/ Fail TC #53 (°F)	Pass/ Fail TC #54 (°F)
0	67	65	66	65	66	72	71	59	61	61	62	61	59
0.25	582	571	358	367	400	467	522	59	61	61	62	61	59
0.5	1042	993	701	671	738	852	913	60	61	61	62	62	59
0.75	1204	1098	845	831	854	997	1018	60	62	61	62	62	59
1	1261	1142	919	930	905	1037	1061	60	62	61	62	62	59
1.25	1299	1154	954	972	926	1079	1076	60	62	61	62	62	59
1.5	1301	1178	977	1005	986	1184	1142	60	63	62	62	62	59
1.75	1305	1189	997	1029	1201	1227	1205	60	62	62	63	62	59
2	1327	1200	1014	1049	1193	1192	1185	60	62	62	62	62	59
2.25	1367	1215	1028	1063	1110	1197	1178	60	62	62	62	62	59
2.5	1343	1238	1037	1071	1099	1197	1191	60	63	63	62	62	59
2.75	1342	1247	1051	1086	1107	1201	1197	60	62	63	62	62	59
3	1364	1255	1062	1094	1115	1219	1203	60	62	62	62	62	59
3.25	1355	1248	1064	1111	1129	1216	1214	60	63	62	63	62	59
3.5	1364	1255	1075	1110	1139	1227	1214	60	63	62	63	63	59
3.75	1381	1257	1080	1121	1146	1229	1221	60	63	63	63	63	59
4	1410	1276	1091	1129	1152	1243	1235	60	63	62	63	63	59
4.25	1392	1295	1098	1135	1172	1240	1238	60	64	63	62	63	59
4.5	1392	1294	1098	1151	1176	1250	1247	60	63	63	62	62	59
4.75	1411	1310	1117	1150	1190	1269	1272	60	63	63	63	63	59
5	1455	1318	1131	1175	1228	1294	1291	60	63	63	62	63	59
5.25	1474	1367	1157	1184	1232	1314	1306	60	63	63	63	63	60
5.5	1448	1367	1163	1190	1231	1299	1310	60	63	63	63	62	60
5.75	1452	1376	1162	1194	1233	1296	1312	60	63	63	63	63	60
6	1447	1369	1161	1191	1238	1303	1306	60	63	63	63	63	60
6.25	1446	1373	1162	1191	1234	1307	1307	60	63	62	63	62	60
6.5	1429	1350	1161	1198	1233	1305	1306	60	63	63	63	63	60
6.75	1466	1366	1167	1204	1234	1309	1300	60	63	63	63	63	60
7	1464	1374	1172	1199	1236	1314	1312	60	63	63	63	63	60
7.25	1416	1364	1183	1202	1249	1302	1323	60	63	63	63	63	60
7.5	1417	1386	1186	1196	1249	1309	1314	60	64	63	63	63	60
7.75	1413	1378	1185	1200	1252	1312	1317	60	64	63	63	63	60
8	1425	1379	1185	1199	1255	1310	1324	60	63	63	64	63	60
8.25	1424	1366	1184	1203	1254	1312	1317	60	63	63	63	63	60
8.5	1438	1370	1186	1210	1253	1318	1316	60	63	63	64	63	60
8.75	1461	1374	1189	1221	1252	1323	1320	60	63	64	65	63	60
9	1451	1368	1191	1225	1253	1324	1326	61	63	63	66	63	60
9.25	1476	1359	1192	1221	1255	1325	1318	61	63	63	65	64	60
9.5	1453	1360	1190	1221	1256	1326	1319	61	63	64	64	64	60
9.75	1460	1373	1193	1228	1257	1326	1321	60	64	64	64	64	60
10	1450	1382	1197	1228	1261	1334	1332	61	64	64	64	64	61
10.25	1473	1381	1203	1230	1258	1333	1329	61	64	64	64	64	61
10.5	1449	1382	1207	1229	1263	1332	1329	61	64	64	64	64	61
10.75	1431	1391	1211	1222	1275	1328	1338	61	63	63	63	64	61
11	1444	1386	1212	1223	1274	1327	1335	61	63	64	64	64	61
11.25	1469	1403	1213	1231	1272	1333	1338	61	63	63	64	64	61
11.5	1439	1398	1219	1234	1282	1339	1339	61	63	63	64	64	61
11.75	1430	1398	1217	1232	1283	1338	1345	61	63	64	64	64	61
12	1452	1412	1219	1241	1282	1341	1343	61	63	64	64	64	61
12.25	1433	1394	1223	1240	1283	1340	1342	61	63	64	64	64	61
12.5	1444	1398	1222	1237	1291	1345	1347	61	63	63	64	65	62
12.75	1475	1390	1224	1244	1286	1351	1346	61	63	64	64	65	62
13	1493	1408	1230	1256	1285	1352	1346	61	63	64	64	65	62
13.25	1476	1416	1232	1253	1291	1354	1351	61	64	64	64	65	62
13.5	1479	1416	1238	1252	1295	1353	1351	61	63	63	64	65	62
13.75	1457	1403	1236	1256	1293	1359	1360	61	64	63	64	65	63
14	1456	1397	1231	1261	1294	1359	1353	61	64	63	64	65	63
14.25	1488	1422	1234	1268	1291	1361	1354	62	63	64	65	65	63
14.5	1474	1420	1238	1259	1297	1365	1356	62	64	64	65	65	63

Time (min)	TC #42 (°F)	TC #43 (°F)	TC #44 (°F)	TC #45 (°F)	TC #46 (°F)	TC #47 (°F)	TC #48 (°F)	Pass/ Fail TC #49 (°F)	Pass/ Fail TC #50 (°F)	Pass/ Fail TC #51 (°F)	Pass/ Fail TC #52 (°F)	Pass/ Fail TC #53 (°F)	Pass/ Fail TC #54 (°F)
14.75	1481	1408	1241	1253	1300	1362	1358	62	64	64	65	65	63
15	1462	1420	1246	1252	1319	1368	1376	62	64	64	65	65	64
15.25	1519	1495	1287	1292	1381	1425	1441	62	64	64	65	65	64
15.5	1525	1494	1306	1305	1389	1442	1452	62	64	64	65	65	64
15.75	1577	1514	1310	1322	1389	1447	1449	62	64	64	65	65	64
16	1600	1555	1319	1337	1399	1461	1458	62	64	64	65	66	65
16.25	1573	1545	1333	1342	1401	1462	1464	62	64	64	65	66	65
16.5	1572	1532	1333	1342	1417	1470	1477	62	64	64	65	66	65
16.75	1578	1549	1335	1347	1418	1478	1477	62	64	64	65	66	65
17	1592	1533	1335	1356	1417	1481	1471	62	64	64	65	66	65
17.25	1581	1528	1335	1356	1417	1480	1478	63	65	64	65	66	65
17.5	1588	1527	1335	1360	1423	1491	1488	63	64	64	65	66	66
17.75	1576	1544	1345	1358	1427	1488	1488	63	65	64	65	66	66
18	1592	1527	1346	1364	1433	1490	1491	63	65	64	65	66	66
18.25	1570	1542	1345	1364	1438	1494	1499	63	65	65	66	66	66
18.5	1577	1546	1350	1370	1443	1503	1505	63	65	65	66	67	67
18.75	1565	1548	1350	1363	1438	1493	1496	63	65	65	66	67	67
19	1579	1549	1353	1370	1447	1504	1512	63	65	65	66	67	67
19.25	1579	1556	1358	1374	1452	1505	1510	63	65	65	66	67	68
19.5	1598	1556	1357	1376	1452	1505	1507	64	65	65	66	67	68
19.75	1585	1544	1357	1379	1451	1502	1506	64	65	65	67	67	68
20	1573	1571	1371	1375	1454	1505	1510	64	65	65	67	68	68
20.25	1587	1569	1371	1374	1463	1508	1517	64	65	65	67	67	68
20.5	1608	1591	1371	1382	1456	1511	1516	64	65	65	67	68	69
20.75	1606	1568	1374	1382	1457	1513	1515	64	65	65	67	68	69
21	1593	1556	1371	1398	1467	1525	1531	65	65	65	67	68	69
21.25	1606	1555	1371	1396	1465	1526	1525	65	66	66	67	68	70
21.5	1604	1567	1377	1394	1462	1523	1518	65	66	66	67	68	70
21.75	1592	1571	1383	1393	1469	1518	1523	65	66	65	67	68	70
22	1571	1569	1393	1392	1485	1520	1535	65	66	65	67	68	70
22.25	1598	1556	1383	1402	1474	1527	1530	66	66	66	67	68	71
22.5	1624	1583	1384	1405	1474	1535	1536	66	66	66	68	68	71
22.75	1617	1581	1384	1406	1473	1532	1533	67	66	66	68	68	71
23	1601	1566	1384	1407	1474	1537	1529	67	66	67	68	69	71
23.25	1619	1578	1384	1407	1476	1539	1536	67	66	67	68	69	72
23.5	1624	1598	1389	1414	1477	1542	1541	67	67	66	68	69	72
23.75	1597	1580	1391	1404	1476	1533	1536	67	66	66	68	69	72
24	1598	1591	1395	1403	1488	1530	1544	68	66	66	68	69	72
24.25	1598	1574	1392	1409	1487	1535	1537	68	66	66	67	69	73
24.5	1614	1576	1392	1417	1491	1531	1534	69	67	66	68	69	73
24.75	1621	1590	1393	1421	1479	1541	1537	69	67	66	68	69	73
25	1619	1579	1396	1416	1496	1552	1551	69	67	66	68	69	74
25.25	1655	1627	1419	1434	1521	1578	1578	70	67	66	68	69	74
25.5	1667	1640	1428	1441	1539	1598	1603	70	67	66	68	69	74
25.75	1684	1652	1436	1449	1548	1604	1602	71	67	66	68	69	75
26	1682	1645	1443	1468	1555	1615	1611	71	68	66	68	69	75
26.25	1682	1640	1436	1465	1547	1607	1611	71	67	66	69	69	75
26.5	1679	1650	1445	1464	1558	1616	1613	71	67	66	68	69	75
26.75	1682	1654	1447	1474	1561	1621	1624	72	68	67	69	70	76

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Time (min)	TC #42 (°F)	TC #43 (°F)	TC #44 (°F)	TC #45 (°F)	TC #46 (°F)	TC #47 (°F)	TC #48 (°F)	Pass/ Fail TC #49 (°F)	Pass/ Fail TC #50 (°F)	Pass/ Fail TC #51 (°F)	Pass/ Fail TC #52 (°F)	Pass/ Fail TC #53 (°F)	Pass/ Fail TC #54 (°F)
27	1690	1637	1448	1481	1575	1635	1627	72	68	67	69	70	76
27.25	1703	1650	1452	1492	1567	1632	1633	72	68	67	69	70	76
27.5	1706	1669	1457	1486	1588	1639	1625	73	68	67	69	70	77
27.75	1706	1665	1458	1488	1567	1632	1630	73	68	67	69	70	77
28	1709	1662	1462	1490	1574	1638	1634	74	68	68	69	70	78
28.25	1696	1671	1467	1490	1578	1647	1638	74	68	67	70	70	78
28.5	1694	1672	1473	1486	1582	1641	1646	75	68	68	70	70	78
28.75	1709	1680	1473	1494	1587	1642	1649	75	69	68	69	71	78
29	1718	1659	1470	1500	1587	1649	1649	76	69	68	70	71	78
29.25	1684	1678	1476	1488	1581	1630	1638	75	69	68	70	71	79
29.5	1731	1678	1470	1499	1583	1649	1644	76	69	69	70	71	79
29.75	1721	1667	1475	1499	1580	1646	1636	77	69	68	70	71	80
30	1740	1660	1474	1506	1590	1656	1649	78	70	68	70	71	80
30.25	1506	1488	1384	1401	1448	1464	1467	78	69	69	70	71	80
30.5	1231	1211	1160	1189	1222	1222	1225	78	70	69	71	71	81
30.75	1118	1094	1040	1085	1108	1099	1105	78	70	69	70	71	81
31	1039	1013	943	1007	1022	1012	1014	79	70	69	70	72	81
31.25	986	963	895	960	967	963	954	79	70	68	70	72	82
31.5	937	919	852	915	915	916	907	79	70	69	71	72	82
31.75	902	882	821	880	878	878	869	80	70	69	71	72	82
32	868	844	791	847	838	841	829	80	71	69	71	73	83
32.25	841	818	765	821	811	810	805	81	70	69	71	72	83
32.5	812	791	736	794	783	783	777	81	70	69	71	72	84
32.75	789	770	709	772	761	762	757	81	70	69	71	72	84
33	766	748	687	751	736	738	733	83	71	69	71	73	84
33.25	745	730	670	731	718	720	714	83	71	69	71	73	84
33.5	726	712	654	714	698	701	698	83	71	70	71	73	85
33.75	710	695	639	700	682	686	681	83	71	69	71	73	85
34	692	679	624	683	666	670	664	83	71	70	72	73	86
34.25	679	665	610	670	652	655	653	84	72	70	72	73	86
34.5	663	650	596	657	635	640	634	84	72	70	72	73	86
34.75	651	637	584	644	622	628	623	84	72	70	72	73	86
35	638	624	572	629	610	616	608	86	72	71	73	73	87
35.25	625	614	561	619	598	603	600	86	72	71	72	73	87
35.5	613	603	550	609	587	592	589	85	72	70	73	73	87
35.75	604	593	541	599	577	581	579	85	72	70	73	73	87
36	593	583	531	589	567	571	570	86	72	70	73	73	87
36.25	584	575	522	580	557	560	560	86	72	70	73	74	87
36.5	574	565	514	570	547	551	550	87	73	70	73	74	88
36.75	565	557	506	561	537	542	541	86	72	70	73	74	88
37	555	548	498	552	528	533	531	87	72	70	73	73	88
37.25	547	540	492	544	518	526	523	87	73	70	73	74	88
37.5	538	531	482	535	512	517	514	87	73	70	73	73	88
37.75	531	524	475	529	503	510	508	87	73	70	73	74	89
38	523	517	467	521	494	501	499	88	72	70	73	73	89
38.25	516	511	462	515	488	495	494	87	73	70	73	74	89
38.5	509	503	456	507	481	488	486	88	72	70	73	74	89
38.75	503	497	450	501	476	483	479	89	73	70	73	74	89
39	496	490	445	495	469	473	473	88	73	70	73	74	89
39.25	491	485	439	489	462	467	466	89	73	70	73	74	90
39.5	484	478	433	483	455	461	458	89	73	71	73	74	90
39.75	479	472	428	478	449	457	453	89	73	70	73	73	90
40	473	466	423	472	445	450	448	90	72	71	73	74	90
Max Temp	1740	1680	1476	1506	1590	1656	1649	90	73	71	73	74	90
Max Allowed								559	561	561	562	561	559

APPENDIX C
Photographs


DensGlass
GP
01/21/2013 10:02


01/21/2013 10:10

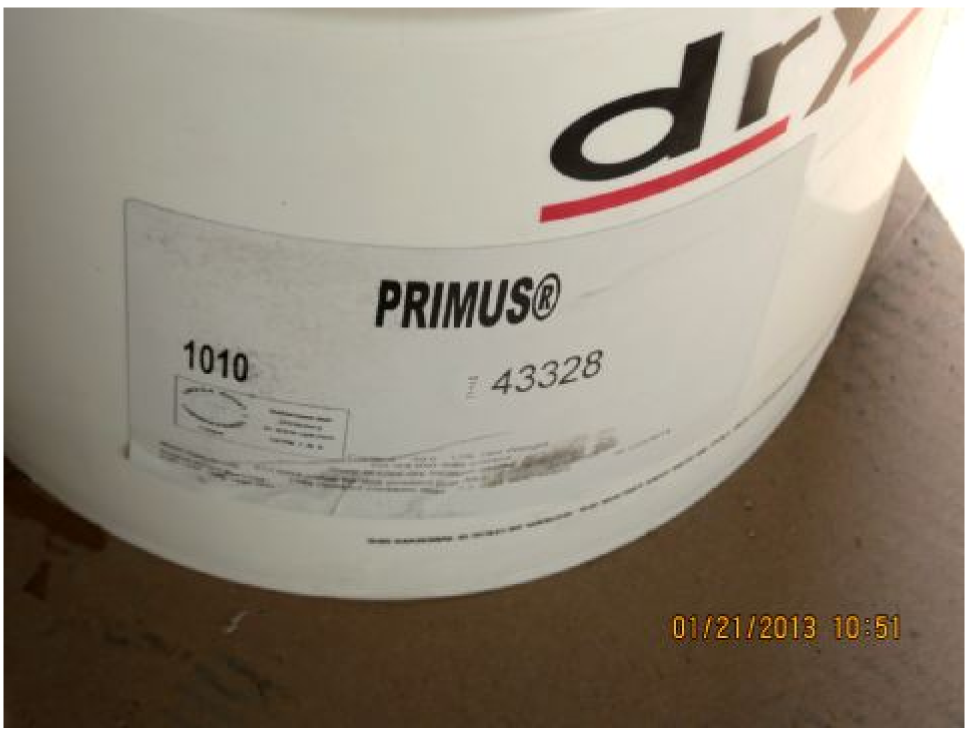

01/21/2013 10:16


dryvit®
BACKSTOP® NT TEXTURE
1197
44717
01/21/2013 10:23


DensGlass
DensGlass
DensGlass
ensGlass
01/21/2013 10:14


01/21/2013 10:24


01/21/2013 10:51


PRIMUS®
1010
43328
01/21/2013 10:51


01/22/2013 11:14


01/22/2013 11:11


01/21/2013 11:22


01/21/2013 11:17


01/21/2013 16:12


01/22/2013 10:20


01/22/2013 11:24


01/22/2013 12:45


dryvit
QUARZPUTZ®
Pastel Base
1020198
43803
01/24/2013 11:27


01/24/2013 11:27


02/26/2013 12:02


02/26/2013 12:03


02/26/2013 12:03


02/26/2013 12:21


02/26/2013 12:22


G100944630
SAT-002
02/26/2013 12:22


G100944630
SAT-002
02/26/2013 12:35


02/26/2013 12:36


02/26/2013 12:38


02/26/2013 12:40
SAT-002


G100944630
SAT-002
02/26/2013 12:41

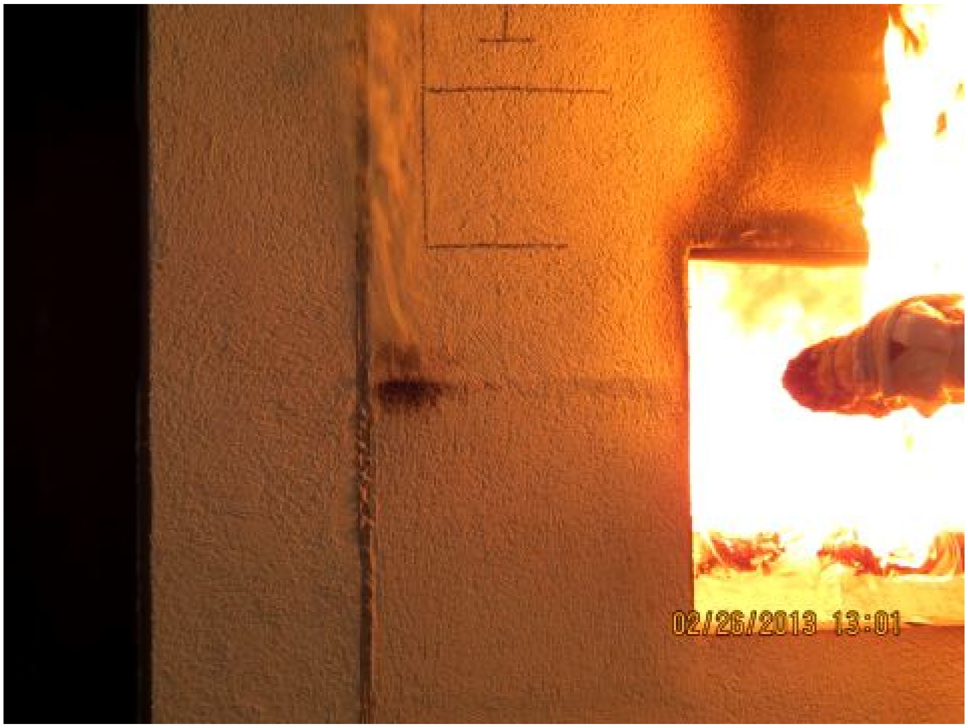

G100944630
SAT-002
02/26/2013 12:47


G100944630
SAT-002
02/26/2013 12:47


02/26/2013 12:48


G100944630
SAT-002
02/26/2013 12:54


G100944630
SAT-002
02/26/2013 13:01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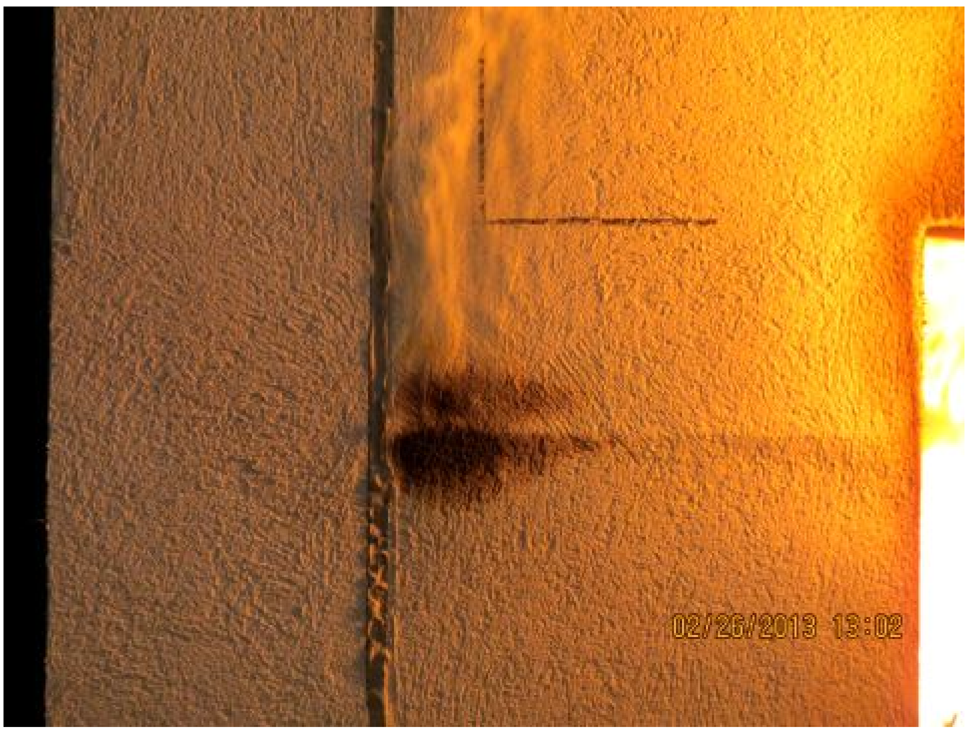
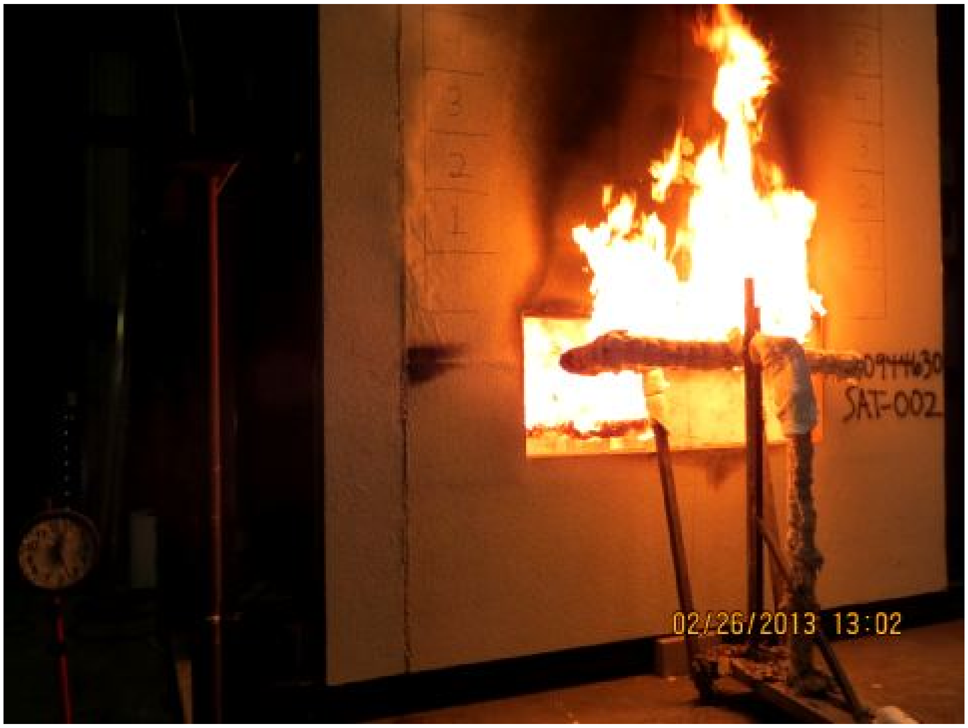

02/26/2013 13:02


SAT-002
02/26/2013 13:02


02/26/2013 13:04


G100944630
SAT-002
02/26/2013 13:05


2
1
02/26/2013 13:09


G100944630
SAT-002
02/26/2013 13:15


G100944630
SAT-002
02/27/2013 16:17


02/27/2013 16:17

CALIBRATED INSTRUMENTATION USED FOR TESTING

Description	Serial No.	Calibration Due Date
Thermo-Hygrometer (Horizontal Furnace)	111765171	8/30/2013
100-Channel Data Acquisition System	99LE004	3/19/2013
Stop Watch	111901142	11/2/2013

REVISION SUMMARY

DATE	SUMMARY
February 28, 2013	Original Issue Date
April 9, 2013 MABrown VMBurgos	1) Inserted Revision Number and Date throughout 2) Revised “mesh” to Dryvit Grid Tape (pg 4) 3) Revised language in 3.2.4, to add “over the exterior sheathing” and revised coating thickness to “approximately 12 mils dry thickness”; inserted installation of Dryvit Grid Tape around the window opening (pg 4) 4) Revised “imbedded” to “embedded” (pg 4)

TEST REPORT

Intertek

REPORT NUMBER: 100944630SAT-008
ORIGINAL ISSUE DATE: October 23, 2013
REVISED DATE: N/A

EVALUATION CENTER
16015 Shady Falls Road
Elmendorf, TX 78112
Phone: (210) 635-8100
Fax: (210) 635-8101
www.intertek.com

RENDERED TO

Dryvit Systems, Inc.
One Energy Way
WEST WARWICK RI 02893

PRODUCT EVALUATED: Exterior Insulation and Finish System (EIFS) using VIP Insulation Panels with Foam Shapes
EVALUATION PROPERTY: Fire Resistance

Report of Testing an Exterior Insulation and Finish System (EIFS) using VIP Insulation Panels with Foam Shapes for compliance with the applicable requirements of the following criteria: *NFPA 285 Standard Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components, 2012 Edition.*

1 Table of Contents

2 Introduction

Intertek Testing Services NA, Inc. (Intertek) has conducted testing for Dryvit Systems, Inc., on their Exterior Insulation and Finish System (EIFS) using VIP Insulation Panels with Foam Shapes, to evaluate its fire resistance. Testing was conducted in accordance with the applicable requirements of **NFPA 285 Standard Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components, 2012 Edition**. This evaluation took place on October 10, 2013.

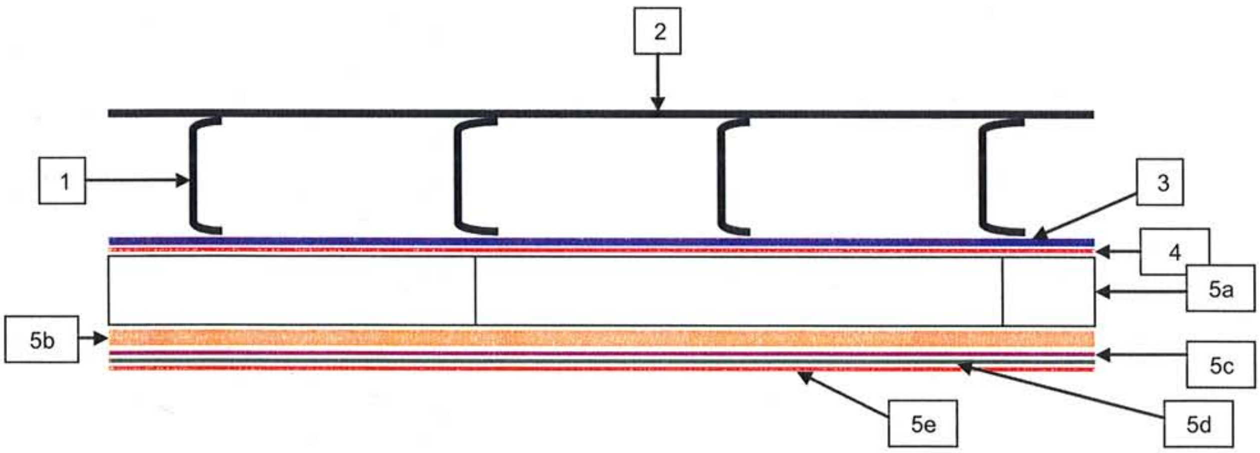
3 Test Samples

3.1. SAMPLE SELECTION

Samples were submitted to Intertek directly from the client. Samples were not independently selected for testing. Materials for the construction of the assembly were received at the Evaluation Center on August 29, 2013 through September 10, 2013 (San Antonio I.D. SAT1308291616-002 through SAT1308291616-009 and SAT1309101001-001).

3.2. SAMPLE AND ASSEMBLY DESCRIPTION

The 18'-3" high X 13'-4" ISMA test wall was constructed using steel studs, interior and exterior sheathing, the Dryvit EIFS System and EPS foam shapes.



1. Framing –3-5/8" deep, 20 GA galvanized steel studs, 24" o.c., inserted into 20 GA at the top and bottom track; secured front and back with #8 x 1/2" long lath head screws at each stud.

2. Interior Sheathing – 4' x 10' x 5/8" thick, USG Sheetrock® Brand, Firecode® Core Type X gypsum board, installed with the long edge perpendicular to the studs using #6 X 1-1/4" self drilling screws spaced 8" o.c. around the perimeter and 12" o.c. in the field; exposed joints and fasteners received a Level 2 finish.

3. Exterior Sheathing – 4' x 8' x 1/2" DensGlass® Gold Exterior Sheathing (Georgia Pacific) installed over exterior side, with the long edge perpendicular to the studs; secured with #6 X 1-1/4" self drilling screws, spaced 8" o.c. around the perimeter and 12" o.c. in the field; 4" Dryvit Grid Tape and then Backstop® NT Texture was installed over all sheathing joints.

4. Coating – Backstop® NT Texture was trowelled onto the entire wall by representatives for Dryvit Systems, Inc. The Backstop® NT Texture was applied over the exterior sheathing resulting in an approximate dry mil thickness of 12 mils; a strip of Dryvit Standard 4.3 oz/yd^2 mesh was installed around the edge of the window opening, a nominal 4" embedded in the Backstop® NT Texture.

5. EIF System – Exterior Insulation and Finish System (EIFS) installed over the exterior sheathing by representatives of Dryvit Systems, Inc., on September 10 through 12, 2013.

    a. Primus® mixture (1:1 Primus® mixture of Primus® and Portland cement by weight) was applied to the back of the 3-3/4" thick insulation board (3-3/4" encapsulated VIP EPS composite) sections and to the outer edges of the panels whose ends would be exposed, e.g., the expansion joint, wall perimeter, and window perimeter using 3/8" x 1/2" x 1-1/2" notched trowel; sections installed over the Backstop® NT Texture surface; the protruding mesh was wrapped around the peripheral panels and embedded in Primus® mixture.

    b. EPS Foam Shapes were adhered to the surface of the 3-3/4" encapsulated VIP EPS composite with the Primus® mixture as noted in "a" above. The shapes were positioned as specified in Appendix A.

    c. Primus® mixture applied over the entire insulation board surface including the EPS foam shapes and 4.3 oz/yd^2 mesh, applied horizontally, (starting at the top), embedded with minimum 3" overlap at the joints, and smoothed over with additional Primus® mixture -- nominal thickness 1/16"

    d. The entire wall, including the EPS foam shapes, was covered with a skim coat of 1:1 Primus® / Portland cement mixture and allowed to dry.

    e. Quarzputz® Pastel Base was applied over the entire exterior surface as the finish coat on September 12, 2013.

    f. 5/8" backer rod was installed in the expansion joint and recessed 3/8". Dow Corning® 790 Silicone building Sealant was installed over the backer rod flush with the exterior of the wall (not shown).

4 Testing and Evaluation Methods

4.1. INSTRUMENTATION

Fifty-four (54) 24 GA, Type K, fiberglass jacketed thermocouples were installed in compliance with the standard (see Appendix A). The output of the thermocouples was monitored by a 100-channel Yokogawa, Inc., Darwin Data Acquisition Unit. The computer was programmed to scan and save data every 15 seconds. Following the test, those files were imported into MS Excel for tabular and graphical display (presented in Appendix B).

4.2. TEST STANDARD

Testing was conducted in accordance with the applicable requirements of, and following the standard methods of **NFPA 285 Standard Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components, 2012 Edition.**

The assembly was secured to the test laboratory's Intermediate-Scale, Multi-story Test Apparatus (ISMA), with ceramic fiber insulation installed between the assembly and the furnace to create an effective seal. The window burner was centered on the vertical centerline of the window, 9" below the top of the opening, and with the longitudinal centerline of the burner 3" from the plane of the exterior wall, consistent with the standard and the calibration of the test apparatus. The assembly was tested using commercial grade propane gas at the flow rates determined during the calibration of the apparatus.

5 Testing and Evaluation Results

5.1. RESULTS AND OBSERVATIONS

The test was initiated on Thursday, October 10, 2013. Bill Preston, Beth Manteuffel and Tom Venticina, representing Dryvit Systems, Inc., Steve Altum representing Dow Corning Corp., and Jesse Beitel, representing Hughes Associates, Inc., were present to witness the test. The ambient temperature at the time of the test was 75°F and humidity was 67% R.H. The Maximum TC Limits, established by the initial thermocouple temperatures and the test standard, are presented in the following table:

Location	TCs	Max TC Limit
Exterior Surface	11, 14 - 17	1000°F
Core	18 – 19; 28, 31 - 40	750°F rise
2nd floor Interior Surface	49 - 54	500°F rise

Observations made during the test are listed below:

Time (min:sec)	Observation
0:00	The test was initiated at 9:22A.M.
1:15	There was flaming out the room due to gypsum paper ignition
1:58	The paper was consumed and the flames receded back into the room
4:00	There was flaming out of the room due to EPS ignition
5:00	The window burner was ignited
6:00	The window sill ignited and there were flames around the window perimeter
6:15	There was flaming on the foam shape above the window
7:00	There was flaming 3-1/2' above the window
9:00	There was flaming above the window to the shape
10:15	There were indentions of the material above the shape
13:00	The flaming continued up to the foam shape
17:00	There was flaming along the bottom of the shape even with the edge of the window
21:00	The flaming continued along the shape

23:00	There was flaming to 4' at the lateral left edge of the window
28:00	The lateral flame was back to even with the edge of the window.
30:00	There burners were extinguished; there was small flaming along the window header
35:00	Smoking continued with no visual flaming
40:00	The test was terminated and smoking continued

Time (min:sec)	Observations from the 2nd Floor Room
15:16	There was smoke from the bottom right angle
22:33	There was smoke from the top of the wall
23:07	The smoke was thicker and darker from the bottom left side of the wall
39:25	The smoke began to diminish

Flames on the exterior panels were within the established limit during the test (10' above the top of the window, 5' beyond the side of the window); there were no flames that spread through the core components or infiltrated the second story room; none of the thermocouples exceeded their maximum limits.

Assembly drawings, the test data and photographs documenting the test are located in the Appendices of this test report.

6 Conclusion

Intertek Testing Services NA, Inc. (Intertek) has conducted testing for Dryvit Systems, Inc., on their Exterior Insulation and Finish System (EIFS) using VIP Insulation Panels with Foam Shapes, to evaluate its fire resistance. Testing was conducted in accordance with the applicable requirements of **NFPA 285 Standard Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components, 2012 Edition**. This evaluation took place on October 10, 2013.

Based on the results from this test, the assembly met the conditions of acceptance of the above mentioned standard.

The conclusions of this test report may not be used as part of the requirements for Intertek product certification. Authority to Mark must be issued for a product to become certified.

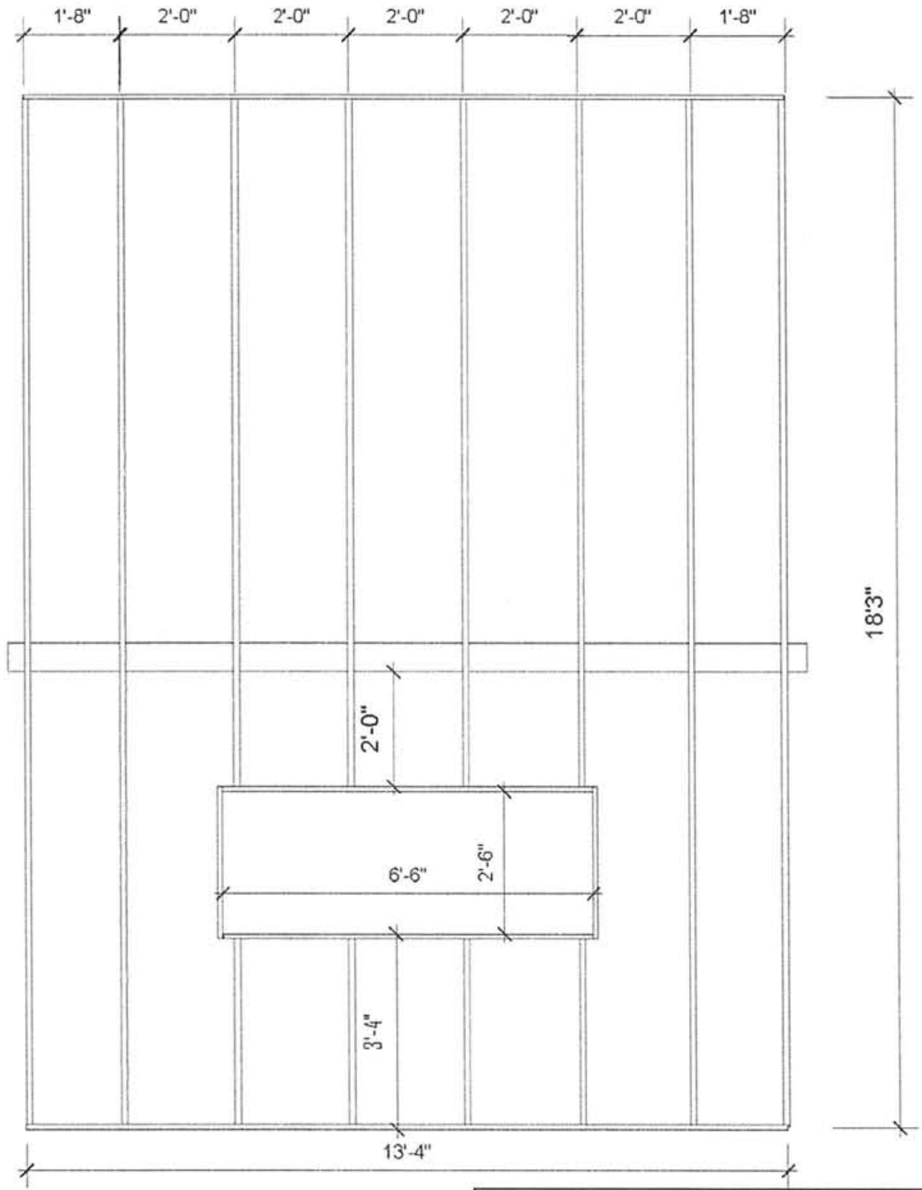
INTERTEK TESTING SERVICES NA, INC.

Tested by: ______________________
Joseph Zatopek
Engineering Team Leader, Fire Resistance

Reported by: ______________________
David Priest
Technical Writer

Reviewed by: ______________________
Victor M. Burgos
Project Engineer, Fire Resistance

APPENDIX A
Assembly Drawings



Note:
The wall was framed using 3-5/8", 20GA galvanized steel studs spaced 24" o.c.; fastened to top and bottom 20GA galvanized steel track using #8 x 1/2" long lath head screws at each location

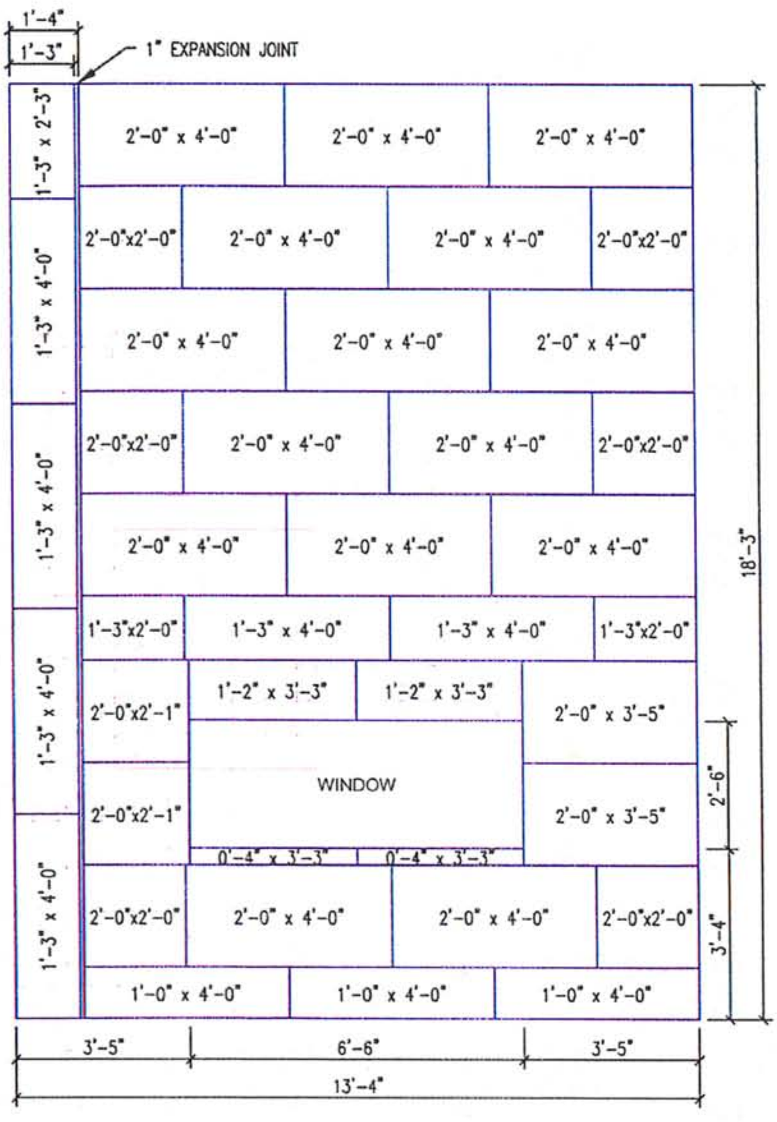
INTERTEK TESTING SERVICES NA, INC.

Project No. G100944630SAT-008

Dryvit Systems, Inc.

Steel Framing

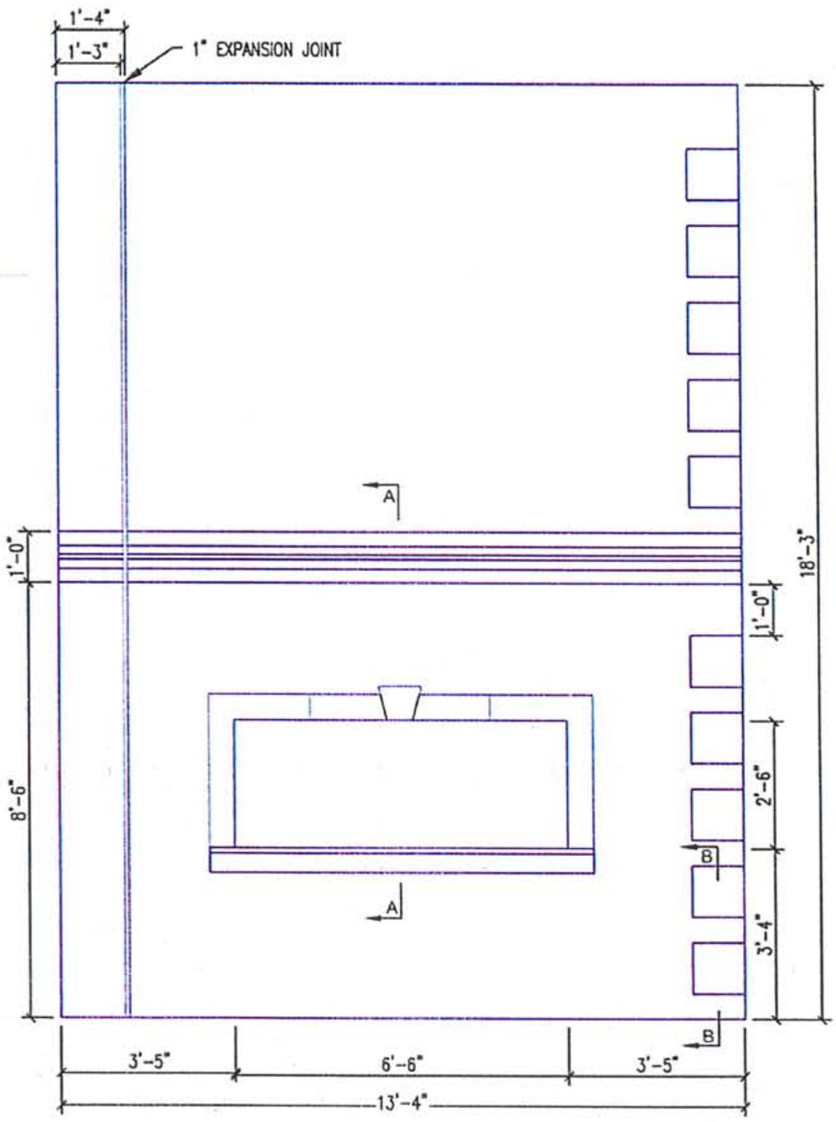
INSULATION PANEL LAYOUT



MATERIAL LIST	
PANEL SIZE	QTY
2'-0" x 2'-0"	6
2'-0" x 4'-0"	15
1'-3" x 4'-0"	2
1'-2" x 3'-3"	2
1'-3" x 2'-0"	2
1'-3" x 4'-0"	6
1'-3" x 2'-3"	1
2'-0" x 2'-1"	2
2'-0" x 3'-5"	2
0'-4" x 3'-3"	2
1'-0" x 4'-0"	3

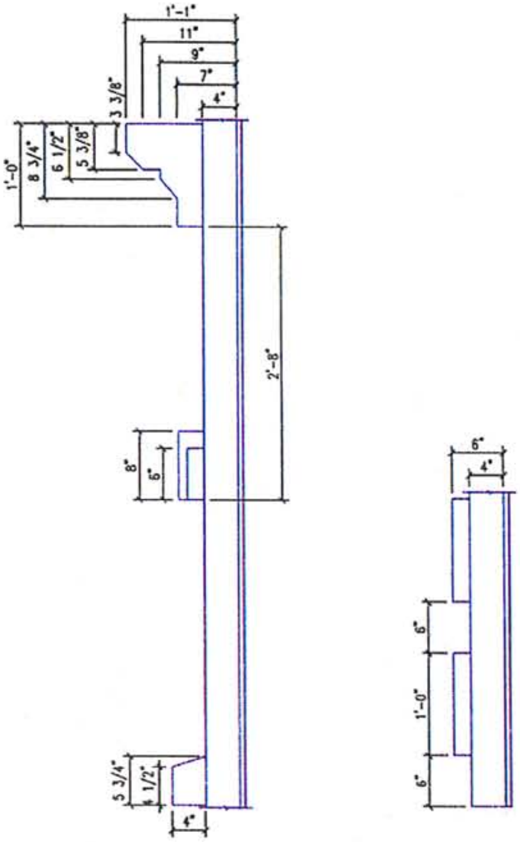
SCALE: ⅜" = 1'-0"

EPS SHAPE LAYOUT



SCALE: 3/8" = 1'-0"

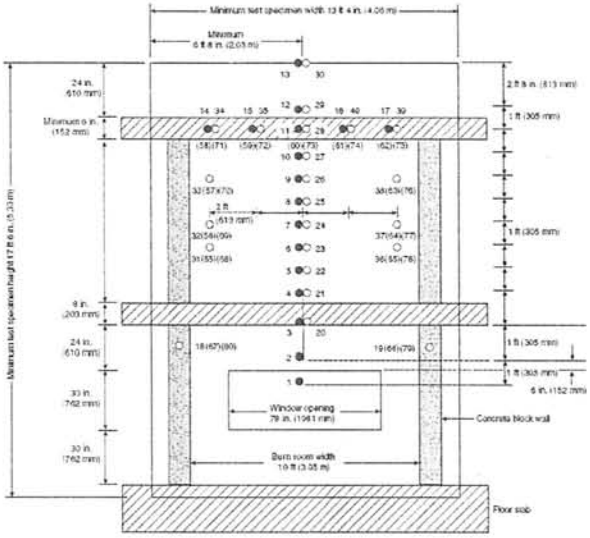
EPS SHAPE SECTIONS



SECTION A-A

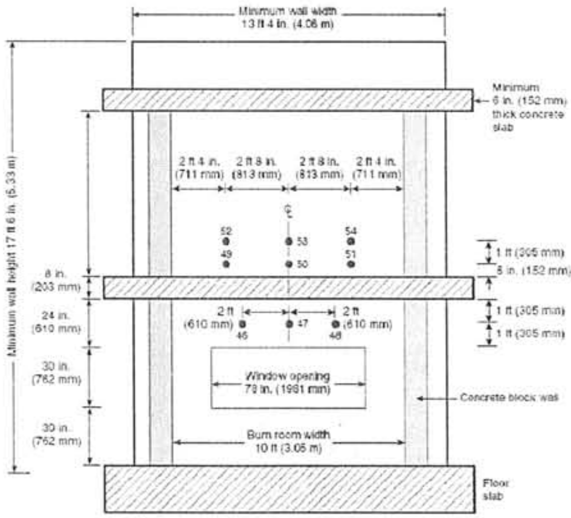
SECTION B-B

SCALE: ¾" = 1'-0"



● Thermocouples — 1 in. (25 mm) from exterior wall surface
○ Thermocouples — In the wall cavity air space or the insulation, or both, as shown in Figure 6.1(b) Details A through I.
( ) Thermocouples — Additional thermocouples in the insulation or the stud cavity, or both, where required for the test specimen construction being tested, as shown in Figure 6.1(b) Details C through I.

FIGURE 6.1(a) From View of Test Specimen Superimposed over Test Apparatus Thermocouple Locations.

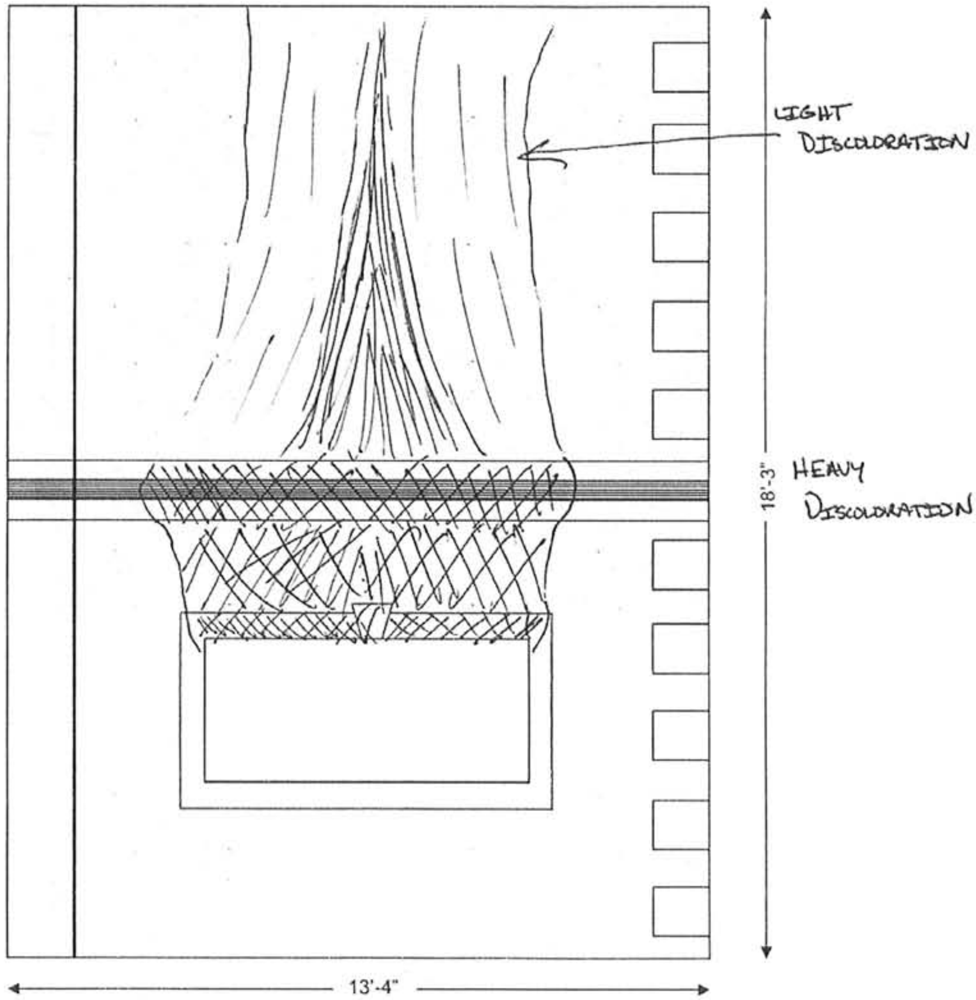


● Thermocouples — 1 in. (25 mm) from interior wall surface

FIGURE 6.1(c) Interior View of the Test Specimen. Instrumentation arrangement.

Source: NFPA 285 Standard Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components; 2012 Edition, Pgs 10, 14..

DISCOLORATION TO TOP OF WALL. DARK DISCOLORATION ABOVE THE WINDOW AND ON THE FOAM SHAPE THAT CONTINUED UP THE CENTER OF THE WALL.



INTERTEK TESTING SERVICES NA, INC.

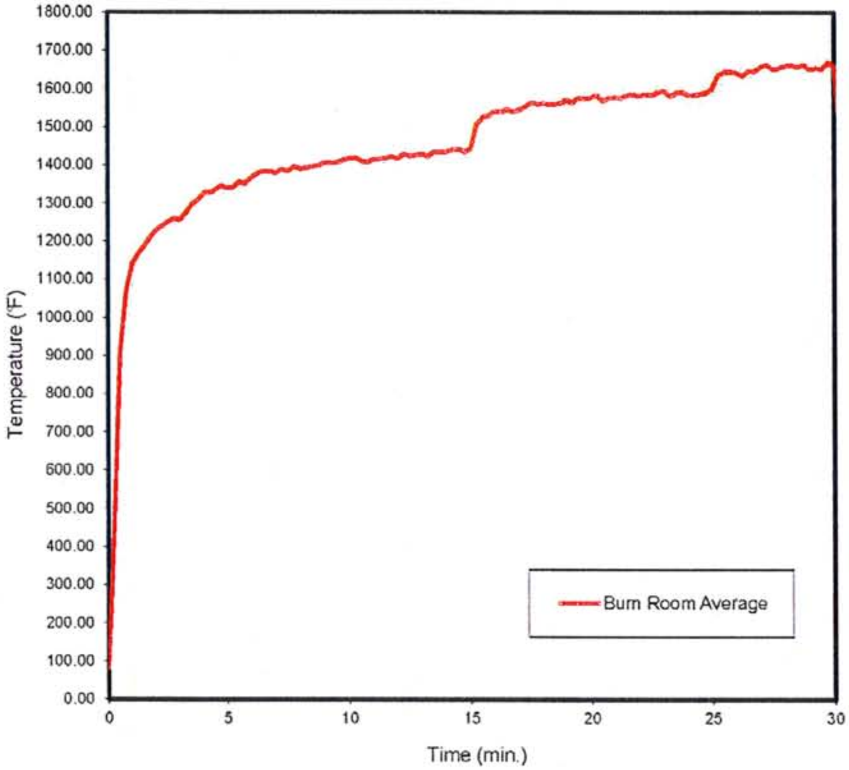
Project No. G100944630SAT-008

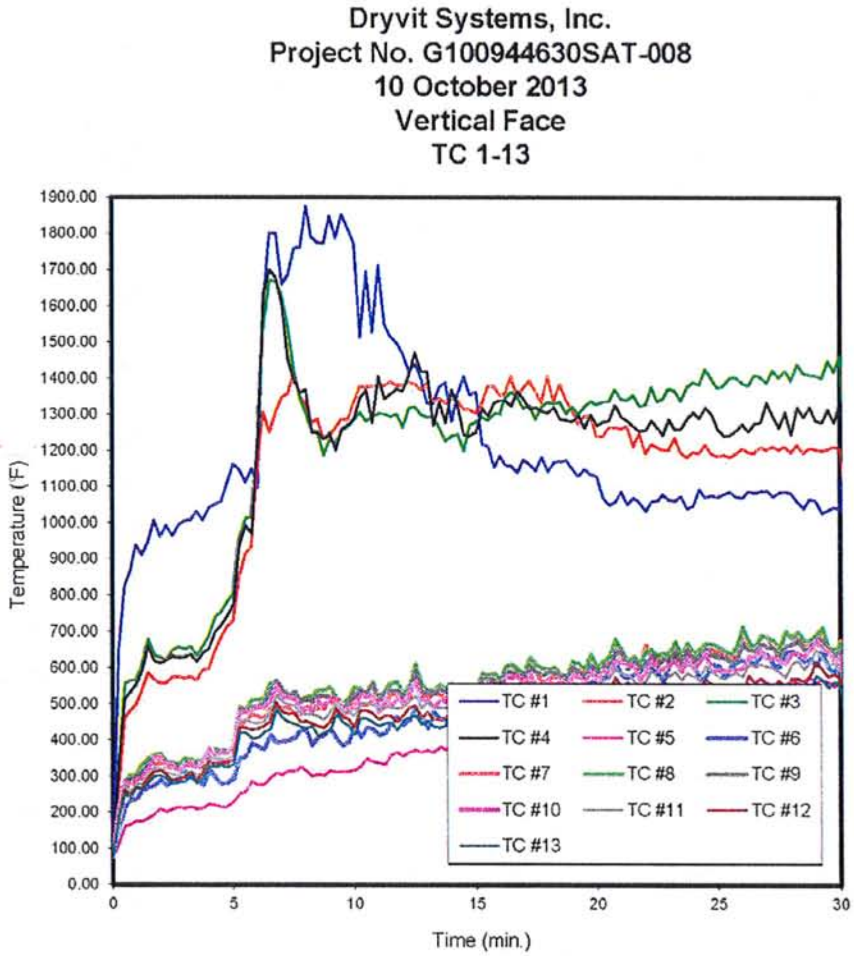
Dryvit Systems, Inc.

Damage Sketch

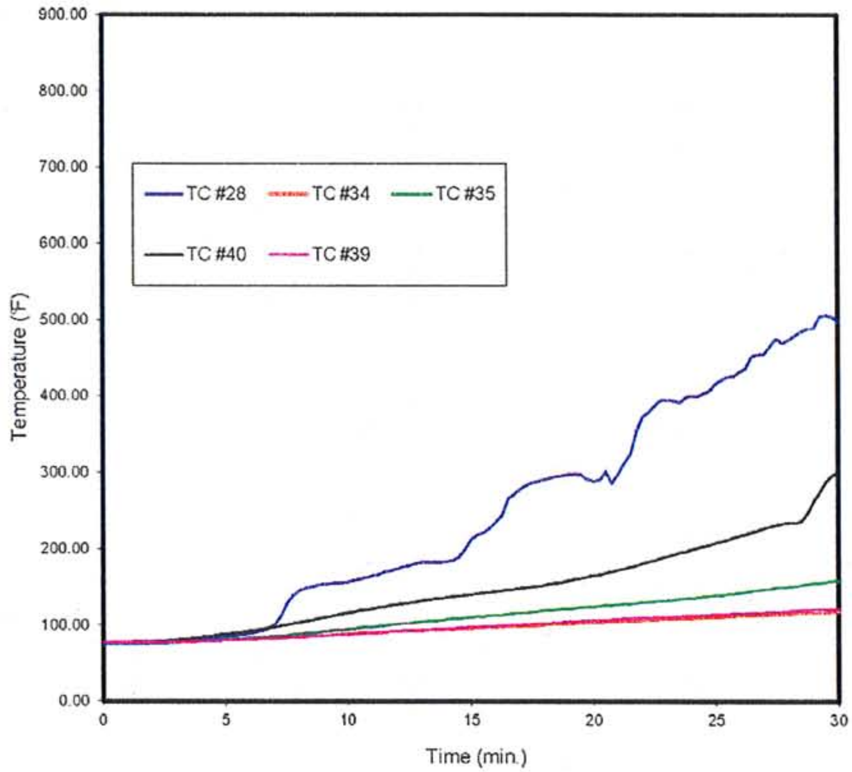
APPENDIX B
Temperature Data

**Dryvit Systems, Inc.
Project No. G100944630SAT-008
10 October 2013
Burn Room Average**

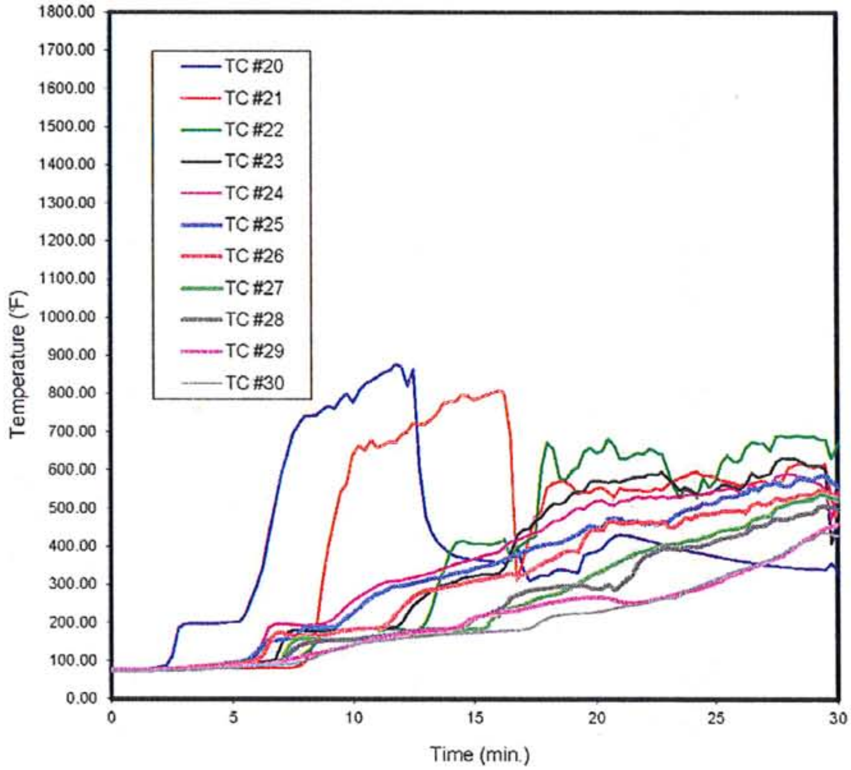


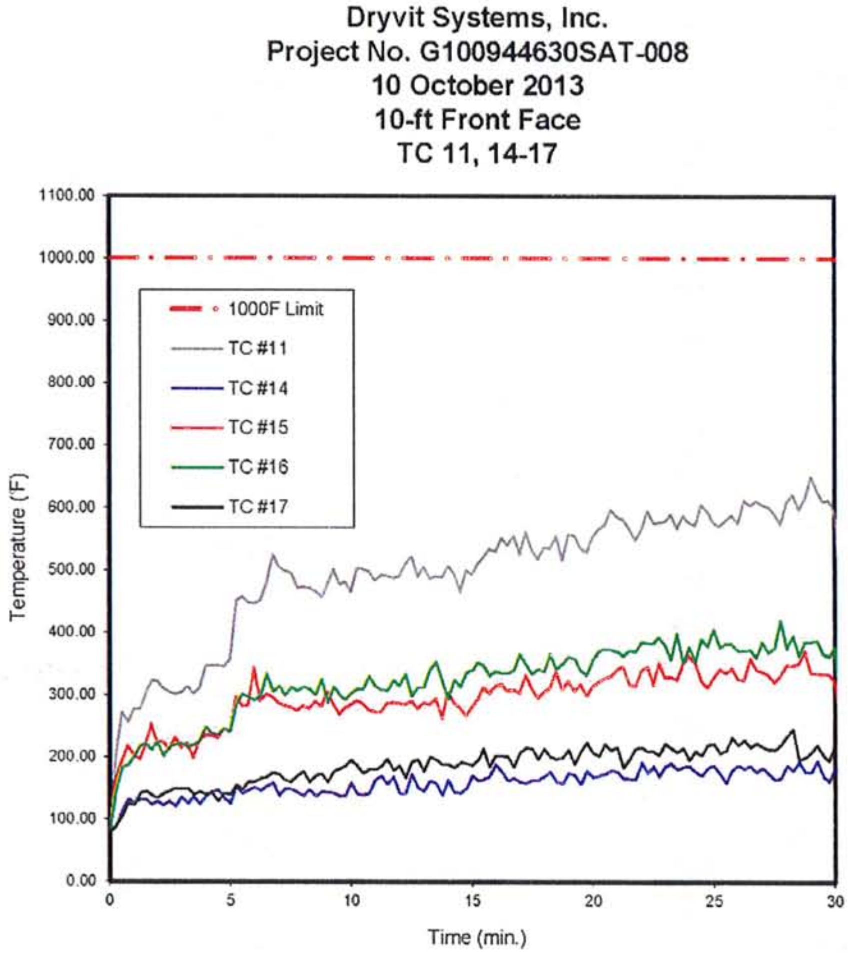

Dryvit Systems, Inc.
Project No. G100944630SAT-008
10 October 2013
Vertical Face
TC 1-13
Temperature (°F)
Time (min.)
1900.00
1800.00
1700.00
1600.00
1500.00
1400.00
1300.00
1200.00
1100.00
1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
0
5
10
15
20
25
30
TC #1
TC #2
TC #3
TC #4
TC #5
TC #6
TC #7
TC #8
TC #9
TC #10
TC #11
TC #12
TC #13

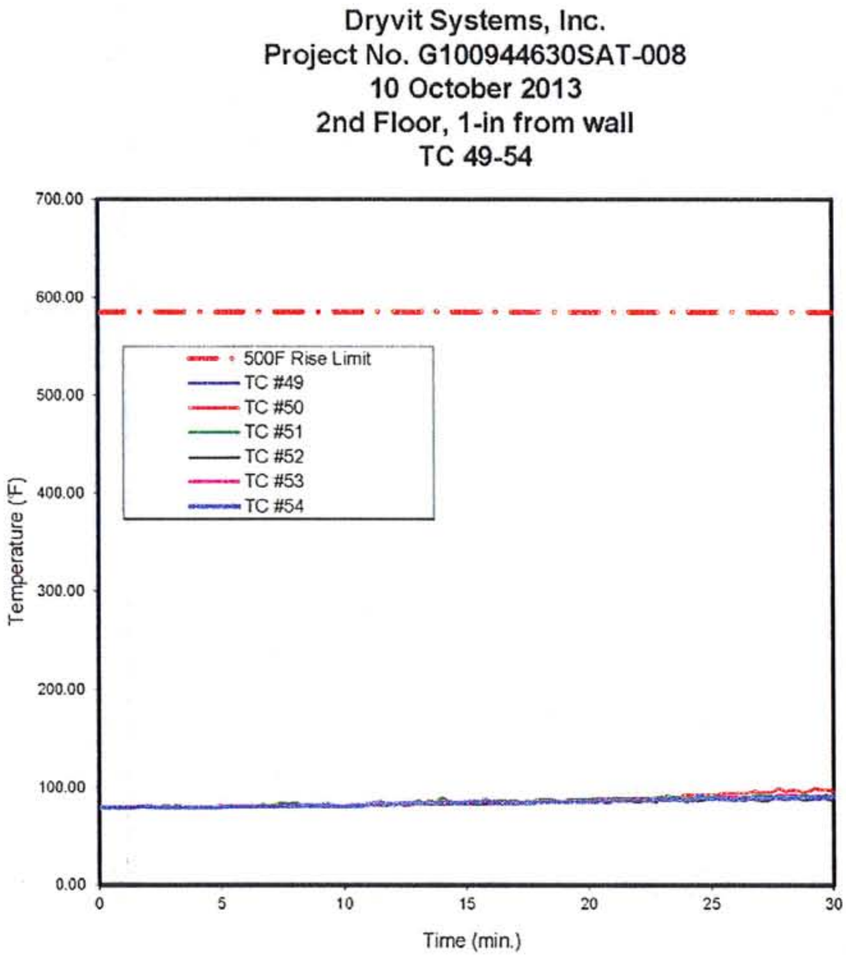
Dryvit Systems, Inc.
Project No. G100944630SAT-008
10 October 2013
10-ft Core
TC 28, 34, 35, 40, 39

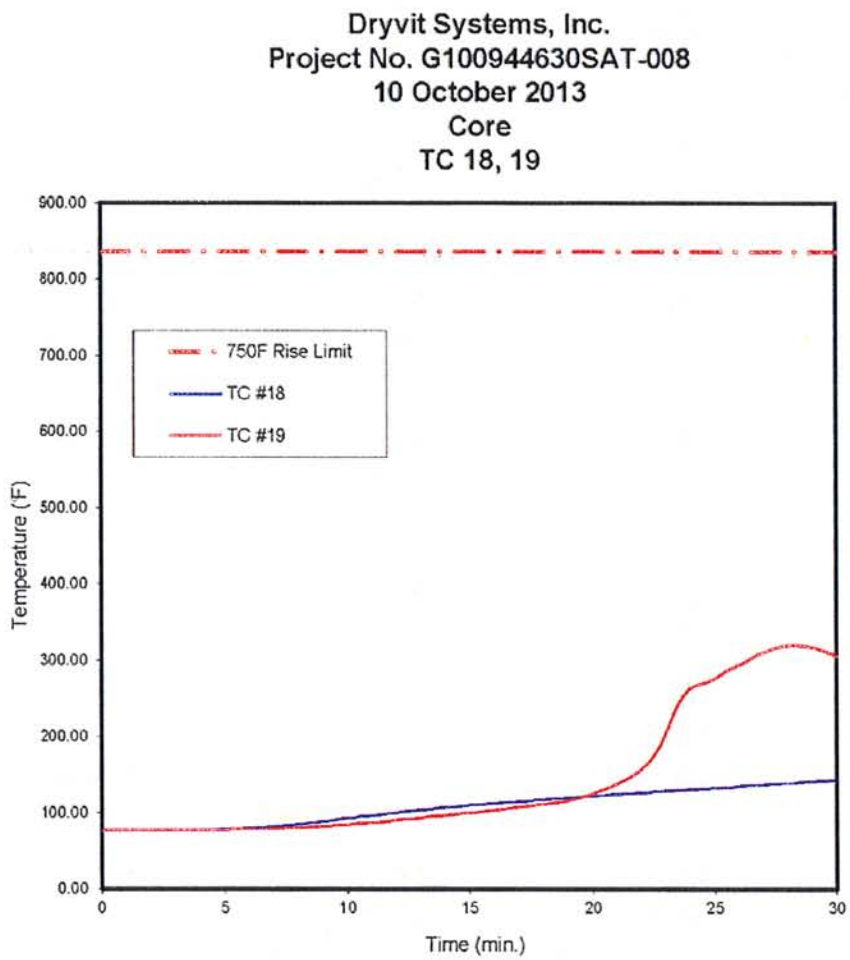


Dryvit Systems, Inc.
Project No. G100944630SAT-008
10 October 2013
Vertical Core
TC 20-30

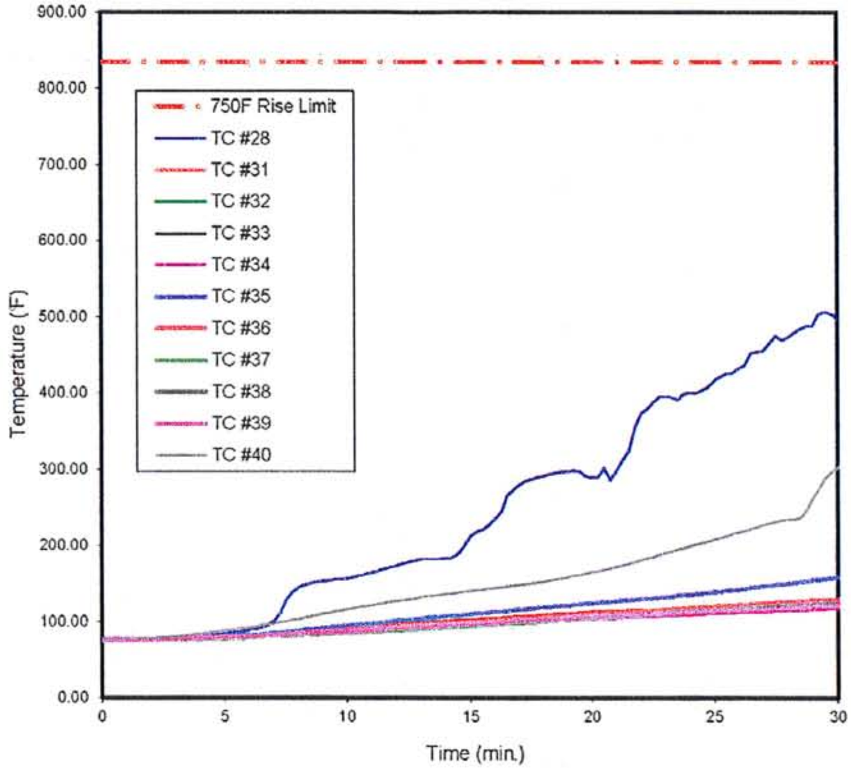


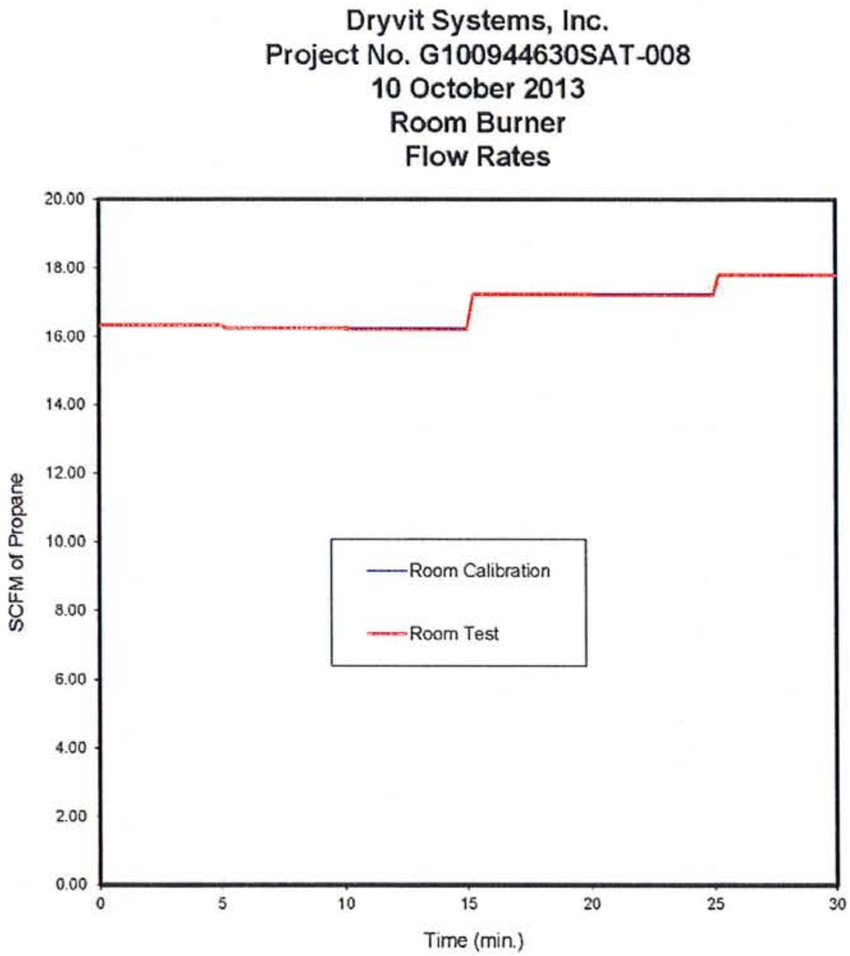

Dryvit Systems, Inc.
Project No. G100944630SAT-008
10 October 2013
10-ft Front Face
TC 11, 14-17
1000F Limit
TC #11
TC #14
TC #15
TC #16
TC #17
Temperature (°F)
Time (min.)
0.00
100.00
200.00
300.00
400.00
500.00
600.00
700.00
800.00
900.00
1000.00
1100.00
0
5
10
15
20
25
30

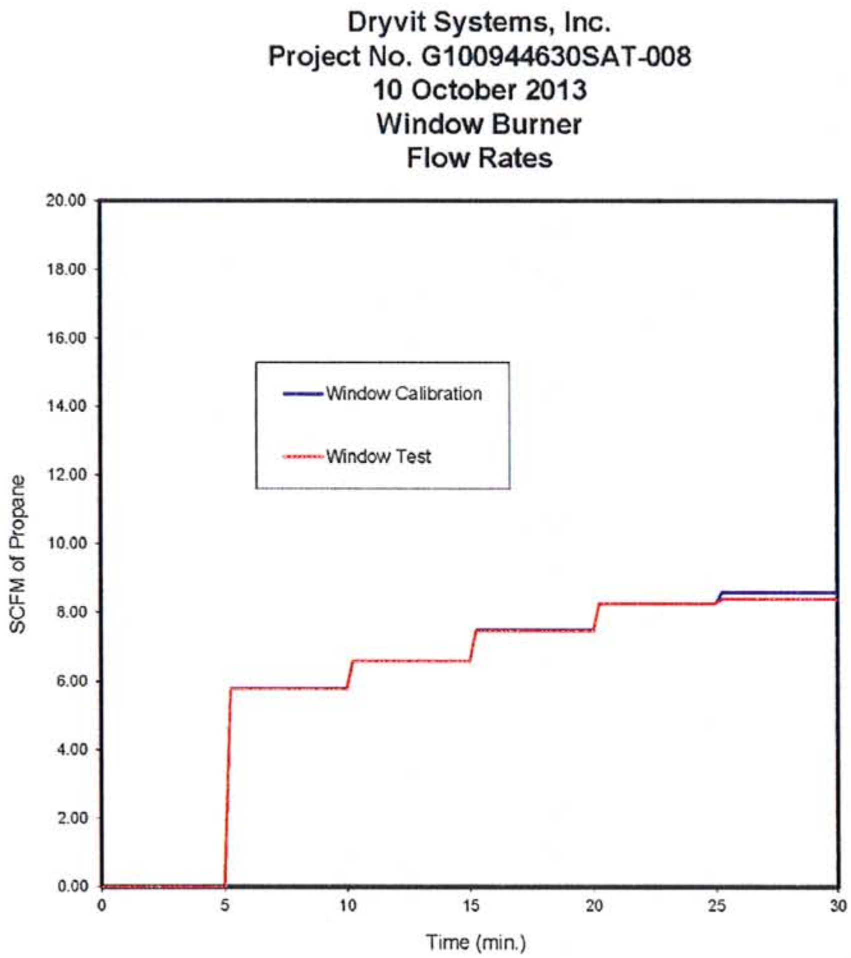

Dryvit Systems, Inc.
Project No. G100944630SAT-008
10 October 2013
2nd Floor, 1-in from wall
TC 49-54
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Temperature (°F)
500F Rise Limit
TC #49
TC #50
TC #51
TC #52
TC #53
TC #54
0
5
10
15
20
25
30
Time (min.)


Dryvit Systems, Inc.
Project No. G100944630SAT-008
10 October 2013
Core
TC 18, 19
750F Rise Limit
TC #18
TC #19
Temperature (°F)
Time (min.)
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
0
5
10
15
20
25
30

Dryvit Systems, Inc.
Project No. G100944630SAT-008
10 October 2013
Core
TC 28, 31-40




Dryvit Systems, Inc.
Project No. G100944630SAT-008
10 October 2013
Room Burner
Flow Rates
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
SCFM of Propane
0
5
10
15
20
25
30
Time (min.)
Room Calibration
Room Test


Dryvit Systems, Inc.
Project No. G100944630SAT-008
10 October 2013
Window Burner
Flow Rates
Window Calibration
Window Test
SCFM of Propane
Time (min.)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
5
10
15
20
25
30

Time (min)	Burn Room (°F)	TC #1 (°F)	TC #2 (°F)	TC #3 (°F)	TC #4 (°F)	TC #5 (°F)	TC #6 (°F)	TC #7 (°F)	TC #8 (°F)	TC #9 (°F)	TC #10 (°F)	Pass/ Fall TC #11 (°F)	TC #12 (°F)	TC #13 (°F)	Pass/ Fall TC #14 (°F)
0	84	80	79	79	78	77	77	77	77	78	79	80	81	80	80
0.25	444	650	260	333	340	111	155	186	204	214	216	202	193	190	87
0.5	907	826	459	556	513	160	215	264	285	286	282	272	260	252	113
0.75	1068	866	480	564	533	166	234	280	300	291	279	256	245	239	131
1	1140	939	496	567	554	174	236	286	303	298	288	277	268	267	127
1.25	1167	911	535	608	593	174	260	314	331	308	293	277	266	263	132
1.5	1187	948	587	677	660	183	269	322	348	334	318	304	292	282	131
1.75	1211	1007	567	635	619	193	274	329	355	349	352	323	311	299	123
2	1230	961	556	628	613	208	290	337	361	350	351	322	315	301	129
2.25	1239	992	556	621	621	200	274	324	337	331	333	310	304	293	122
2.5	1251	963	574	647	632	208	285	321	336	332	328	304	287	278	129
2.75	1258	993	575	656	628	213	294	322	332	316	314	301	290	282	120
3	1255	1005	570	650	629	210	312	350	348	333	327	304	296	285	136
3.25	1274	1008	575	657	637	215	294	328	344	338	336	313	308	302	125
3.5	1296	1031	564	633	617	208	289	327	339	329	321	302	289	280	136
3.75	1308	1007	594	658	640	211	275	317	348	328	342	311	304	294	124
4	1327	1042	597	689	652	222	316	348	374	372	376	347	338	327	137
4.25	1326	1050	644	739	700	219	297	354	374	364	354	347	334	326	144
4.5	1336	1059	682	754	717	214	278	340	368	371	365	347	335	329	147
4.75	1345	1111	711	781	742	215	281	335	370	369	362	346	338	325	134
5	1339	1163	728	804	774	228	294	354	382	382	380	357	342	332	125
5.25	1340	1146	850	955	939	250	349	432	490	486	471	450	434	420	153
5.5	1355	1112	913	1013	993	257	355	454	483	478	478	457	433	420	141
5.75	1350	1150	934	1015	970	285	391	469	511	489	480	447	427	404	147
6	1366	1098	1162	1214	1233	275	381	465	511	495	492	446	431	405	151
6.25	1377	1617	1305	1549	1633	276	373	458	516	498	487	451	438	421	146
6.5	1383	1802	1249	1670	1700	293	414	486	557	536	508	479	450	430	153
6.75	1382	1801	1306	1669	1679	308	392	495	553	564	549	524	504	485	158
7	1378	1659	1346	1627	1605	303	395	486	541	537	515	504	477	461	138
7.25	1388	1685	1356	1542	1453	314	399	490	526	522	519	498	472	450	149
7.5	1383	1759	1410	1418	1393	312	406	472	525	532	511	495	473	444	148
7.75	1395	1762	1347	1341	1360	325	429	472	510	506	483	471	449	437	143
8	1388	1877	1326	1302	1369	314	424	490	520	511	490	472	452	432	138
8.25	1391	1790	1274	1253	1251	298	385	491	521	506	476	471	445	439	148
8.5	1396	1775	1286	1251	1248	305	408	487	537	522	509	465	438	411	137
8.75	1398	1772	1231	1188	1232	301	413	489	538	521	486	456	433	420	144
9	1405	1847	1238	1229	1247	314	431	519	546	518	515	477	449	427	143
9.25	1404	1787	1262	1219	1200	310	405	481	519	515	514	501	485	470	142
9.5	1406	1853	1287	1254	1260	311	384	458	494	485	477	476	464	451	137
9.75	1412	1814	1284	1265	1271	312	393	480	513	509	486	481	458	440	138
10	1416	1773	1332	1285	1288	316	441	528	546	526	487	465	435	415	158
10.25	1419	1513	1376	1305	1345	326	407	494	541	537	526	502	481	460	141
10.5	1410	1694	1374	1280	1368	348	434	496	532	530	518	501	481	459	139
10.75	1407	1527	1378	1293	1276	339	430	511	559	555	525	497	474	449	142
11	1413	1712	1377	1302	1406	336	412	478	511	501	480	483	456	439	163
11.25	1415	1548	1379	1301	1344	331	420	491	539	536	516	492	467	446	170
11.5	1417	1515	1389	1293	1356	359	445	529	558	536	493	490	466	449	156
11.75	1422	1498	1380	1301	1371	365	464	523	562	537	513	487	451	428	168
12	1416	1467	1380	1264	1365	355	441	496	523	517	505	490	468	453	142
12.25	1427	1420	1388	1317	1410	367	456	518	553	544	531	510	489	464	142
12.5	1422	1439	1383	1320	1471	371	490	575	609	592	560	521	495	467	172
12.75	1425	1400	1368	1300	1419	366	461	532	553	531	510	489	460	444	151
13	1429	1331	1385	1291	1420	370	433	512	539	531	509	505	476	452	145
13.25	1422	1330	1335	1293	1269	365	478	537	537	529	487	486	458	437	162
13.5	1435	1376	1343	1261	1335	380	458	525	552	543	510	490	457	434	157
13.75	1433	1388	1332	1226	1276	373	453	513	542	533	505	488	461	442	139
14	1434	1280	1344	1240	1368	378	438	517	557	548	536	506	489	469	163
14.25	1439	1357	1338	1245	1323	390	450	499	521	518	498	494	474	450	143
14.5	1442	1405	1314	1198	1243	389	456	504	525	513	491	465	446	428	142

Time (min)	Burn Room (°F)	TC #1 (°F)	TC #2 (°F)	TC #3 (°F)	TC #4 (°F)	TC #5 (°F)	TC #6 (°F)	TC #7 (°F)	TC #8 (°F)	TC #9 (°F)	TC #10 (°F)	Pass/ Fail TC #11 (°F)	TC #12 (°F)	TC #13 (°F)	Pass/ Fail TC #14 (°F)
14.75	1433	1353	1311	1270	1241	396	450	507	538	529	503	499	490	466	150
15	1443	1362	1304	1278	1251	392	453	508	538	531	507	493	447	427	170
15.25	1506	1217	1327	1292	1317	415	484	540	585	572	533	510	470	452	162
15.5	1524	1211	1378	1284	1296	422	490	550	581	569	556	520	485	463	164
15.75	1529	1153	1377	1302	1332	429	496	576	584	566	549	534	514	496	169
16	1540	1185	1352	1301	1339	427	508	564	564	551	533	529	497	474	188
16.25	1538	1159	1357	1345	1339	447	534	595	604	586	576	551	518	497	177
16.5	1544	1157	1404	1362	1323	455	545	588	609	589	572	540	511	490	162
16.75	1538	1139	1351	1348	1364	457	518	579	596	580	581	555	530	509	166
17	1544	1175	1371	1317	1343	464	517	565	582	578	543	525	495	470	160
17.25	1553	1161	1393	1325	1315	472	554	602	628	605	584	561	533	501	158
17.5	1563	1144	1364	1287	1319	471	544	589	608	589	550	531	497	481	163
17.75	1559	1182	1332	1321	1309	462	515	560	600	580	547	517	478	456	163
18	1560	1142	1405	1334	1304	469	527	568	597	589	562	537	505	481	169
18.25	1558	1167	1334	1329	1320	470	531	578	602	587	549	534	481	452	176
18.5	1559	1170	1383	1335	1287	461	514	569	582	581	566	555	523	501	161
18.75	1561	1173	1340	1302	1284	462	506	560	575	565	544	515	494	468	157
19	1570	1149	1310	1321	1280	467	529	593	617	603	580	557	522	492	174
19.25	1563	1129	1272	1300	1299	475	541	589	611	587	576	555	519	500	171
19.5	1577	1148	1294	1320	1262	477	561	598	598	578	559	535	491	460	156
19.75	1574	1134	1296	1336	1300	477	559	613	636	608	591	528	490	456	178
20	1576	1128	1238	1327	1269	477	570	604	599	579	564	554	523	508	168
20.25	1582	1070	1238	1335	1279	489	576	615	619	605	593	566	522	498	170
20.5	1568	1049	1262	1335	1283	515	587	617	629	603	582	573	532	512	173
20.75	1576	1057	1263	1369	1326	526	620	653	678	642	622	597	574	547	179
21	1577	1086	1259	1342	1294	506	580	630	646	643	615	585	545	515	177
21.25	1576	1050	1267	1340	1282	502	572	605	621	599	609	581	559	534	166
21.5	1583	1070	1210	1353	1267	518	583	621	630	618	604	566	534	509	165
21.75	1584	1055	1247	1323	1253	509	591	614	614	599	566	548	514	495	165
22	1581	1032	1192	1327	1257	515	622	661	646	610	588	566	539	506	191
22.25	1585	1060	1217	1376	1283	520	599	621	648	634	625	595	554	524	175
22.5	1583	1060	1209	1336	1264	519	595	629	633	609	595	575	542	516	186
22.75	1590	1079	1201	1343	1243	498	557	622	639	627	597	576	537	514	169
23	1593	1063	1202	1373	1286	525	620	644	636	618	609	578	536	509	185
23.25	1580	1061	1235	1365	1258	525	637	665	670	644	620	590	545	507	190
23.5	1589	1074	1193	1338	1260	514	602	644	634	613	591	567	523	496	181
23.75	1591	1040	1180	1376	1288	537	616	648	667	652	629	587	546	512	184
24	1582	1047	1196	1389	1306	529	617	638	638	618	596	576	537	510	186
24.25	1583	1093	1192	1383	1290	516	567	625	649	633	618	572	537	501	177
24.5	1586	1070	1216	1425	1319	526	577	643	667	651	640	605	569	542	170
24.75	1589	1077	1190	1399	1301	522	609	654	665	636	593	594	555	541	183
25	1599	1071	1184	1373	1260	535	608	643	657	632	596	576	542	507	187
25.25	1634	1080	1188	1381	1241	525	576	631	647	628	593	570	537	513	174
25.5	1643	1086	1181	1402	1243	528	601	629	639	617	595	581	545	524	159
25.75	1644	1072	1191	1403	1256	541	618	643	653	623	597	588	547	515	180
26	1641	1069	1205	1387	1273	542	624	687	713	665	600	575	528	512	187
26.25	1632	1088	1195	1380	1253	548	616	647	671	648	632	612	579	546	182
26.5	1646	1083	1193	1409	1275	544	613	650	654	645	630	603	560	526	186
26.75	1645	1088	1209	1404	1278	554	635	683	691	666	649	611	572	537	176
27	1657	1090	1202	1389	1333	559	635	687	682	657	626	604	558	526	184
27.25	1662	1073	1211	1422	1296	550	610	658	676	655	629	601	549	508	174
27.5	1650	1084	1202	1402	1263	553	604	640	650	629	621	590	566	540	164
27.75	1654	1087	1211	1421	1307	550	642	697	700	659	612	574	535	509	166
28	1659	1081	1194	1395	1244	568	646	688	683	663	641	610	571	541	187
28.25	1661	1058	1216	1439	1320	559	638	688	699	677	640	621	571	544	179
28.5	1656	1040	1193	1414	1293	552	620	663	674	650	631	597	563	528	192
28.75	1663	1066	1206	1410	1321	575	625	669	676	652	647	615	577	538	177
29	1650	1060	1203	1408	1283	561	607	663	690	679	673	650	615	579	176
29.25	1654	1027	1198	1401	1277	567	649	689	711	677	654	627	598	568	195

Time (min)	Burn Room (°F)	TC #1 (°F)	TC #2 (°F)	TC #3 (°F)	TC #4 (°F)	TC #5 (°F)	TC #6 (°F)	TC #7 (°F)	TC #8 (°F)	TC #9 (°F)	TC #10 (°F)	Pass/ Fail TC #11 (°F)	TC #12 (°F)	TC #13 (°F)	Pass/ Fail TC #14 (°F)
29.5	1652	1035	1204	1448	1314	562	602	641	656	645	644	610	576	547	170
29.75	1669	1044	1210	1418	1277	550	586	625	645	637	616	612	584	564	161
30	1658	1037	1206	1465	1337	560	633	676	669	645	632	593	568	549	184
30.25	1450	1488	1016	1012	938	475	487	524	516	496	475	460	428	406	173
30.5	1227	959	876	795	754	411	398	420	401	388	379	365	344	330	144
30.75	1125	694	817	739	698	396	379	385	373	363	350	335	324	314	135
31	1047	638	786	687	632	369	352	352	345	338	334	317	305	293	140
31.25	996	608	764	636	607	353	334	345	340	330	322	303	291	280	132
31.5	949	577	762	625	579	330	301	321	313	311	296	290	276	269	125
31.75	915	553	753	590	565	316	297	311	306	302	288	286	269	260	120
32	881	525	742	566	534	304	283	297	289	287	274	269	257	250	120
32.25	853	495	721	532	519	303	278	291	286	281	272	261	248	240	128
32.5	826	476	702	528	504	290	265	277	274	272	268	260	246	239	116
32.75	805	459	686	515	488	285	255	269	268	270	258	254	242	237	115
33	782	447	664	496	466	275	248	263	261	263	254	251	237	232	115
33.25	764	432	653	482	462	269	243	257	255	257	247	245	235	231	113
33.5	745	420	638	467	448	261	241	246	243	242	236	227	218	215	114
33.75	729	409	625	435	437	257	237	245	244	245	234	230	220	216	115
34	713	400	608	440	429	249	232	240	239	239	237	228	219	210	111
34.25	699	391	598	415	426	253	230	239	239	238	233	225	217	211	115
34.5	684	382	592	425	410	249	221	232	229	231	222	219	208	204	113
34.75	672	374	583	412	404	244	221	229	228	228	221	218	210	206	113
35	659	365	570	384	388	240	222	229	228	227	218	212	203	199	110
35.25	647	359	563	370	391	239	221	226	226	223	217	208	200	196	110
35.5	636	350	549	372	382	235	216	224	224	223	216	210	203	198	111
35.75	626	343	540	353	373	238	215	220	220	218	213	207	198	193	111
36	615	337	533	346	368	229	209	217	216	214	208	205	199	193	108
36.25	606	334	521	340	356	237	208	215	213	211	206	200	195	190	108
36.5	596	326	510	354	359	237	210	214	214	210	204	197	190	185	108
36.75	588	320	493	308	347	231	209	210	208	206	203	194	190	186	103
37	579	315	487	312	343	228	207	211	210	206	203	194	186	180	108
37.25	571	309	481	333	336	225	197	204	199	197	192	189	182	179	104
37.5	562	303	473	328	329	216	191	201	198	196	191	186	180	176	103
37.75	555	299	467	295	326	208	191	199	198	199	189	187	179	176	106
38	547	296	459	293	322	209	188	196	196	196	191	186	179	176	106
38.25	541	289	451	305	321	205	188	193	195	194	188	184	177	174	105
38.5	533	287	453	249	309	209	197	201	203	200	194	189	181	178	105
38.75	526	282	448	227	306	215	200	206	205	202	197	189	183	177	105
39	520	278	437	221	300	209	196	203	201	199	195	189	180	174	101
39.25	514	275	428	204	297	204	194	200	199	196	190	188	182	178	104
39.5	508	270	417	193	293	200	193	198	193	190	186	178	170	165	105
39.75	502	267	410	209	292	198	185	194	194	191	184	180	172	171	100
40	496	262	402	216	283	191	181	189	187	187	182	179	173	170	103
Max Temp		1877	1410	1670	1700	575	649	697	713	679	673	650	615	579	195
Max Allowed												1000			1000

Time (min)	Pass/ Fail TC #15 (°F)	Pass/ Fail TC #16 (°F)	Pass/ Fail TC #17 (°F)	Pass/ Fail TC #18 (°F)	Pass/ Fail TC #19 (°F)	TC #20 (°F)	TC #21 (°F)	TC #22 (°F)	TC #23 (°F)	TC #24 (°F)	TC #25 (°F)	TC #26 (°F)	TC #27 (°F)	Pass/ Fail TC #28 (°F)
0	80	80	80	77	77	79	79	76	77	76	76	76	76	75
0.25	160	146	90	77	77	79	79	76	77	76	76	76	76	75
0.5	192	183	105	77	77	79	79	76	77	76	76	76	76	75
0.75	217	187	125	77	77	79	79	76	77	76	76	76	76	75
1	203	201	123	77	77	79	79	76	77	76	76	76	76	75
1.25	195	218	142	77	77	79	79	76	77	76	76	77	76	75
1.5	223	221	145	77	77	80	79	77	77	77	77	77	77	75
1.75	253	211	139	77	77	81	79	77	77	77	77	77	77	75
2	225	224	134	77	77	83	79	77	78	78	78	78	77	76
2.25	224	202	141	77	77	87	79	78	78	78	78	78	77	76
2.5	212	216	145	77	77	113	79	78	78	79	79	79	77	76
2.75	231	220	150	77	77	185	79	78	79	80	80	80	77	77
3	215	222	150	77	77	196	79	79	80	81	81	81	78	77
3.25	222	216	150	77	77	197	79	79	80	82	82	81	78	78
3.5	198	219	140	77	77	198	79	80	81	84	84	83	79	78
3.75	226	226	144	77	77	197	79	81	82	85	85	84	79	79
4	235	248	140	77	77	197	80	81	83	87	87	85	80	80
4.25	235	237	143	77	77	197	79	82	84	89	88	86	81	81
4.5	230	236	129	77	77	199	80	83	86	91	90	88	81	82
4.75	245	245	142	78	77	200	79	84	87	92	92	89	82	83
5	240	242	140	78	77	200	80	85	89	95	94	91	83	84
5.25	296	286	155	78	78	202	79	86	90	97	96	92	84	85
5.5	282	301	148	78	78	221	80	87	92	100	101	94	85	86
5.75	283	296	160	79	78	258	79	88	93	104	109	97	86	87
6	343	291	160	79	78	297	80	89	95	115	124	102	88	89
6.25	290	299	165	80	78	346	80	90	96	147	140	112	89	90
6.5	301	333	168	80	78	433	80	92	99	187	152	147	92	92
6.75	296	305	175	81	79	510	80	93	105	195	153	171	94	95
7	286	314	172	82	79	586	80	96	142	196	155	173	104	101
7.25	282	299	163	82	79	638	80	98	173	195	158	169	131	112
7.5	279	312	160	83	80	695	82	103	181	193	165	166	153	129
7.75	274	306	170	84	80	718	85	109	180	192	174	165	159	139
8	282	313	177	85	80	740	95	118	179	192	189	164	159	145
8.25	277	309	160	85	80	741	127	131	178	192	187	164	158	148
8.5	289	300	170	87	81	743	188	153	178	192	187	165	156	150
8.75	281	325	173	87	81	757	307	168	179	195	187	167	155	152
9	305	287	160	89	82	768	400	176	180	202	188	169	154	153
9.25	284	313	177	89	82	760	472	179	180	212	189	173	153	154
9.5	268	300	181	90	83	785	542	181	181	227	201	179	152	155
9.75	278	292	185	92	84	799	564	182	182	244	214	180	152	155
10	284	302	195	93	84	776	639	182	183	258	228	182	153	156
10.25	290	309	186	93	85	807	663	182	184	268	240	183	153	158
10.5	285	309	174	95	86	825	650	182	186	278	255	184	154	160
10.75	275	330	180	95	86	834	678	182	187	287	268	184	156	162
11	272	314	180	96	87	843	657	181	187	297	276	185	157	164
11.25	272	308	185	97	87	855	665	181	187	304	282	188	159	166
11.5	286	307	197	98	88	860	673	182	187	308	293	202	162	169
11.75	287	323	179	99	89	877	671	184	189	309	295	221	165	171
12	286	315	186	100	90	870	692	183	200	311	297	240	168	173
12.25	284	333	167	101	91	820	699	178	226	314	300	254	169	176
12.5	290	298	192	102	91	863	723	175	247	318	304	269	170	178
12.75	277	312	196	103	92	605	719	180	259	322	307	277	168	180
13	287	312	177	104	93	479	720	202	273	326	312	284	168	182
13.25	284	340	200	104	94	435	732	240	284	330	316	286	170	182
13.5	294	353	196	105	95	410	748	300	293	336	316	289	169	182
13.75	262	323	188	106	95	395	774	340	298	341	320	292	172	182
14	303	293	188	107	96	381	778	385	304	348	326	295	176	183
14.25	287	324	183	107	97	373	779	410	309	354	330	298	180	184
14.5	278	313	191	108	98	370	796	416	317	358	333	302	183	189

Time (min)	Pass/ Fail TC #15 (°F)	Pass/ Fail TC #16 (°F)	Pass/ Fail TC #17 (°F)	Pass/ Fail TC #18 (°F)	Pass/ Fail TC #19 (°F)	TC #20 (°F)	TC #21 (°F)	TC #22 (°F)	TC #23 (°F)	TC #24 (°F)	TC #25 (°F)	TC #26 (°F)	TC #27 (°F)	Pass/ Fail TC #28 (°F)
14.75	266	336	190	109	99	367	793	410	320	362	335	306	184	199
15	281	340	187	110	100	366	783	406	322	367	343	310	183	212
15.25	292	352	195	110	100	364	789	407	326	372	346	312	182	218
15.5	312	348	213	111	101	362	795	406	327	378	349	314	189	221
15.75	302	331	184	112	102	360	802	406	326	380	353	317	214	227
16	314	338	203	112	103	358	806	411	330	385	358	320	220	235
16.25	317	335	202	113	104	357	803	419	345	399	366	325	232	244
16.5	306	335	201	114	105	365	689	364	387	413	374	329	239	266
16.75	308	340	184	114	106	400	311	398	430	417	377	320	241	272
17	303	365	207	115	107	341	362	407	444	423	387	326	247	279
17.25	332	349	215	115	108	310	420	420	448	430	391	334	253	284
17.5	309	334	214	116	109	317	479	427	469	436	400	344	262	287
17.75	295	342	197	117	110	325	492	602	478	441	403	353	267	289
18	305	338	213	117	111	323	555	672	500	454	406	362	271	291
18.25	311	365	201	118	112	335	566	656	513	466	407	367	273	293
18.5	338	342	197	119	113	339	571	580	511	469	410	379	279	295
18.75	308	350	199	119	114	337	570	575	520	478	417	386	286	296
19	322	361	212	120	116	334	559	597	540	492	425	389	295	297
19.25	306	359	189	120	118	332	539	607	547	502	432	386	303	298
19.5	317	340	209	121	120	378	545	647	547	498	445	421	312	297
19.75	298	332	224	121	122	383	542	659	571	512	456	441	324	291
20	314	357	207	122	125	387	553	645	573	520	448	444	330	289
20.25	321	370	202	123	128	396	555	650	571	521	451	443	336	290
20.5	327	373	221	123	131	415	543	682	569	511	472	464	346	301
20.75	330	372	211	124	134	427	530	665	573	509	475	467	354	286
21	341	369	217	124	138	431	554	630	569	519	473	459	362	298
21.25	346	363	183	125	142	430	548	630	576	521	463	462	370	312
21.5	317	371	197	125	146	427	547	637	580	525	467	461	377	324
21.75	314	369	214	126	151	423	548	645	583	532	466	465	384	355
22	340	384	216	126	158	418	546	642	583	526	459	462	388	373
22.25	345	383	209	127	165	414	545	657	592	532	461	466	393	379
22.5	316	383	210	128	176	410	553	647	588	526	458	460	397	388
22.75	352	392	203	128	188	406	548	642	595	534	463	467	402	395
23	328	380	222	129	206	401	564	597	578	527	467	450	405	395
23.25	329	357	215	129	223	398	573	555	565	531	480	451	407	394
23.5	324	398	208	130	241	394	580	528	548	528	488	463	407	391
23.75	351	351	215	130	254	391	584	552	557	535	496	476	415	398
24	362	377	195	131	263	387	592	545	549	538	500	472	416	400
24.25	352	354	210	131	267	384	595	531	537	535	502	481	417	399
24.5	322	389	203	132	270	381	586	580	538	537	514	486	424	403
24.75	312	378	220	132	272	378	586	556	540	542	512	485	427	407
25	328	405	222	133	276	374	582	574	548	547	515	488	436	416
25.25	342	376	207	133	281	371	574	619	563	548	529	492	442	421
25.5	335	382	211	134	287	368	571	639	563	553	531	493	445	425
25.75	343	381	232	134	290	365	568	622	558	552	532	492	446	426
26	325	371	220	135	294	362	560	623	551	541	536	495	449	432
26.25	324	371	228	136	297	360	565	658	565	547	542	489	454	436
26.5	359	372	216	136	302	357	566	674	594	568	552	509	469	452
26.75	341	360	223	137	307	355	571	670	582	550	549	515	475	454
27	337	384	217	137	310	352	572	669	587	563	565	510	479	455
27.25	332	368	213	138	313	350	566	651	592	563	563	514	480	465
27.5	320	375	212	138	316	349	567	689	622	584	571	527	502	475
27.75	332	420	220	139	318	347	574	690	632	589	559	523	507	469
28	348	374	234	139	319	345	605	687	630	591	559	524	513	473
28.25	347	395	245	139	320	344	612	690	631	589	572	531	518	479
28.5	351	363	196	140	319	343	619	690	623	577	582	537	520	484
28.75	370	385	200	141	318	342	611	687	614	574	577	537	524	488
29	335	385	208	141	317	341	605	690	612	571	576	534	525	488
29.25	335	387	220	142	315	341	611	681	611	566	585	549	537	504

Time (min)	Pass/ Fail TC #15 (°F)	Pass/ Fail TC #16 (°F)	Pass/ Fail TC #17 (°F)	Pass/ Fail TC #18 (°F)	Pass/ Fail TC #19 (°F)	TC #20 (°F)	TC #21 (°F)	TC #22 (°F)	TC #23 (°F)	TC #24 (°F)	TC #25 (°F)	TC #26 (°F)	TC #27 (°F)	Pass/ Fail TC #28 (°F)
29.5	333	366	204	142	312	340	615	680	603	553	589	544	535	506
29.75	333	362	194	143	309	356	535	631	409	471	570	539	528	504
30	322	377	220	143	306	333	467	669	477	541	560	534	523	497
30.25	261	287	185	144	304	312	439	686	515	581	565	542	525	505
30.5	222	229	154	144	300	291	418	680	529	561	567	544	523	500
30.75	214	213	141	145	296	279	406	654	531	474	554	538	517	492
31	208	198	134	145	290	269	397	635	528	461	542	525	506	479
31.25	198	195	134	145	286	263	391	615	525	458	525	506	487	463
31.5	183	191	134	146	281	258	385	592	510	470	506	489	472	446
31.75	174	186	130	146	277	255	379	572	481	471	489	476	460	433
32	171	182	133	146	274	253	374	545	462	432	480	459	447	413
32.25	173	177	126	146	271	251	371	527	451	416	468	450	439	404
32.5	169	168	126	147	268	250	367	508	437	395	457	440	427	392
32.75	165	166	124	147	265	248	364	492	426	388	448	430	417	384
33	159	173	122	147	262	248	361	481	417	379	433	417	407	374
33.25	152	166	120	147	260	247	356	489	423	391	436	411	398	368
33.5	161	159	116	147	257	246	351	492	429	410	440	401	389	363
33.75	156	161	115	147	255	245	347	504	432	414	437	394	383	354
34	157	153	116	146	254	244	346	492	429	407	425	387	375	348
34.25	153	153	116	146	253	243	346	485	428	406	420	381	368	343
34.5	146	153	119	146	252	242	344	455	408	380	401	372	360	336
34.75	151	156	116	146	249	242	338	436	385	351	392	365	354	332
35	143	154	113	146	247	242	334	454	395	376	397	369	354	330
35.25	147	148	112	146	245	241	327	460	397	367	386	358	344	320
35.5	146	143	112	145	243	241	317	538	457	435	428	381	351	340
35.75	144	141	110	145	242	240	310	559	473	446	423	399	365	346
36	137	142	108	145	241	239	303	629	510	476	439	403	368	346
36.25	142	145	108	144	240	239	299	712	523	500	456	422	384	353
36.5	138	137	107	144	238	238	294	530	455	429	400	372	356	336
36.75	138	135	105	144	236	238	290	452	421	383	375	346	330	317
37	137	136	105	143	234	237	287	415	401	356	363	336	317	302
37.25	128	137	106	143	232	237	286	396	389	342	355	330	307	296
37.5	126	138	107	142	230	237	286	384	377	329	346	326	303	290
37.75	132	138	105	142	228	236	285	374	368	318	340	322	298	285
38	137	139	107	142	226	236	282	363	360	308	334	317	295	281
38.25	133	134	105	141	224	236	281	358	353	298	328	313	292	276
38.5	135	138	106	141	224	281	362	443	426	417	390	371	342	321
38.75	135	138	105	140	222	274	343	389	385	359	347	325	315	300
39	135	134	102	140	220	265	330	362	366	332	333	320	306	285
39.25	134	136	106	139	218	259	323	348	355	315	326	314	299	278
39.5	136	138	109	139	216	254	322	337	345	305	319	309	294	274
39.75	128	136	106	138	214	252	321	330	338	296	314	304	291	270
40	127	132	104	138	212	249	316	323	330	289	309	299	287	266
Max Temp	370	420	245	147	320	877	806	712	632	591	589	549	537	506
Max Allowed	1000	1000	1000	827	827									825

Time (min)	TC #29 (°F)	TC #30 (°F)	Pass/ Fail TC #31 (°F)	Pass/ Fail TC #32 (°F)	Pass/ Fail TC #33 (°F)	Pass/ Fail TC #34 (°F)	Pass/ Fail TC #35 (°F)	Pass/ Fail TC #36 (°F)	Pass/ Fail TC #37 (°F)	Pass/ Fail TC #38 (°F)	Pass/ Fail TC #39 (°F)	Pass/ Fail TC #40 (°F)	TC #41 (°F)	TC #42 (°F)
0	77	75	76	77	77	77	77	76	76	76	77	77	86	84
0.25	77	75	76	77	77	77	77	76	76	76	77	77	449	586
0.5	77	75	76	77	77	77	77	76	76	76	77	77	992	1144
0.75	77	75	76	77	77	77	77	76	76	76	77	77	1152	1281
1	77	75	76	77	77	77	77	76	76	76	77	77	1204	1343
1.25	77	75	76	77	77	77	77	76	76	76	77	78	1233	1359
1.5	77	75	77	77	77	77	77	76	76	76	77	78	1246	1392
1.75	77	75	77	77	77	77	77	76	76	76	77	78	1287	1421
2	78	75	77	77	77	77	77	76	76	76	77	78	1313	1419
2.25	78	75	77	77	78	78	77	76	76	77	77	79	1323	1423
2.5	78	76	77	77	78	77	77	76	76	77	77	79	1321	1468
2.75	78	76	77	78	78	78	78	77	77	77	78	80	1314	1476
3	79	76	78	78	78	78	78	77	77	77	78	80	1317	1450
3.25	79	76	78	78	78	78	78	77	77	77	78	81	1345	1480
3.5	80	77	78	78	79	78	78	78	77	77	78	82	1336	1537
3.75	80	78	78	78	79	79	79	78	77	78	78	83	1379	1531
4	81	78	79	79	79	79	79	78	77	78	79	84	1424	1488
4.25	82	79	79	79	79	79	80	78	78	78	79	85	1423	1479
4.5	83	80	79	79	79	79	80	79	78	78	79	86	1464	1475
4.75	84	80	80	79	80	80	80	79	78	79	79	87	1469	1510
5	85	81	80	79	80	80	81	80	78	79	80	88	1449	1487
5.25	86	81	80	80	80	80	81	80	79	79	80	89	1448	1508
5.5	87	83	81	80	81	81	82	80	79	80	80	90	1504	1517
5.75	87	83	81	80	81	81	82	81	79	80	81	91	1513	1475
6	89	84	82	80	81	81	83	81	80	80	81	92	1490	1505
6.25	90	85	82	81	81	82	83	81	80	81	81	93	1491	1547
6.5	92	86	83	81	82	82	84	82	80	81	82	95	1504	1553
6.75	94	87	84	82	82	82	84	82	81	81	82	96	1508	1551
7	97	89	84	82	83	83	85	83	81	82	82	97	1475	1551
7.25	101	90	85	82	83	83	86	83	81	82	83	99	1506	1555
7.5	105	92	85	83	84	84	86	84	81	82	83	100	1476	1559
7.75	108	95	86	83	84	84	87	84	82	83	84	102	1502	1576
8	112	99	87	84	84	84	88	85	82	83	84	103	1468	1575
8.25	115	104	87	84	85	85	89	85	83	84	84	105	1461	1581
8.5	118	111	88	84	85	85	89	86	83	84	85	106	1479	1574
8.75	122	117	88	85	86	86	90	86	83	84	85	108	1475	1575
9	125	124	89	85	86	86	91	87	84	85	86	110	1497	1574
9.25	129	130	90	86	87	86	92	87	84	85	86	111	1480	1583
9.5	133	135	91	86	87	87	93	88	85	86	87	113	1463	1603
9.75	137	138	91	87	87	87	93	88	85	86	87	114	1495	1588
10	142	142	92	87	88	88	94	89	86	87	87	116	1489	1602
10.25	146	145	92	87	88	88	95	89	86	87	88	117	1495	1602
10.5	150	147	93	88	89	89	96	90	86	87	88	119	1481	1583
10.75	155	149	94	88	89	89	97	91	87	88	89	120	1463	1584
11	159	152	94	89	89	89	97	91	87	88	89	121	1476	1591
11.25	162	153	95	89	90	89	98	92	87	89	90	123	1475	1602
11.5	166	155	95	90	90	90	99	92	88	89	90	124	1461	1610
11.75	168	157	96	90	91	91	100	93	89	90	91	126	1478	1613
12	170	159	97	91	91	91	101	93	89	90	91	127	1473	1588
12.25	172	160	97	91	92	91	102	94	89	91	92	128	1485	1603
12.5	174	161	98	91	92	92	102	94	90	91	92	129	1478	1599
12.75	176	163	98	92	92	92	103	95	90	92	93	130	1475	1600
13	178	164	99	92	93	92	104	95	91	92	93	132	1493	1602
13.25	179	166	99	93	93	93	105	96	91	93	93	133	1504	1563
13.5	180	168	100	93	94	93	105	96	92	93	94	134	1508	1611
13.75	181	169	100	93	94	93	106	97	92	94	94	135	1497	1617
14	183	170	101	94	94	94	107	97	93	94	95	136	1500	1603
14.25	186	171	101	94	95	94	108	98	93	95	95	137	1491	1616
14.5	194	172	102	95	95	95	108	98	94	95	96	138	1505	1618

Time (min)	TC #29 (°F)	TC #30 (°F)	Pass/ Fail TC #31 (°F)	Pass/ Fail TC #32 (°F)	Pass/ Fail TC #33 (°F)	Pass/ Fail TC #34 (°F)	Pass/ Fail TC #35 (°F)	Pass/ Fail TC #36 (°F)	Pass/ Fail TC #37 (°F)	Pass/ Fail TC #38 (°F)	Pass/ Fail TC #39 (°F)	Pass/ Fail TC #40 (°F)	TC #41 (°F)	TC #42 (°F)
14.75	206	173	102	95	95	95	109	99	94	96	96	139	1499	1594
15	213	174	103	96	96	95	110	99	95	96	97	140	1511	1620
15.25	217	175	103	96	96	96	111	100	95	97	97	141	1586	1725
15.5	221	176	104	96	97	96	111	100	96	97	98	142	1619	1721
15.75	224	177	104	97	97	97	112	101	96	98	98	143	1620	1716
16	225	178	105	97	97	97	113	101	97	98	98	144	1605	1764
16.25	227	179	105	98	98	97	113	102	97	98	99	145	1614	1734
16.5	230	180	106	98	98	98	114	102	98	99	99	146	1617	1725
16.75	232	180	106	98	99	98	115	103	98	100	100	147	1624	1712
17	236	182	107	99	99	98	116	103	98	100	100	148	1593	1729
17.25	239	185	107	99	99	99	116	104	99	100	101	149	1619	1760
17.5	244	193	108	100	100	99	117	104	99	101	101	150	1657	1759
17.75	247	204	108	100	100	99	118	105	100	101	102	151	1634	1755
18	251	212	109	101	101	100	119	105	100	102	102	152	1633	1747
18.25	254	217	109	101	101	100	119	106	101	102	102	154	1641	1739
18.5	257	220	110	102	102	101	120	106	101	103	103	155	1638	1739
18.75	259	222	110	102	102	101	121	107	102	103	103	156	1639	1746
19	262	223	111	102	103	101	121	107	102	104	104	158	1638	1769
19.25	264	224	111	103	103	102	122	108	103	104	104	160	1627	1752
19.5	266	225	112	103	103	102	123	108	103	105	105	161	1648	1779
19.75	266	226	112	103	104	103	124	109	104	105	105	163	1638	1777
20	266	228	113	104	104	103	124	109	104	106	106	165	1663	1759
20.25	266	230	113	104	104	103	125	110	105	106	106	166	1667	1768
20.5	264	234	113	105	105	104	126	110	105	106	106	168	1640	1750
20.75	259	237	114	105	105	104	126	111	106	107	107	170	1638	1756
21	255	241	114	105	106	104	127	111	106	107	107	172	1670	1741
21.25	252	244	114	106	106	105	128	112	107	108	108	174	1637	1767
21.5	251	246	115	106	106	105	128	112	108	108	108	176	1642	1773
21.75	252	248	115	107	107	105	129	113	108	109	109	178	1644	1784
22	254	252	115	107	107	106	130	113	108	109	109	181	1650	1769
22.25	258	255	115	108	108	106	130	114	109	110	109	183	1653	1773
22.5	262	260	115	108	108	106	131	115	110	110	110	185	1648	1778
22.75	266	263	116	108	108	107	132	115	110	110	110	188	1674	1778
23	270	265	116	109	109	107	132	116	110	111	110	190	1671	1766
23.25	273	265	117	110	109	107	133	116	111	111	111	192	1637	1760
23.5	277	271	118	110	110	108	134	117	112	112	111	195	1648	1773
23.75	281	281	118	110	110	108	135	117	112	112	112	196	1661	1768
24	285	290	118	111	110	108	135	118	112	113	112	199	1639	1746
24.25	288	295	119	111	111	109	136	118	113	113	112	201	1652	1736
24.5	293	301	119	112	111	109	137	119	113	114	113	203	1663	1741
24.75	299	308	120	112	112	110	138	119	114	114	113	205	1669	1747
25	305	314	120	113	112	110	139	120	114	115	114	208	1665	1781
25.25	311	320	120	113	112	110	139	120	115	115	114	210	1723	1829
25.5	321	329	121	113	113	111	141	121	115	115	114	212	1724	1848
25.75	326	334	121	114	113	111	141	121	116	116	115	215	1724	1834
26	332	340	122	114	113	112	142	122	116	116	115	217	1731	1820
26.25	339	344	122	115	114	112	143	122	117	116	115	219	1687	1810
26.5	345	349	123	115	114	112	145	123	117	117	116	222	1714	1823
26.75	351	355	123	115	114	112	145	123	118	117	116	224	1716	1825
27	358	361	124	116	115	113	147	124	118	118	116	227	1744	1850
27.25	364	366	124	116	115	113	147	124	119	118	117	229	1741	1858
27.5	370	375	124	116	115	114	149	125	119	119	117	231	1729	1829
27.75	377	380	125	117	116	114	149	125	120	119	117	233	1736	1823
28	388	393	125	117	116	114	150	126	120	120	118	234	1743	1825
28.25	399	402	126	118	117	115	151	126	120	120	118	234	1756	1830
28.5	411	409	126	118	117	115	152	127	121	121	119	236	1755	1819
28.75	421	417	126	118	117	115	153	127	121	121	119	246	1749	1843
29	429	421	127	119	118	116	155	128	122	122	120	262	1727	1814
29.25	439	435	127	119	118	116	155	128	122	122	120	274	1719	1841

Time (min)	TC #29 (°F)	TC #30 (°F)	Pass/ Fail TC #31 (°F)	Pass/ Fail TC #32 (°F)	Pass/ Fail TC #33 (°F)	Pass/ Fail TC #34 (°F)	Pass/ Fail TC #35 (°F)	Pass/ Fail TC #36 (°F)	Pass/ Fail TC #37 (°F)	Pass/ Fail TC #38 (°F)	Pass/ Fail TC #39 (°F)	Pass/ Fail TC #40 (°F)	TC #41 (°F)	TC #42 (°F)
29.5	448	436	127	119	118	116	156	128	123	122	120	288	1738	1799
29.75	454	433	128	119	118	117	157	129	123	123	120	296	1756	1856
30	458	429	128	119	119	117	158	129	123	123	121	301	1747	1811
30.25	461	434	129	120	119	117	159	130	124	123	121	311	1484	1518
30.5	464	434	129	120	119	118	159	131	125	124	121	318	1247	1266
30.75	465	430	130	120	120	118	159	131	125	124	122	317	1139	1164
31	464	420	131	121	120	118	160	131	125	124	122	312	1062	1084
31.25	460	413	131	121	120	118	159	132	126	125	122	309	1010	1032
31.5	455	405	131	121	120	119	159	132	126	125	122	303	963	982
31.75	450	392	132	121	120	119	160	132	126	125	123	297	927	946
32	442	378	132	122	121	119	160	133	127	126	123	285	893	910
32.25	436	372	133	122	121	119	162	133	127	126	123	281	866	882
32.5	428	365	133	122	121	119	163	133	127	126	123	273	839	854
32.75	422	359	133	122	121	119	164	133	128	126	123	268	817	833
33	414	353	133	122	121	119	165	133	128	126	123	261	795	808
33.25	409	348	133	122	121	119	166	133	128	126	123	260	776	789
33.5	402	346	133	122	121	119	168	133	128	126	123	257	756	769
33.75	395	340	133	122	121	119	169	133	128	126	123	254	740	753
34	388	335	133	122	121	119	169	132	128	126	123	251	723	735
34.25	382	331	133	122	121	119	170	132	128	126	123	249	709	719
34.5	375	324	133	122	121	119	171	132	127	126	122	244	693	705
34.75	369	319	133	122	120	119	172	132	127	125	122	239	681	693
35	363	317	133	122	120	119	172	131	127	125	122	237	667	679
35.25	357	311	132	121	120	118	173	131	127	125	122	236	656	666
35.5	355	317	132	121	120	118	173	131	126	125	121	242	644	654
35.75	355	319	132	121	120	118	173	130	126	124	121	243	634	643
36	353	317	132	121	120	118	173	130	126	124	121	243	622	632
36.25	354	321	131	121	119	117	173	130	126	124	121	243	613	623
36.5	348	311	131	120	119	117	173	129	125	124	120	239	603	613
36.75	340	305	131	120	119	117	173	129	125	123	120	232	595	604
37	331	298	130	120	118	117	172	128	125	123	120	227	586	594
37.25	325	289	130	120	118	116	172	128	124	123	119	224	577	586
37.5	319	284	130	119	118	116	172	127	124	122	119	222	568	577
37.75	314	280	129	119	118	116	171	127	124	122	119	219	561	570
38	308	278	129	119	117	116	171	127	123	122	118	216	553	562
38.25	303	274	129	119	117	115	170	126	123	121	118	213	547	555
38.5	320	294	129	119	117	115	171	126	123	121	118	222	538	547
38.75	312	286	128	118	117	115	170	125	123	121	118	221	532	540
39	305	278	128	117	116	115	169	125	123	120	117	215	525	533
39.25	300	273	127	117	116	114	168	124	122	120	117	212	519	527
39.5	295	270	127	117	116	114	168	124	122	120	117	209	512	521
39.75	291	267	126	117	116	114	167	123	121	119	116	206	508	515
40	287	264	126	116	115	114	166	123	121	119	116	204	500	508
Max Temp	465	436	133	122	121	119	173	133	128	126	123	318	1756	1858
Max Allowed			826	827	827	827	827	826	826	826	827	827		

Time (min)	TC #43 (°F)	TC #44 (°F)	TC #45 (°F)	TC #46 (°F)	TC #47 (°F)	TC #48 (°F)	Pass/ Fail TC #49 (°F)	Pass/ Fail TC #50 (°F)	Pass/ Fail TC #51 (°F)	Pass/ Fail TC #52 (°F)	Pass/ Fail TC #53 (°F)	Pass/ Fail TC #54 (°F)
0	83	83	82	86	89	89	79	80	80	79	79	79
0.25	527	311	346	442	503	363	79	80	80	79	79	79
0.5	1017	683	699	870	954	693	80	80	80	79	79	79
0.75	1178	874	857	992	1064	801	80	80	80	79	79	79
1	1227	967	959	1048	1130	838	80	80	80	79	79	79
1.25	1247	995	1003	1072	1195	1009	80	80	80	79	79	79
1.5	1239	1017	1043	1200	1210	1154	80	80	80	79	79	79
1.75	1243	1040	1063	1242	1224	895	80	80	80	79	80	80
2	1281	1056	1082	1188	1248	1021	80	80	80	79	80	80
2.25	1291	1070	1089	1178	1249	1109	80	80	80	79	80	79
2.5	1281	1074	1109	1178	1261	1102	80	80	80	79	79	79
2.75	1291	1085	1124	1203	1279	995	80	80	81	80	80	79
3	1286	1089	1132	1220	1277	1062	80	80	80	80	80	79
3.25	1295	1104	1146	1235	1295	1022	80	80	81	80	80	79
3.5	1335	1118	1156	1236	1315	908	80	80	80	80	80	79
3.75	1335	1131	1164	1251	1322	956	80	80	80	80	80	79
4	1378	1161	1182	1295	1327	922	80	80	80	80	80	79
4.25	1361	1171	1196	1324	1372	954	80	80	80	80	80	79
4.5	1356	1180	1204	1308	1378	1017	80	80	80	80	80	79
4.75	1352	1183	1210	1308	1377	1095	80	80	80	80	80	79
5	1358	1190	1209	1333	1376	983	80	81	80	80	80	79
5.25	1358	1180	1208	1355	1399	1004	80	81	81	80	80	80
5.5	1357	1186	1211	1370	1407	984	80	81	80	80	80	80
5.75	1358	1192	1214	1351	1409	1054	80	81	81	80	80	80
6	1391	1215	1228	1340	1402	1106	80	81	81	80	80	80
6.25	1397	1219	1232	1344	1389	1243	80	81	81	80	80	80
6.5	1405	1219	1232	1340	1397	1231	80	81	81	80	80	80
6.75	1398	1219	1234	1340	1389	1229	80	81	82	80	80	80
7	1410	1215	1238	1357	1387	1193	80	81	81	80	80	80
7.25	1413	1227	1240	1354	1386	1217	80	81	82	80	80	80
7.5	1411	1224	1243	1349	1394	1223	81	81	83	80	80	81
7.75	1421	1229	1248	1358	1393	1210	81	81	82	80	80	80
8	1411	1232	1254	1366	1393	1186	81	81	83	80	80	80
8.25	1415	1240	1257	1355	1393	1143	81	81	82	80	80	81
8.5	1421	1247	1259	1359	1402	1175	81	81	82	80	80	81
8.75	1431	1248	1259	1367	1399	1193	81	81	81	80	81	81
9	1435	1254	1265	1367	1403	1190	81	81	81	80	81	81
9.25	1430	1256	1270	1369	1405	1230	81	81	84	80	81	82
9.5	1436	1252	1277	1374	1415	1247	81	81	81	80	81	81
9.75	1438	1257	1280	1381	1415	1260	81	81	81	80	81	80
10	1447	1259	1285	1376	1412	1269	81	81	81	81	81	80
10.25	1454	1262	1283	1378	1419	1279	81	82	81	81	81	81
10.5	1440	1260	1288	1378	1411	1254	81	82	82	81	81	81
10.75	1439	1259	1290	1381	1420	1256	81	82	82	81	81	81
11	1443	1265	1290	1375	1417	1262	82	82	83	81	81	82
11.25	1432	1274	1293	1379	1421	1266	82	82	85	81	81	84
11.5	1451	1269	1296	1381	1416	1264	82	83	85	81	82	83
11.75	1450	1271	1296	1384	1427	1279	82	83	83	81	82	83
12	1444	1271	1303	1387	1438	1293	82	82	83	81	82	82
12.25	1464	1281	1304	1387	1429	1289	82	83	83	82	82	83
12.5	1454	1282	1299	1389	1428	1293	82	82	84	81	82	84
12.75	1466	1281	1302	1398	1429	1288	82	83	84	82	82	84
13	1459	1289	1301	1388	1431	1292	82	83	86	82	82	83
13.25	1453	1291	1297	1389	1431	1297	82	83	84	82	82	83
13.5	1461	1291	1302	1394	1433	1296	82	84	86	82	82	84
13.75	1457	1286	1308	1394	1442	1300	82	84	84	82	83	83
14	1466	1290	1310	1400	1431	1295	83	84	89	82	83	85
14.25	1479	1295	1314	1405	1438	1292	83	84	85	83	84	85
14.5	1473	1294	1320	1410	1442	1287	83	85	84	83	84	84

Time (min)	TC #43 (°F)	TC #44 (°F)	TC #45 (°F)	TC #46 (°F)	TC #47 (°F)	TC #48 (°F)	Pass/ Fail TC #49 (°F)	Pass/ Fail TC #50 (°F)	Pass/ Fail TC #51 (°F)	Pass/ Fail TC #52 (°F)	Pass/ Fail TC #53 (°F)	Pass/ Fail TC #54 (°F)
14.75	1460	1298	1314	1404	1440	1288	84	85	84	83	84	84
15	1468	1299	1315	1405	1443	1285	84	86	84	83	83	85
15.25	1531	1330	1356	1477	1505	1331	84	86	85	83	84	86
15.5	1551	1353	1374	1487	1517	1338	84	85	85	83	84	85
15.75	1563	1364	1384	1495	1534	1350	84	85	88	83	84	86
16	1567	1372	1394	1504	1542	1354	84	85	86	83	83	85
16.25	1576	1373	1391	1500	1535	1355	84	84	86	83	83	84
16.5	1589	1385	1405	1532	1548	1362	84	84	86	83	83	83
16.75	1570	1383	1403	1517	1547	1356	84	84	86	83	83	84
17	1595	1393	1411	1528	1555	1363	85	85	86	83	83	83
17.25	1579	1392	1415	1524	1555	1358	85	85	85	83	83	84
17.5	1582	1399	1416	1529	1564	1365	84	85	86	83	83	84
17.75	1581	1402	1422	1545	1567	1364	84	86	86	84	84	84
18	1594	1400	1428	1537	1574	1370	84	86	87	84	84	85
18.25	1586	1403	1421	1532	1569	1364	85	86	87	84	84	85
18.5	1590	1408	1420	1540	1571	1365	84	86	87	84	84	85
18.75	1584	1410	1426	1545	1573	1366	84	86	86	84	84	85
19	1590	1413	1439	1555	1580	1365	85	86	86	84	84	85
19.25	1585	1415	1434	1550	1576	1363	86	86	87	84	84	85
19.5	1600	1418	1438	1552	1585	1371	85	86	87	84	84	85
19.75	1593	1418	1444	1559	1586	1368	85	87	87	85	85	85
20	1596	1421	1443	1560	1583	1368	86	87	87	85	85	85
20.25	1607	1426	1443	1564	1590	1373	86	88	87	84	85	85
20.5	1588	1422	1438	1560	1589	1368	86	88	87	85	85	86
20.75	1621	1424	1443	1562	1594	1370	86	87	88	84	86	86
21	1601	1429	1445	1570	1594	1367	85	89	88	85	86	86
21.25	1600	1429	1446	1571	1589	1358	86	88	89	85	86	86
21.5	1613	1433	1452	1576	1596	1367	86	88	88	85	85	86
21.75	1604	1432	1455	1574	1596	1361	86	88	88	85	86	86
22	1602	1429	1453	1568	1603	1362	86	89	88	85	86	87
22.25	1607	1434	1458	1575	1603	1360	86	88	89	85	86	86
22.5	1597	1439	1454	1573	1597	1354	86	88	88	85	86	86
22.75	1608	1439	1453	1587	1605	1364	87	89	88	85	86	87
23	1625	1444	1460	1583	1604	1358	87	90	90	86	87	87
23.25	1608	1439	1454	1575	1601	1356	87	91	89	86	86	87
23.5	1623	1440	1463	1589	1611	1355	88	89	90	86	87	87
23.75	1615	1447	1463	1594	1608	1355	87	90	89	86	87	87
24	1621	1443	1463	1592	1600	1348	87	92	89	85	87	87
24.25	1617	1449	1460	1599	1605	1355	87	91	89	86	87	86
24.5	1617	1449	1460	1586	1610	1352	87	92	90	86	89	91
24.75	1617	1451	1461	1588	1620	1358	89	92	90	87	89	89
25	1630	1453	1467	1590	1616	1350	89	92	90	87	89	88
25.25	1651	1475	1493	1632	1656	1373	89	92	91	88	90	88
25.5	1662	1486	1495	1630	1652	1373	89	94	90	87	90	88
25.75	1672	1488	1500	1636	1653	1376	89	94	89	87	90	87
26	1664	1486	1503	1660	1667	1386	89	94	89	87	90	87
26.25	1668	1491	1505	1653	1681	1393	89	94	90	86	89	88
26.5	1687	1497	1510	1654	1669	1381	89	94	90	87	89	88
26.75	1673	1497	1515	1659	1679	1384	89	96	91	87	90	89
27	1679	1500	1514	1656	1677	1380	88	94	91	86	90	89
27.25	1689	1507	1515	1657	1684	1387	89	95	91	86	89	89
27.5	1671	1507	1514	1663	1687	1387	89	95	91	88	90	89
27.75	1684	1505	1523	1662	1693	1383	90	99	90	88	92	89
28	1694	1512	1522	1678	1691	1388	90	95	91	87	91	89
28.25	1682	1514	1524	1669	1685	1383	89	97	92	88	92	89
28.5	1674	1512	1522	1678	1693	1388	90	96	92	88	91	89
28.75	1685	1515	1523	1675	1685	1383	89	95	92	87	91	90
29	1671	1518	1519	1670	1686	1384	90	96	91	88	91	90
29.25	1672	1516	1523	1686	1689	1384	90	99	91	88	91	89

Time (min)	TC #43 (°F)	TC #44 (°F)	TC #45 (°F)	TC #46 (°F)	TC #47 (°F)	TC #48 (°F)	Pass/ Fail TC #49 (°F)	Pass/ Fail TC #50 (°F)	Pass/ Fail TC #51 (°F)	Pass/ Fail TC #52 (°F)	Pass/ Fail TC #53 (°F)	Pass/ Fail TC #54 (°F)
29.5	1681	1520	1521	1669	1686	1382	91	97	91	89	91	89
29.75	1685	1523	1524	1678	1683	1378	90	97	92	88	90	90
30	1685	1520	1526	1681	1696	1386	89	96	92	87	90	91
30.25	1458	1391	1397	1463	1466	1213	90	96	92	88	90	91
30.5	1228	1186	1208	1239	1252	1042	92	96	92	89	91	90
30.75	1123	1081	1116	1132	1151	957	90	95	92	89	90	91
31	1042	1003	1044	1055	1070	890	90	98	93	88	92	92
31.25	992	952	996	1005	1017	845	92	97	93	88	91	91
31.5	944	907	951	957	968	806	92	97	93	88	90	91
31.75	909	874	918	920	930	776	90	97	92	88	90	91
32	875	842	884	884	893	746	90	95	92	89	90	91
32.25	848	813	858	857	866	722	90	96	92	89	91	91
32.5	820	787	831	827	837	699	90	96	92	88	91	91
32.75	799	765	811	805	816	682	90	98	92	88	91	91
33	776	744	789	781	792	664	91	99	93	89	92	92
33.25	758	726	771	759	773	648	92	99	93	89	92	92
33.5	739	708	753	739	753	632	91	97	93	89	92	91
33.75	724	691	737	725	740	619	91	96	92	89	89	91
34	709	675	721	707	723	607	91	96	93	88	90	91
34.25	695	663	708	691	709	594	90	98	93	89	92	91
34.5	681	648	694	675	692	582	91	96	92	88	90	91
34.75	669	636	681	663	681	571	91	97	92	89	91	90
35	655	624	668	648	669	562	91	97	93	89	91	91
35.25	645	613	657	640	657	553	90	97	94	88	91	90
35.5	634	601	645	629	645	544	90	96	93	88	90	93
35.75	624	592	636	622	634	537	92	98	94	89	91	92
36	614	582	625	611	625	530	91	94	94	88	89	93
36.25	605	573	616	603	615	522	90	96	93	89	90	92
36.5	595	563	606	593	605	513	92	94	93	89	90	92
36.75	587	555	598	585	596	507	92	96	93	89	90	92
37	579	547	589	575	588	499	91	97	92	89	92	91
37.25	572	539	581	566	580	492	90	95	93	88	90	92
37.5	563	532	572	560	571	485	91	96	94	89	90	92
37.75	557	524	565	553	563	480	91	95	93	88	90	93
38	549	516	556	545	556	473	91	98	93	89	91	91
38.25	542	509	550	537	549	467	91	97	93	89	92	91
38.5	535	502	541	528	540	455	90	97	93	88	90	93
38.75	528	496	535	523	534	450	89	96	93	89	90	92
39	521	490	529	516	527	444	91	99	91	90	92	91
39.25	514	485	524	511	521	438	91	100	92	91	92	92
39.5	508	480	517	506	514	433	91	98	93	90	92	92
39.75	503	474	512	499	508	429	92	99	93	91	92	91
40	497	468	506	494	502	424	91	98	93	90	93	92
Max Temp	1694	1523	1526	1686	1696	1393	92	100	94	91	93	93
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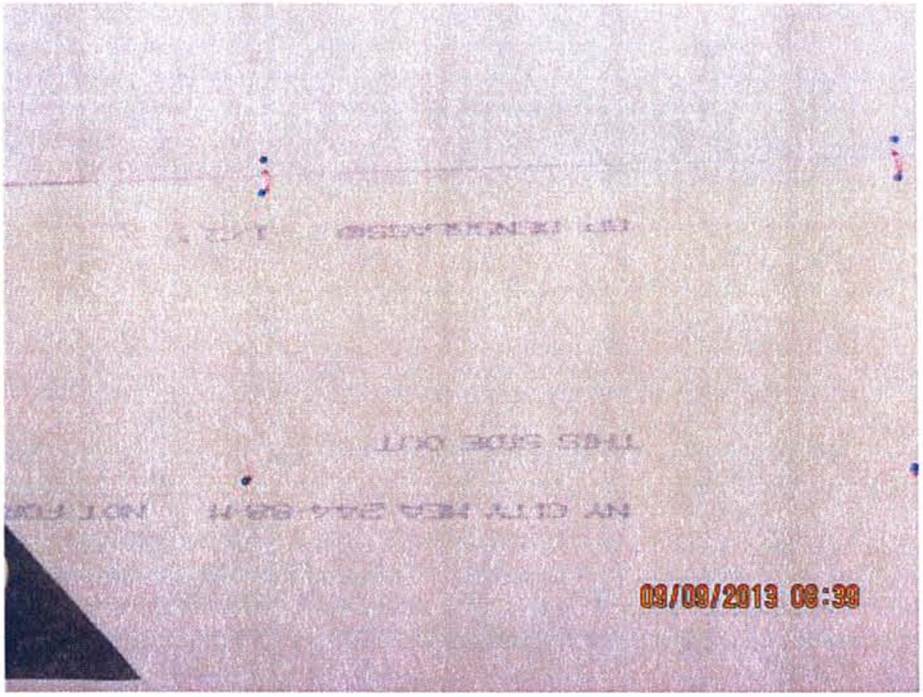
APPENDIX C
Photographs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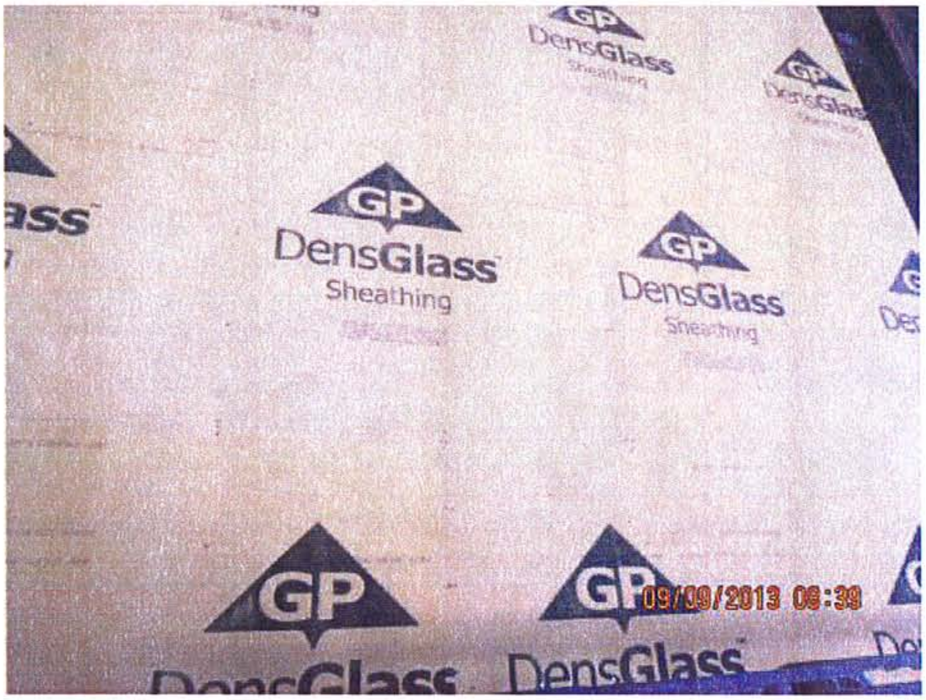
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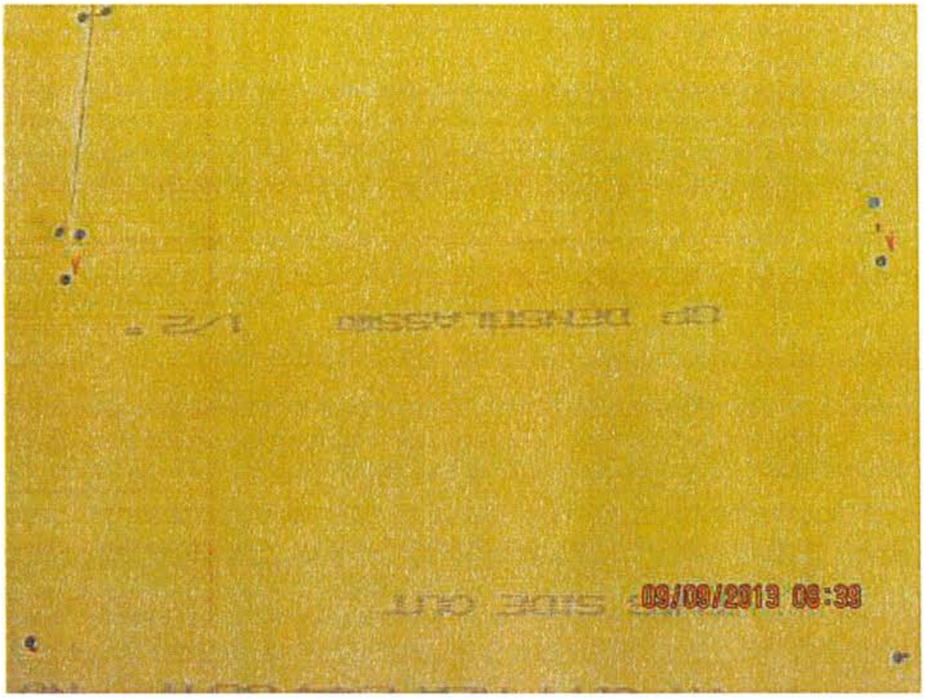
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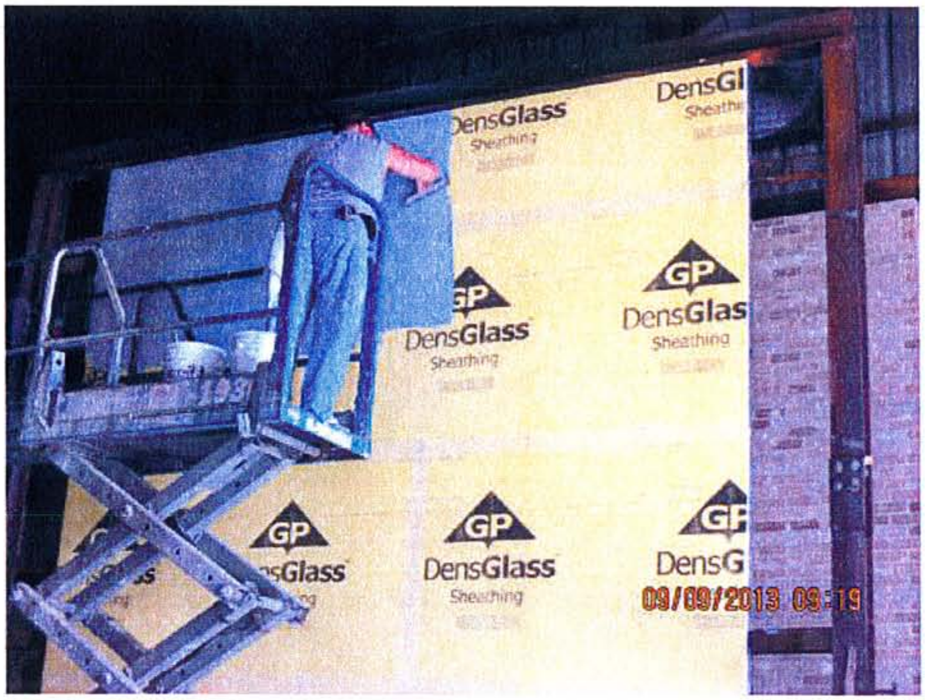
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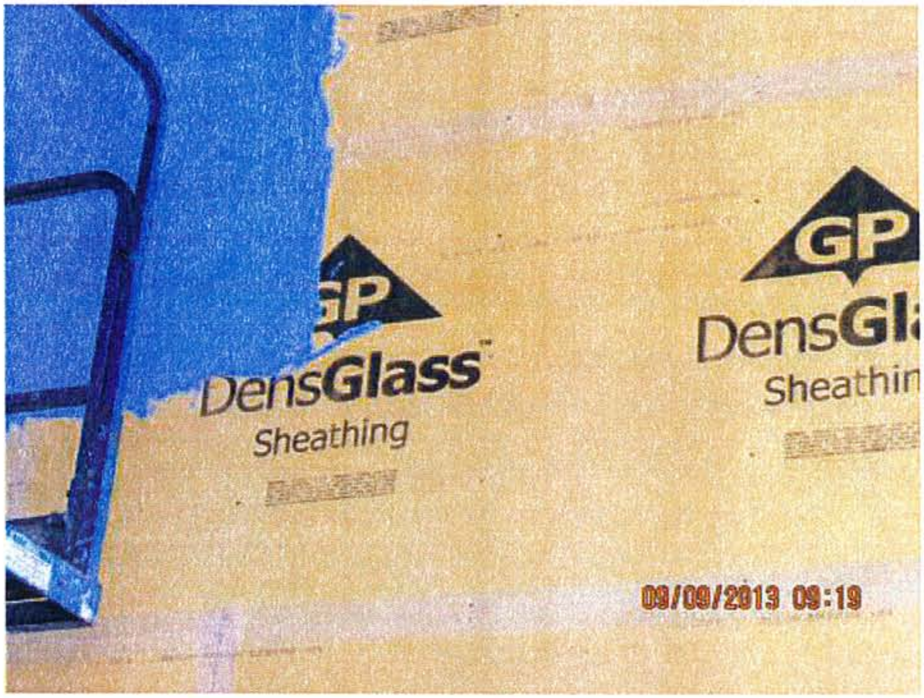
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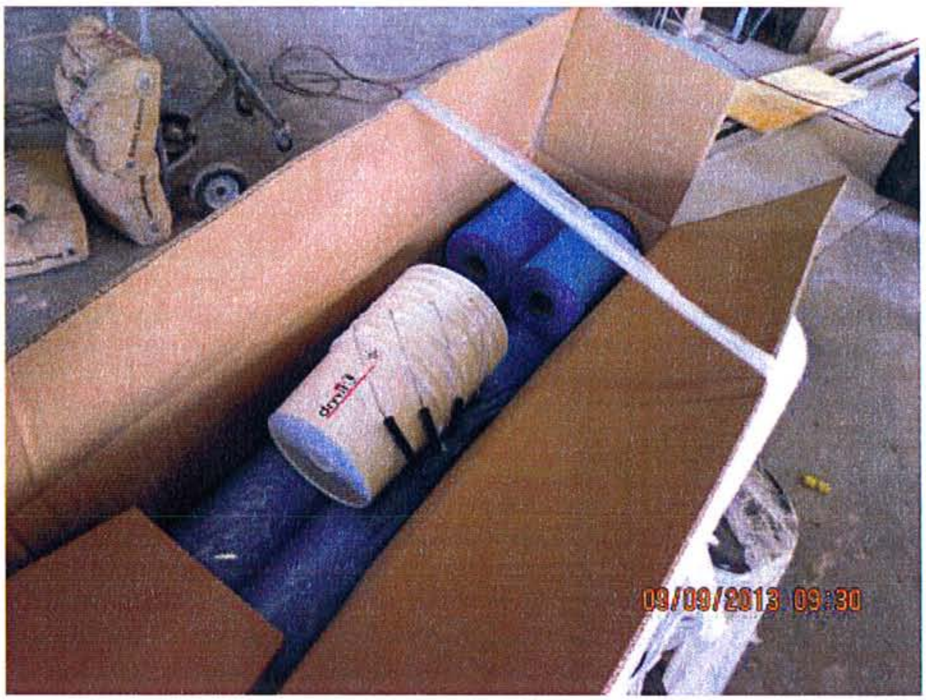
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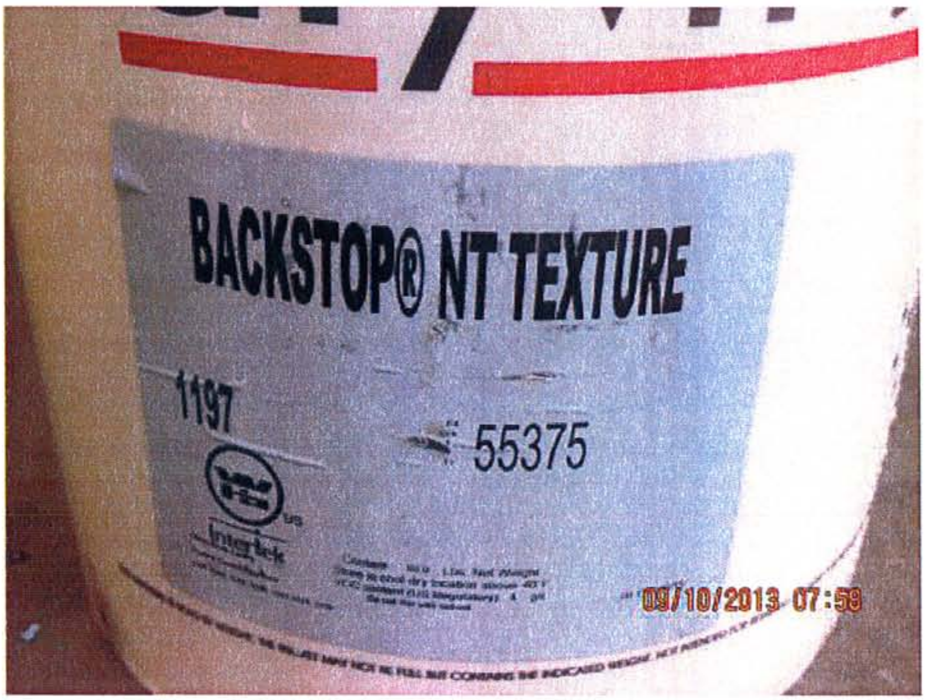
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Intertek
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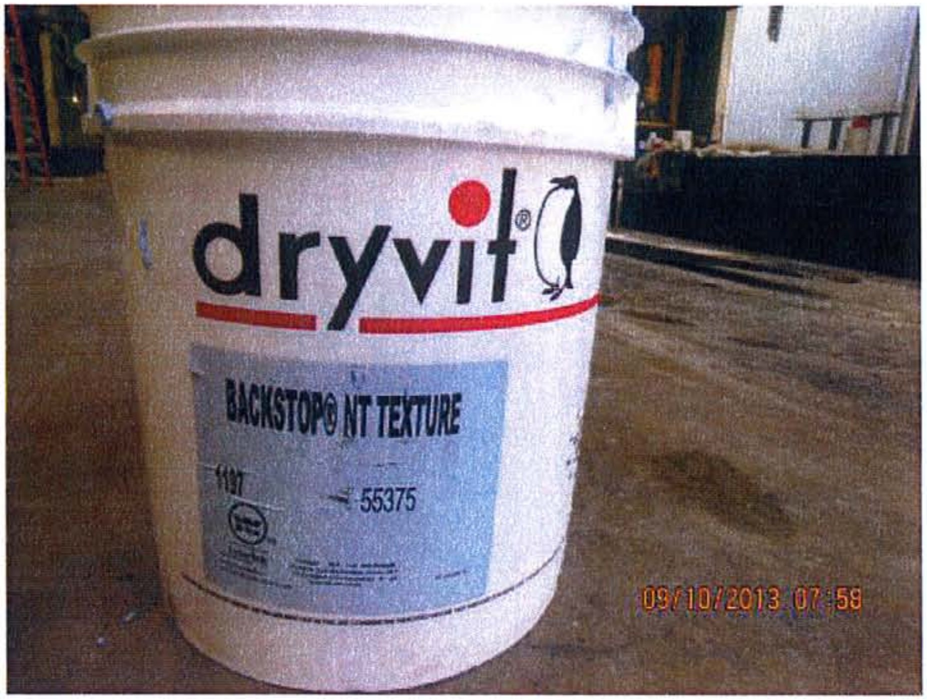
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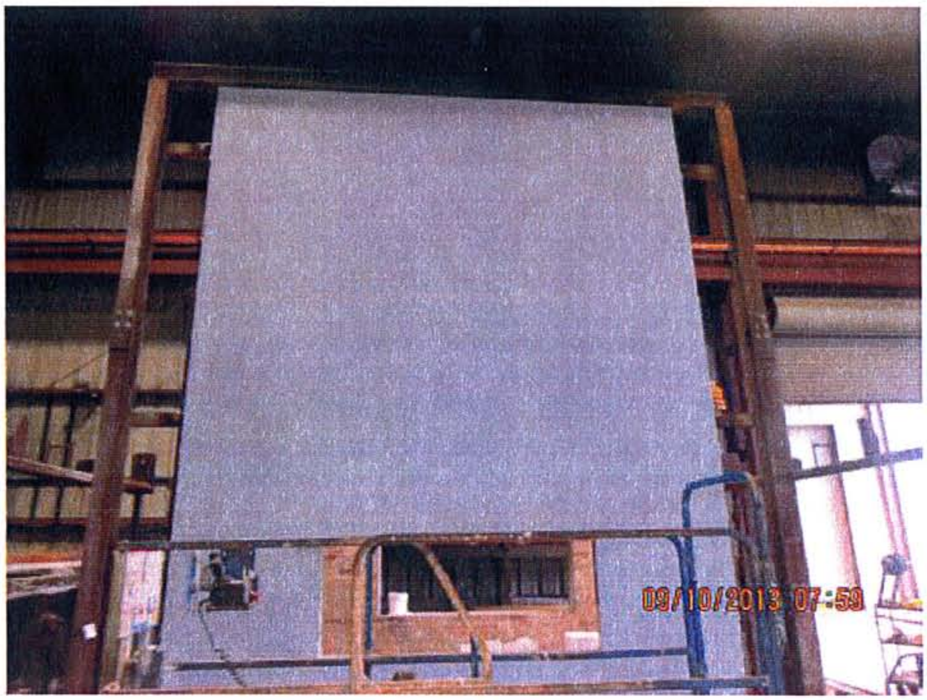
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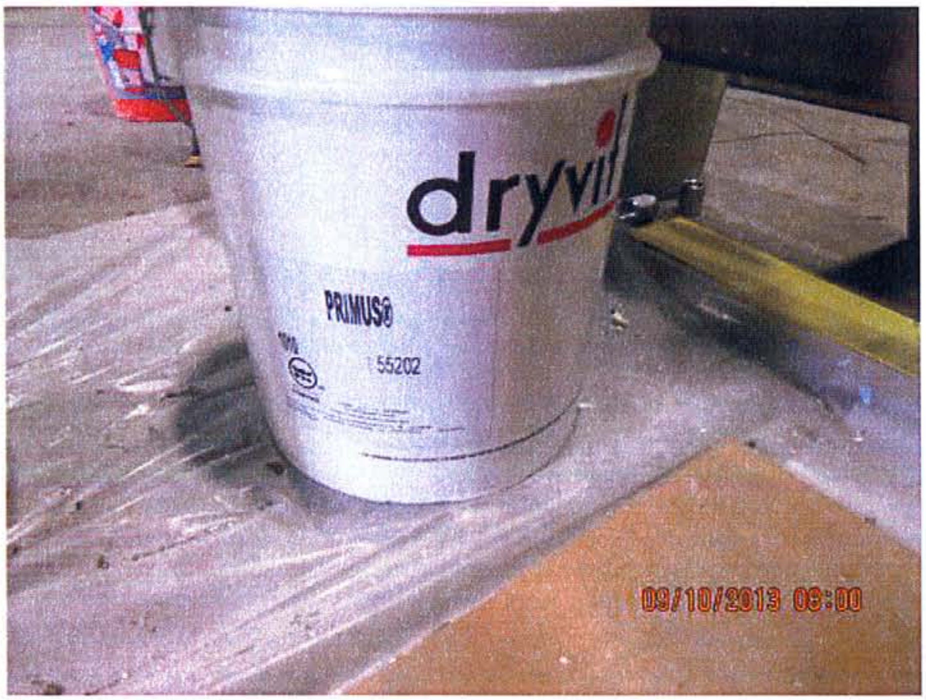
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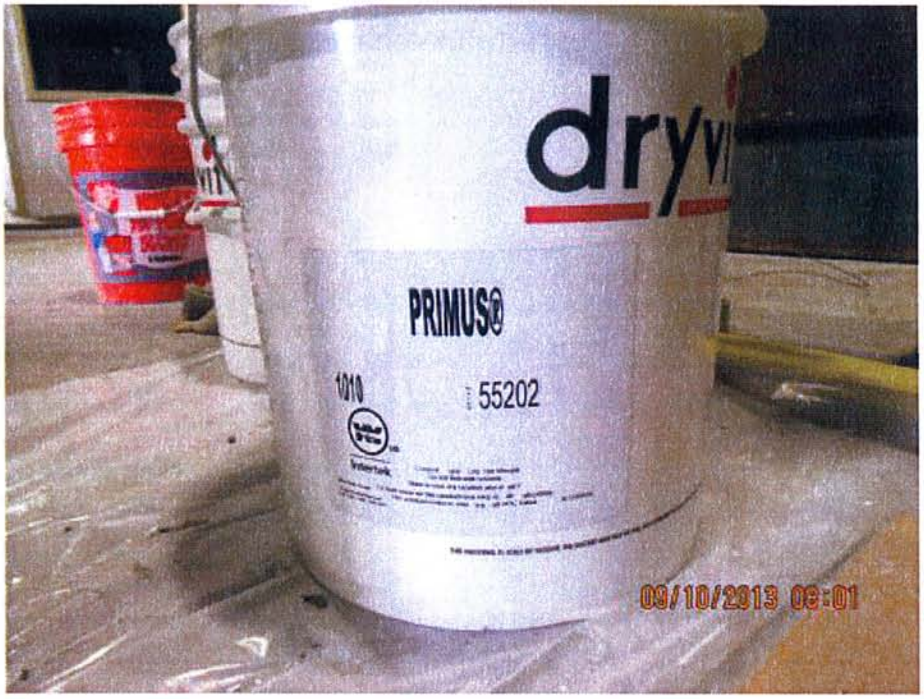
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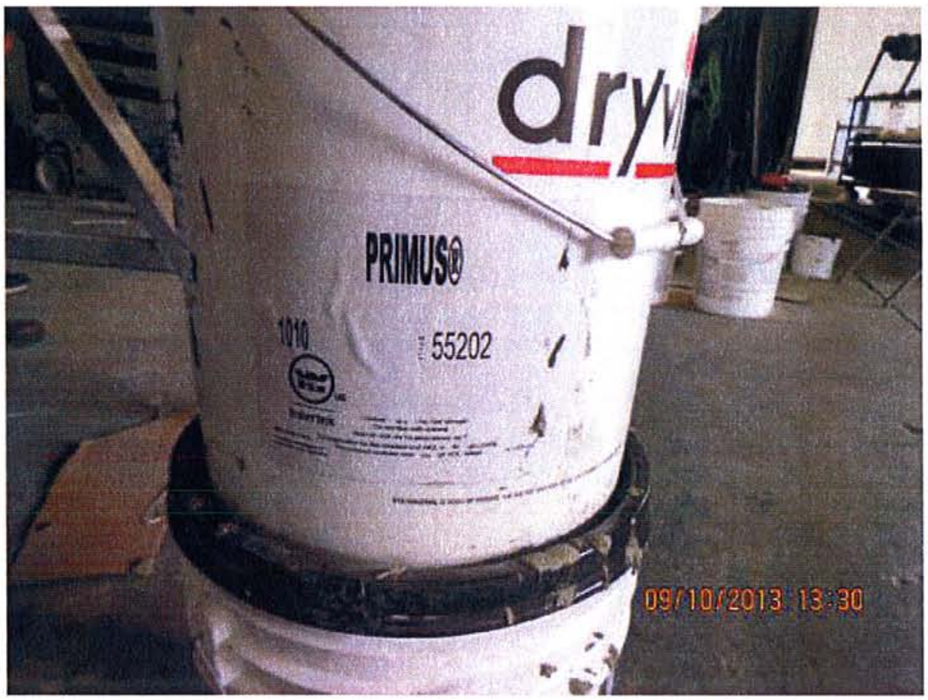
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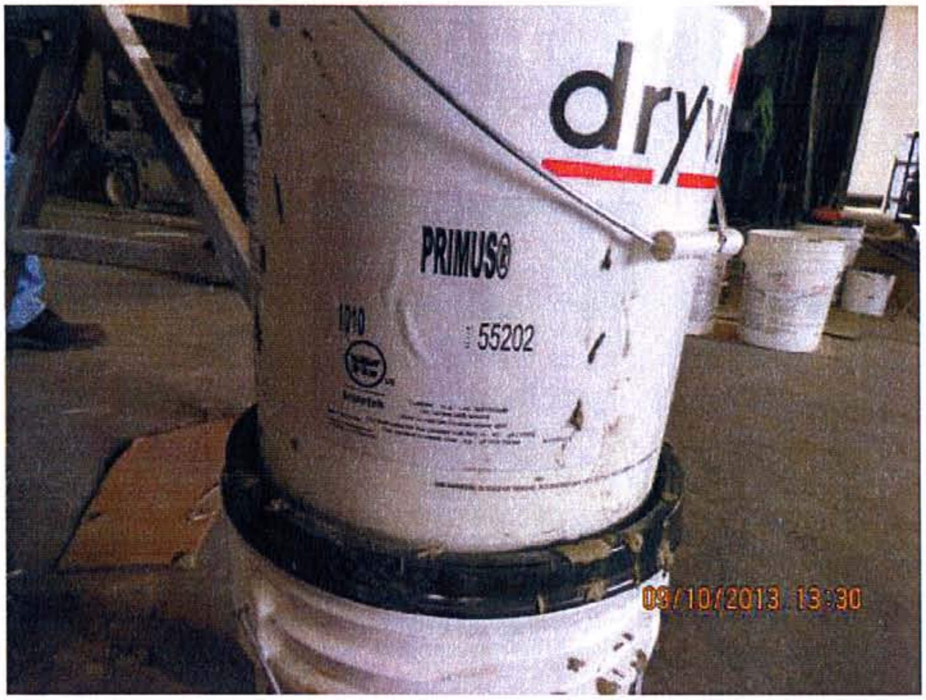
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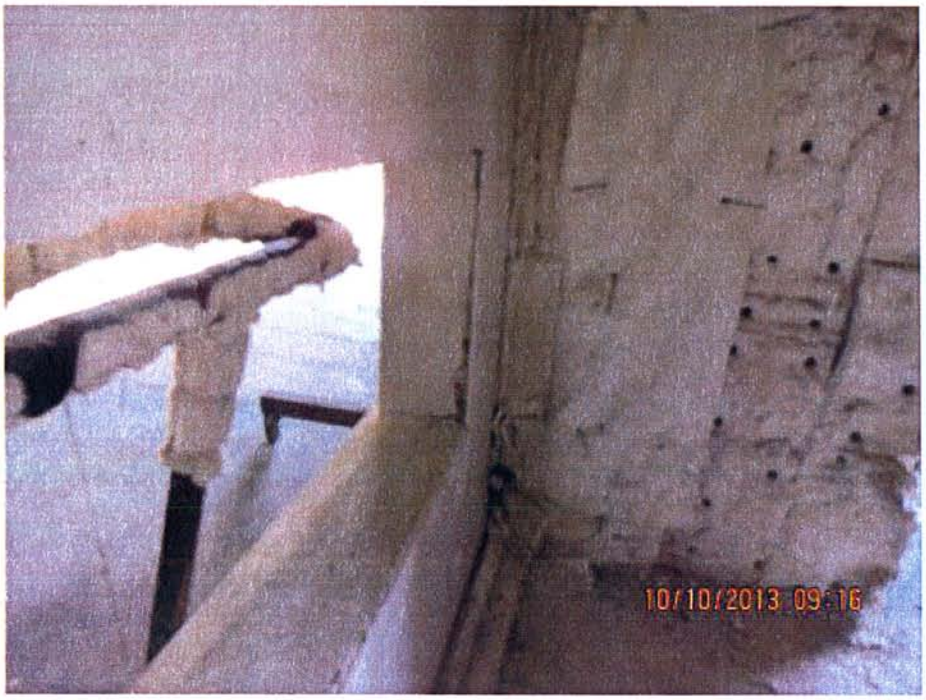
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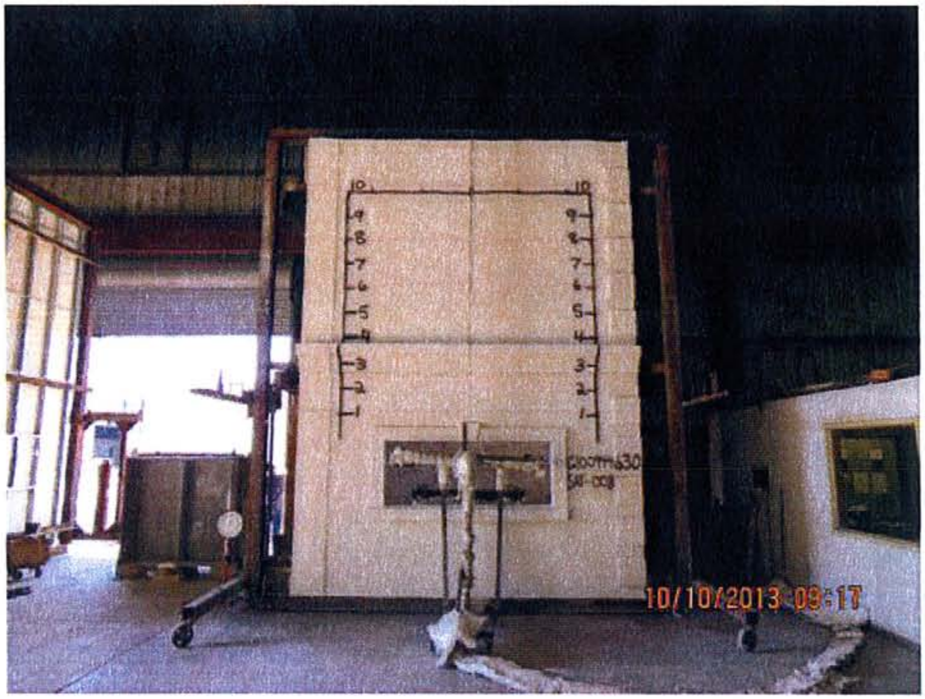
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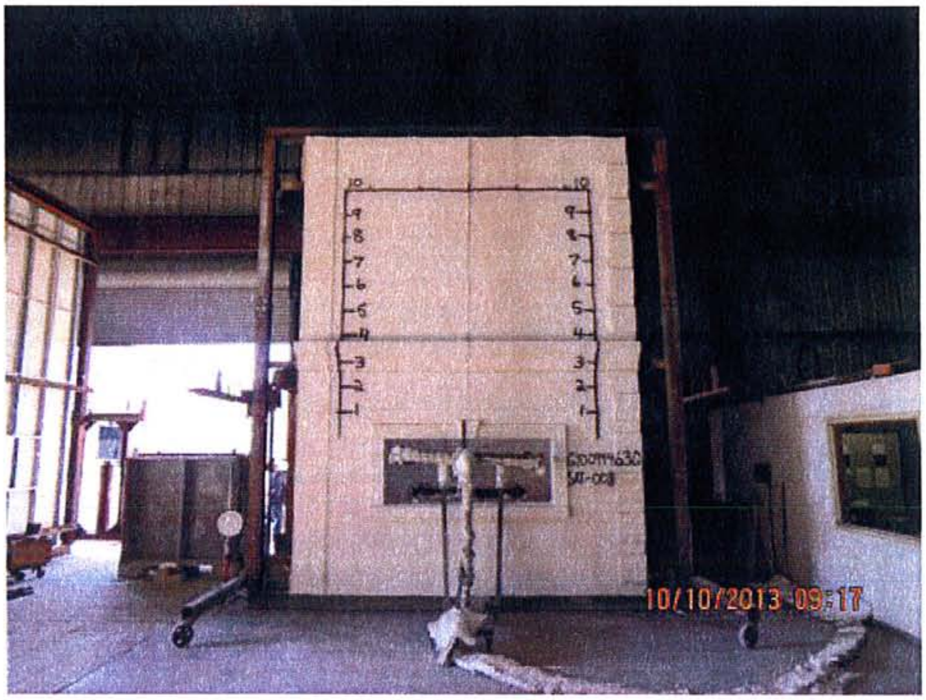
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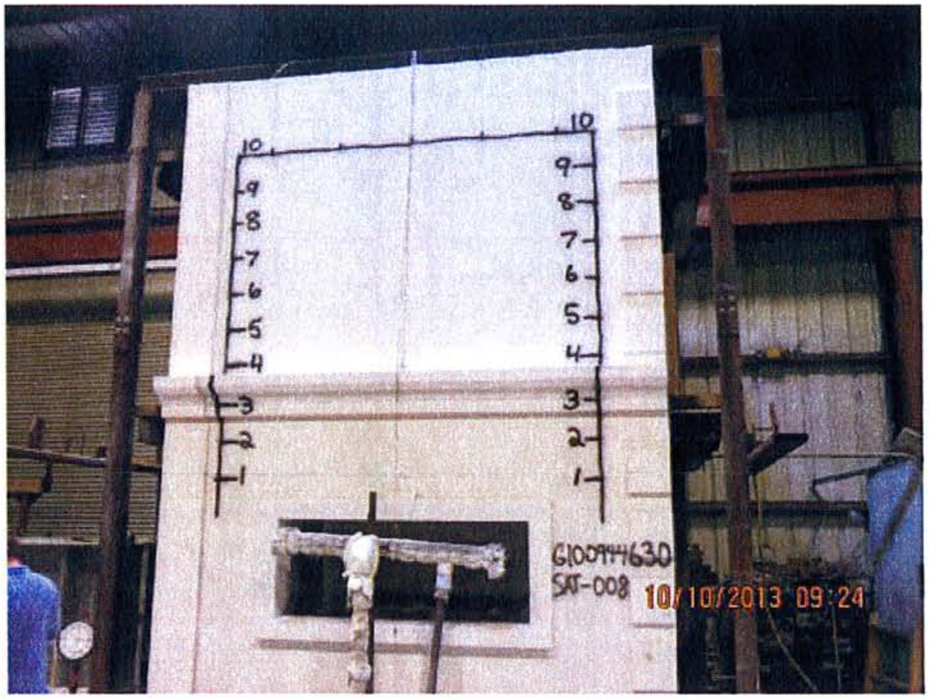
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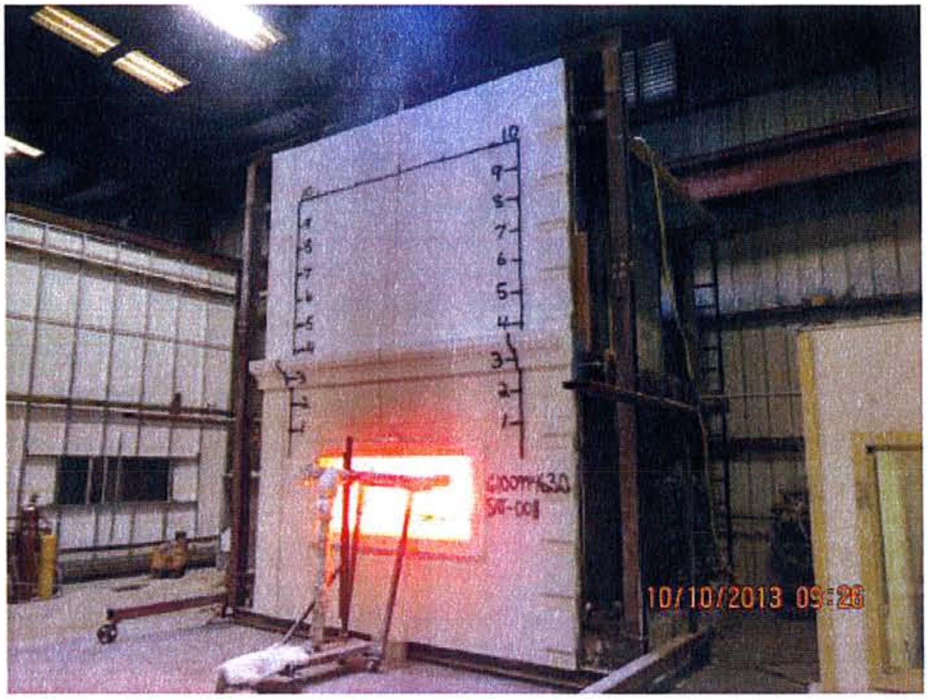
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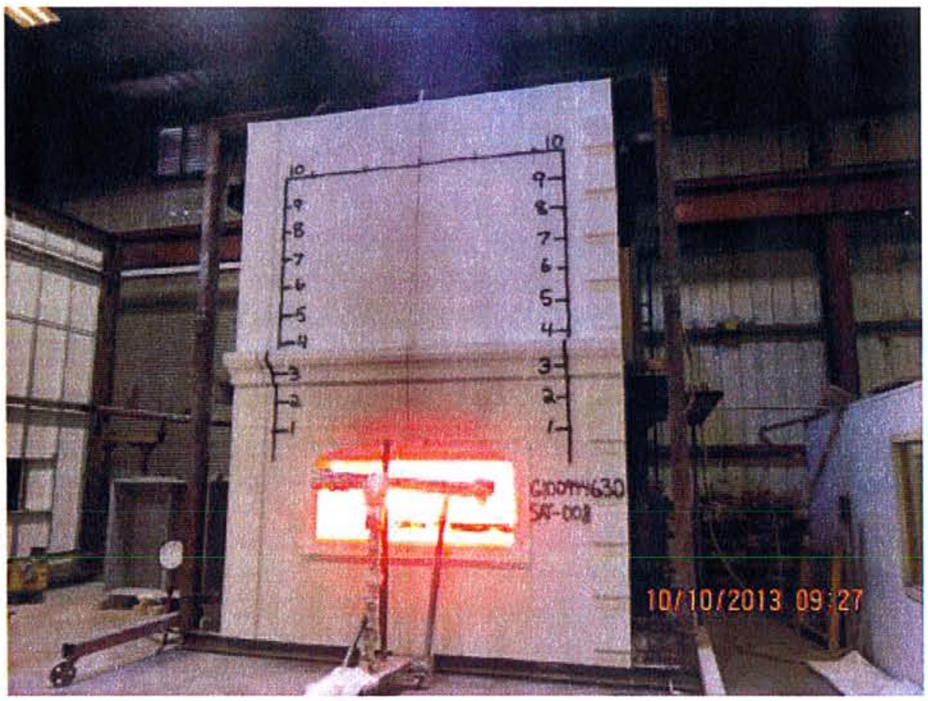
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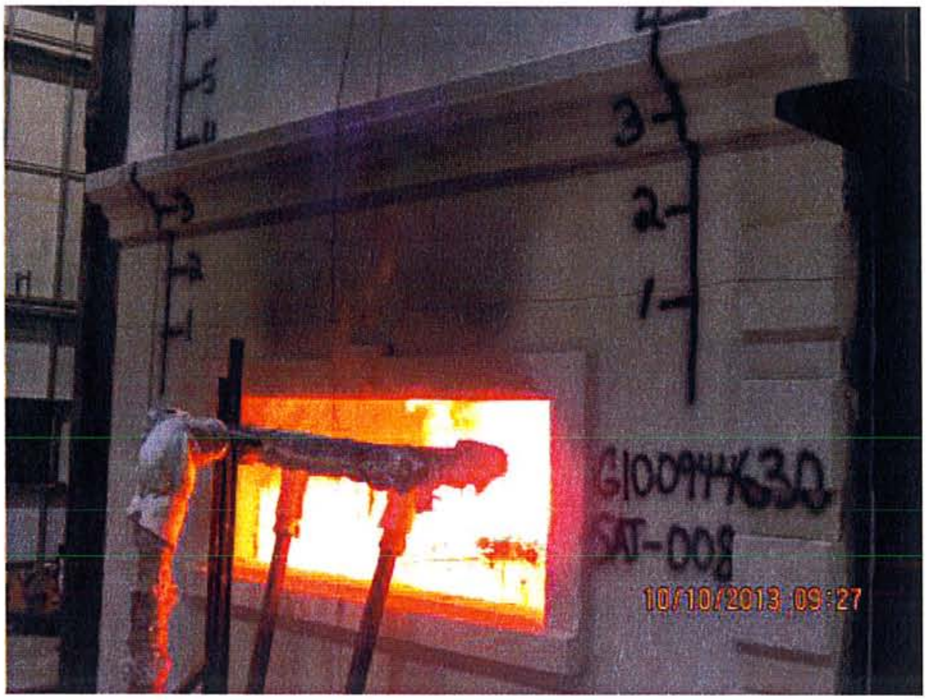
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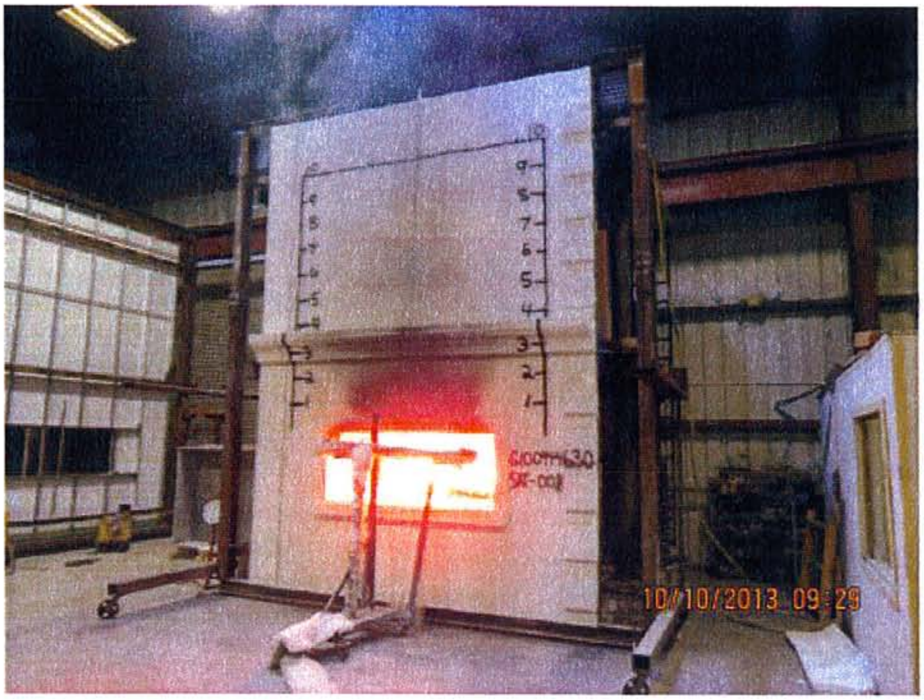
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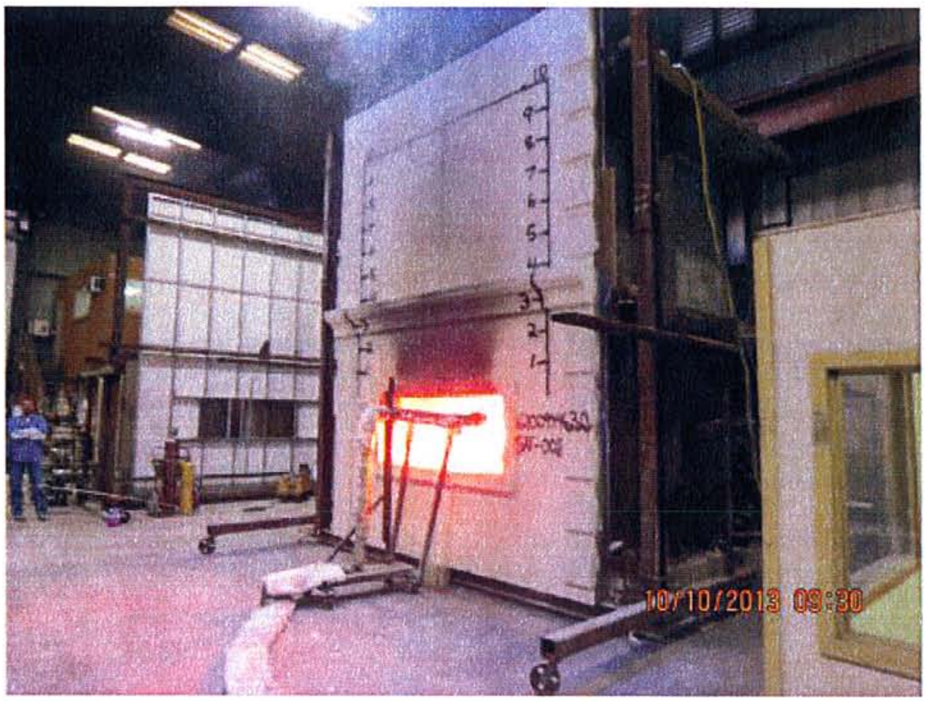
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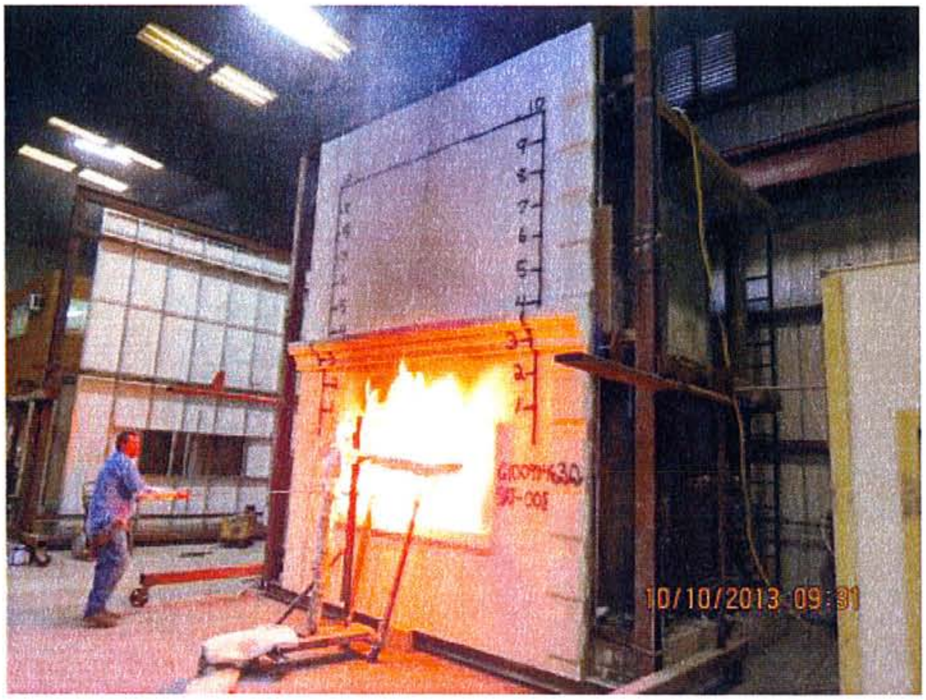
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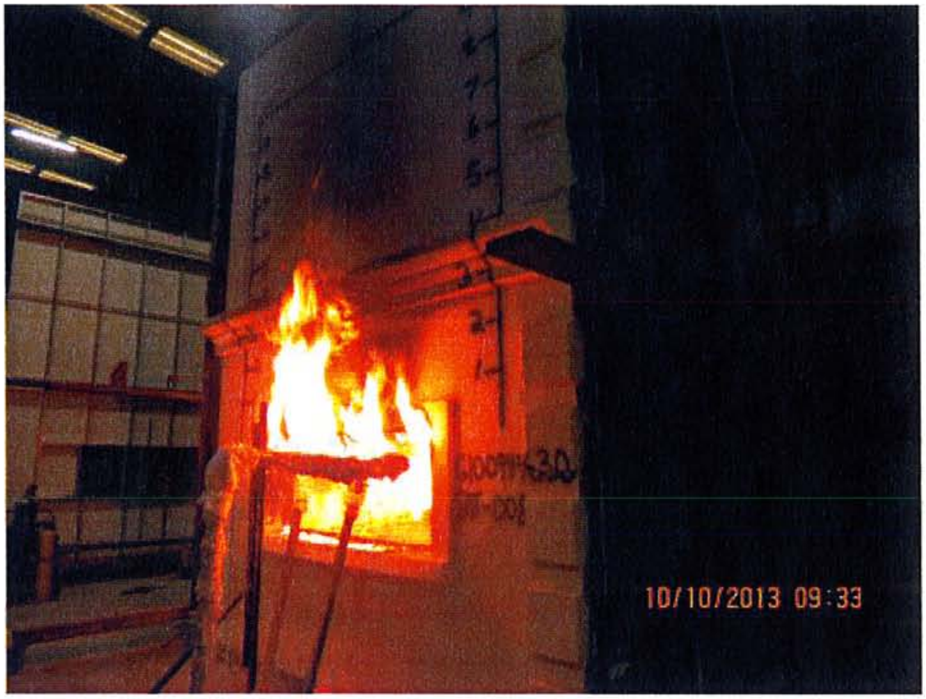
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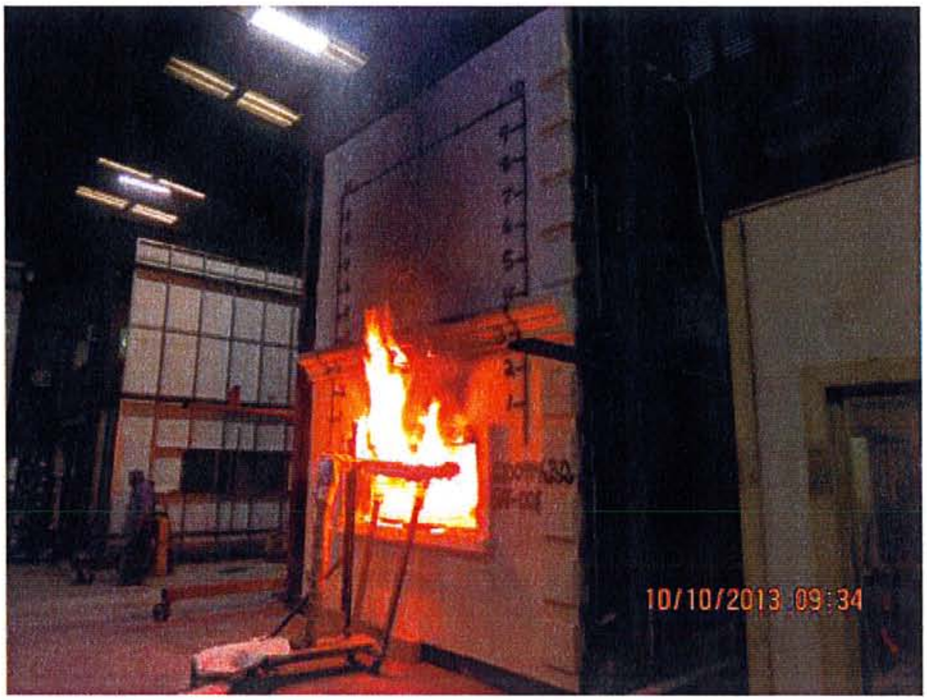
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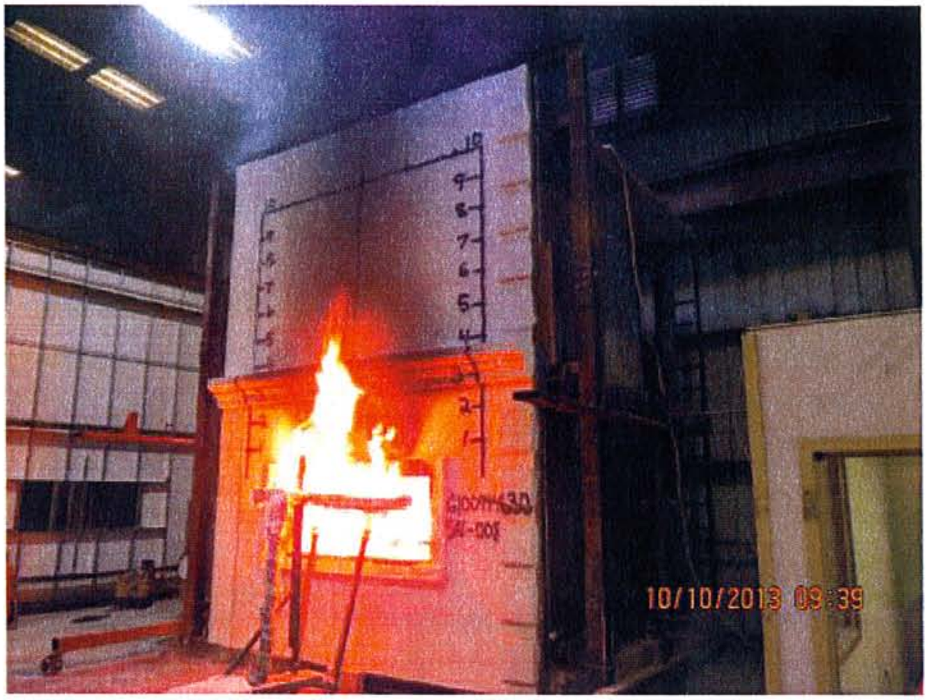
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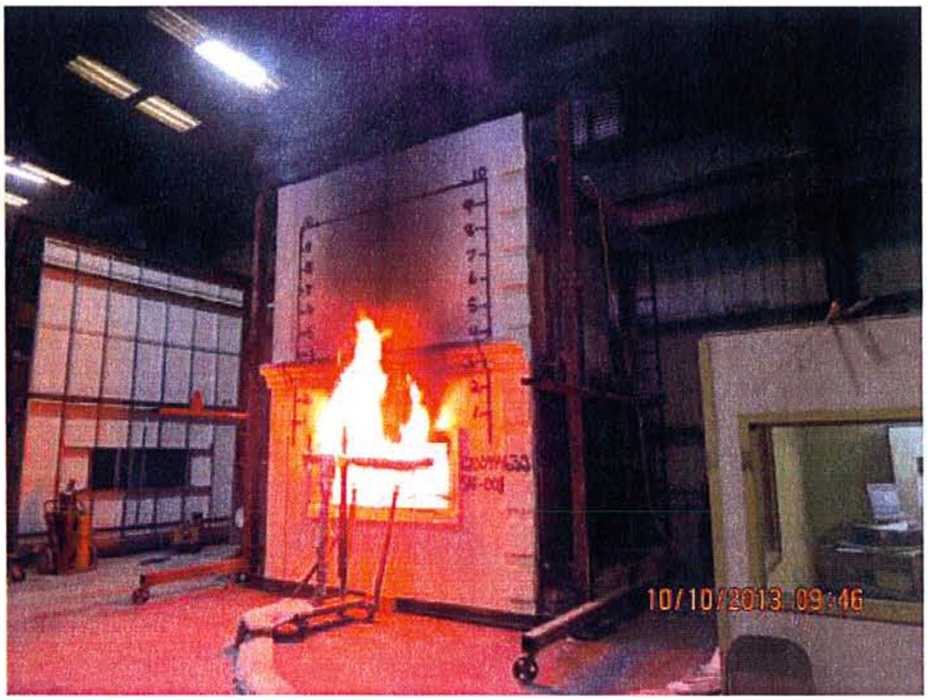
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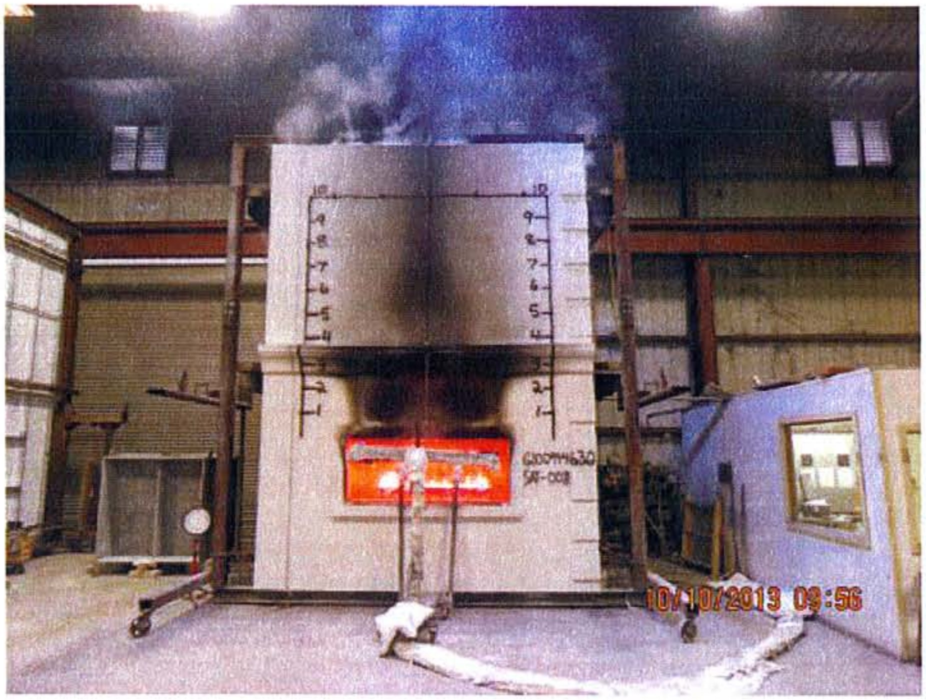
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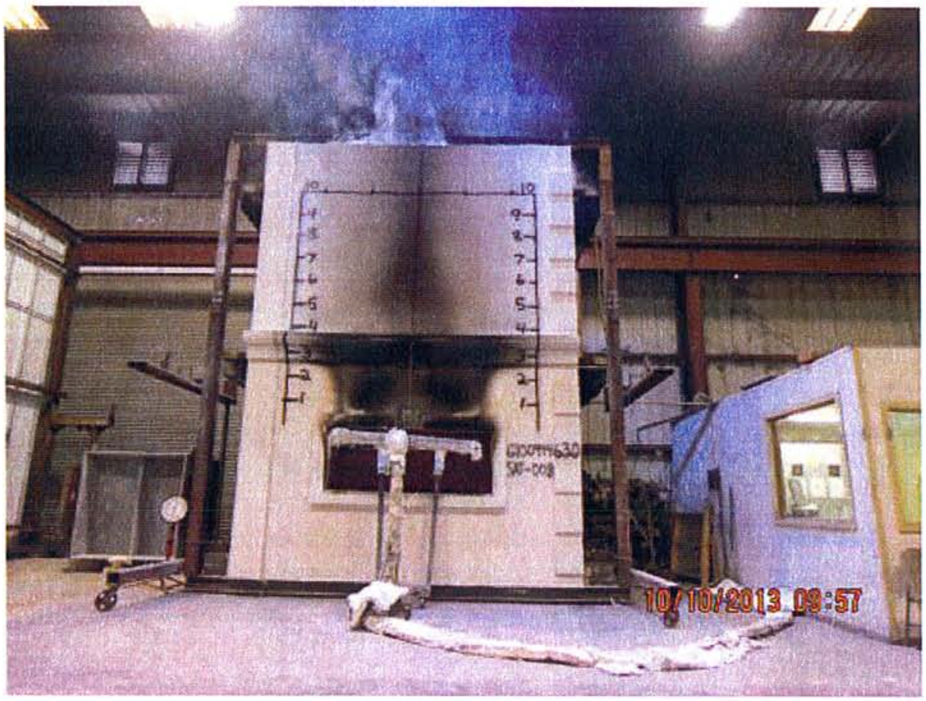
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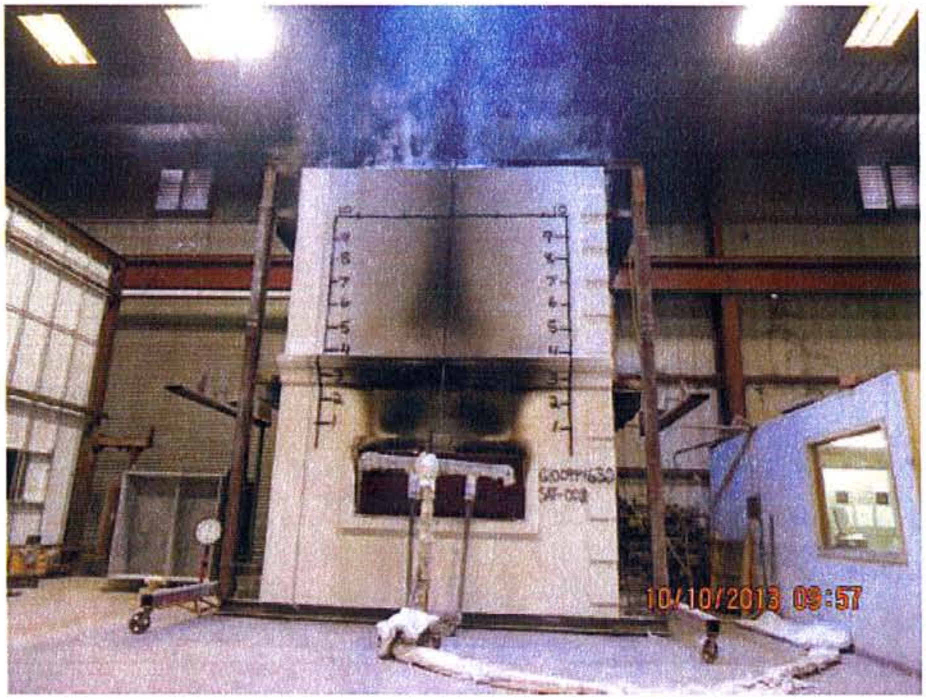
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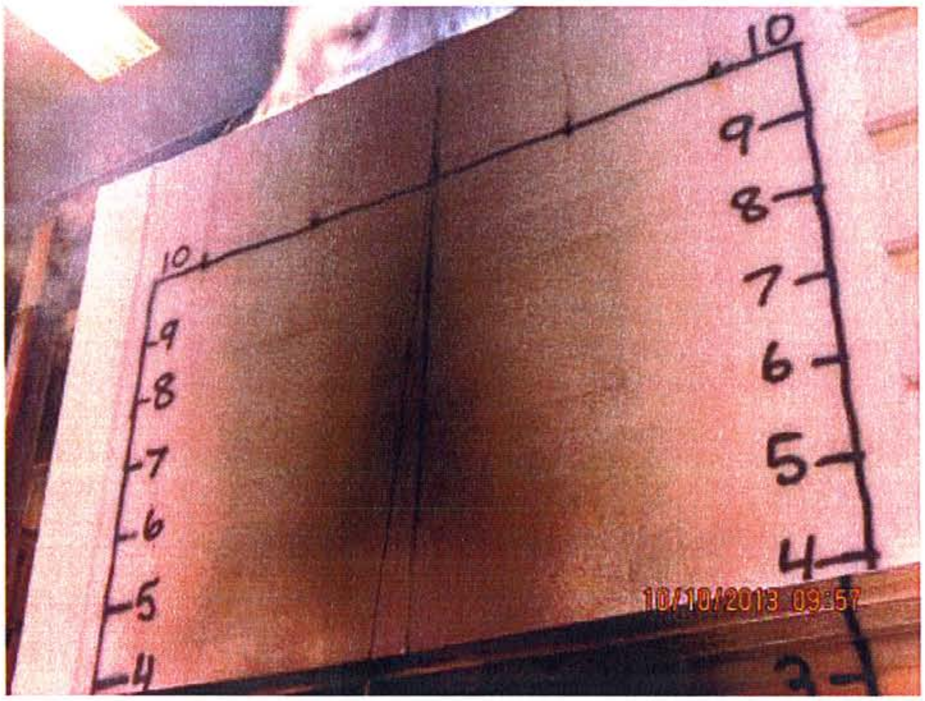
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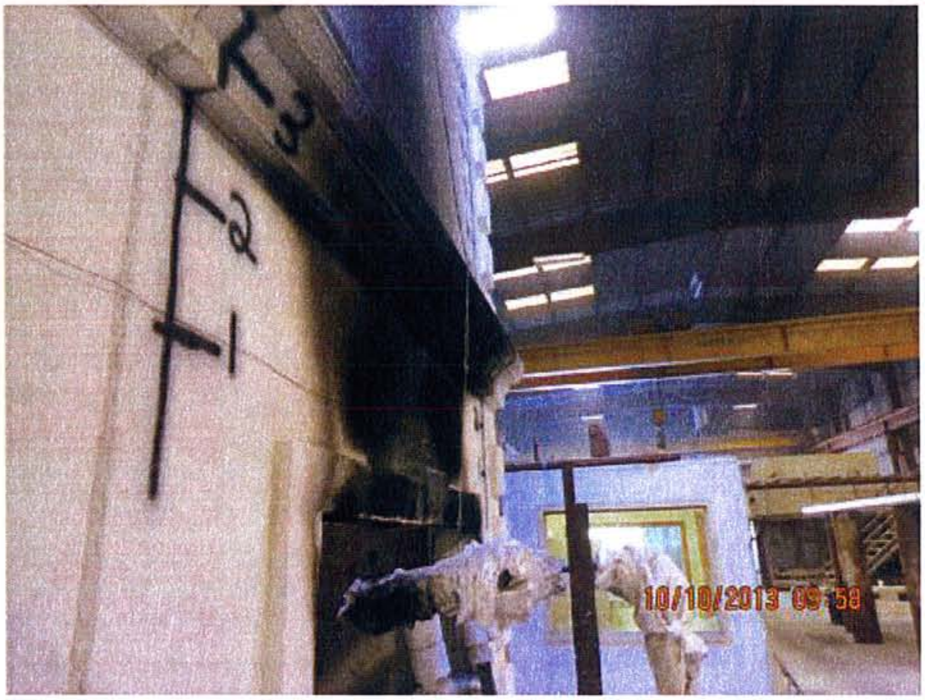
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10/10/2013 10:00


G100944630
SAT-008
10/10/2013 10:03


10/10/2013 10:05

CALIBRATED INSTRUMENTATION USED FOR TESTING

Description	Serial No.	Calibration Due Date
Thermo-Hygrometer	111901126	11/2/2013
100-Channel Data Acquisition System	99LE006	3/7/2014
Stop Watch	122382540	7/10/2014

REVISION SUMMARY

DATE	SUMMARY
October 23, 2013	Original Issue Date

TEST REPORT

REPORT NUMBER: 101183208SAT-002I
ORIGINAL ISSUE DATE: November 21, 2013
REVISED DATE: N/A

EVALUATION CENTER
16015 Shady Falls Road
Elmendorf, TX 78112
Phone: (210) 635-8100
Fax: (210) 635-8101
www.intertek.com

RENDERED TO

Dryvit Systems, Inc.
One Energy Way
WEST WARWICK RI 02893

PRODUCT EVALUATED: 8-1/2" thick Dryvit System with VIP
EVALUATION PROPERTY: Fire Resistance

Report of Testing an 8-1/2" thick Dryvit System with VIP Panel, for compliance with the applicable requirements of the following criteria: NFPA 268 Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source, 2012 Edition.

ES.22.00.019

1 Table of Contents

2 Introduction

Testing was performed for Dryvit Systems, Inc., on a 8-1/2" thick Dryvit System with VIP at Southwest Research Institute® (SwRI®) as agreed to Proposal Number 500454271, dated 05/07/2013, as a subcontractor to Intertek Testing Services NA, Inc. (Intertek). Testing was conducted in accordance with the applicable requirements of a **NFPA 268 Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source, 2012 Edition**. This test took place on October 10, 2013.

3 Test Samples

3.1. SAMPLE SELECTION

Samples were submitted to Intertek directly from the client. Samples were not independently selected for testing. Materials for the construction of the assembly were received at the Evaluation Center on August 29, 2013 and assigned Intertek Sample ID #SAT1308291616-002 through -009.

3.2. SAMPLE AND ASSEMBLY DESCRIPTION

As described by the client, the asymmetrical, 4' x 8' x 8-1/2" wall was constructed of steel studs, gypsum wallboard, ASTM C 1777 sheathing, VIP encapsulated in EPS, and a Dryvit finish system:

1. Framing – 3-5/8" x 20GA steel studs, 24" o.c.

2. Interior Sheathing – 4' x 8' x 5/8" thick, gypsum wallboard, installed with the long edge parallel to the studs using #6 X 1-1/4" self-drilling screws spaced 12" o.c.

3. Exterior Sheathing – 4' x 8' x 1/2" Dens-Glass Gold, installed with the long edge parallel to the studs using #6 X 1-1/4" self-drilling screws spaced 8" o.c.

4. Water Resistive Barrier – Dryvit Backstop® NT was trowelled onto the Dens-Glass Gold. The thickness of the Backstop® NT was approximate 12 mils dry. The Backstop® NT was allowed to dry for 24 hours prior to installation of the encapsulated VIP's.

5. EIF System – Exterior Insulation and Finish System (EIFS) was applied over the exterior sheathing, on September 9 through 12, 2013:

    a. Installation of 9-1/2" Detail Mesh for back wrapping the encapsulated VIP. 9-1/2" Detail Mesh was embedded in the Primus mixture at the perimeter of each panel. Mesh was positioned to allow for a 2-1/2" return onto the face of the panel once encapsulated VIP was installed (not shown).

    b. Primus Mixture – Mixed 1 to 1 by weight with Portland cement.

c. Encapsulated VIP – 1/2" Type II EPS Tray, Dow 795. 1-1/2" VIP, Dow 795, 1-3/4" Type II EPS Lid.

d. Primus® mixture was applied to the back of the insulation (1/2" side) of the encapsulated VIP's using a notched trowel measuring 3/8" x 1/2" x 1-1/2".

e. Primus mixture was used to embed the Detail mesh that was previously installed around the panel ensuring that all edges were completely covered.

f. Primus mixture was then applied over the face of the panel and Dryvit Standard Reinforcing Mesh weighing 4.3 oz/yd^2 was totally embedded. The base was allowed to set up and a skim coat was then applied.

g. Dryvit Finish was then applied over the surface of the panel.

4 Testing and Evaluation Methods

4.1. TEST STANDARD

Testing was conducted in accordance with applicable requirements of a **NFPA 268 Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source, 2012 Edition.**

5 Testing and Evaluation Results

5.1. RESULTS AND OBSERVATIONS

The test was initiated on Thursday, October 10, 2013 at the Southwest Research Institute® test facility, located at 6220 Culebra Road, San Antonio TX 78238. The ambient temperature at the time of the test was 85°F and the relative humidity was 50%.

The test assembly was subjected to a radiant heat flux of 12.5 kW/m^2 ± 5% for a total of 20 minutes in the presence of a spark ignition source. The assembly did not exhibit sustained flaming during the exposure.

For testing details and observations, see the Southwest Research Institute test report, SwRI® Project No. 01.19582.01.201a, dated October 31, 2013, presented in Appendix A.

6 Conclusion

Testing was performed for Dryvit Systems, Inc., on an 8-1/2" thick Dryvit System with VIP at Southwest Research Institute® (SwRI®) as agreed to Proposal Number 500454271, dated 05/07/2013, as a subcontractor to Intertek Testing Services NA, Inc. (Intertek). Testing was conducted in accordance with the applicable requirements of a **NFPA 268 Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source, 2012 Edition**. This test took place on October 10, 2013.

The test report states:

"The Dryvit System with VIP assembly was exposed to a radiant heat flux of 12.5 kW/m^2 ± 5% in the presence of a spark ignition source. The panel assembly did not exhibit sustained flaming, thus it meets the acceptance criteria described in NFPA 268".

The conclusions of this test report may not be used as part of the requirements for Intertek product certification. Authority to Mark must be issued for a product to become certified.

INTERTEK TESTING SERVICES NA, INC.

Tested by: ______________________
Joseph Zatopek
Engineering Team Leader, Fire Resistance

Reported by: ______________________
David Priest
Technical Writer

Reviewed by: ______________________
Victor M. Burgos
Project Engineer, Fire Resistance

APPENDIX A

Southwest Research Institute (SwRI®) Report

SOUTHWEST RESEARCH INSTITUTE®

6220 CULEBRA ROAD 78238 5166 • PO DRAWER 28510 78228-0510 • SAN ANTONIO TEXAS USA • (210) 684-5111 • WWW.SWRI.ORG
CHEMISTRY AND CHEMICAL ENGINEERING DIVISION
FIRE TECHNOLOGY DEPARTMENT
WWW.FIRE.SWRI.ORG
FAX (210) 522-3377

PERFORMANCE EVALUATION OF A DRYVIT FINISH SYSTEM PANEL TESTED IN ACCORDANCE WITH NFPA 268, 2012 EDITION, *STANDARD TEST METHOD FOR DETERMINING IGNITIBILITY OF EXTERIOR WALL ASSEMBLIES USING A RADIANT HEAT ENERGY SOURCE*

TRADE NAME: ***Dryvit System with VIP***

FINAL REPORT
Consisting of 11 Pages

SwRI® Project No. 01.19582.01.201a
Test Date: October 10, 2013
Report Date: October 31, 2013

Prepared for:

Intertek ETL Semko
16015 Shady Falls Rd.
Elmendorf, TX 78112

Prepared by:

Joshua W. Terry
Engineer
Material Flammability Section

Approved by:

Matthew S. Blais, Ph.D.
Director
Fire Technology Department

1.0 INTRODUCTION

Southwest Research Institute's (SwRI) Fire Technology Department, located in San Antonio, Texas, conducted one radiant panel test for Intertek ETL Semko. The test was conducted on October 10, 2013, in accordance with the procedures described in the National Fire Protection Association (NFPA) 268, 2012 Edition, *Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source.*

The objective of the test was to evaluate the propensity for ignition of an external wall assembly when subjected to a minimum radiant heat flux of 12.5 kW/m² ± 5% in the presence of a pilot ignition source, during a 20-min period. Ignition is defined as the time at which flaming is sustained. Sustained flaming is defined as the visual confirmation of the uninterrupted existence of flame on, or near, the surface of the specimen for at least 5 s.

The procedure described in NFPA 268 test standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use. This report includes a description of the test materials, procedures used, and results. The results presented in this report apply only to the materials tested, in the manner tested, and not to any similar materials or material combinations.

2.0 MATERIAL DESCRIPTION

SwRI received a 1220 × 2440 × 216-mm (4 × 8 × 8½-in.) thick wall constructed of interior gypsum wallboard, steel studs, ASTM C 1777 sheathing, VIP encapsulated in EPS, and a Dryvit finish system panel assembly from Intertek ETL Semko on October 7, 2013. The frame assembly was conditioned at ambient conditions.

Client provided sample description:

A 4 × 8 ft wall constructed of interior gypsum wallboard, steel studs, ASTM C 1777 sheathing, VIP encapsulated in EPS, and a Dryvit finish system.

1. Framing – 3⅝-in. × 20-ga. steel studs at 24 in. o.c.
2. Interior sheathing – 4 × 8-ft × ⅝-in. thick gypsum wallboard installed with the long edge parallel to the studs using #6 × 1¼-in. self drilling screws spaced at 12 in. o.c.
3. Exterior sheathing – 4 × 8-ft × ½-in. Dens-Glass Gold installed with the long edge parallel to the studs using #6 × 1¼-in. self drilling screws spaced at 8 in. o.c.
4. Water-Resistive Barrier – Dryvit Backstop NT was troweled onto the Dens-Glass Gold.

The thickness of the Backstop NT was approximately 12 mils dry. The Backstop NT was allowed to dry for 24 hours prior to installation of the encapsulated VIP's.

5. EIF System – The EIF System was applied over the course of September 9 through September 12, 2013.

   a. Installation of 9½-in. Detail Mesh for back wrapping the encapsulated VIP'S. 9½-in. Details Mesh was embedded in the Primus mixture at the perimeter of each panel. Mesh was positioned to allow for a 2½ in. return onto the face of the panel once encapsulated VIP was installed.

   b. Primus mixture- mixed 1 to 1 by weight with Portland cement.

   c. Encapsulated VIP – ½-in. Type II EPS Tray, Dow 795, 1½-in. VIP, Dow 795, 1¾-in. Type II EPS lid.

   d. Primus mixture was applied to the back of the insulation (½ in. side) of encapsulated VIP's using a notched trowel measuring ⅜ × ½ × 1½ in.

   e. Primus mixture was used to embed the Detail mesh that was previously installed around the panel ensuring that all edges were completely covered.

   f. Primus mixture was then applied over the face of the panel and Dryvit Standard Reinforcing Mesh weighting 4.3 oz/yd^2 was totally embedded. The base was allowed to set up and a skim coat was then applied.

   g. Dryvit Finish was then applied over the surface of the panel.

3.0 TEST PROCEDURE

The NFPA 268, 2012 Edition, *Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source*, was conducted using SwRI's calibrated 0.91 m × 0.91 m (3 × 3-ft) propane-fired radiant panel heat source.

A calibration test was performed to establish the distance from the radiant panel to the calibration panel, in order to maintain an average 12.5-kW/m^2 ± 5% heat flux for a 20-min period. The radiant panel was ignited and brought to a specified steady-state temperature of 871°C ± 27.8°C (1,600 °F ± 50 °F). The radiant shield was removed, and the distance between the calibration panel and the radiant panel was adjusted to achieve the specified heat flux. The distance to the face of the calibration panel measured 838 mm (33.0 in.). The 12.5-kW/m^2 heat flux was determined by averaging the four heat flux meters located at the corners of the central square foot of the calibration panel. A reference heat flux meter, mounted adjacent to the calibration panel and the calibration heat flux meters, was present during the calibration. The reference heat flux was determined to be 6.500 kW/m^2, which directly correlated to the calibrated heat flux level of 12.5 kW/m^2 ± 5%. After the completion of the calibration, the radiant shield was moved into place, and the calibration panel was replaced with the test frame assembly.

The radiant shield was removed, and the specified radiant heat flux of 12.5 kW/m^2 ± 5% was maintained for 20 min in the presence of a spark ignition source by observing and maintaining the reference heat flux meter output of 6.500 kW/m^2 ± 2.5%.

4.0 TEST RESULTS

The *Dryvit System with VIP* assembly, as constructed and described herein, did not exhibit sustained flaming when exposed to a radiant heat flux of 12.5 kW/m^2 ± 5% for a 20-min period in the presence of a spark ignition source. A summary of observations taken during the test are presented in Appendix A. See Appendix B for photographic documentation of the test. Appendix C consists of the temperature and heat flux data in graphical format.

5.0 CONCLUSIONS

The *Dryvit System with VIP* assembly was exposed to a radiant heat flux of 12.5 kW/m^2 ± 5% in the presence of a spark ignition source. The panel assembly did not exhibit sustained flaming, thus it **meets** the acceptance criteria described in NFPA 268.

APPENDIX A

TEST OBSERVATIONS

(CONSISTING OF 1 PAGE)

Test Information:

Test Type:	NFPA 268
Test Date:	October 10, 2013
Project No:	01.19582.01.201a
Trade Name:	*Dryvit System with VIP*
Dimensions:	1220 × 2440 × 216 mm (4 × 8 ft × 8½ in.)
Witnesses:	Mr. Jesse Beitel representing Hughes Associates, Mr. Bill Preston and Mrs. Beth Manteuffel representing Dryvit Systems Inc., and Mr. Steve Altum representing Dow Corning

Calibration Date: .... October 9, 2013
Radiant Panel Exposure Reference Heat Flux
Average During Calibration:..................................... 6.400 kW/m^2
Average During Test:.. 6.531 kW/m^2
Distance to Test Sample:.. 813 mm (32.0 in.)
Radiometer Distance to Sample: .... 102 mm (4 in.)
Ambient Temperature:
During Calibration:.. 29.4 °C (85 °F)
During Test:... 29.4 °C (85 °F)
Relative Humidity:
During Calibration:.. 50%
During Test:... 50%
Test Duration: .... 21 min total (includes 1 minute baseline)

TIME MIN:S	VISUAL OBSERVATIONS
00:00	Baseline begins.
01:00	Baseline ends. Start of test. Radiant heat shield removed.
02:00	Test assembly moved forward 25 mm to stabilize heat flux reading.
02:08	Light smoke from face of panel.
03:00	Light discoloration on front face of panel.
04:00	Framing visible via discoloration.
08:45	Thick smoke continues to emit from front face of panel.
12:00	Discoloration spreading to encompass entire front face of test panel.
18:00	Light smoke and discoloration continues.
20:00	Test stopped. No ignition or sustained flaming. **Pass.**

APPENDIX B
PHOTOGRAPHIC DOCUMENTATION
(CONSISTING OF 2 PAGES)

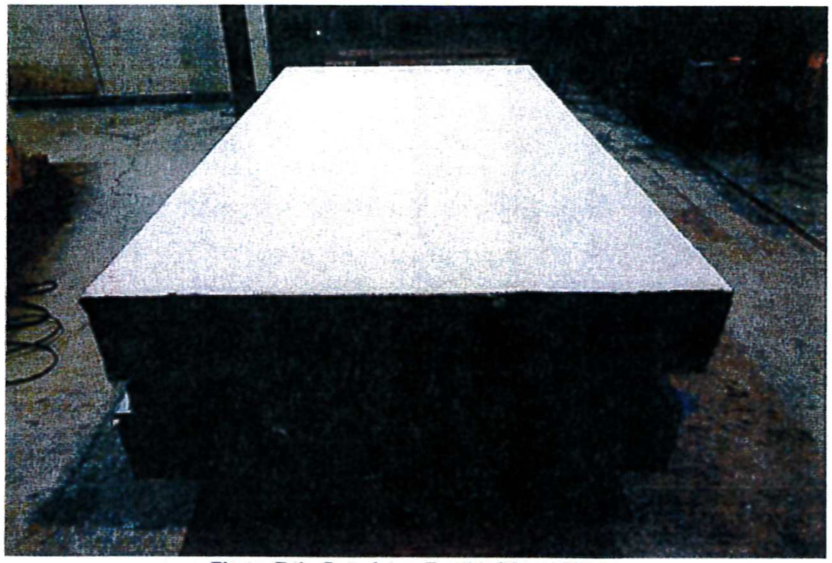


Figure B-1. Samples as Received from Client.

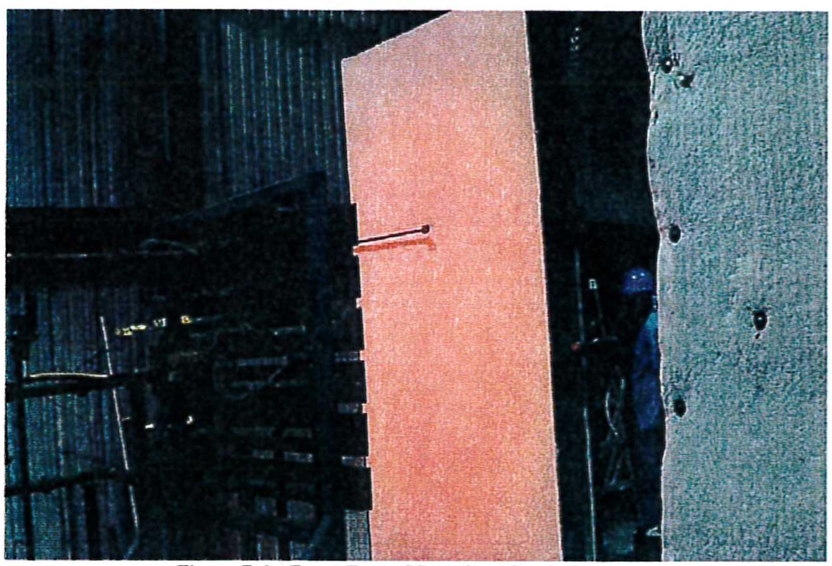


Figure B-2. Front Face of Sample at Start of Testing.

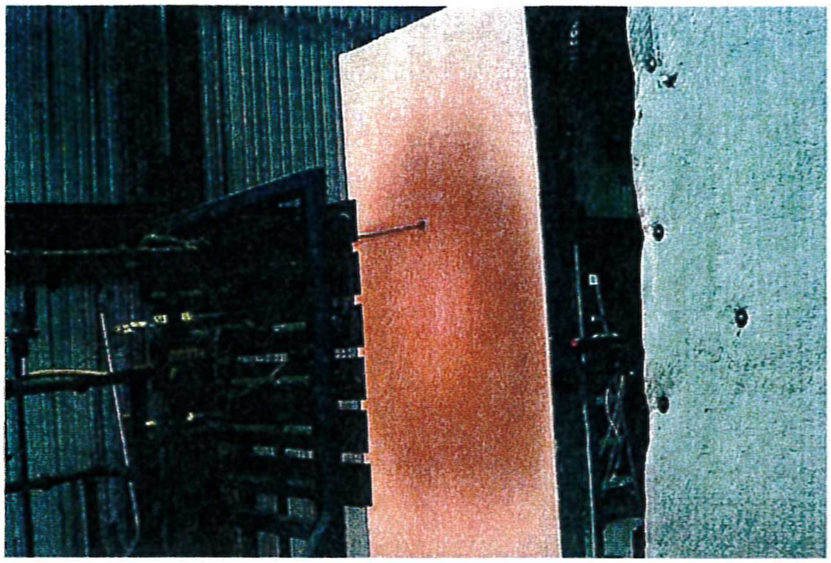


Figure B-3. Front Face of Sample after Testing.

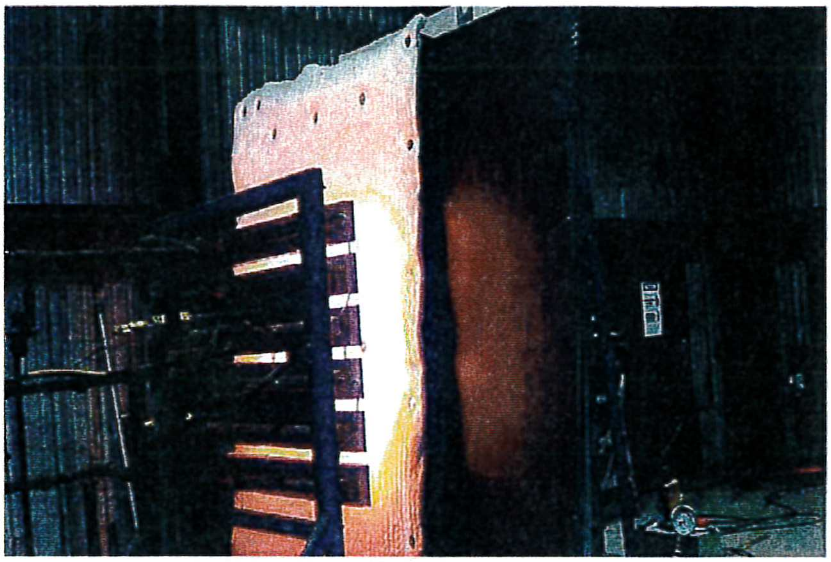
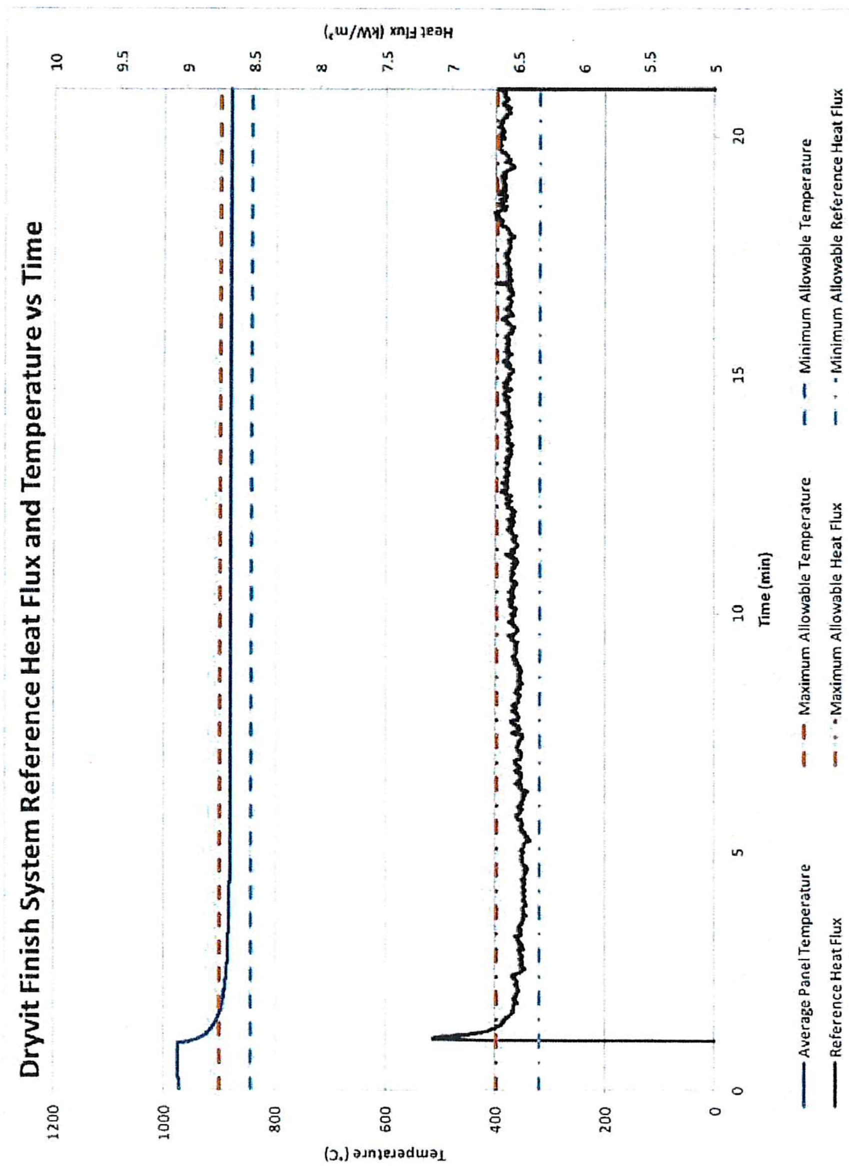


Figure B-4. Sample with Radiant Shield in Place.

APPENDIX C
TEMPERATURE AND HEAT FLUX DATA
(CONSISTING OF 1 PAGE)


Dryvit Finish System Reference Heat Flux and Temperature vs Time
Temperature (°C)
Heat Flux (kW/m²)
Time (min)
1200
1000
800
600
400
200
0
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
0
5
10
15
20
Average Panel Temperature
Maximum Allowable Temperature
Minimum Allowable Temperature
Reference Heat Flux
Maximum Allowable Heat Flux
Minimum Allowable Reference Heat Flux

REVISION SUMMARY

DATE	SUMMARY
November 21, 2013	Original Issue Date

TEST REPORT

Intertek

REPORT NUMBER: 101183208SAT-002D
ORIGINAL ISSUE DATE: July 30, 2013
REVISED DATE: N/A

EVALUATION CENTER
16015 Shady Falls Road
Elmendorf, TX 78112
Phone: (210) 635-8100
Fax: (210) 635-8101
www.intertek.com

RENDERED TO

Dryvit Systems, Inc.
One Energy Way
WEST WARWICK RI 02893

PRODUCT EVALUATED: 7-3/4" thick Dryvit System with VIP (Panel 5)
EVALUATION PROPERTY: Fire Resistance

Report of Testing a 7-3/4" thick Dryvit System with VIP Panel, for compliance with the applicable requirements of the following criteria: *NFPA 268 Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source, 2012 Edition.*

1 Table of Contents

2 Introduction

Testing was performed for Dryvit Systems, Inc., on a 7-3/4" thick Dryvit System with VIP Panel (Panel 5) at Southwest Research Institute® (SwRI®) as agreed to Proposal Number 500454271, dated 05/07/2013, as a subcontractor to Intertek Testing Services NA, Inc. (Intertek). Testing was conducted in accordance with the applicable requirements of a **NFPA 268 Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source, 2012 Edition**. This test took place on June 11, 2013.

3 Test Samples

3.1. SAMPLE SELECTION

Samples were submitted directly to Southwest Research Institute® from the client. Samples were not independently selected for testing. Materials for the construction of the assembly were received on May 28, 2013.

3.2. SAMPLE AND ASSEMBLY DESCRIPTION

As described by the client, the asymmetrical, 4' x 8' x 7-3/4" panel was constructed of wood studs, gypsum wallboard, ASTM C 1777 sheathing, VIP encapsulated in EPS, and a Dryvit finish system:

1. Framing – 2 x 4 wood studs, 24" o.c.
2. Interior Sheathing – 4' x 8' x 1/2" thick, gypsum wallboard, installed with the long edge parallel to the studs using #6 X 1-1/4" wood screws spaced 12" o.c.
3. Exterior Sheathing – 4' x 8' x 1/2" Dens-Glass Gold, installed with the long edge parallel to the studs using #6 X 1-1/4" wood screws spaced 8" o.c.
4. Water Resistive Barrier – Dryvit Backstop® NT was trowelled onto the Dens-Glass Gold. The thickness of the Backstop® NT was approximate 12 mils dry. The Backstop® NT was allowed to dry for 24 hours prior to installation of the encapsulated VIP.
5. EIF System – Exterior Insulation and Finish System (EIFS) was applied over the exterior sheathing, on May 7 through 9, 2013:
    a. Installation of 9-1/2" Detail Mesh for back wrapping the encapsulated VIP. 9-1/2" Detail Mesh was embedded in the Primus mixture at the perimeter of each panel. Mesh was positioned to allow for a 2-1/2" return onto the face of the panel once encapsulated VIP was installed (not shown)..
    b. Primus Mixture – Mixed 1 to 1 by weight with Portland cement.

c. Encapsulated VIP –1/2" Type II EPS Flat Board, Dow 795, 1-1/2" VIP, Dow 795, 1" Type II EPS Flat Board.

d. Primus® mixture was applied to the back of the insulation (1/2" side) of encapsulated VIP's using 3/8" x 1/2" x 1-1/2" notched trowel.

e. Thermal couples were installed by Art Parker of Hughes Associates. A hot wire cutter was used to cut a groove into the face of the insulation board and 3 thermal couples were installed.

f. Primus mixture was used to embed the Detail mesh that was previously installed around the panel ensuring that all edges were completely covered.

g. Primus mixture was then applied over the face of the panel and Dryvit Standard Reinforcing Mesh, weighing 4.3 oz/yd^2, was totally embedded. The base was allowed to set up and a skim coat was then applied.

h. Dryvit Finish was then applied over the surface of the panel.

4 Testing and Evaluation Methods

4.1. TEST STANDARD

Testing was conducted in accordance with applicable requirements of a **NFPA 268 Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source, 2012 Edition.**

5 Testing and Evaluation Results

5.1. RESULTS AND OBSERVATIONS

The test was initiated on Tuesday, June 11, 2013 at the Southwest Research Institute® test facility, located at 6220 Culebra Road, San Antonio TX 78228. The ambient temperature at the time of the test was 84°F and the relative humidity was 61%.

The test assembly was subjected to a radiant heat flux of 12.5 kW/m^2 ± 5% for a total of 20 minutes in the presence of a spark ignition source. The assembly did not exhibit sustained flaming during the exposure.

For testing details and observations, see the Southwest Research Institute test report, SwRI® Project No. 01.17794.01.208d, dated July 24, 2013, presented in Appendix A.

6 Conclusion

Testing was performed for Dryvit Systems, Inc., on a 7-3/4" thick Dryvit System with VIP Panel (Panel 5) at Southwest Research Institute® (SwRI®) as agreed to Proposal Number 500454271, dated 05/07/2013, as a subcontractor to Intertek Testing Services NA, Inc. (Intertek). Testing was conducted in accordance with the applicable requirements of a **NFPA 268 Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source, 2012 Edition**. This test took place on June 11, 2013.

The test report states:

"The [Dryvit System with VIP] Panel 5 was exposed to a radiant heat flux of 12.5 kW/m^2 ± 5% in the presence of a spark ignition source. The panel assembly did not exhibit sustained flaming, thus it meets the acceptance criteria described in NFPA 268".

The conclusions of this test report may not be used as part of the requirements for Intertek product certification. Authority to Mark must be issued for a product to become certified.

INTERTEK TESTING SERVICES NA, INC.

Tested by: Joseph Zatopek
Engineer, Fire Resistance

Reported by: Michael A Brown
Quality Supervisor / Technical Writer

Reviewed by: Victor M. Burgos
Project Engineer, Fire Resistance

APPENDIX A
Southwest Research Institute (SwRI®) Report

SOUTHWEST RESEARCH INSTITUTE®

6220 CULEBRA ROAD 78238 5166 • P O DRAWER 28510 78228 0510 • SAN ANTONIO TEXAS USA • (210) 684-5111 • WWW.SWRI.ORG

CHEMISTRY AND CHEMICAL ENGINEERING DIVISION
FIRE TECHNOLOGY DEPARTMENT
WWW.FIRE.SWRI.ORG
FAX (210) 522-3377

PERFORMANCE EVALUATION OF A DRYVIT SYSTEM WITH VIP ASSEMBLY IN ACCORDANCE WITH NFPA 268, 2012 EDITION, *STANDARD TEST METHOD FOR DETERMINING IGNITIBILITY OF EXTERIOR WALL ASSEMBLIES USING A RADIANT HEAT ENERGY SOURCE*

MATERIAL ID: ***Panel 5***
TRADE NAME: ***Dryvit System wilt VIP***

FINAL REPORT
Consisting of 10 Pages

SwRI® Project No. 01.17794.01.208d
Test Date: June 11, 2013
Report Date: July 24, 2013

Prepared for:

Intertek ETL Semko
16015 Shady Falls Rd
Elmendorf, TX 78112

Prepared by:

JWT Joshua W. Terry
Engineer
Material Flammability Section

Approved by:

Matthew S. Blais, Ph.D.
Director
Fire Technology Department

Benefiting government, industry and the public through innovative science and technology

1.0 INTRODUCTION

Southwest Research Institute's (SwRI) Fire Technology Department, located in San Antonio, Texas, conducted one radiant panel test for Intertek ETL Semko. The test was conducted on June 11, 2013, in accordance with the procedures described in the National Fire Protection Association (NFPA) 268, 2012 Edition, *Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source*.

The objective of the test was to evaluate the propensity for ignition of an external wall assembly when subjected to a minimum radiant heat flux of 12.5 kW/m² ± 5% in the presence of a pilot ignition source, during a 20-min period. Ignition is defined as the time at which flaming is sustained. Sustained flaming is defined as the visual confirmation of the uninterrupted existence of flame on, or near, the surface of the specimen for at least 5 s.

The procedure described in NFPA 268 test standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use. This report includes a description of the test materials, procedures used, and results. The results presented in this report apply only to the materials tested, in the manner tested, and not to any similar materials or material combinations.

2.0 MATERIAL DESCRIPTION (Panel Number 5)

SwRI received a 4 × 8 ft × 7-3/4-in. (nominal) thick Dryvit finish system test panel assembly from Dryvit Systems, Inc. on May 28, 2013. The frame assembly was conditioned at ambient conditions.

The 7-3/4-in. thick, four foot by eight foot wall was constructed of interior gypsum wallboard, wood studs, ASTM C 1777 sheathing, VIP encapsulated in EPS, and a Dryvit finish system. As per the client's description, and in ascending order, the 7-3/4-in. thick *Dryvit Systems wih VIP* panel consisted of:

1. Framing – 2 × 4 wood studs at 24 in. o.c.
2. Interior Sheathing – 4 × 8 ft × 1/2-in. thick gypsum wallboard installed with the long edge parallel to the studs using #6 × 1-1/4-in. long wood screws spaced at 12 in. o.c.
3. Exterior Sheathing – 4 × 8 ft × 1/2-in. thick Dens-Glass Gold installed with the long edge parallel to the studs using #6 × 1-1/4-in. long wood screws spaced at 8 in. o.c.
4. Water-Resistive Barrier – Dryvit Backstop NT was troweled onto the Dens-Glass Gold. The thickness of the Backstop NT was approximately 12 mils dry. The Backstop NT was allowed

to dry for 24 hours prior to installation of the encapsulated VIP's.

5. EIF System – The EIF System was applied over the course of May 7 - 9, 2013.
   a. Installation of 9-1/2-in. Detail Mesh for back wrapping the encapsulated VIP's. The 9-1/2-in. Detail Mesh was embedded in the Primus mixture at the perimeter of each panel. Mesh was positioned to allow for a 2-1/2-in. return onto the face of the panel once encapsulated VIP was installed.
   b. Primus mixture – mixed 1 to 1 by weight with Portland cement.
   c. Encapsulated VIP – 1/2-in. thick Type II EPS Flat Board, Dow 795, 1-1/2 in. VIP, Dow 795. 1-in. thick Type II EPS Flat Board.
   d. Primus mixture was applied to the back of the insulation (1/2 in. side) of encapsulated VIP's using a notched trowel measuring 3/8 in. × 1/2 in. × 1-1/2 in.
   e. Thermocouples were installed by Art Parker of Hughes Associates. A hot wire cutter was used to cut a groove into the face of the insulation board and 3 thermocouples were installed.
   f. Primus mixture was used to embed the Detail mesh that was previously installed around the panel ensuring that all edges were completely covered.
   g. Primus mixture was then applied over the face of the panel and Dryvit Standard Reinforcing Mesh weighing 4.3 oz/yd^2 was totally embedded. The base was allowed to set up and a skim coat was then applied.
   h. Dryvit Finish was then applied over the surface of the panel.

3.0 TEST PROCEDURE

The NFPA 268, 2012 Edition, *Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source*, was conducted using SwRI's calibrated 3 × 3-ft propane-fired radiant panel heat source.

A calibration test was performed to establish the distance from the radiant panel to the calibration panel, in order to maintain an average 12.5-kW/m^2 ± 5% heat flux for a 20-min period. The radiant panel was ignited and brought to a specified steady-state temperature of 1,600 °F ± 50 °F. The radiant shield was removed, and the distance between the calibration panel and the radiant panel was adjusted to achieve the specified heat flux. The distance to the face of the calibration panel measured 32.5 in. The 12.5-kW/m^2 heat flux was determined by averaging the four heat flux meters located at the corners of the central square foot of the calibration panel. A reference heat flux meter, mounted adjacent to the calibration panel and the calibration heat flux meters, was present during the calibration. The reference heat flux was determined to be 3.538 KW/m^2, which directly correlated to the calibrated heat flux level of 12.5 kW/m^2 ± 5%. After the completion of the calibration, the radiant shield was moved into place, and the calibration panel was replaced with the test frame assembly.

The radiant shield was removed, and the specified radiant heat flux of 12.5 $kW/m^2 \pm 5\%$ was maintained for 20 min in the presence of a spark ignition source by observing and maintaining the reference heat flux meter output of 3.538 $kW/m^2 \pm 2.5\%$.

4.0 TEST RESULTS

The *Dryvit Systems with VIP* assembly, as constructed and described herein, did not exhibit sustained flaming when exposed to a radiant heat flux of 12.5 $kW/m^2 \pm 5\%$ for a 20-min period in the presence of a spark ignition source. A summary of observations taken during the test are presented in Appendix A. See Appendix B for photographic documentation of the test. Appendix C consists of the temperature and heat flux data in graphical format.

5.0 CONCLUSIONS

The Panel 5 assembly was exposed to a radiant heat flux of 12.5 $kW/m^2 \pm 5\%$ in the presence of a spark ignition source. The panel assembly did not exhibit sustained flaming, thus it meets the acceptance criteria described in NFPA 268.

APPENDIX A

TEST OBSERVATIONS

(CONSISTING OF 1 PAGE)

Test Information:

Test Type:	NFPA 268
Test Date:	June 11, 2013
Project No:	01.17794.01.208d
Material ID:	*Panel 5*
Trade Name:	*Dryvit Systems wih VIP*
Dimensions:	48 in. wide × 96 in. long × 7-3/4 in. thick
Witnesses:	Messrs. Stephen Altum and Brent Dull, representing Dow Corning Corp., and Mr. Jesse Beitel, representing Hughes Associates, Inc.

Calibration Date: .... June 10, 2013
Radiant Panel Exposure Reference Heat Flux
Average During Calibration:..................................... 3.538 kW/m^2
*Average During Test:.. 3.550 kW/m^2
Distance to Test Sample:.. 32.5 in.
Radiometer Distance to Sample: .... 4 in.
Ambient Temperature:
During Calibration:... 85 °F (29.4 °C)
During Test:.. 84 °F (28.9 °C)
Relative Humidity:
During Calibration:... 50%
During Test:.. 61%
Test Duration: .... 21 min total (includes 1 minute baseline)

TIME MIN:S	VISUAL OBSERVATIONS
00:00	Baseline begins.
01:00	Start of test. Radiant heat shield removed.
02:37	Panel moved 1/2 in. forward to stabilize reference radiometer heat flux.
02:37	Light smoke emitting from panel.
03:40	Discoloration noted.
06:00	Continuing smoke and discoloration.
09:15	Smoke continues to emit. Slight bulging out of panel face.
12:30	Light smoke continues.
18:00	Continued smoke and light discoloration.
21:00	Test stopped. No ignition or sustained flaming. Pass.

APPENDIX B

PHOTOGRAPHIC DOCUMENTATION

(CONSISTING OF 1 PAGE)

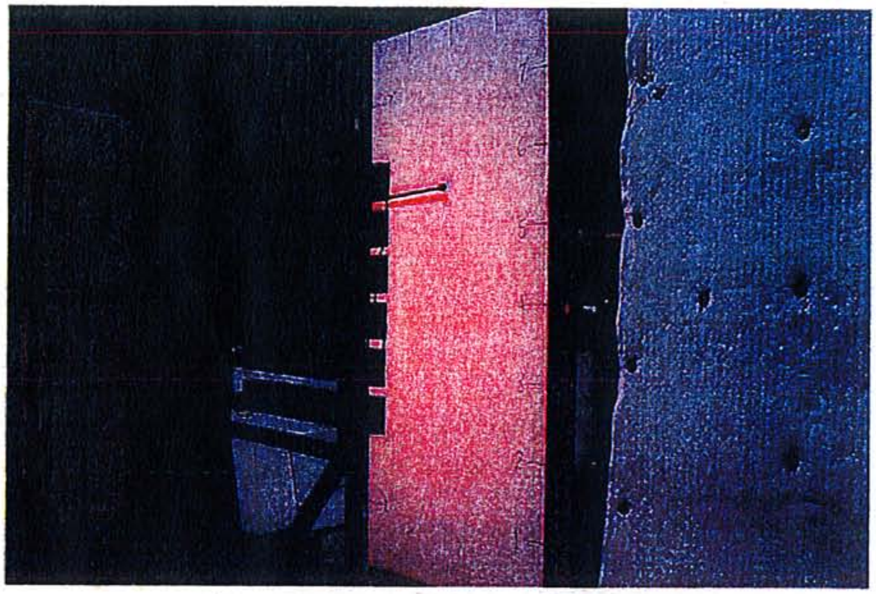


Figure B-1. Panel 5 with Heat Shield Removed.

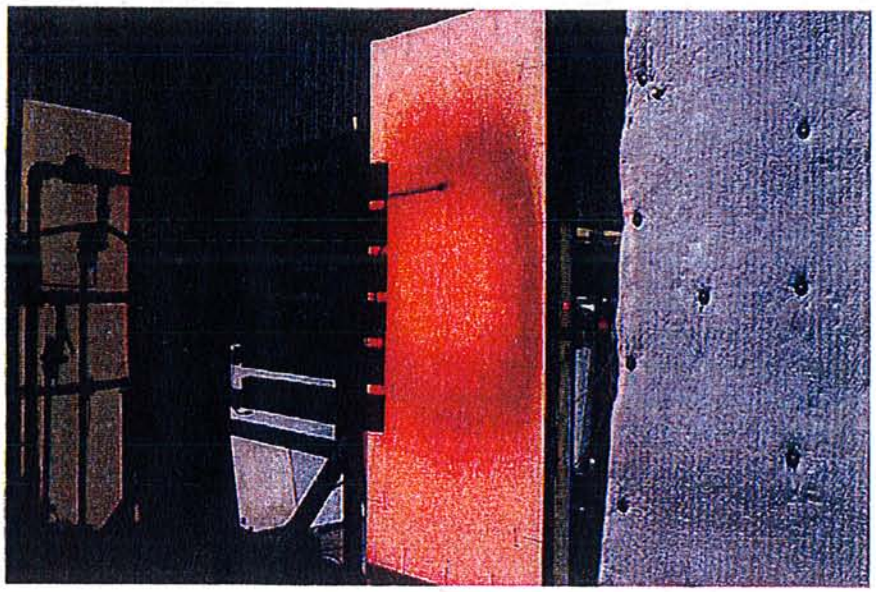
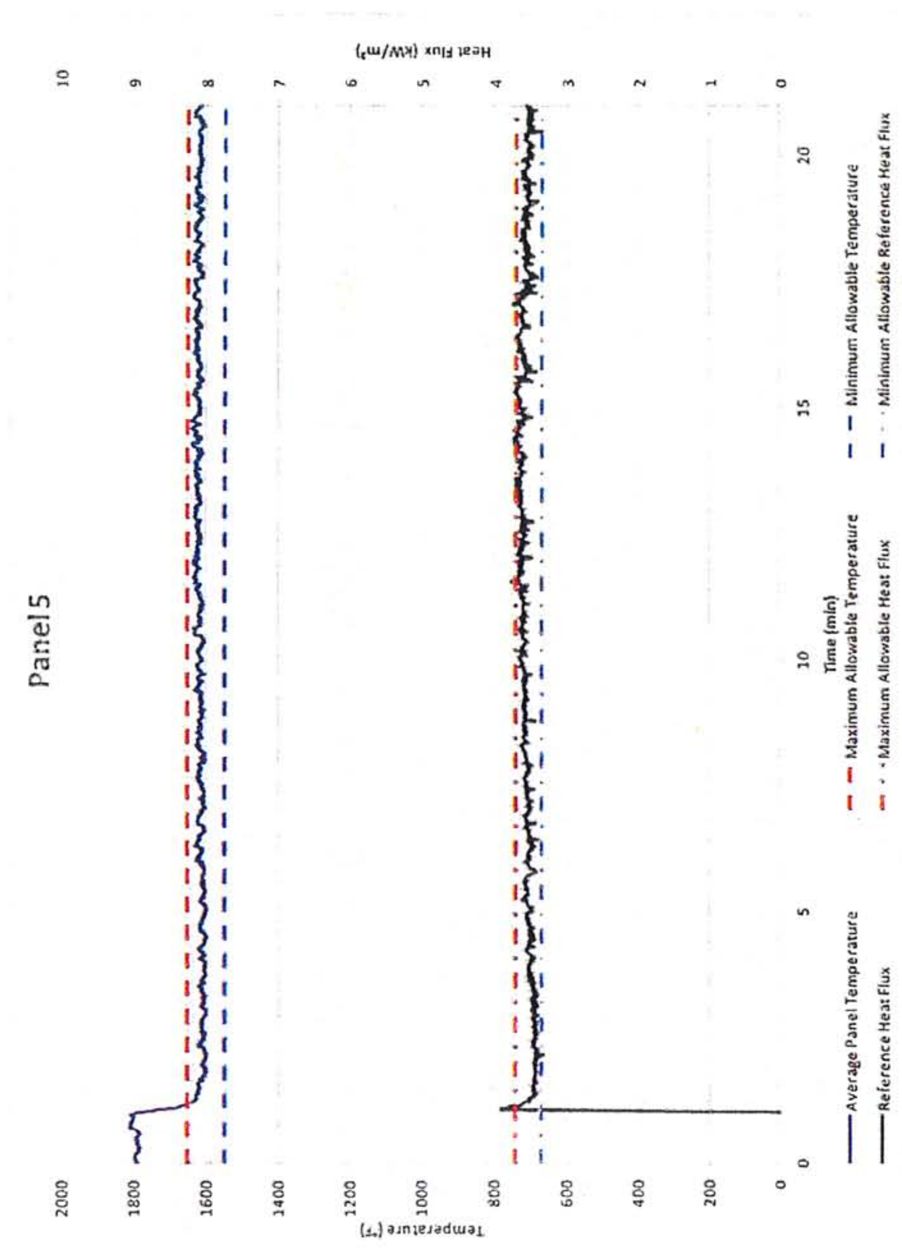


Figure B-2. Panel 5 Front Face during Testing.

APPENDIX C

TEMPERATURE AND HEAT FLUX DATA

(CONSISTING OF 1 PAGE)


Panel 5
Temperature (°F)
Heat Flux (kW/m²)
Time (min)
Average Panel Temperature
Reference Heat Flux
Maximum Allowable Temperature
Maximum Allowable Heat Flux
Minimum Allowable Temperature
Minimum Allowable Reference Heat Flux

REVISION SUMMARY

DATE	SUMMARY
July 30, 2013	Original Issue Date

Intertek

TEST REPORT

REPORT NUMBER: 101220658COQ-003
ORIGINAL ISSUE DATE: June 10, 2013

EVALUATION CENTER
Intertek Testing Services NA Ltd.
1500 Brigantine Drive
Coquitlam, BC V3K 7C1

RENDERED TO

Dow Corning Corporation
2200 W. Salzburg Road
Auburn, MI 48686

PRODUCT EVALUATED: Vacuum Insulating Panels
EVALUATION PROPERTY: Surface Burning Characteristics

Report of testing Vacuum Insulating Panels for compliance with the applicable requirements of the following criteria: ASTM E84-12c, *Standard Test Method for Surface Burning Characteristics of Materials.*

1 Table of Contents

PAGE

2 Introduction

Intertek Testing Services NA Ltd. (Intertek) has conducted testing for Dow Corning Corporation to evaluate the surface burning characteristics of Vacuum Insulating Panels. Testing was conducted in accordance with the standard methods of ASTM E84-12c, *Standard Test Method for Surface Burning Characteristics of Materials*.

This evaluation began June 7, 2013 and was completed the same day.

3 Test Samples

3.1. SAMPLE SELECTION

Samples were submitted to Intertek directly from the client and were not independently selected for testing. The sample materials were received at the Evaluation Center on June 4, 2013.

3.2. SAMPLE AND ASSEMBLY DESCRIPTION

Upon receipt of the samples at the Intertek Coquitlam laboratory they were placed in a conditioning room where they remained in an atmosphere of 23 ± 3°C (73.4 ± 5°F) and 50 ± 5% relative humidity.

The sample panels were described by the client as “Dow Corning Vacuum Insulating Panels” with a Metallic Scrim ID# 2-P527497-1-00099.3219. Each panel measured 24 in. wide by 4 ft. long by 1 in. thick.

For this trial run, six 4 ft. long panels were butted together and placed on the upper ledge of the flame spread tunnel to form the required 24 ft. sample length, with the metallic scrim face oriented toward the flame. A layer of 6 mm reinforced cement board was placed over top of the samples, the tunnel lid was lowered into place, and the samples were then tested in accordance with ASTM E84-12c.

4 Testing and Evaluation Methods

4.1. TEST STANDARD

The results of the tests are expressed by indexes, which compare the characteristics of the sample under tests relative to that of select grade red oak flooring and inorganic-cement board.

(A) Flame Spread Classification:

This index relates to the rate of progression of a flame along a sample in the 25 foot tunnel. A natural gas flame is applied to the front of the sample at the start of the test and drawn along the sample by a draft kept constant for the duration of the test. An observer notes the progression of the flame front relative to time.

The test apparatus is calibrated such that the flame front for red oak flooring passes out the end of the tunnel in five minutes, thirty seconds (plus or minus 15 seconds).

(B) Smoke Developed:

A photocell is used to measure the amount of light, which is obscured by the smoke passing down the tunnel duct. When the smoke from a burning sample obscures the light beam, the output from the photocell decreases. This decrease with time is recorded and compared to the results obtained for red oak, which is defined to be 100.

5 Testing and Evaluation Results

5.1. RESULTS AND OBSERVATIONS

(A) Flame Spread

The resultant flame spread classifications are as follows:
(Classification rounded to nearest 5)

Sample	Flame Spread	Flame Spread Classification
1 in. Thick Vacuum Insulating Panels	15	15

(B) Smoke Developed

The areas beneath the smoke developed curve and the related classifications are as follows:
(For smoke developed indexes 200 or more, classification is rounded to the nearest 50. For smoke developed indexes less than 200, classification is rounded to nearest 5)

Sample	Smoke Developed	Smoked Developed Classification
1 in. Thick Vacuum Insulating Panels	18	20

(C) Observations

Surface ignition occurred at approximately 10 seconds.

6 Conclusion

The 1 in. thick Dow Corning Vacuum Insulating Panels, submitted by Dow Corning Corporation, exhibited the following flame spread characteristics when tested in accordance with ASTM E84-12c, *Standard Test Method for Surface Burning Characteristics of Materials*.

Sample	Flame Spread Classification	Smoked Developed Classification
1in. Thick Insulated Panels	15	20

The conclusions of this test report may not be used as part of the requirements for Intertek product certification. Authority to Mark must be issued for a product to become certified.

INTERTEK TESTING SERVICES NA LTD.

Tested and Reported by: ____________________
Greg Philp
Technician – Building Products

Reviewed by: ____________________
Scott Leduc EIT
Test Engineer – Building Products

APPENDIX A

DATA SHEETS

ASTM E84-12c DATA SHEETS

ASTM E84

Page 1 of 2

Client: Dow Corning
Date: 06 07 2013
Project Number: 101220658
Test Number: 1
Operator: Greg Philp

Specimen ID: 1/2 in thick VIP Panels ID 2-P527497-1-00099.3219

TEST RESULTS

FLAMESPREAD INDEX: 15

SMOKE DEVELOPED INDEX: 20

SPECIMEN DATA . . .

Time to Ignition (sec): 10
Time to Max FS (sec): 23
Maximum FS (feet): 2.9
Time to 980 F (sec): Never Reached
Time to End of Tunnel (sec): Never Reached
Max Temperature (F): 572
Time to Max Temperature (sec): 598
Total Fuel Burned (cubic feet): 44.00

FS*Time Area (ft*min): 28.9
Smoke Area (%A*min): 17.2
Unrounded FSI: 14.9
Unrounded SDI: 17.9

CALIBRATION DATA . . .

Time to Ignition of Last Red Oak (Sec): 42.0
Red Oak Smoke Area (%A*min): 95.9

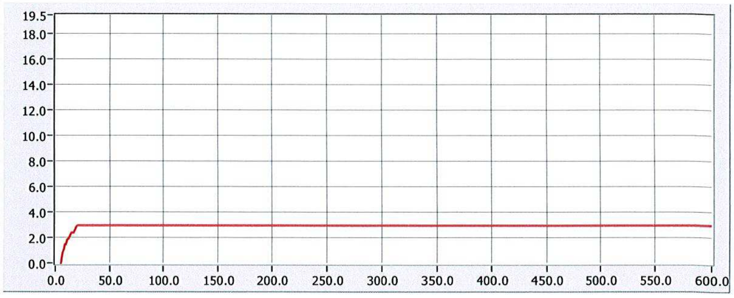
Tested By

Reviewed By

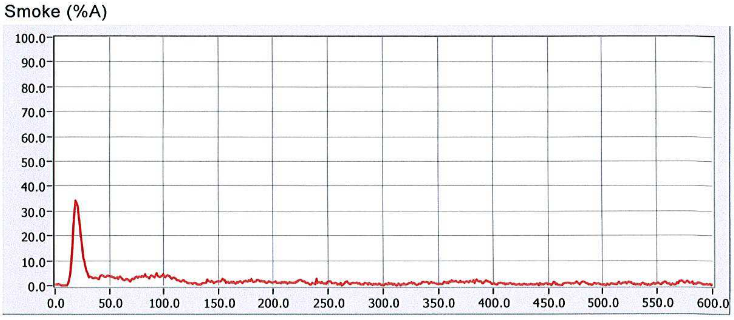
ASTM E84-12c DATA SHEETS

Project No: 101220658

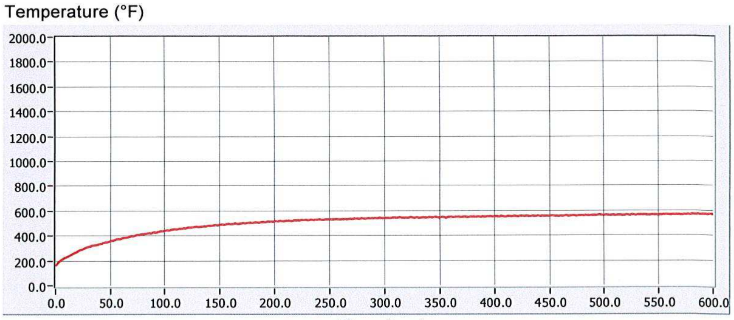
FLAME SPREAD (ft)



Smoke (%A)



Temperature (°F)



Time (sec)

600

REVISION SUMMARY

DATE	PAGE(S)	SUMMARY
November 26, 2012	All	Original Issue Date

TEST REPORT

REPORT NUMBER: 101220658COQ-002
ORIGINAL ISSUE DATE: June 10, 2013

EVALUATION CENTER
Intertek Testing Services NA Ltd.
1500 Brigantine Drive
Coquitlam, B.C. V3K 7C1

RENDERED TO

Dow Corning Corporation
2200 W. Salzburg Road
Auburn, MI 48686

PRODUCT EVALUATED: Vacuum Insulating Panels
EVALUATION PROPERTY: Surface Burning Characteristics

Report of testing Vacuum Insulating Panels for compliance with the applicable requirements of the following criteria: CAN/ULC S102-10, *Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.*

1 Table of Contents

PAGE

2 Introduction

Intertek Testing Services NA Ltd. (Intertek) has conducted testing for Dow Corning Corporation to evaluate the surface burning characteristics of Vacuum Insulating Panels. Testing was conducted in accordance with the standard methods of CAN/ULC S102-10, *Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies*.

This evaluation began June 7, 2013 and was completed the same day.

3 Test Samples

3.1. SAMPLE SELECTION

Samples were submitted to Intertek directly from the client and were not independently selected for testing. The sample materials were received at the Evaluation Center on June 4, 2013.

3.2. SAMPLE AND ASSEMBLY DESCRIPTION

Upon receipt of the samples at the Intertek Coquitlam laboratory they were placed in a conditioning room where they remained in an atmosphere of 23 ± 3°C (73.4 ± 5°F) and 50 ± 5% relative humidity.

The sample panels were described by the client as “Dow Corning Vacuum Insulating Panels” with a Metallic Scrim ID# 2-P527497-1-00099.3219. Each panel measured 24 in. wide by 4 ft. long by 1 in. thick.

For each trial run, six 4 ft. panels were placed on the upper ledge of the flame spread tunnel, with the metallic scrim face oriented toward the flame, and butted together to form the required 24 ft. sample length. A layer of 6mm reinforced cement board was placed over top of the samples, the tunnel lid was lowered into place, and the samples were then tested in accordance with CAN/ULC S102-10.

4 Testing and Evaluation Methods

4.1. TEST STANDARD

The results of the tests are expressed by indexes, which compare the characteristics of the sample under tests relative to that of select grade red oak flooring and inorganic-cement board.

(A) Flame Spread Classification:

This index relates to the rate of progression of a flame along a sample in the 25 foot tunnel. A natural gas flame is applied to the front of the sample at the start of the test and drawn along the sample by a draft kept constant for the duration of the test. An observer notes the progression of the flame front relative to time.

The test apparatus is calibrated such that the flame front for red oak flooring passes out the end of the tunnel in five minutes, thirty seconds (plus or minus 15 seconds).

(B) Smoke Developed:

A photocell is used to measure the amount of light, which is obscured by the smoke passing down the tunnel duct. When the smoke from a burning sample obscures the light beam, the output from the photocell decreases. This decrease with time is recorded and compared to the results obtained for red oak, which is defined to be 100.

5 Testing and Evaluation Results

5.1. RESULTS AND OBSERVATIONS

(A) Flame Spread

The resultant flame spread classifications are as follows:
(Classification rounded to nearest 5)

1 in. Thick Vacuum Insulating Panels	Flame Spread	Flame Spread Classification
Run 1	15	15
Run 2	17	
Run 3	19	

(B) Smoke Developed

The areas beneath the smoke developed curve and the related classifications are as follows:
(Classification rounded to nearest 5)

1 in. Thick Vacuum Insulating Panels	Smoke Developed	Smoked Developed Classification
Run 1	7	15
Run 2	14	
Run 3	14	

(C) Observations

During the tests, surface ignition was noted between 12 and 14 seconds.

6 Conclusion

The 1 in. thick Dow Corning Vacuum Insulating Panels, submitted by Dow Corning Corporation, exhibited the following flame spread characteristics when tested in accordance CAN/ULC S102-10, *Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies*.

A series of three test runs of each material was conducted to conform to the requirements of the National Building Code of Canada.

Sample Material	Flame Spread Classification	Smoke Developed Classification
1 in. Thick Vacuum Insulating Panels	15	15

The conclusions of this test report may not be used as part of the requirements for Intertek product certification. Authority to Mark must be issued for a product to become certified.

INTERTEK TESTING SERVICES NA LTD.

Reported by: ______________________
Greg Philp
Technician – Building Products

Reviewed by: ______________________
Scott Leduc, EIT
Test Engineer - Building Products

APPENDIX A

DATA SHEETS

CAN/ULC S102-10 DATA SHEETS
Run 1

Standard: ULC S102

Page 1 of 2

Client: Dow Corning
Date: 06 07 2013
Project Number:
Test Number: 1
Operator: Greg Philp

Specimen ID: 1 in thck VIP Panels ID 2- P527497-1-00099.3219

TEST RESULTS

FLAMESPREAD INDEX: 15

SMOKE DEVELOPED INDEX: 5

SPECIMEN DATA . . .

Time to Ignition (sec): 12
Time to Max FS (sec): 379
Maximum FS (mm): 838.7
Time to 527 C (sec): Never Reached
Time to End of Tunnel (sec): Never Reached
Max Temperature (C): 310
Time to Max Temperature (sec): 573
Total Fuel Burned (cubic feet): 44.00

FS*Time Area (M*min): 8.1
Smoke Area (%A*min): 11.8
Unrounded FSI: 14.9
Unrounded SDI: 7.0

CALIBRATION DATA . . .

Time to Ignition of Last Red Oak (Sec): 44.0
Red Oak Smoke Area (%A*min): 168.3

Tested By: ______________

Reviewed By: ______________

CAN/ULC S102-10 DATA SHEETS
Run 1

Page 2 of 2

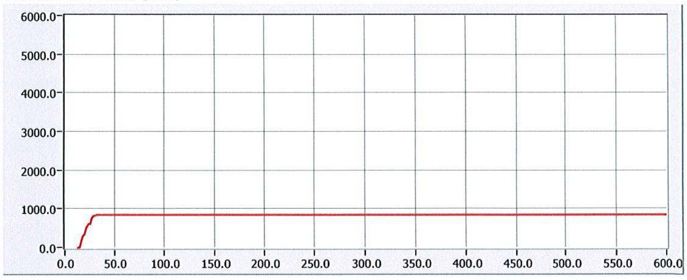
Client: Dow Corning

Specimen ID: 1 in thck VIP Panels ID 2- P527497-1-

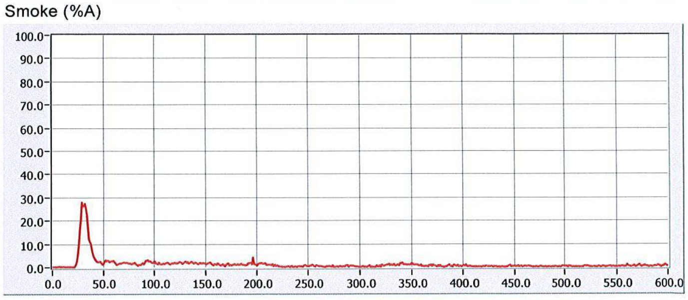
Test No.: 1

Standard: ULC S102

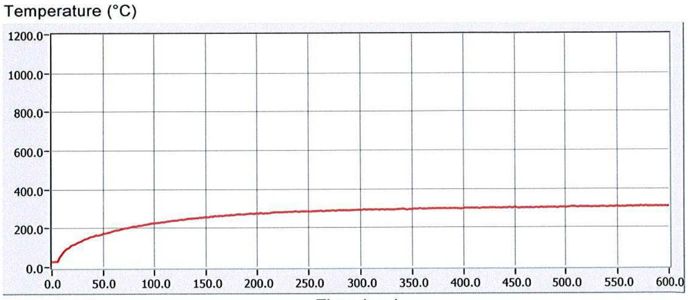
FLAME SPREAD (MM)



Smoke (%A)



Temperature (°C)



Time (sec)

600

Tested By: ____________

Reviewed By: ____________

CAN/ULC S102-10 DATA SHEETS
Run 2

Standard: ULC S102 Page 1 of 2

Client: Dow Corning
Date: 06 07 2013
Project Number:
Test Number: 2
Operator: Greg Philp

Specimen ID: 1 in thick VIP Panels ID 2-P527497-1-00099.3219

TEST RESULTS

FLAMESPREAD INDEX: 15

SMOKE DEVELOPED INDEX: 15

SPECIMEN DATA . . .

Time to Ignition (sec): 14
Time to Max FS (sec): 32
Maximum FS (mm): 925.5
Time to 527 C (sec): Never Reached
Time to End of Tunnel (sec): Never Reached
Max Temperature (C): 310
Time to Max Temperature (sec): 588
Total Fuel Burned (cubic feet): 44.00

FS*Time Area (M*min): 9.0
Smoke Area (%A*min): 22.9
Unrounded FSI: 16.6
Unrounded SDI: 13.6

CALIBRATION DATA . . .

Time to Ignition of Last Red Oak (Sec): 44.0
Red Oak Smoke Area (%A*min): 168.3

Tested By: ____________

Reviewed By: ____________

CAN/ULC S102-10 DATA SHEETS
Run 2

Page 2 of 2

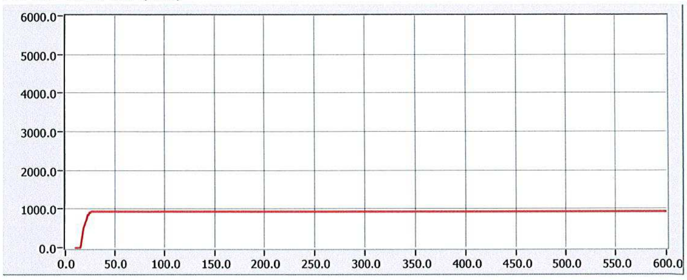
Client: Dow Corning

Specimen ID: 1 in thick VIP Panels ID 2-P527497-1-

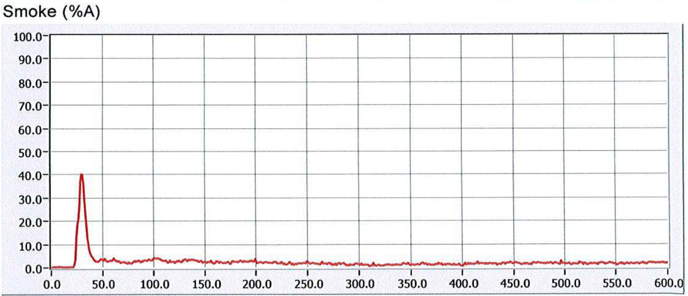
Test No.: 2

Standard: ULC S102

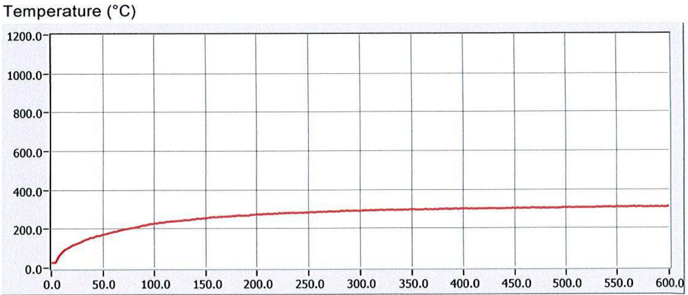
FLAME SPREAD (MM)



Smoke (%A)



Temperature (°C)



Time (sec)

600

Tested By: ____________

Reviewed By: ____________

CAN/ULC S102-10 DATA SHEETS
Run 3

Standard: ULC S102

Page 1 of 2

Client: Dow Corning
Date: 06 07 2013
Project Number:
Test Number: 3
Operator: Greg Philp

Specimen ID: 1 in thick VIP Panels ID 2-P527497-1-00099.3219

TEST RESULTS

FLAMESPREAD INDEX: 20

SMOKE DEVELOPED INDEX: 15

SPECIMEN DATA . . .

Time to Ignition (sec): 14
Time to Max FS (sec): 36
Maximum FS (mm): 1073.1
Time to 527 C (sec): Never Reached
Time to End of Tunnel (sec): Never Reached
Max Temperature (C): 293
Time to Max Temperature (sec): 595
Total Fuel Burned (cubic feet): 44.00

FS*Time Area (M*min): 10.4
Smoke Area (%A*min): 23.4
Unrounded FSI: 19.2
Unrounded SDI: 13.9

CALIBRATION DATA . . .

Time to Ignition of Last Red Oak (Sec): 44.0
Red Oak Smoke Area (%A*min): 168.3

Tested By: ____________

Reviewed By: ____________

CAN/ULC S102-10 DATA SHEETS
Run 3

Page 2 of 2

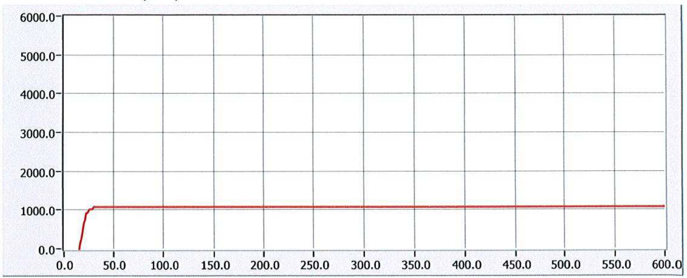
Client: Dow Corning

Specimen ID: 1 in thick VIP Panels ID 2-P527497-1-

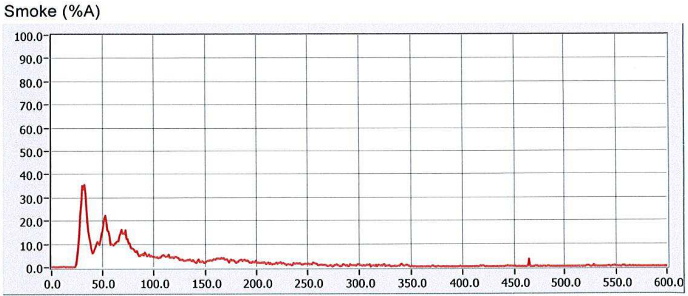
Test No.: 3

Standard: ULC S102

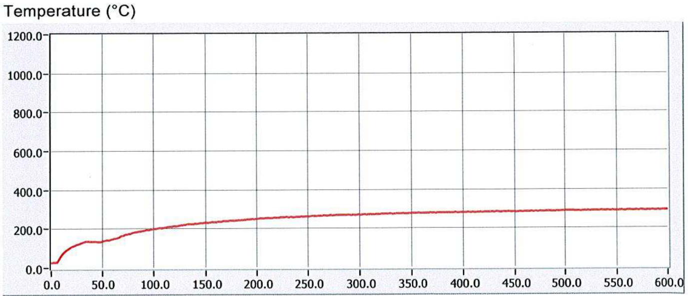
FLAME SPREAD (MM)



Smoke (%A)



Temperature (°C)



Time (sec)

600

Tested By: ____________

Reviewed By: ____________

REVISION SUMMARY

DATE	PAGE(S)	SUMMARY
June 10, 2013	All	Original Issue Date

OUTSULATION® H.E. SYSTEM™

An Exterior Wall Insulation and Finish System With Moisture Drainage Incorporating Vacuum Insulated Sandwich Elements (V.I.S.E.)

DS849

Outsulation H.E. Specifications

INTRODUCTION

This document contains the Manufacturer's Standard Specification for the Outsulation H.E. System. These specifications follow the Construction Specification Institute's 3-part format.

TAILORING THE DRYVIT MANUFACTURER'S SPECIFICATIONS TO YOUR PROJECT.

These specifications cover all the common ways of using the Outsulation H.E. System. Most projects use only a few of the possible combinations of these materials and methods. To tailor the specifications to your project, simply use those sections which apply. Also, it may be prudent to place certain parts of the Dryvit Outsulation H.E. Specification in other parts of the project's total specification, such as sealants and framing. The project design professionals are responsible for ensuring that the project specifications are suitable for the project. For assistance in preparing your specification, contact your Dryvit Distributor or Dryvit Systems, Inc.

UNITS

English Units are included in parentheses after the Standard International (SI) equivalents thus:

12.7 mm (1/2 in) 16 Kg/m^3 (1.0 pcf)

Please note that the conversions may not be exact but rather represent commonly used equivalents.

WARNING

The Outsulation H.E. System is designed as a drainage wall system and is detailed to discharge incidental moisture from within the System. Specifications should be followed and proper details adhered to, in order to prevent water intrusion, resulting in possible damage to the system or other building elements. Care should be taken to insure that all building envelope elements, including without limitations, roof designs, windows, flashings, sealants, etc., are compatible with this system.

DISCLAIMER

Information contained in this specification conforms to standard detail and product recommendations for the installation of the Dryvit Outsulation H.E. System products as of the date of publication of this document and is presented in good faith. Dryvit Systems, Inc. assumes no liability, expressed or implied, as to the architecture, engineering or workmanship of any project. To insure that you are using the latest, most complete information, visit our website at www.dryvit.com or contact Dryvit Systems, Inc., at

One Energy Way
West Warwick, RI 02893
(401) 822-4100
FAX: (401) 822-1980

* The Trained Contractor Certificate referenced in Section 1.06.A.2 and 1.06.A.4 indicates certain employees of the company have been instructed in the proper application of Dryvit products and have received copies of Dryvit's Application Instructions and Specifications. The Trained Contractor Program is not an apprenticeship or endorsement. Each trained contractor is an independent company experienced in the trade and bears responsibility for its own workmanship. Dryvit Systems, Inc. assumes no liability for the workmanship of a trained contractor.

DRYVIT SYSTEMS, INC.
MANUFACTURER'S SPECIFICATION
SECTION 07240
OUTSULATION® H.E. SYSTEM
EXTERIOR INSULATION AND FINISH SYSTEM CLASS PB

PART I GENERAL

1.01 SUMMARY

A. This document is to be used in preparing specifications for projects utilizing the Dryvit Outsulation H.E. System. For complete product description and usage refer to:
   1. Dryvit Outsulation H.E. System Data Sheet, DS848.
   2. Dryvit Outsulation H.E. System Application Instructions, DS850
   3. Dryvit Outsulation H.E. System Installation Details, DS851

B. Related Sections
   1. Unit Masonry – Section 04200
   2. Concrete – Sections 03300 and 03400
   3. Light Gauge Cold Formed Steel Framing – Section 05400
   4. Wood Framing – Section 06100
   5. Sealant – Section 07900
   6. Flashing – Section 07600

1.02 REFERENCES

A. Section Includes
   1. ASTM B 117 (Federal Test Standard 141A Method 6061) Standard Practice for Operating Salt Spray (Fog) Apparatus
   2. ASTM C 67 Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
   3. ASTM C 150 Standard Specification for Portland Cement
   4. ASTM C 177 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
   5 ASTM C 203 Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation
   6. ASTM C 272 Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions
   7. ASTM C 297 Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions
   8. ASTM C 303 Standard Test Method for Dimensions and Density of Performed Block and Board – Type Thermal Insulation
   9. ASTM C 518 Standard Test Method for Steady State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
   10. ASTM C 1177 Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
   11 ASTM C 1396 (formerly C 79) Standard Specification for Gypsum Board
   12. ASTM D 968 (Federal Test Standard 141A Method 6191) Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
   13. ASTM D 1621 Standard Test Method for Compressive Properties of Rigid Cellular Plastics
   14. ASTM D 1622 Standard Test Method for Apparent Density of Rigid Cellular Plastics
   15. ASTM D 1970 Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
   16. ASTM D 2247 (Federal Test Standard 141A Method 6201) Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity
   17. ASTM D 2863 Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
   18. ASTM D 2898 Standard Test Method for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
   19. ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
   20. ASTM D 4060 Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
   21. ASTM E 72 Standard Test Methods of Conducting Strength Tests of Panels for Building Construction
   22. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
   23. ASTM E 96 Standard Test Methods for Water Vapor Transmission of Materials
   24. ASTM E 119 Standard Method for Fire Tests of Building Construction and Materials

25. ASTM E 283 Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen
26. ASTM E 330 Test Method for Structural Performance of Exterior Windows, Doors and Curtain Walls by Uniform Static Air Pressure Difference
27. ASTM E 331 Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Uniform Static Air Pressure Difference
28. ASTM E 1233 Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Cyclic Air Pressure Differential
29. ASTM E 2098 Test Method for Determining the Tensile Breaking Strength of Glass Fiber Reinforcing Mesh for use in Class PB Exterior Insulation and Finish Systems (EIFS), after Exposure to Sodium Hydroxide Solution
30. ASTM E 2134 Test Method for Evaluating the Tensile-Adhesion Performance of Exterior Insulation and Finish Systems (EIFS)
31. ASTM E 2178 Standard Test Method for Air Permeance of Building Materials
32. ASTM E 2273 Test Method for Determining the Drainage Efficiency of Exterior Insulation and Finish Systems (EIFS) Clad Wall Assemblies
33. ASTM E 2357 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies
34. ASTM E 2430 Standard Specification for Expanded Polystyrene (EPS) Thermal Insulation Boards for use in Exterior Insulation and Finish Systems (EIFS)
35. ASTM E 2485 (formerly EIMA Std. 101.01) Standard Test Method for Freeze-Thaw Resistance of Exterior Insulation and Finish Systems (EIFS) and Water-Resistive Barrier Coatings
36. ASTM E 2486 (formerly EIMA Std. 101.86) Standard Test Method for Impact Resistance of Class PB and PI Exterior Insulation and Finish Systems (EIFS)
37. ASTM G 154 Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials
38. ASTM G 155 (Federal Test Standard 141A Method 6151) Standard Practice for Operating-Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials
39. DS131, Dryvit Expanded Polystyrene Insulation Board Specification
40. DS151, Custom Brick™ Polymer System Specifications for Use On Vertical Walls
41. DS152, Dryvit Cleaning and Recoating
42. DS153, Dryvit Expansion Joints and Sealants
43. DS159, Dryvit Water Vapor Transmission
44. DS456, Rapidry DM™ 35-50 or DS457, Rapidry DM™ 50-75 Data Sheets
45. DS494, Dryvit AquaFlash® System
46. DS704, Backstop® DMS
47. DS705, Reflectit™
48. AATCC Test Method 127 Water Resistance: Hydrostatic Pressure Test
49. ANSI FM 4880 Evaluating Insulated Wall or Wall and Roof/Ceiling Assemblies; Plastic Interior Finish Materials; Plastic Exterior Building Panels; Wall/Ceiling Coating Systems; Interior or Exterior Finish Systems
50. Mil Std E5272 Environmental Testing
51. Mil Std 810B Environmental Test Methods
52. NFPA 268 Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source.
53. NFPA 285 Standard Method of Test for the Evaluation of Flammability Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components Using the Intermediate-Scale, Multistory Test Apparatus

1.03 DEFINITIONS

A. Base Coat: Material used to encapsulate one or more layers of reinforcing mesh that is applied to the outside surface of the EPS.
B. Building Expansion Joint: A joint through the entire building structure designed to accommodate structural movement.
C. Contractor: The contractor that installs the Outsulation H.E. System to the substrate.
D. Dryvit: Dryvit Systems, Inc., the manufacturer of the Outsulation H.E. System, a Rhode Island corporation.
E. Encapsulated V.I.S.E.: Vacuum insulated sandwich elements encapsulated in expanded polystyrene (EPS) Insulation.
F. Expansion Joint: A structural discontinuity in the Outsulation H.E. System.
G. Finish: An acrylic-based coating, available in a variety of textures and colors that is applied over the base coat.
H. Panel Erector: The contractor who installs the panelized Outsulation H.E. System.

I. Panel Fabricator: The contractor who fabricates the panelized Outsulation H.E. System.
J. Reinforcing Mesh: Glass fiber mesh(es) used to reinforce the base coat and to provide impact resistance.
K. Sheathing: A substrate in sheet form.
L. Substrate: The material to which the Outsulation H.E. System is affixed.
M. Substrate System: The total wall assembly including the attached substrate to which the Outsulation H.E. System is affixed.

1.04 SYSTEM DESCRIPTION

A. General: The Dryvit Outsulation H.E. System is an Exterior Insulation and Finish System (EIFS), Class PB, consisting of an air/water-resistive barrier, an adhesive, vacuum insulated sandwich elements encapsulated in Type II expanded polystyrene insulation board, base coat, reinforcing mesh(es) and finish.
B. Methods of Installation:
   1. Field Applied: The Outsulation H.E. System is applied to the substrate system in place.
   2. Panelized: The Outsulation H.E. System is shop-applied to the prefabricated wall panels.
C. Design Requirements:
   1. Acceptable substrates for the Outsulation H.E. System shall be:
      a. Exterior grade gypsum sheathing meeting ASTM C 1396 (formerly C 79) requirements for water resistant core or Type X core at the time of application of the Outsulation H.E. System.
      b. Exterior sheathing having a water-resistant core with fiberglass mat facers meeting ASTM C 1177.
      c. Exterior fiber reinforced cement or calcium silicate boards.
      d. APA Exterior or Exposure 1 Rated Plywood, Grade C-D or better, nominal 12.7 mm (1/2 in) minimum 4-ply.
      e. Exterior grade fire retardant treated (FRT) plywood.
      f. APA Exposure 1 Rated Oriented Strand Board (OSB) nominal 11.1 mm (7/16 in) minimum
      g. Unglazed brick, cement plaster, concrete or masonry.
   2. Deflection of the substrate systems shall not exceed 1/240 times the span.
   3. The substrate shall be flat within 6.4 mm (1/4 in) in a 1.2 m (4 ft) radius.
   4. The slope of inclined surfaces shall not be less than 6:12, and the length shall not exceed 305 mm (12 in).
   5. All areas requiring an impact resistance classification higher than "standard", as defined by ASTM E 2486 (formerly EIMA Standard 101.86), shall be as detailed in the drawings and described in the contract documents. Refer to Section 1.04.D.1.d of this specification.
   6. Expansion Joints:
      a. Design and location of expansion joints in the Outsulation H.E. System is the responsibility of the project designer and shall be noted on the project drawings. As a minimum, expansion joints shall be placed at the following locations:
         1) Where expansion joints occur in the substrate system.
         2) Where building expansion joints occur.
         3) At floor lines in wood frame construction.
         4) At floor lines of non-wood framed buildings where significant movement is expected.
         5) Where the Outsulation H.E. System abuts dissimilar materials.
         6) Where the substrate type changes.
         7) Where prefabricated panels abut one another.
         8) In continuous elevations at intervals not exceeding 23 m (75 ft).
         9) Where significant structural movement occurs, such as changes in roof line, building shape or structural system.
   7. Terminations:
      a. Prior to applying the Dryvit Outsulation H.E. System, wall openings shall be treated with Dryvit AquaFlash System or Flashing Tape. Refer to Dryvit Outsulation H.E. Installation Details DS851.
      b. The Outsulation H.E. System shall be held back from adjoining materials around openings and penetrations such as windows, doors, and mechanical equipment a minimum of 19 mm (3/4 in) for sealant application. See Dryvit's Outsulation H.E. System Installation Details, DS851
      c. The system shall be terminated a minimum of 203 mm (8 in) above finished grade.
      d. Sealants
         1) Shall be manufactured and supplied by others.
         2) Shall be compatible with the Outsulation H.E. System materials. Refer to current Dryvit Publication DS153 for listing of sealants tested by sealant manufacturer for compatibility.
         3) The sealant backer rod shall be closed cell.
   8. Vapor Retarders: The use and location of vapor retarders within a wall assembly is the responsibility of the project designer and shall comply with local building code requirements. The type and location shall be noted on the project drawings and specifications. Vapor retarders may be inappropriate in certain

climates and can result in condensation within the wall assembly. Refer to Dryvit Publication DS159 for additional information.

9. Dark Colors: The use of dark colors must be considered in relation to wall surface temperature as a function of local climatic conditions. Use of dark colors in high temperature climates can affect the performance of the system.
10. Flashing: Shall be provided at all roof-wall intersections, windows, doors, chimneys, decks, balconies and other areas as necessary to prevent water from entering behind the Outsulation H.E. System.

D. Performance Requirements:

1. The Outsulation H.E. System shall have been tested as follows:

a. Air/Water-Resistive Barrier Coating

TEST	TEST METHOD	CRITERIA	RESULTS
Tensile Bond	ASTM C 297/E 2134 ICC ES (AC 212)*	Minimum 104 kPa (15 psi)	Substrate: Minimum 131 kPa (19 psi) (Backstop NT) Minimum 166 kPa (24.1 psi) (Backstop DMS) Flashing Minimum 2970 kPa (431 psi) (Backstop NT) Minimum 967 kPa (140 psi) (Backstop DMS)
Freeze-thaw	ASTM E 2485/ICC-ES Proc. ICC ES (AC 212)*	No deleterious effects after 10 cycles	Passed - No deleterious effects after 10 cycles
Water Resistance	ASTM D 2247 ICC ES (AC 212)*	No deleterious effects after 14 days exposure[1]	No deleterious effects after 14 days exposure
Water Vapor Transmission	ASTM E 96 Proc. B ICC ES (AC 212)*	Vapor Permeable	7 perms (Backstop NT)[2] 30 perms (Backstop DMS)
Nail Sealability	ASTM D 1970	No ICC or ANSI/EIMA Criteria	Passes AABA Criteria (Backstop NT)
Air Leakage	ASTM E 283	No ICC or ANSI/EIMA Criteria	0.01 l/sec/m^2 (0.002 cfm/ft^2) (Backstop NT)
Air Permeance	ASTM E 2178	No ICC or ANSI/EIMA Criteria	0.0006 l/s/m^2 @ 75Pa ($1.2x10^{-4}$ cfm/ft^2 @ 1.6 psf) (Backstop NT)
Air Barrier Assembly	ASTM E 2357	No ICC or ANSI/EIMA Criteria	0.05 l/sec m^2 @300 Pa (<0.001 cfm/ft^2 @ 6.24 psf) (Backstop NT)
Structural Performance	ASTM E 1233 Proc. A ICC ES (AC 212)*	Minimum 10 positive cycles at 1/240 deflection; No cracking in field, at joints or interface with flashing	Passed
Racking	ASTM E 72 ICC ES (AC 212)*	No cracking in field, at joints or interface with flashing at net deflection of 3.2 mm (1/8 inch)	Passed
Restrained Environmental	ICC-ES Procedure ICC ES (AC 212)*	5 cycles; No cracking in field, at joints or interface with flashing	Passed
Water Penetration	ASTM E331 ICC ES (AC 212)*	No water penetration beyond the inner-most plane of the wall after 15 minutes at 137 Pa (2.86 psf)	Passed
Weathering **UV Exposure** **Accelerated Aging** **Hydrostatic Pressure Test**	 ICC ES Proc. ICC ES (AC212)* ICC ES Proc. ICC ES (AC212)* AATCC 127 ICC ES (AC212)*	 210 hours of exposure 25 cycles of wetting and drying ICC: 549 mm (21.6 in) water column for 5 hours	 Passed Passed Passed
Surface Burning Characteristics	ASTM E 84	Flame Spread < 25 Smoke Developed < 450	Passed

* (AC212 – Acceptance Criteria for Water-Resistive Coatings Used as Water-Resistive Barriers over Exterior Sheathing, also referred to as ASTM E 2570
1. No cracking, checking, rusting, crazing, erosion, blistering, peeling, or delamination when viewed under 5x magnification
2. Defined as a Class III vapor retarder per the 2009 IBC and IRC

b. Durability

TEST	TEST METHOD	CRITERIA	RESULTS
Abrasion Resistance	ASTM D 968	No deleterious effects after 500 liters (528 quarts)	No deleterious effects after 1000 liters (1056 quarts)
Accelerated Weathering	ASTM G 155 Cycle 1	No deleterious effects after 2000 hours	No deleterious effects after 5000 hours
	ASTM G 154 Cycle 1 (QUV)		No deleterious effects after 5000 hours
Freeze-Thaw	ASTM E 2485 (formerly EIMA 101.01)	No deleterious effects after 60 cycles	Passed - No deleterious effects after 90 cycles
	ASTM C 67 modified	No deleterious effects after 60 cycles	Passed - No deleterious effects after 60 cycles
	ASTM E 2485/ICC-ES Proc. ICC ES (AC235)***	No deleterious effects after 10 cycles	Passed - No deleterious effects after 10 cycles
Mildew Resistance	ASTM D 3273	No growth during 28 day exposure period	No growth during 60 day exposure period
Water Resistance	ASTM D 2247	No deleterious effects after 14 days exposure	No deleterious effects after 42 days exposure
Taber Abrasion	ASTM D 4060	N/A	Passed 1000 cycles
Salt Spray Resistance	ASTM B 117	No deleterious effects after 300 hours exposure	No deleterious effects after 1000 hours exposure
Water Penetration	ASTM E 331 ICC ES (AC 235)***	No water penetration beyond the inner-most plane of the wall after 15 minutes at 137 Pa(2.86 psf)	Passed 15 minutes at 137 Pa (2.86 psf)
Water Vapor Transmission	ASTM E 96 Procedure B	Vapor permeable	Base Coat* 40 Perms Finish** 40 Perms
Drainage Efficiency	ASTM E 2273 ICC ES (AC 235)***	Minimum Drainage Efficiency of 90%	Passed

* Base Coat perm value based on Dryvit Genesis®
** Finish perm value based on Dryvit Quarzputz
*** AC 235 – Acceptance Criteria for EIFS Clad Drainage Wall Assemblies

c. Structural

TEST	TEST METHOD	CRITERIA	RESULTS
Tensile Bond	ASTM C 297/E 2134	Minimum 104 kPa (15 psi) – substrate or insulation failure	Minimum 213.6 kPa (31 psi)
Transverse Wind Load	ASTM E 330	Withstand positive and negative wind loads as specified by the building code	Minimum 4.79 kPa (100 psf)***** 16 inch o.c. framing, ½ in sheathing screw attached at 152 mm (6 inch) o.c.

* All Dryvit components remain intact – for higher wind loads contact Dryvit Systems, Inc.

d. Impact Resistance: In accordance with ASTM E 2486 (formerly EIMA Standard 101.86):

Reinforcing Mesh[1]/Weight g/m² (oz/yd²)	Minimum Tensile Strengths	EIMA Impact Classification	EIMA Impact Range Joules	(in-lbs)	Impact Test Results Joules (in-lbs)	
Standard - 146 (4.3)	27 g/cm (150 lbs/in)	Standard	3-6	(25-49)	4	(36)
Standard Plus™ - 203 (6)	36 g/cm (200 lbs/in).	Medium	6-10	(50-89)	6	(56)
Intermediateâ - 407 (12)	54 g/cm (300 lbs/in).	High	10-17	(90-150)	12	(108)
Panzer® 15* - 509 (15)	71 g/cm (400 lbs/in).	Ultra High	>17	(>150)	18	(162)
Panzer 20* - 695 (20.5)	98 g/cm (550 lbs/in).	Ultra High	>17	(>150)	40	(352)
Detailâ Short Rolls - 146 (4.3)	27 g/cm (150 lbs/in).	n/a	n/a	n/a	n/a	n/a
Corner Mesh™ - 244 (7.2)	49 g/cm (274 lbs/in).	n/a	n/a	n/a	n/a	n/a

*Shall be used in conjunction with Standard Mesh (recommended for areas exposed to high traffic).
1. It shall be colored blue for product identification bearing the Dryvit logo.

e. Fire performance

TEST	TEST METHOD	CRITERIA	RESULTS
Fire Resistance	ASTM E 119	No effect on the fire resistance of a rated wall assembly	Passed 1 hour
Ignitability	NFPA 268	No ignition at 12.5 kw/m^2 at 20 minutes	Passed
Intermediate Multi-Story Fire Test	NFPA 285 (UBC 26-9)	1. Resist flame propagation over the exterior surface 2. Resist vertical spread of flame within combustible core/component of panel from one story to the next 3. Resist vertical spread of flame over the interior surface from one story to the next 4. Resist lateral spread of flame from the compartment of fire origin to adjacent spaces	Passed

2. The Outsulation H.E. components shall be tested for:
   a. Fire

TEST	TEST METHOD	CRITERIA	RESULTS
Surface Burning Characteristics	ASTM E 84	All components shall have a: Flame Spread $\leq$ 25 Smoke Developed $\leq$ 450	Passed

b. Durability

TEST	TEST METHOD	CRITERIA	RESULTS
Reinforcing Mesh			
Alkali Resistance of Reinforcing Mesh	ASTM E 2098 (formerly EIMA 105.01)	> 21dN/cm (120 pli) retained tensile strength after exposure	Passed
EPS (Physical Properties)			
Density	ASTM C 303, D 1622	22kg/m^3 (1.35 lb/ft^3)	Pass
Thermal Resistance	ASTM C 177, C 518	4.0 @ 23.9 °C (75 °F)/25.4 mm (1 in)	Pass
Water Absorption	ASTM C 272	3.0 % max. by volume	Pass
Oxygen Index	ASTM D 2863	24% min. by volume	Pass
Compressive Strength	ASTM D 1621 Proc. A	104 kPa (15 psi) min.	Pass
Flexural Strength	ASTM C 203	240 kPa (35 psi) min.	Pass
Flame Spread	ASTM E 84	25 max.	Pass
Smoke Developed		450 max.	Pass
Vacuum Insulated Sandwich Elements Thermal Resistance	ASTM C 177, C 518	39 @ 23.9 °C (75 °F)/25.4 mm (1 in)	Pass

1.05 SUBMITTALS

A. Product Data: The contractor shall submit to the owner/architect the manufacturer's product data sheets describing products, which will be used on this project.

B. Shop Drawings: The contractor/panel fabricator shall prepare and submit to the owner/architect complete drawings showing: wall layout for the V.I.S.E. panels including Type II EPS fillers, connections, details, expansion joints, and installation sequence.

C. Samples: The contractor shall submit to the owner/architect two (2) samples of the Outsulation H.E. System for each finish, texture and color to be used on the project. The same tools and techniques proposed for the actual installation shall be used. Samples shall be of sufficient size to accurately represent each color and texture being utilized on the project.

D. Test Reports: When requested, the contractor shall submit to the owner/architect copies of selected test reports verifying the performance of the Outsulation H.E. System.

1.06 QUALITY ASSURANCE

A. Qualifications
1. System Manufacturer: Shall be Dryvit Systems, Inc. All materials shall be manufactured or sold by Dryvit and shall be purchased from Dryvit or its authorized distributors.
   a. Materials shall be manufactured at a facility covered by a current ISO 9001:2008 and ISO 14001:2004 certification. Certification of the facility shall be done by a registrar accredited by the American National Standards Institute, Registrar Accreditation Board (ANSI-RAB).
2. Contractor: Shall be knowledgeable in the proper installation of the Dryvit Outsulation H.E. System and shall be experienced and competent in the installation of Exterior Insulation and Finish Systems. Additionally, the contractor shall possess a current Outsulation H.E. System Trained Contractor Certificate* issued by Dryvit Systems, Inc.
3. Insulation Board Manufacturer: Shall be listed by Dryvit Systems, Inc. and shall subscribe to the Dryvit Third Party Certification and Quality Assurance Program.
4. Panel Fabricator: Shall be a contractor experienced and competent in the fabrication of architectural wall panels and shall possess a current Outsulation H.E. System Trained Contractor Certificate* issued by Dryvit Systems, Inc.
5. Panel Erector: Shall be experienced and competent in the installation of architectural wall panel systems and shall be:
   a. The panel fabricator or
   b. An erector approved by the panel fabricator or
   c. An erector under the direct supervision of the panel fabricator

B. Regulatory Requirements:
1. The EPS shall be separated from the interior of the building by a minimum 15-minute thermal barrier.
2. The use and maximum thickness of EPS shall be in accordance with the applicable building code(s).

C. Certification
1. The Outsulation H.E. System shall be recognized for the intended use by the applicable building code(s).

D. Mock-Up
1. The contractor shall, before the project commences, provide the owner/architect with a mock-up for approval.
2. The mock-up shall be of suitable size as required to accurately represent the products being installed, as well as each color and texture to be utilized on the project.
3. The mock-up shall be prepared with the same products, tools, equipment and techniques required for the actual applications. The finish used shall be from the same batch that is being used on the project.
4. The approved mock-up shall be available and maintained at the jobsite.
5. For panelized construction, the mock-up shall be available and maintained at the panel fabrication location.

1.07 DELIVERY, STORAGE AND HANDLING

A. All Dryvit materials shall be delivered to the job site in the original, unopened packages with labels intact.

B. Upon arrival, materials shall be inspected for physical damage, freezing or overheating. Questionable materials shall not be used.
1. Materials shall be stored at the jobsite in a cool, dry location, out of direct sunlight, protected from weather and other sources of damage. Minimum storage temperature shall be as follows:
   a. Demandit®, and Revyvit®: 7 °C (45 °F)
   b. Ameristone™, TerraNeo®, Lymestone™, and Reflectit: 10 °C (50 °F)
   c. DPR, PMR™ and E™ Finishes, Color Prime™, Primus®, Genesis® and NCB™: 4 °C (40 °F)
   d. Custom Brick™ Finish: refer to Custom Brick Polymer Specification, DS151.
   e. For other products, refer to specific product data sheets.
2. Maximum storage temperature shall not exceed 38 °C (100 °F). **NOTE: Minimize exposure of materials to temperatures over 32 °C (90 °F). Finishes exposed to temperatures over 43 °C (110 °F) for even short periods may exhibit skinning, increased viscosity and should be inspected prior to use.**

C. Protect all products from inclement weather and direct sunlight.

1.08 PROJECT CONDITIONS

A. Environmental Requirements
1. Application of wet materials shall not take place during inclement weather unless appropriate protection is provided. Protect materials from inclement weather until they are completely dry.
2. At the time of application, the minimum air and wall surface temperatures shall be as follows:
   a. Demandit®, and Revyvit®: 7 °C (45 °F)
   b. Ameristone™, TerraNeo®, Lymestone™, and Reflectit: 10 °C (50 °F)

c. DPR, PMR and E Finishes, Color Prime, Primus Genesis and NCB: 4 °C (40 °F)
d. Custom Brick Finish: refer to Custom Brick Polymer Specification, DS151.
e. For other products, refer to specific product data sheets.
3. These temperatures shall be maintained with adequate air ventilation and circulation for a minimum of 24 hours (48 hours for Ameristone, TerraNeo and Lymestone) thereafter, or until the products are completely dry. Refer to published product data sheets for more specific information.

B. Existing Conditions: The contractor shall have access to electric power, clean water and a clean work area at the location where the Dryvit materials are to be applied.

1.09 SEQUENCING AND SCHEDULING

A. Installation of the Outsulation H.E. System shall be coordinated with other construction trades.
B. Sufficient manpower and equipment shall be employed to ensure a continuous operation, free of cold joints, scaffold lines, texture variations, etc.

1.10 WARRANTY

A. Dryvit Systems, Inc. shall provide a written moisture drainage and limited materials warranty against defective material upon written request. Dryvit shall make no other warranties, expressed or implied. Dryvit does not warrant workmanship. Full details are available from Dryvit Systems, Inc.
B. The applicator shall warrant workmanship separately. Dryvit shall not be responsible for workmanship associated with installation of the Outsulation H.E. System.

1.11 DESIGN RESPONSIBILITY

A. It is the responsibility of both the specifier and the purchaser to determine if a product is suitable for its intended use. The designer selected by the purchaser shall be responsible for all decisions pertaining to design, detail, structural capability, attachment details, shop drawings and the like. Dryvit has prepared guidelines in the form of specifications, installation details, and product sheets to facilitate the design process only. Dryvit is not liable for any errors or omissions in design, detail, structural capability, attachment details, shop drawings, or the like, whether based upon the information prepared by Dryvit or otherwise, or for any changes which purchasers, specifiers, designers, or their appointed representatives may make to Dryvit's published comments.

1.12 MAINTENANCE

A. Maintenance and repair shall follow the procedures noted in the Dryvit Outsulation H.E. System Application Instructions, DS850.
B. All Dryvit products are designed to require minimal maintenance. However, as with all building products, depending on location, some cleaning may be required. See Dryvit publication DS152 on Cleaning and Recoating.
C. Sealants and Flashings shall be inspected on a regular basis and repairs made as necessary.

PART II PRODUCTS

2.01 MANUFACTURER

A. All components of the Outsulation H.E. System shall be supplied or obtained from Dryvit or its authorized distributors. Substitutions or additions of materials other than specified will void the warranty.

2.02 MATERIALS

A. Portland Cement: Shall be Type I or II, meeting ASTM C 150, white or gray in color, fresh and free of lumps.
B. Water: Shall be clean and free of foreign matter.

2.03 COMPONENTS

A. Air/Water-Resistive Barrier Components:
1. Dryvit Backstop® NT: A flexible, polymer-based noncementitious water-resistive coating and air barrier available in Texture, Smooth or Spray.
2. Dryvit Grid Tape™: An open weave fiberglass mesh tape with pressure sensitive adhesive available in rolls 102 mm (4 in) wide by 91 m (100 yds) long.
3. Dryvit Backstop DMS: A sprayable single step water-resistive membrane/air barrier and adhesive. **NOTE: Backstop DMS is not approved for use over wood based substrates.**

B. Flashing Materials: Used to protect substrate edges at terminations.
1. Liquid Applied: An extremely flexible water-based polymer material, ready for use.
a. Shall be AquaFlash and AquaFlash Mesh

2. Sheet Type:
   a. Shall be Flashing Tape and Surface Conditioner
      1) Dryvit Flashing Tape™: A high density polyethylene film backed with a rubberized asphalt adhesive available in rolls 102 mm (4 in), 152 mm (6 in) and 229 mm (9 in) wide by 23 m (75 ft) long.
      2) Dryvit Flashing Tape Surface Conditioner™: A water-based surface conditioner and adhesion promoter for the Dryvit Flashing Tape.

C. Dryvit AP Adhesive™: A moisture cure, urethane-based adhesive used to adhere the Dryvit Drainage Strip and Drainage Track.

D. Drainage Track: UV treated PVC "J" channel perforated with weep holes, complying with ASTM D 1784 and ASTM C 1063. Drainage track usage is limited to the base of the system at finished grade level. All other horizontal terminations shall utilize the Dryvit Drainage Strip as shown in Outsulation H.E. Installation Details, DS851. Shall be one of the following:
   1. Starter Trac STWP – without drip edge by Plastic Components, Inc.
   2. Starter Trac STDE – with drip edge by Plastic Components, Inc.
   3. Universal Starter Track by Wind-lock Corporation
   4. Sloped Starter Strip with Drip by Vinyl Corp.

E. Dryvit Drainage Strip™: A corrugated plastic sheet material, which provides drainage.

F. Adhesives: Used to adhere the EPS to the air/water-resistive barrier, shall be compatible with the water-resistive barrier and the EPS.
   1. Cementitious: A liquid polymer-based material, which is field mixed with Portland cement.
      a. Shall be Primus, or Genesis®
   2. Ready mixed: A dry blend cementitious, copolymer-based product, field mixed with water.
      a. Shall be Primus® DM, Genesis® DM, Genesis® DMS, Rapidry DM 35-50 or Rapidry DM 50-75

G. Insulation Board: Type II Expanded Polystyrene complying with ASTM C 578.
   1. Insulation boards consist of trays and lids
      a. Thickness of trays shall be minimum 12.7 mm (1/2 in)
      b. Thickness of lids shall be minimum of 25 mm (1 in) and a maximum 44 mm (1 3/4 in)
   2. The insulation board shall be manufactured by a board supplier listed by Dryvit Systems, Inc.

H. Encapsulated Vacuum Insulated Sandwich Element V.I.S.E.
   1. Composite panels are assembled at an approved assembler that subscribes to a third party quality assurance program. The V.I.S.E. panels are available in the following sizes:
      a. 600 mm x 1200 mm (24 in x 48 in)
      b. 600 mm x 1050 mm (24 in x 42 in)
      c. 600 mm x 900 mm (24 in x 36 in)
      d. 600 mm x 750 mm (24 in x 30 in)
      e. 600 mm x 600 mm (24 in x 24 in)
      f. 600 mm x 450 mm (24 in x 18 in)
      g. 600 mm x 300 mm (24 in x 12 in)
      h. 300 mm x 300 mm (12 in x 12 in)
      i. 600 mm x 600 mm (24 in x 24 in) “L” Shape

I. Base Coat: Shall be compatible with the EPS insulation board and reinforcing mesh(es).
   1. Cementitious: A liquid polymer-based material, which is field mixed with Portland cement.
      a. Shall be Primus or Genesis
   2. Noncementitious: A factory-mixed, fully formulated, water-based product.
      a. Shall be NCB
   3. Ready mixed: A dry blend cementitious, copolymer-based product, field mixed with water.
      a. Shall be Primus DM, Genesis DM, Genesis DMS, Rapidry DM 35-50 or Rapidry DM 50-75.

J. Reinforcing Mesh: A balanced, open weave, glass fiber fabric treated for compatibility with other system materials. **NOTE: Reinforcing meshes are classified by impact resistance and specified by weight and tensile strength as listed in Section 1.04.D.1.d.**
   1. Shall be Standard, Standard Plus, Intermediate, Panzer 15, Panzer 20, Detail and Corner Mesh
   2. Shall be colored blue for product identification bearing the Dryvit logo.

K. Finish: Shall be the type, color and texture as selected by the architect/owner and shall be one or more of the following:

1. Standard DPR (Dirt Pickup Resistance): Water-based, acrylic coating with integral color and texture and formulated with DPR chemistry:
   a. Quarzputz® DPR: Open-texture
   b. Sandblast® DPR: Medium texture
   c. Freestyle® DPR: Fine texture
   d. Sandpebble® DPR: Pebble texture
   e. Sandpebble® Fine DPR: Fine pebble texture
2. E: Water-based, lightweight acrylic coating with integral color and texture and formulated with DPR chemistry:
   a. Quarzputz® E
   b. Sandpebble® E
   c. Sandpebble® Fine E
3. Specialty: Factory mixed, water-based acrylic:
   a. Ameristone: Multi-colored quartz aggregate with a flamed granite appearance.
   b. Stone Mist®: Ceramically colored quartz aggregate.
   c. Custom Brick: Acrylic polymer-based finish used in conjunction with a proprietary template system to create the look of stone, brick, slate or tile.
   d. TerraNeo: 100% acrylic-based finish with large mica chips and multi-colored quartz aggregates.
   e. Lymestone: A premixed, 100% acrylic-based finish designed to replicate the appearance of limestone blocks.
   f. Reflectit: 100% acrylic coating providing a pearlescent appearance.
4. Elastomeric DPR (Dirt Pickup Resistance): Water- based, elastomeric acrylic coating with integral color and texture and formulated with DPR chemistry:
   a. Weatherlastic® Quarzputz
   b. Weatherlastic® Sandpebble
   c. Weatherlastic® Sandpebble Fine
   d. Weatherlastic® Adobe
5. Medallion Series PMR™ (Proven Mildew Resistance): Water-based, acrylic coating with integral color and texture and formulated with PMR chemistry:
   a. Quarzputz® PMR
   b. Sandblast® PMR
   c. Freestyle® PMR
   d. Sandpebble® PMR
   e. Sandpebble® Fine PMR
6. Coatings, Primers and Sealers:
   a. Demandit
   b. Weatherlastic® Smooth
   c. Tuscan Glaze™
   d. Revyvit
   e. Color Prime
   f. Prymit®
   g. SealClear™

PART III EXECUTION

3.01 EXAMINATION

A. Prior to installation of the Outsulation H.E. System, the contractor shall verify that the substrate:

1. Is of a type listed in Section 1.04.C.1.
2. Is flat within 6.4 mm (1/4 in) in a 1.2 m (4 ft) radius.
3. Is sound, dry, connections are tight; has no surface voids, projections, or other conditions that may interfere with the Outsulation H.E. System installation or performance.

B. Prior to installation of the Outsulation H.E. System, the architect or general contractor shall insure that all needed flashings and other waterproofing details have been completed, if such completion is required prior to the Outsulation H.E. application. Additionally the Contractor shall ensure that:

1. Metal roof flashing has been installed in accordance with Asphalt Roofing Manufacturers Association (ARMA) Standards.

2. Openings are flashed in accordance with the Outsulation H.E. System Installation Details, DS851, or as otherwise necessary to prevent water penetration.
3. Chimneys, Balconies and Decks have been properly flashed.
4. Windows, Doors, etc. are installed and flashed per manufacturer's requirements and the Outsulation H.E. System Installation Details, DS851.

C. Prior to the installation of the Outsulation H.E. System, the contractor shall notify the general contractor, and/or architect, and/or owner of all discrepancies.

3.02 PREPARATION

A. The Outsulation H.E. materials shall be protected by permanent or temporary means from inclement weather and other sources of damage prior to, during, and following application until completely dry.
B. Protect adjoining work and property during Outsulation H.E. installation.
C. The substrate shall be prepared as to be free of foreign materials, such as oil, dust, dirt, form-release agents, efflorescence, paint, wax, water repellants, moisture, frost, and any other condition that may inhibit adhesion.

3.03 INSTALLATION

A. The system shall be installed in accordance with the Dryvit Outsulation H.E. System Application Instructions, DS850.
B. The overall minimum base coat thickness shall be sufficient to fully embed the mesh. The recommended method is to apply the base coat in two (2) passes.
C. Sealant shall not be applied directly to textured finishes or base coat surfaces. Dryvit Outsulation H.E. System surfaces in contact with sealant shall be coated with Demandit or Color Prime.
D. High impact meshes shall be installed as specified at ground level, high traffic areas and other areas exposed to or susceptible to impact damage.

3.04 FIELD QUALITY CONTROL

A. The contractor shall be responsible for the proper application of the Outsulation H.E. materials.
B. Dryvit assumes no responsibility for on-site inspections or application of its products.
C. If required, the contractor shall certify in writing the quality of work performed relative to the substrate system, details, installation procedures, workmanship and as to the specific products used.
D. If required, the EPS supplier shall certify in writing that the EPS meets Dryvit's specifications.
E. If required, the sealant contractor shall certify in writing that the sealant application is in accordance with the sealant manufacturer's and Dryvit's recommendations.

3.05 CLEANING

A. All excess Outsulation H.E. System materials shall be removed from the job site by the contractor in accordance with contract provisions and as required by applicable law.
B. All surrounding areas, where the Dryvit Outsulation H.E. System has been applied, shall be left free of debris and foreign substances resulting from the contractor’s work.

3.06 PROTECTION

A. The Outsulation H.E. System shall be protected from inclement weather and other sources of damage until dry and permanent protection in the form of flashings, sealants, etc. are installed.

Dryvit Systems, Inc.
One Energy Way
West Warwick, RI 02893
800-556-7752
www.dryvit.com

For more information on Dryvit Systems or Continuous Insulation, visit these links.

Outsulation® H.E. System®

DS851

Outsulation H.E. System
Installation Details

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NOTE

DRYVIT MAKES NO REPRESENTATION REGARDING CONFORMITY OF ITS SUGGESTIONS TO MODEL BUILDING CODES, ENGINEERING CRITERIA, SPECIFIC APPLICATIONS OR PROJECT LOCATIONS. ALL COMPONENTS INDICATED IN ILLUSTRATIONS, AS WELL AS OTHERS THAT MAY BE REQUIRED FOR THE INTEGRITY OF THE SYSTEM SHALL BE DESIGNED, DETAILED AND ENGINEERED BY REPRESENTATIVES OF THE ARCHITECT, OWNER OR CONTRACTOR TO BE IN CONFORMANCE WITH MODEL CODES, ARCHITECTURAL AND ENGINEERING REQUIREMENTS PERTAINING TO SPECIFIC BUILDING PROJECTS.

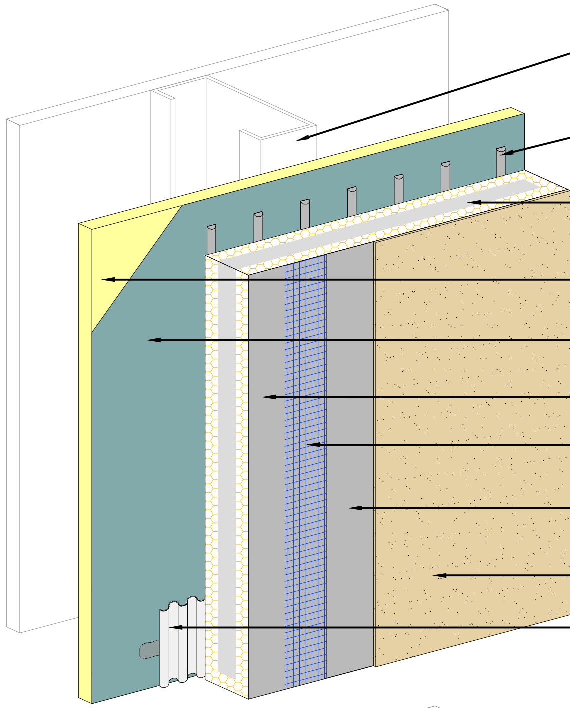
DRYVIT MAKES NO WARRANTY, EXPRESSED OR IMPLIED, AS TO THE ARCHITECTURAL DESIGN, ENGINEERING, OR WORKMANSHIP OF PROJECTS UTILIZING DRYVIT SYSTEMS OR PRODUCTS.

THE LIABILITIES OF DRYVIT SHALL BE AS STATED IN THE OUTSULATION HE LIMITED COMMERCIAL WARRANTY. CONTACT DRYVIT FOR A FULL AND COMPLETE COPY OF THE OUTSULATION H.E. WARRANTY.

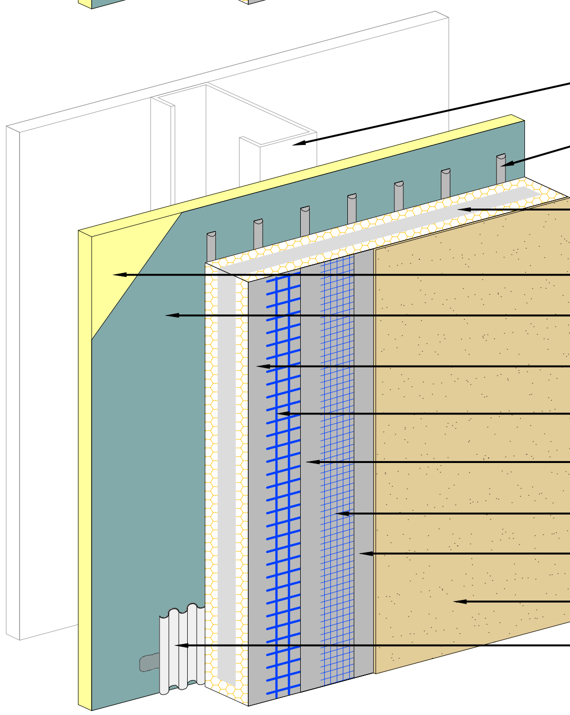
dryvit®

Issued: 08/2013

NORMAL IMPACT



HIGH IMPACT



Outsulation® H.E. System®

Outsulation H.E. System

NOTES:
1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

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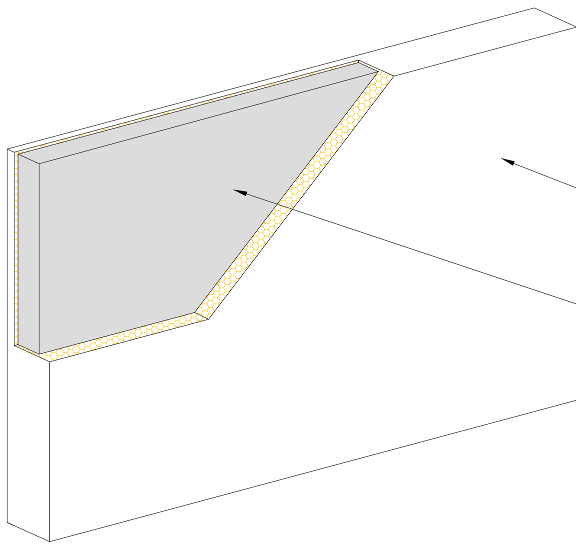

Outsulation® H.E. System®

Encapsulated Vacuum Insulated Sandwich Element

NOTES:
1. REFER TO PRODUCT DATA SHEET FOR AVAILABLE SIZES.

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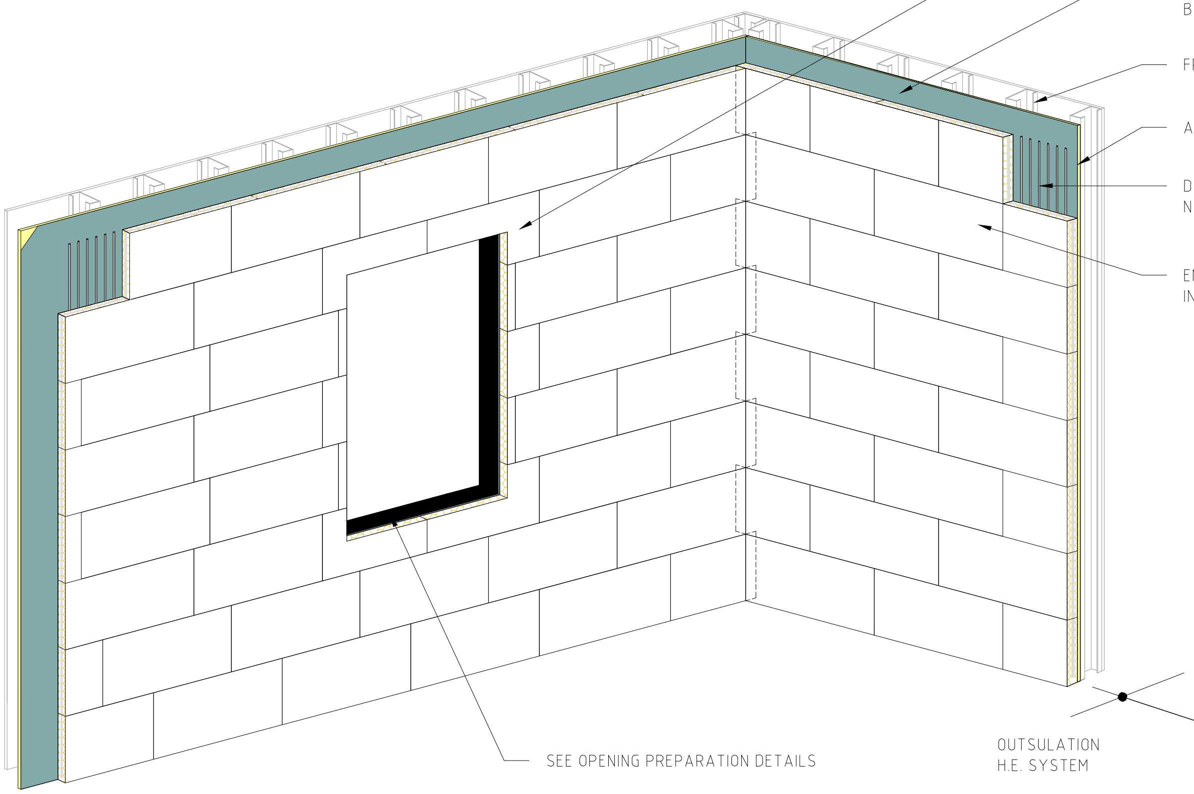
OHE 0.0.03



Outsulation® H.E. System®

Wall System Layout

The architecture, engineering, and design of the project using the Dryvit products is the responsibility of the project's design professional. All systems must comply with local building codes and standards. This detail is for general information and guidance only and Dryvit specifically disclaims any liability for the use of this detail and for the architecture, design, engineering or workmanship of any project. The project design professional determines, in its sole discretion, whether this detail or a functionally equivalent detail does not violate Dryvit's warranty. This detail is subject to change without notice. Contact Dryvit to insure you have the most recent version.

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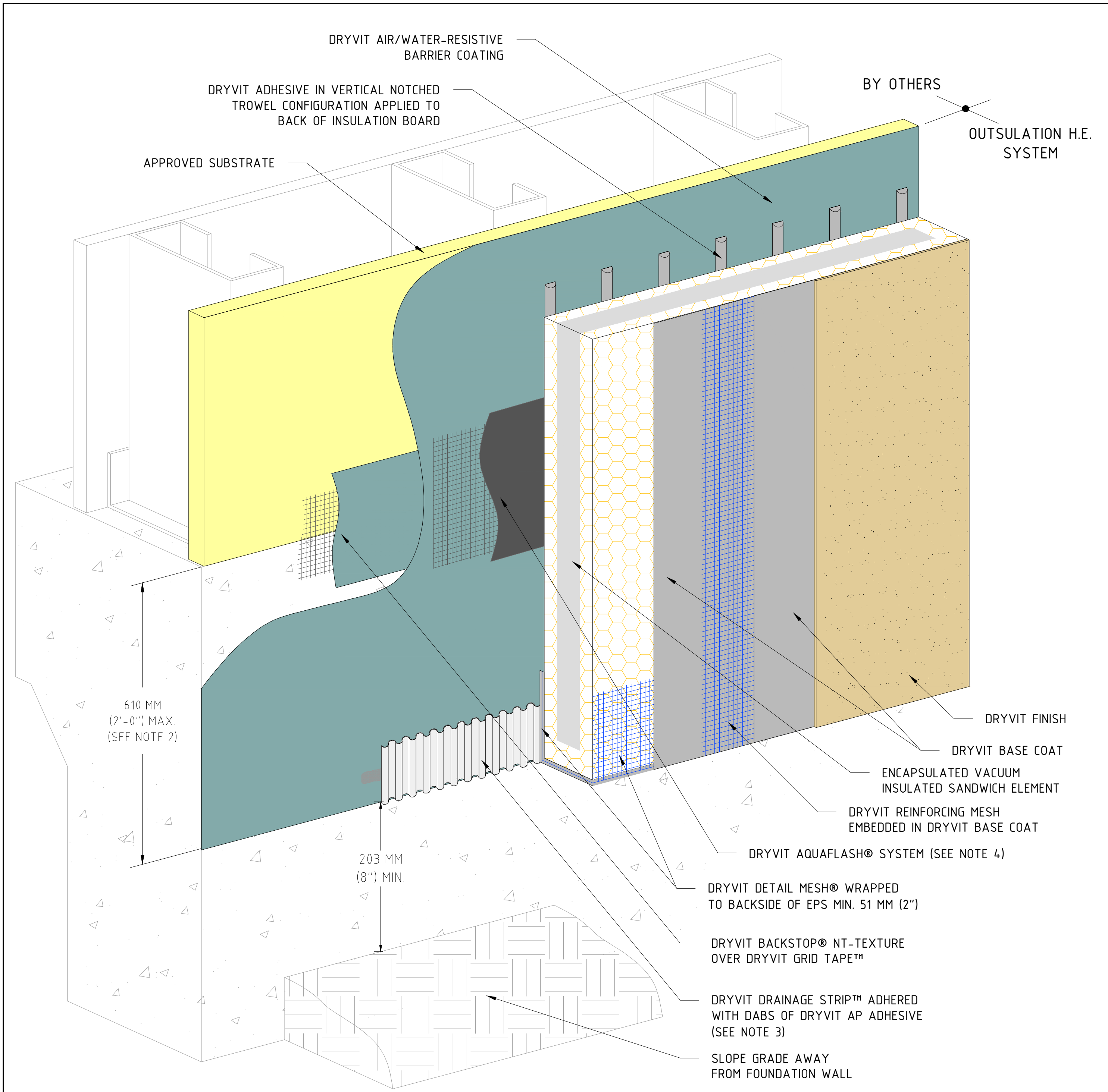

Outsulation® H.E. System®

Termination at Grade

NOTES

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS

2. EXPANSION JOINT IS REQUIRED ALONG TOP OF FOUNDATION IF 610 MM (2'-0") DIMENSION IS EXCEEDED.

3. ENSURE BOTTOM EDGE OF DRAINAGE STRIP IS LEFT FREE TO DRAIN.

4. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.

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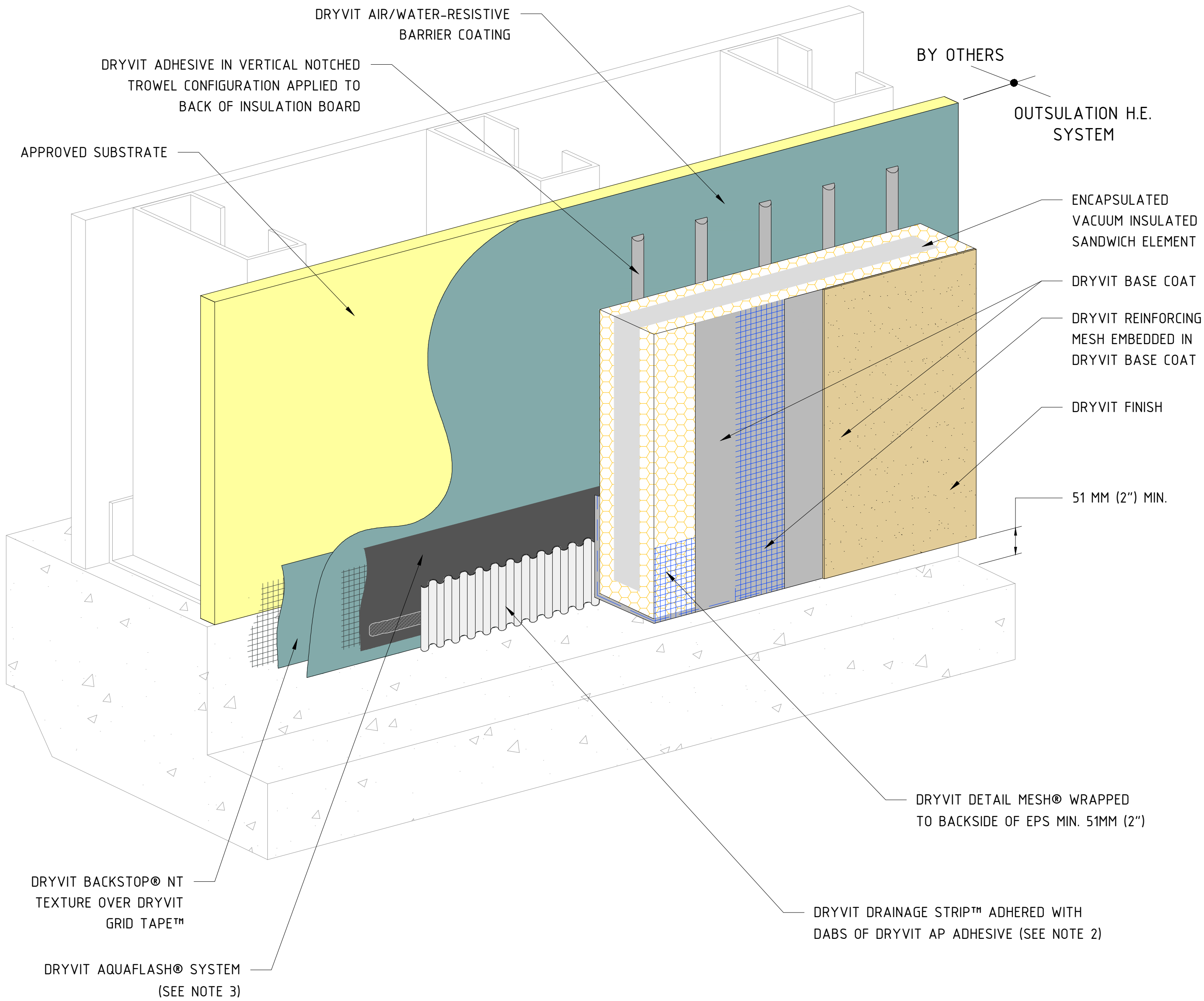

Outsulation® H.E. System®

Termination At Concrete Curb

NOTE:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. ENSURE BOTTOM EDGE OF DRAINAGE STRIP IS LEFT FREE TO DRAIN.

3. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.

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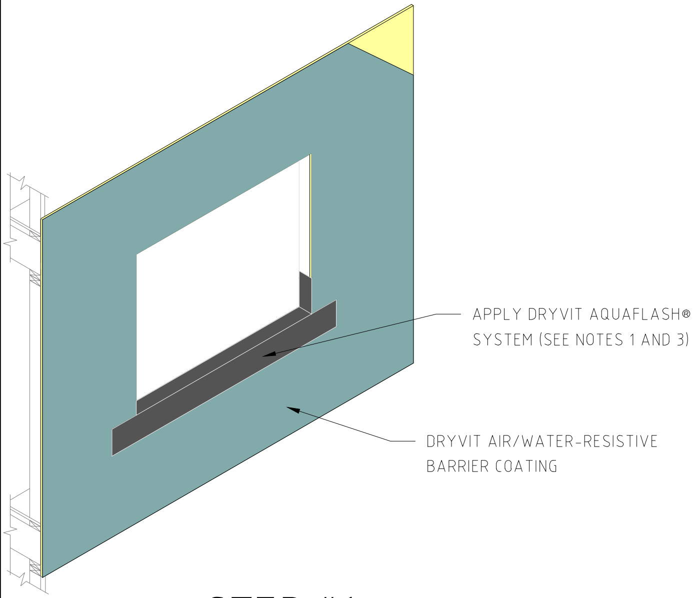

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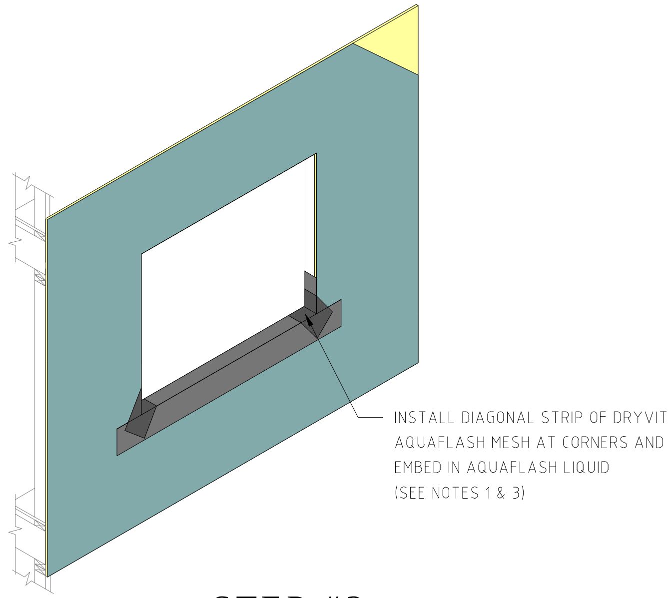

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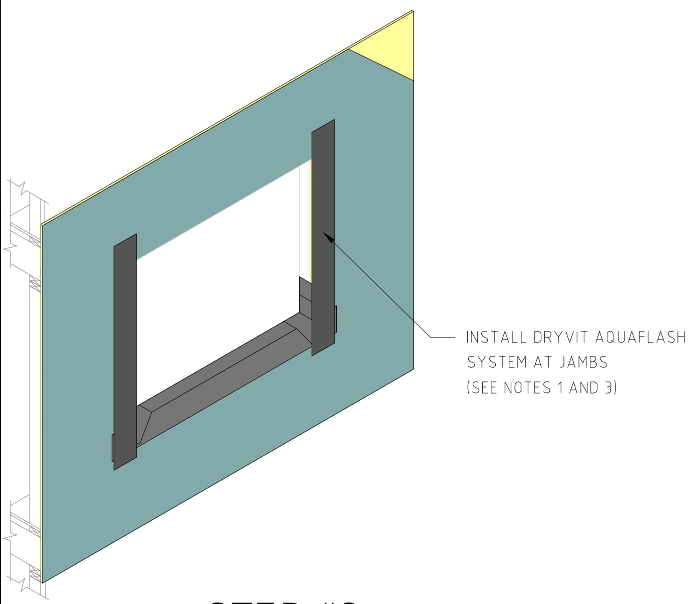

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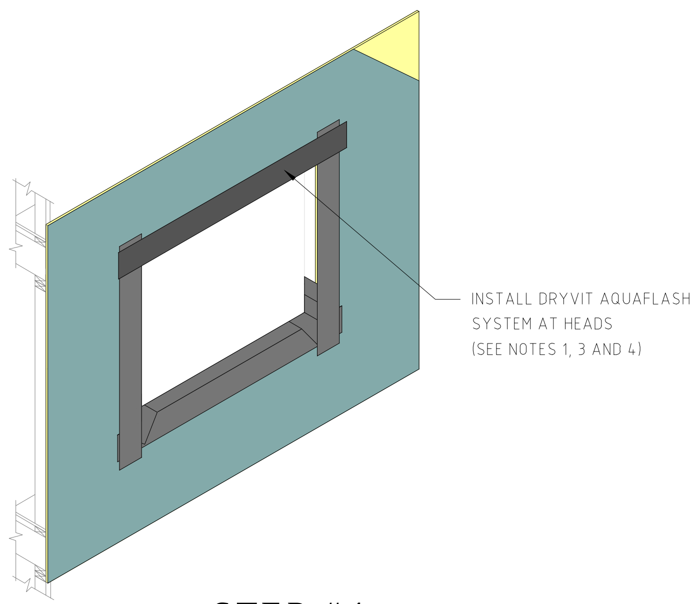

STEP #4

Outsulation® H.E. System®

Opening Preparation - AquaFlash® System[5] Option

NOTES:

1. DRYVIT AQUAFLASH SHALL EXTEND TO INTERIOR FACE OF OPENING.

2. REFER TO HEAD, SILL AND JAMB DETAILS FOR FLASHING INTEGRATION.

3. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.

4. INSTALL WINDOW UNIT AND ASSOCIATED FLASHINGS PER MANUFACTURER'S RECOMMENDATIONS, CODE REQUIREMENTS AND PROJECT DOCUMENTS.

5. AQUAFLASH SYSTEM CONSISTS OF AQUAFLASH MESH AND AQUAFLASH LIQUID.

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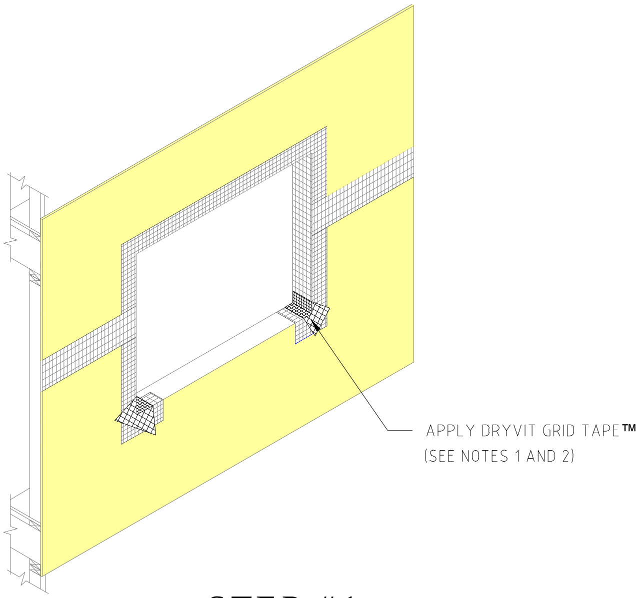

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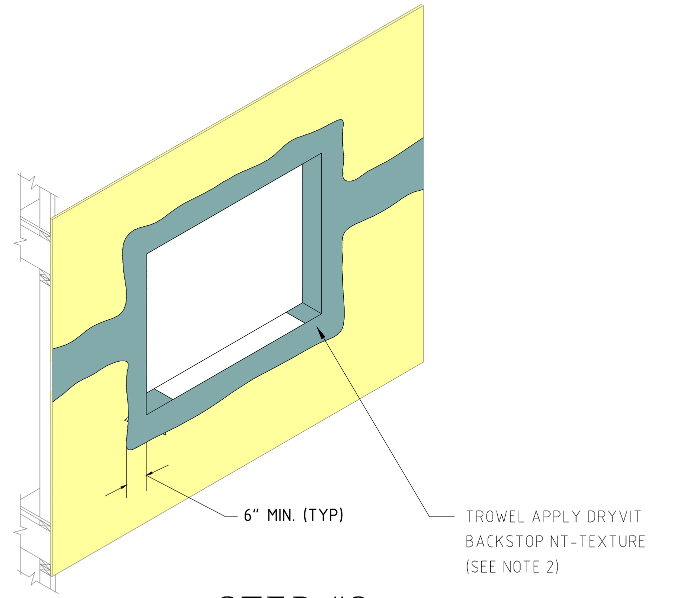

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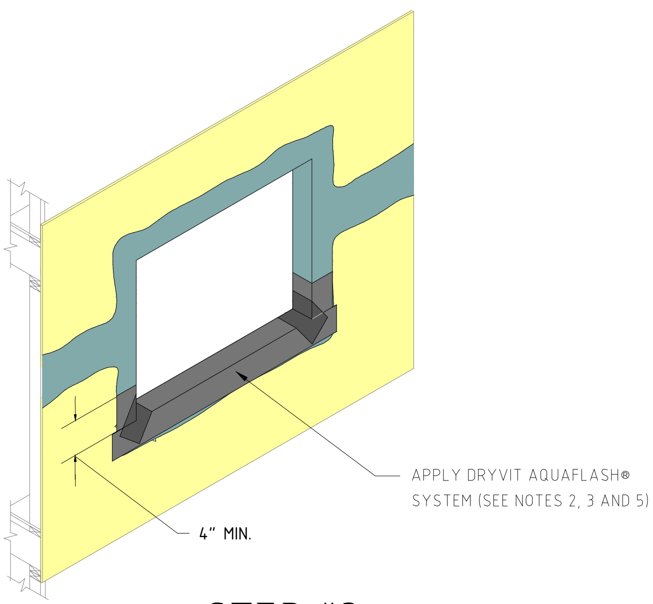

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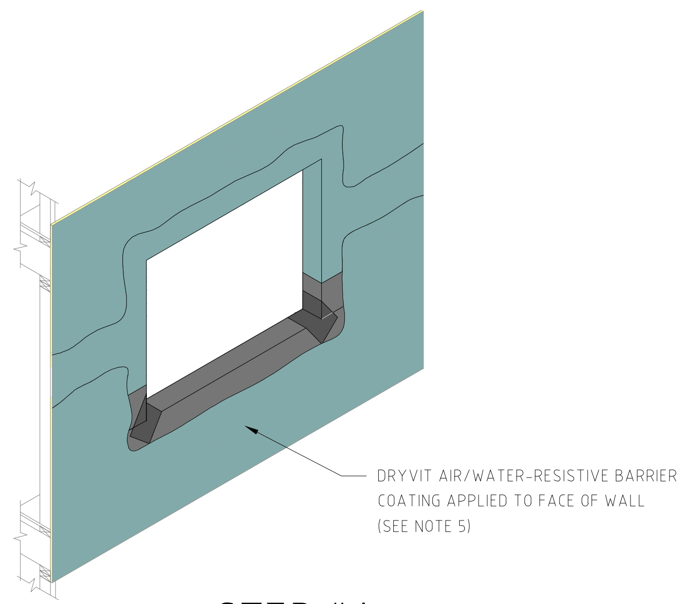

STEP #4

Outsulation® H.E. System®

Opening Preparation- Backstop® NT Option

NOTES:

1. APPLY DRYVIT GRID TAPE ON HEAD, JAMB, AND CORNERS OF OPENINGS AND SHEATHING JOINTS.

2. TROWEL APPLY DRYVIT BACKSTOP NT-TEXTURE OVER THE DRYVIT GRID TAPE ALL THE WAY TO INSIDE FACE OF OPENING. ALL VOIDS MUST BE FILLED; MULTIPLE PASSES MAY BE REQUIRED. AS AN OPTION, DRYVIT GRID TAPE AND DRYVIT BACKSTOP NT-TEXTURE MAY ALSO BE APPLIED AT THE SILL PRIOR TO DRYVIT AQUAFLASH SYSTEM OR FLASHING TAPE APPLICATION.

3. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM AT SILL, INCLUDING CORNER SPLICES.

4. INSTALL WINDOW UNIT AND ASSOCIATED FLASHINGS PER MANUFACTURER'S RECOMMENDATIONS, CODE REQUIREMENTS AND PROJECT DOCUMENTS.

5. REFER TO HEAD, SILL, AND JAMB DETAILS FOR FLASHING INTEGRATION.

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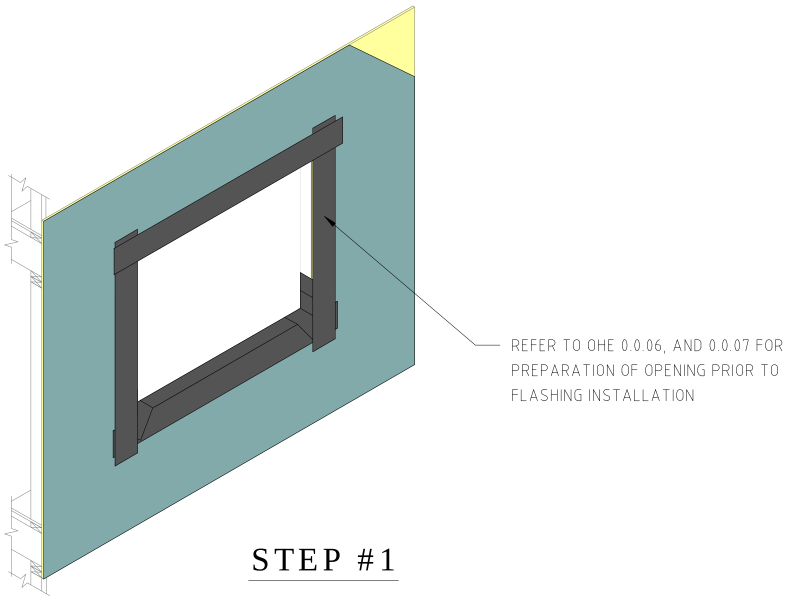

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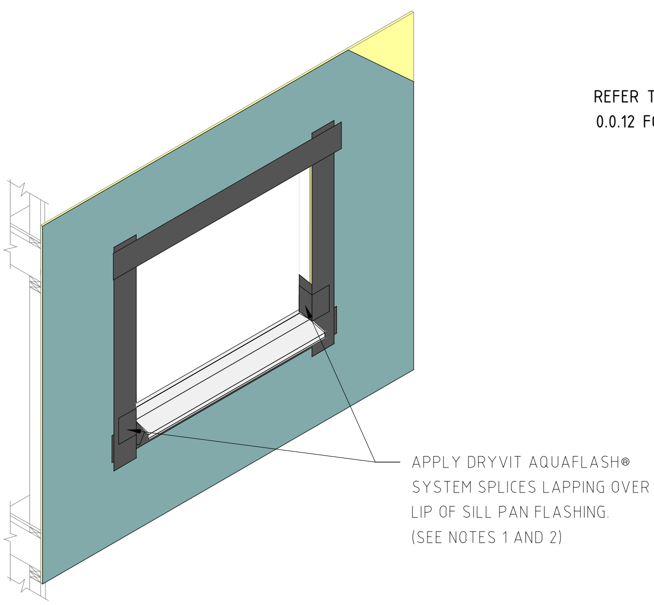

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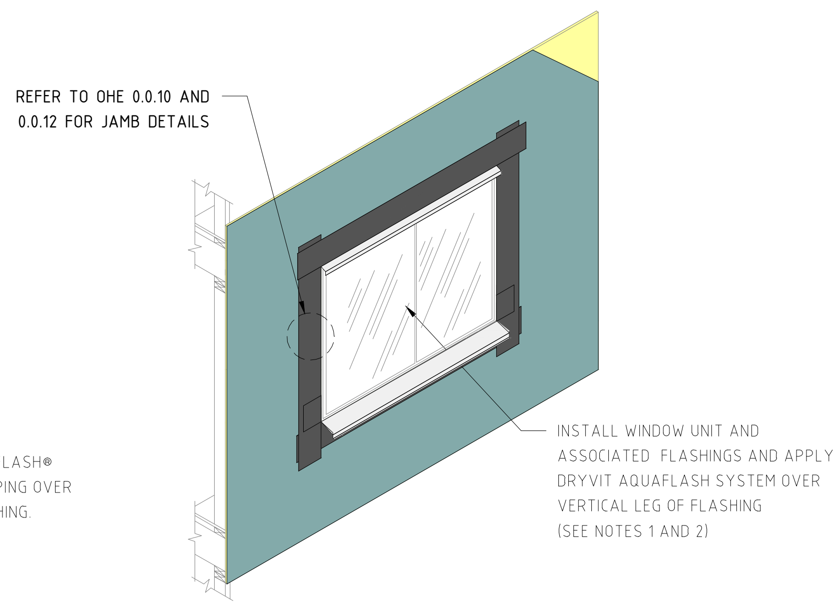

STEP #3

Outsulation® H.E. System®

Opening Flashing Integration

NOTE:
1. REFER TO HEAD, SILL, AND JAMB DETAILS FOR INTEGRATION OF FLASHING.

2. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.

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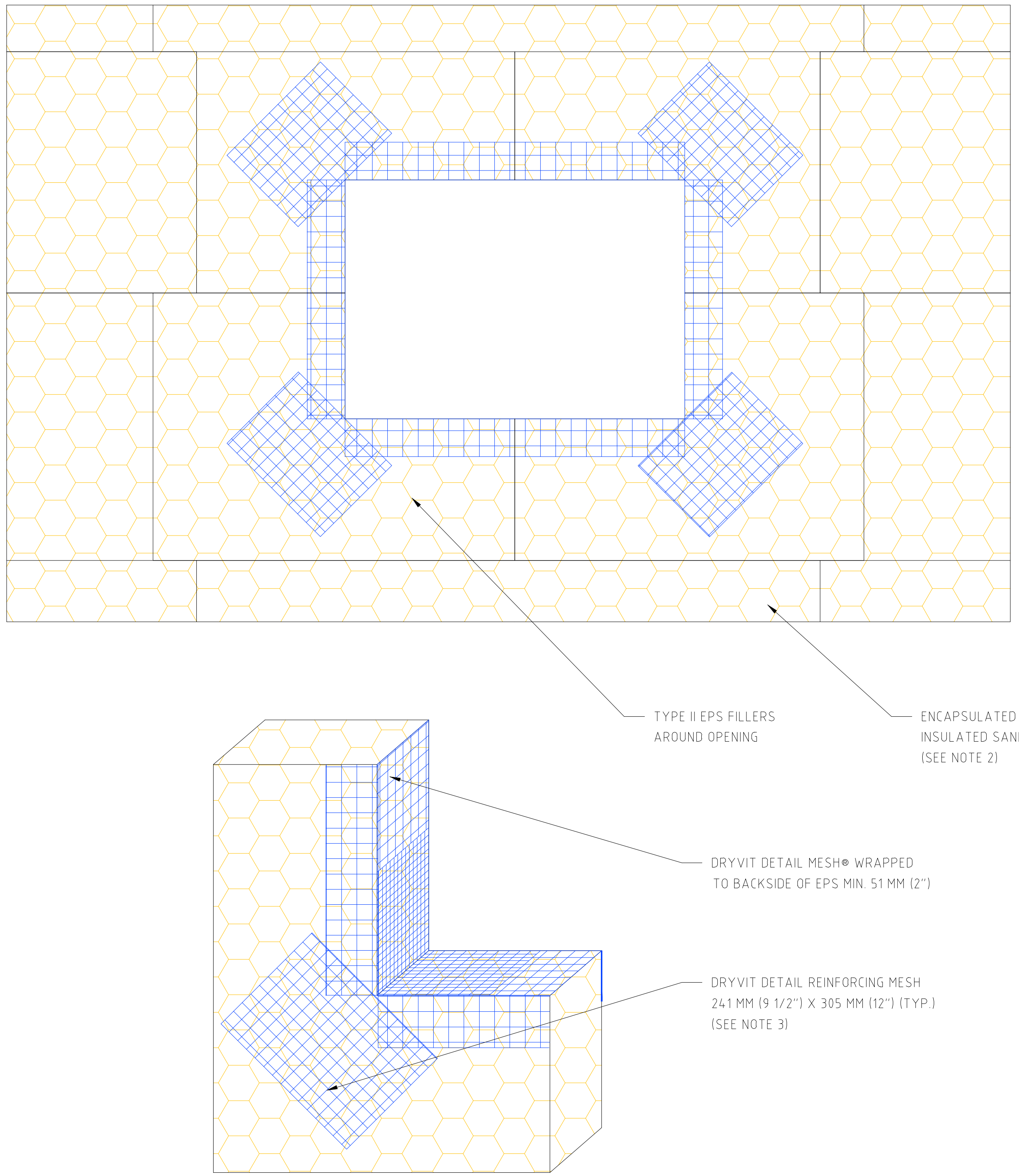

Outsulation® H.E. System®

EPS Preparation At Wall Penetrations

NOTES:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. LOCATE INSULATION BOARDS SUCH THAT BOARD EDGES DO NOT ALIGN WITH CORNERS OF PENETRATION.

3. APPLY A PIECE OF 241 MM (9 1/2") X 305 MM (12") DETAIL REINFORCING MESH DIAGONALLY AT EACH CORNER.

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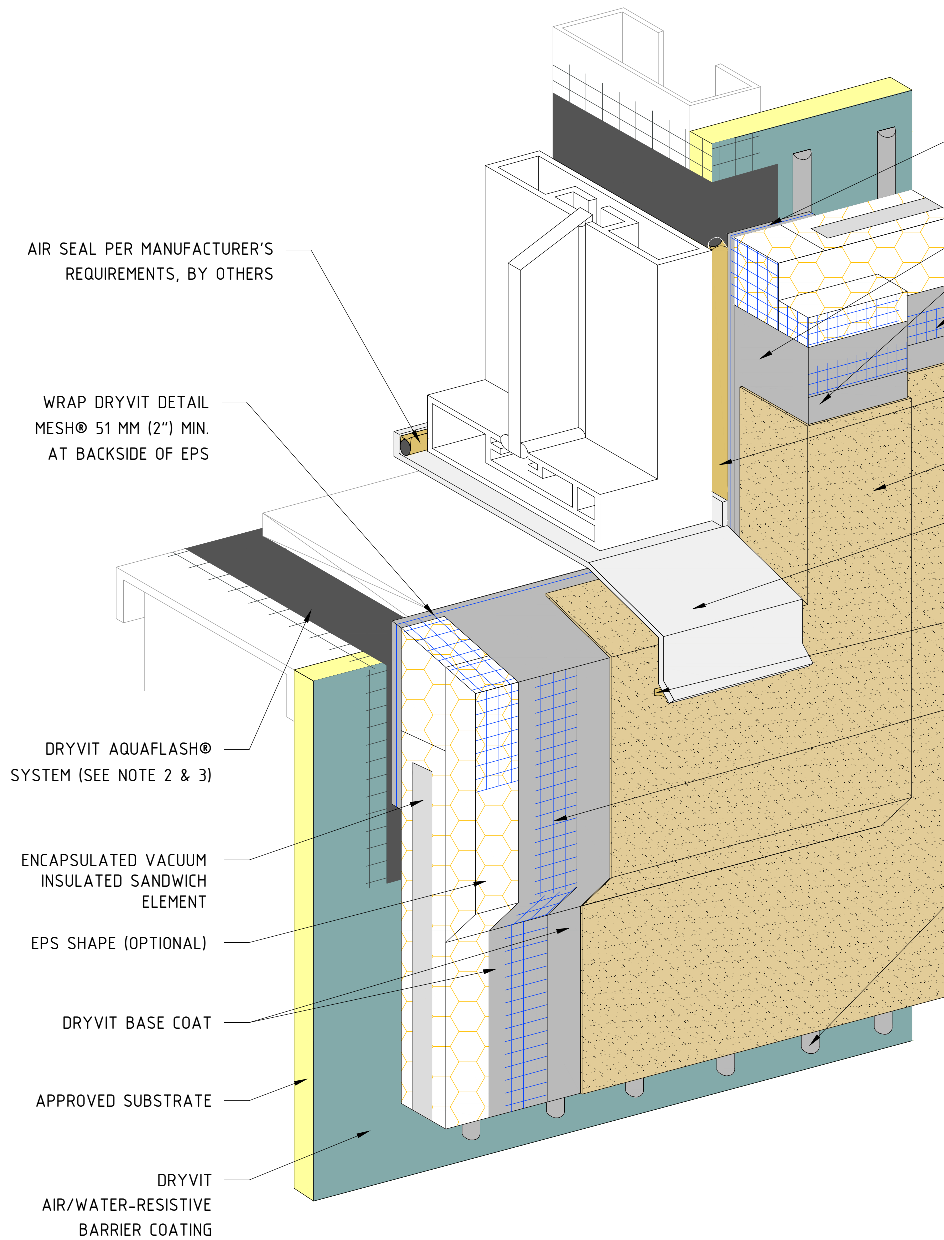

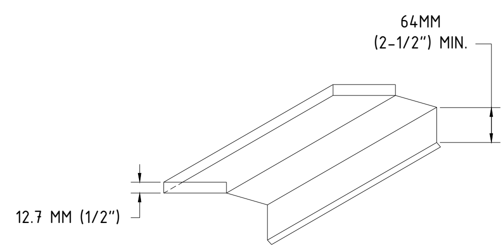

SILL PAN FLASHING DETAIL

Outsulation® H.E. System®

Storefront Window Sill/ Jamb

NOTE:
1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.

3. DRYVIT BACKSTOP NT-TEXTURE OVER GRID TAPE IS AN ALTERNATIVE OPTION AT JAMB AND HEAD CONDITION PER DETAIL OHE 0.0.07.

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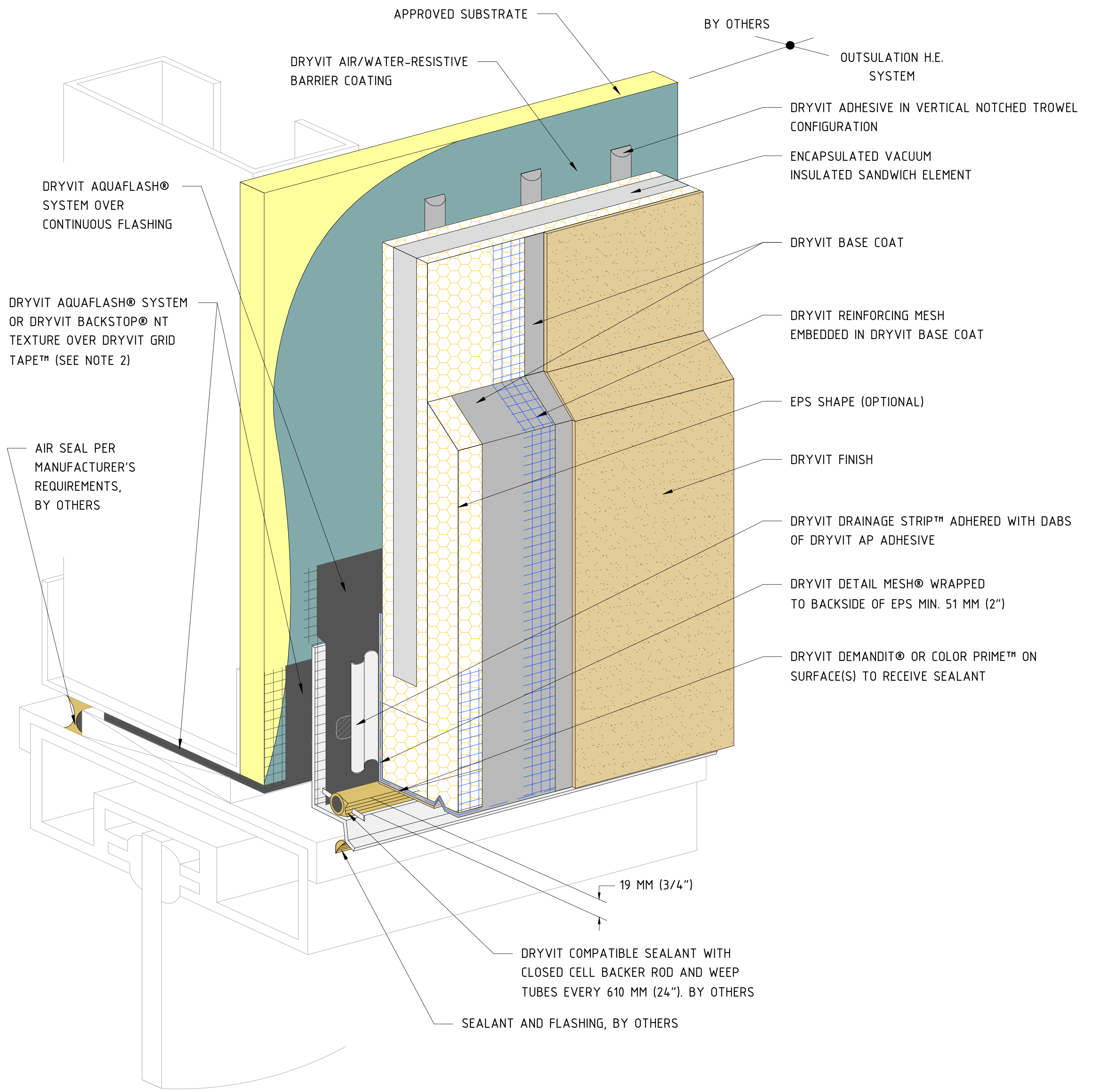
OHE 0.0.11



Outsulation® H.E. System®

Storefront Window/ Head

NOTE:
1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.

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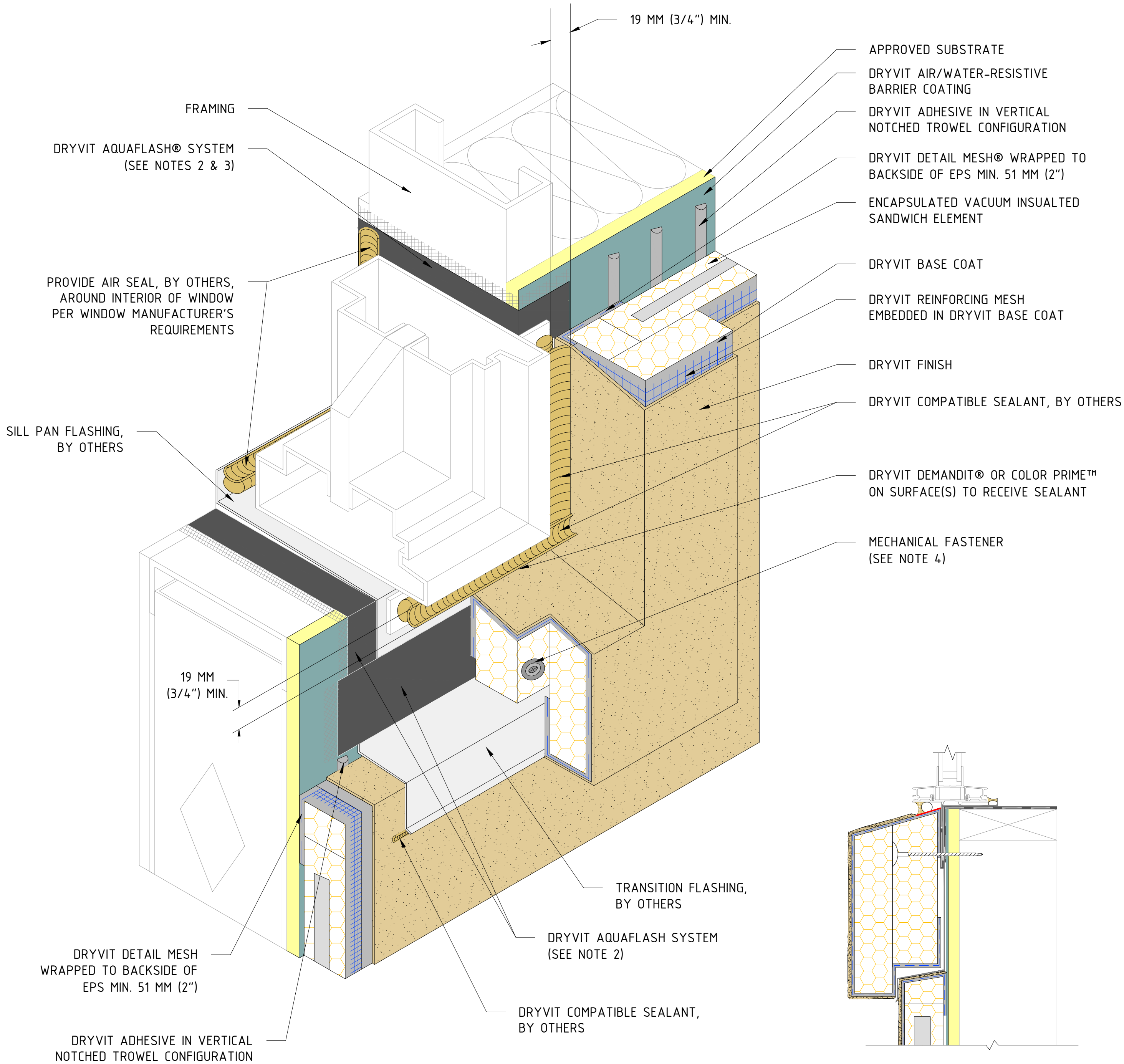

Outsulation® H.E. System®

Sill/ Jamb - Self Flashing Window

NOTES:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.

3. DRYVIT BACKSTOP NT-TEXTURE OVER GRID TAPE IS AN ALTERNATIVE OPTION AT JAMB AND HEAD CONDITION PER DETAIL OHE 0.0.07.

4. ADHESIVE ONLY APPLICATION IS ACCEPTABLE WHEN USING DRYVIT AQUAFLASH SYSTEM.

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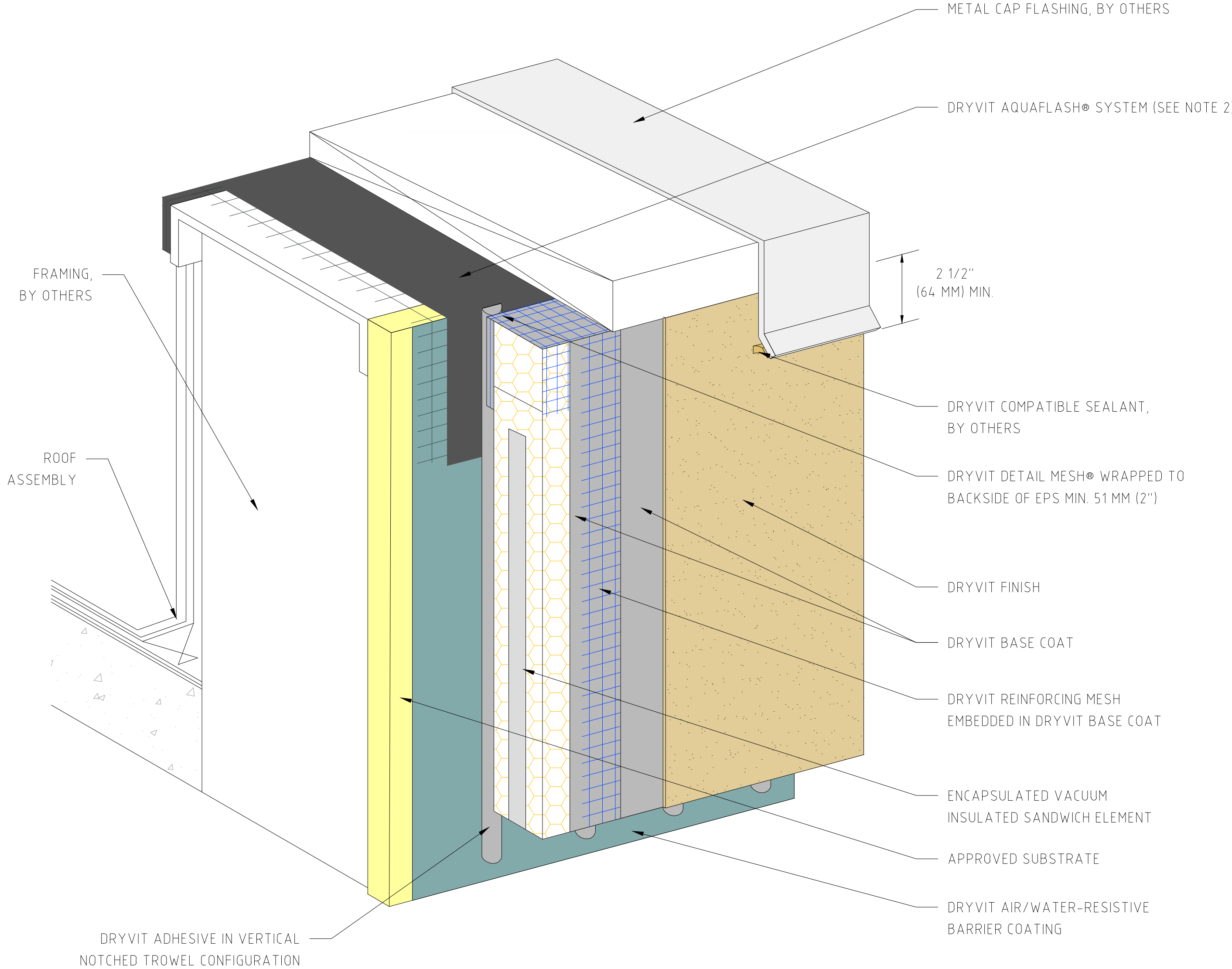

Outsulation® H.E. System®

Termination At Parapet - Cap Flashing

NOTE:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS

2. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.

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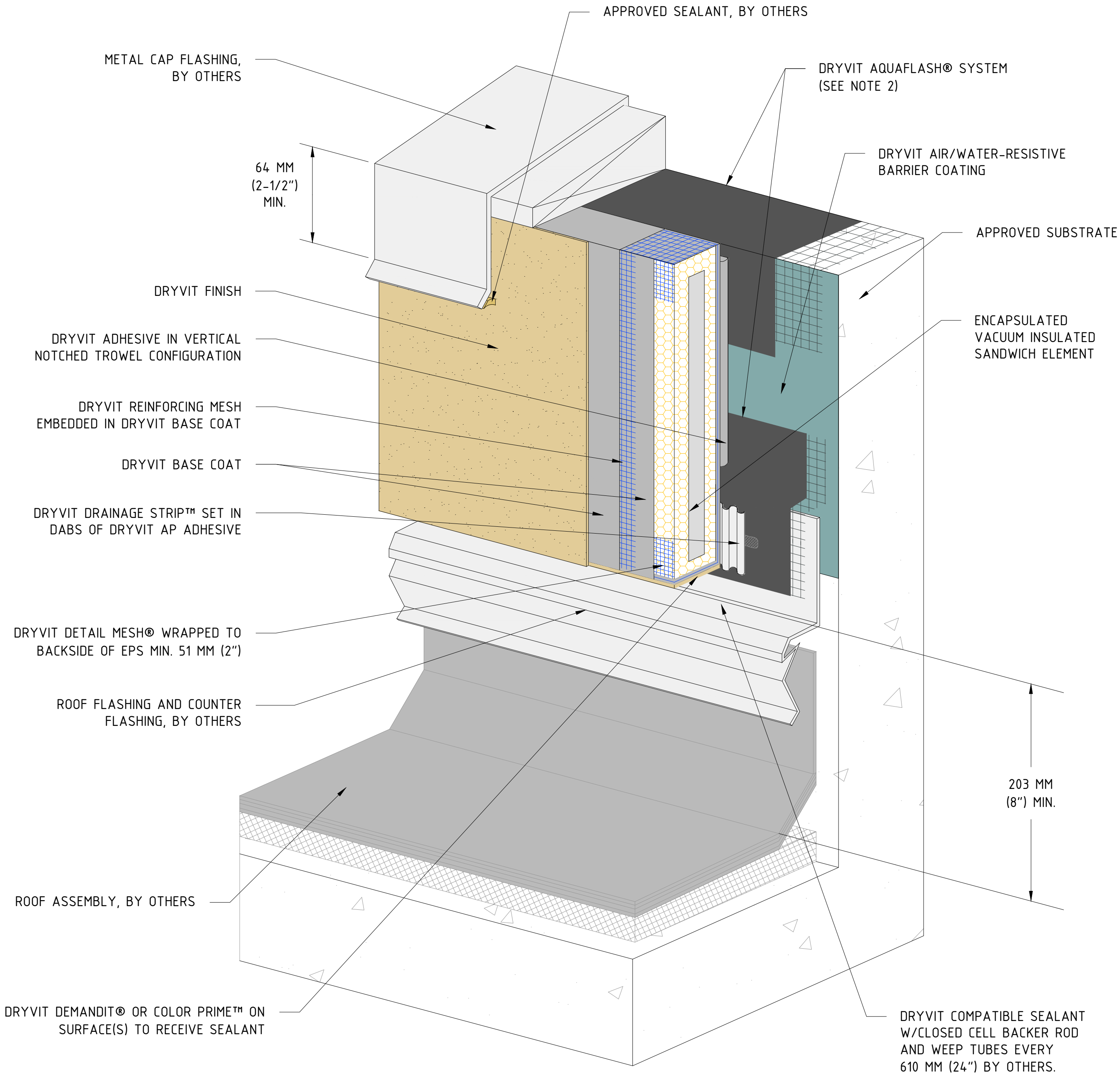

Outsulation® H.E. System®

Termination At Parapet - Cap Flashing

NOTE:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED LIEU OF DRYVIT AQUAFLASH SYSTEM.

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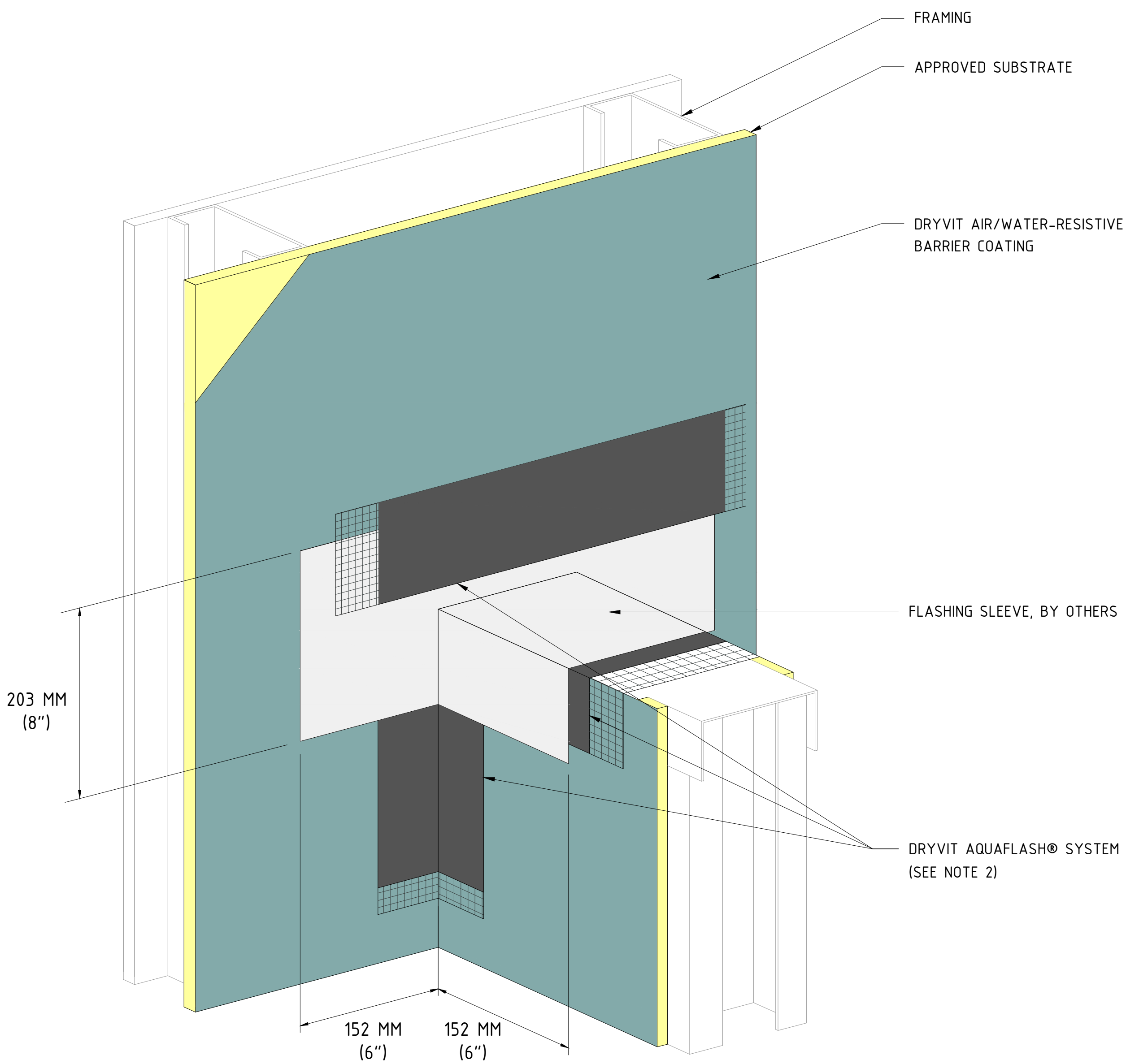

Outsulation® H.E. System®

Preparation At Parapet/Wall Intersection

NOTE:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS

2. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.

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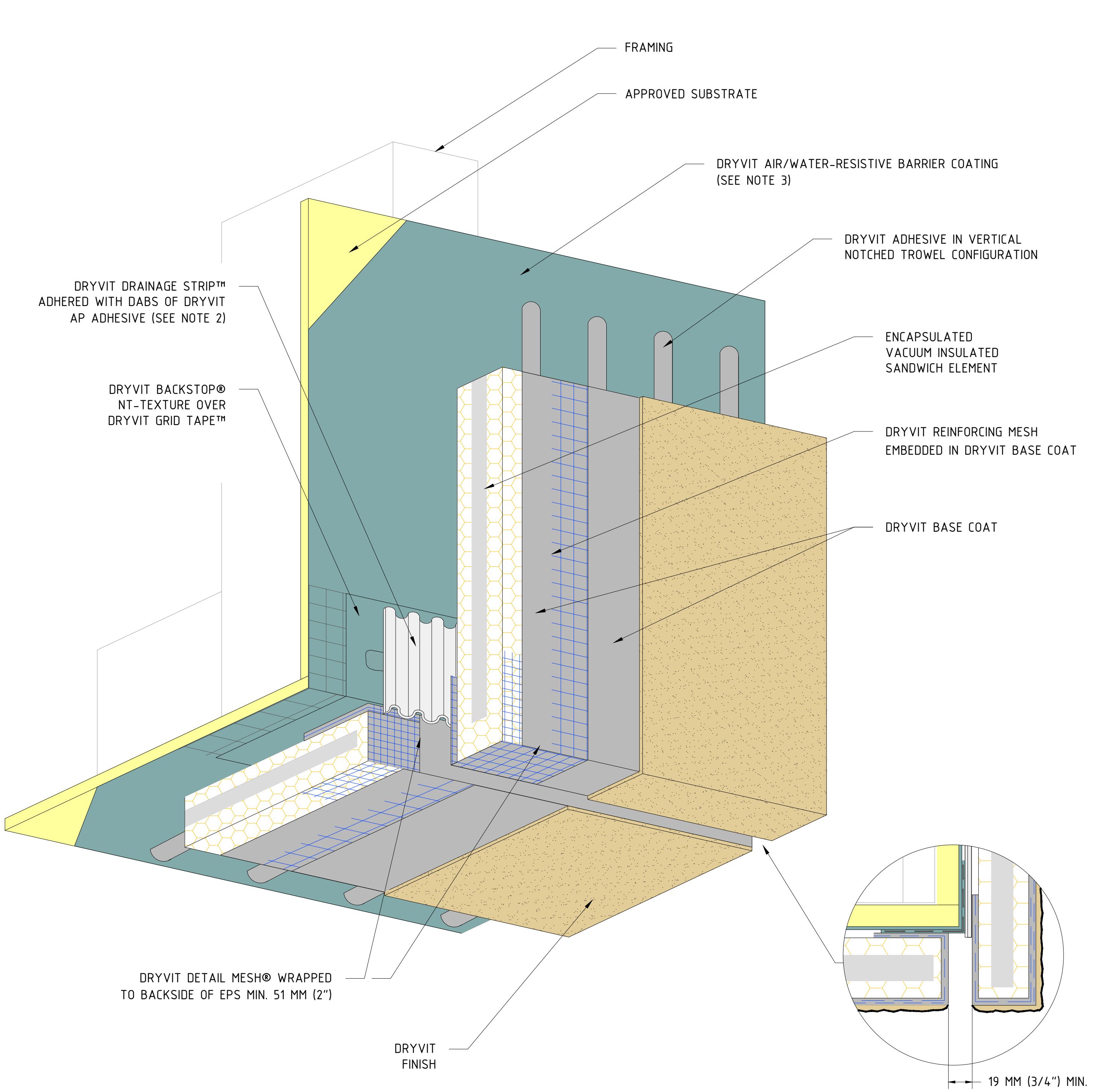

Outsulation® H.E. System®

Transition At Soffit/Fascia Intersection

NOTE:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. ENSURE BOTTOM EDGE OF DRAINAGE STRIP IS LEFT FREE TO DRAIN.

3. DRYVIT AIR/WATER-RESISTIVE BARRIER IS REQUIRED OVER VERTICAL SUBSTRATES, APPLICATION OVER HORIZONTAL SOFFIT SUBSTRATE IS OPTIONAL UNLESS REQUIRED AS PART OF A CONTINUOUS AIR BARRIER SYSTEM.

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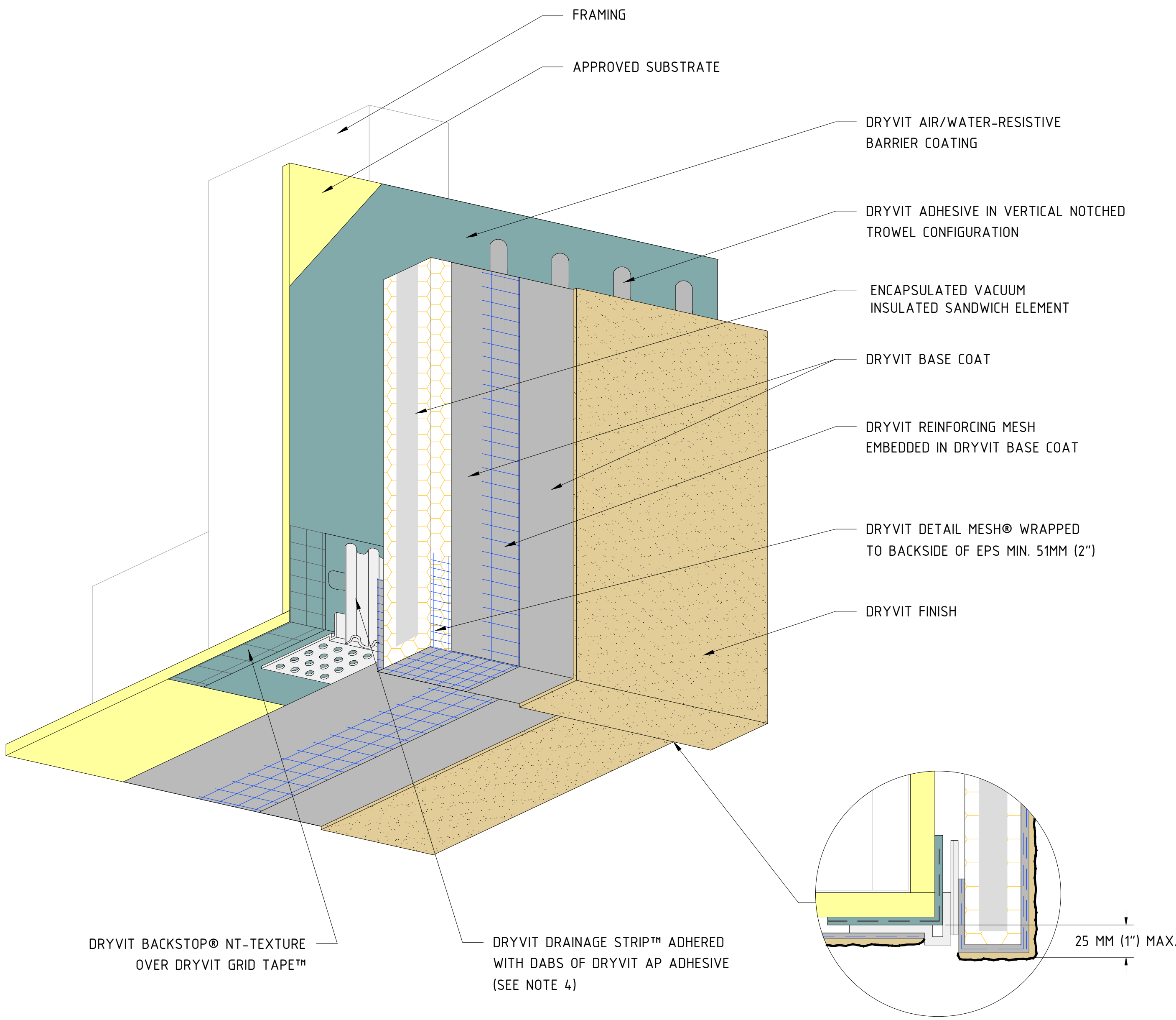

Outsulation® H.E. System®

Termination At Soffit - Uninsulated

NOTE:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. SOFFITS WITHOUT EPS INSULATION REQUIRE EXPANSION JOINTS EVERY 6 M (20 FT).

3. REFER TO DRYVIT PUBLICATION DS 173 FOR SPECIFIC REQUIREMENTS FOR SOFFIT AREAS.

4. BOTTOM EDGE OF DRYVIT DRAINAGE STRIP SHALL BE MASKED DURING INSTALLATION TO PREVENT CLOGGING OF DRAINAGE CHANNELS.

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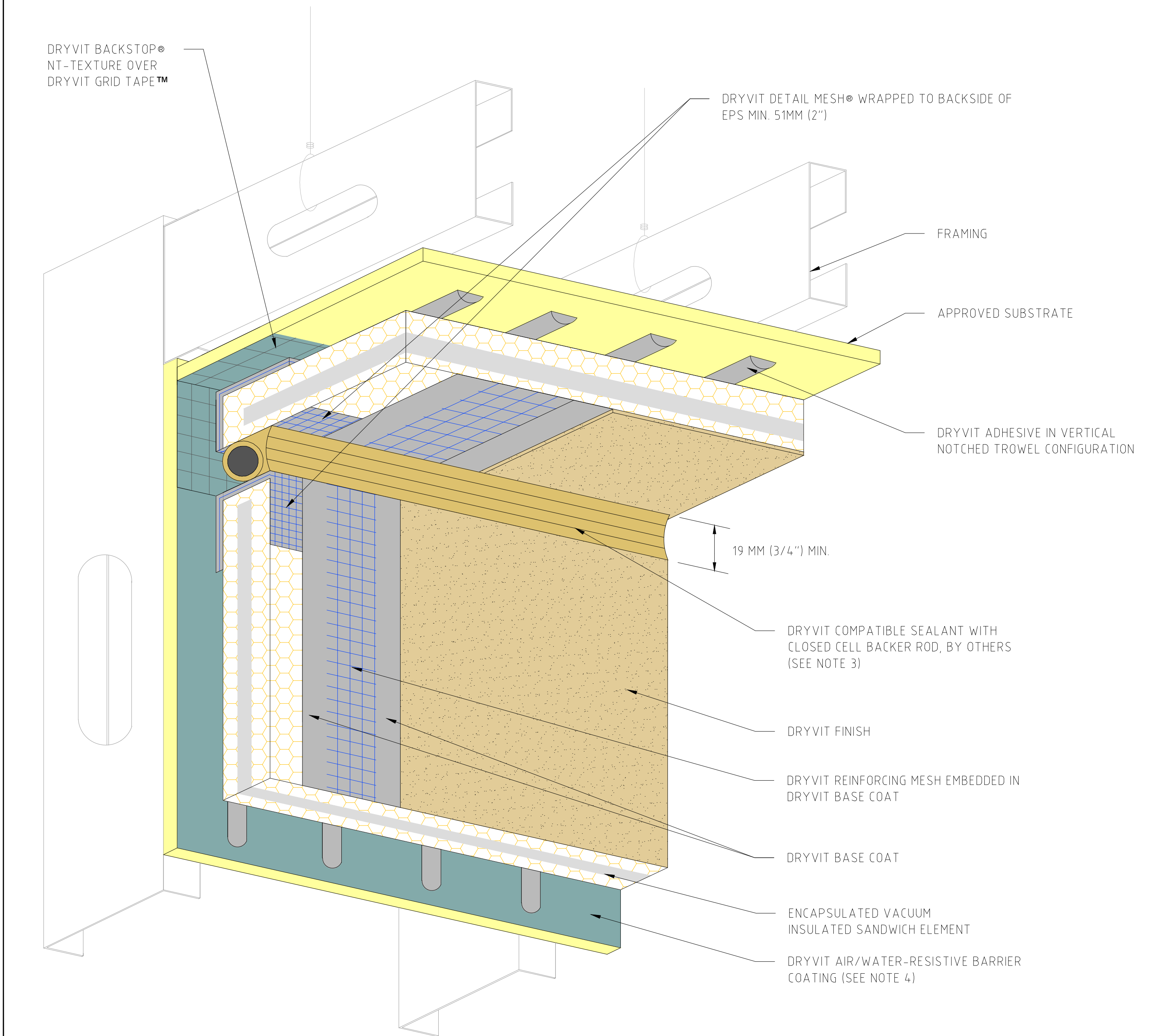

Outsulation® H.E. System®

Vertical Wall/ Insulated Soffit Transition

NOTE:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. ENSURE BOTTOM EDGE OF DRAINAGE STRIP IS LEFT FREE TO DRAIN.

3. DRYVIT DEMANDIT® OR COLOR PRIME™ ON SURFACES TO RECEIVE SEALANT.

4. DRYVIT AIR/WATER-RESISTIVE BARRIER IS REQUIRED OVER VERTICAL SUBSTRATES. APPLICATION OVER HORIZONTAL SOFFIT SUBSTRATE IS OPTIONAL UNLESS REQUIRED AS PART OF A CONTINUOUS AIR BARRIER SYSTEM.

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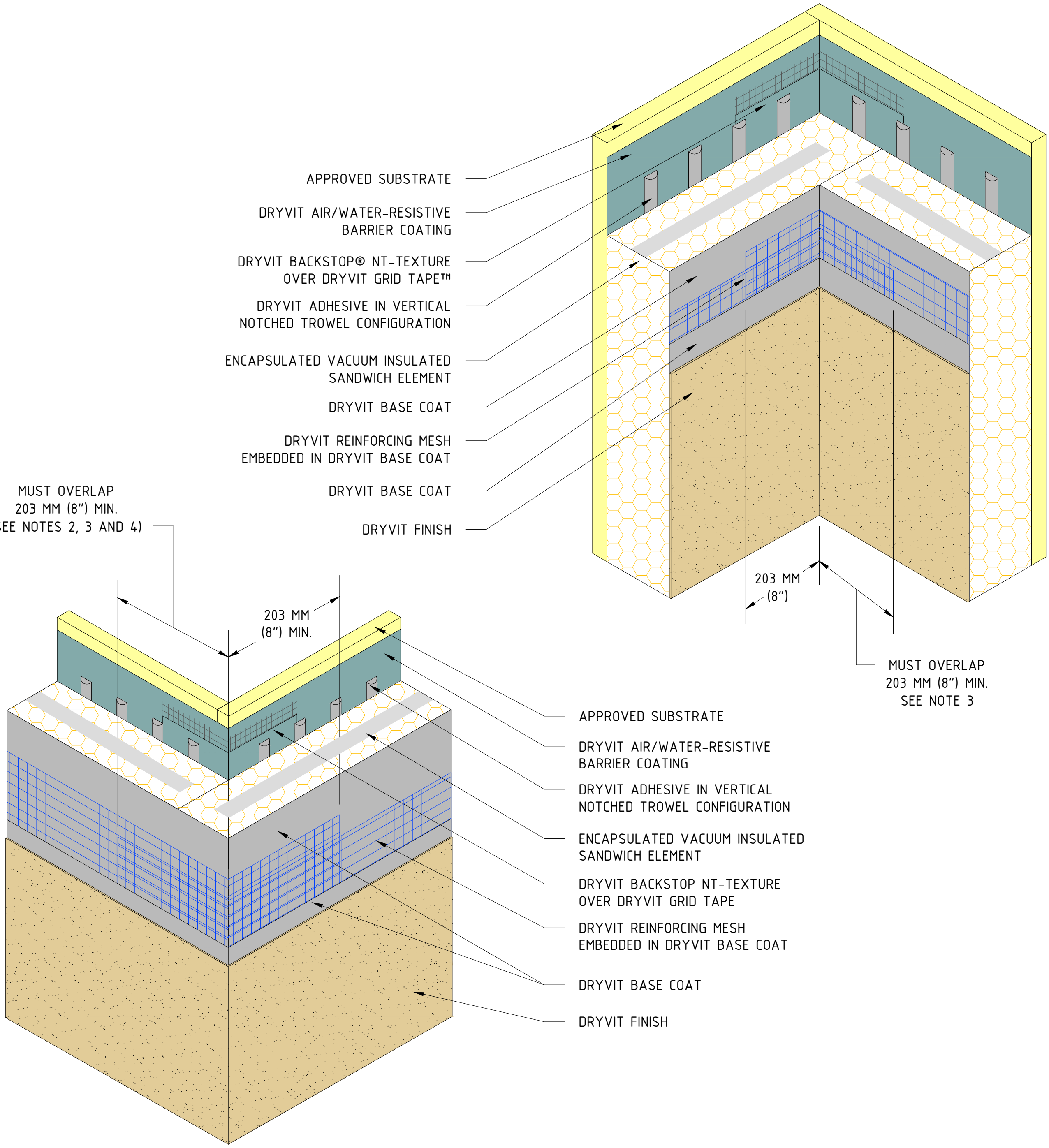

Outsulation® H.E. System®

Inside/Outside Corners

NOTE:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. DOUBLE WRAP OUTSIDE CORNERS WITH REINFORCING MESH OR USE CORNER MESH.

3. DO NOT LAP REINFORCING MESH WITHIN 203 MM (8") OF A CORNER.

4. OUTSIDE INSULATION BOARD EDGES SHALL BE OFFSET.

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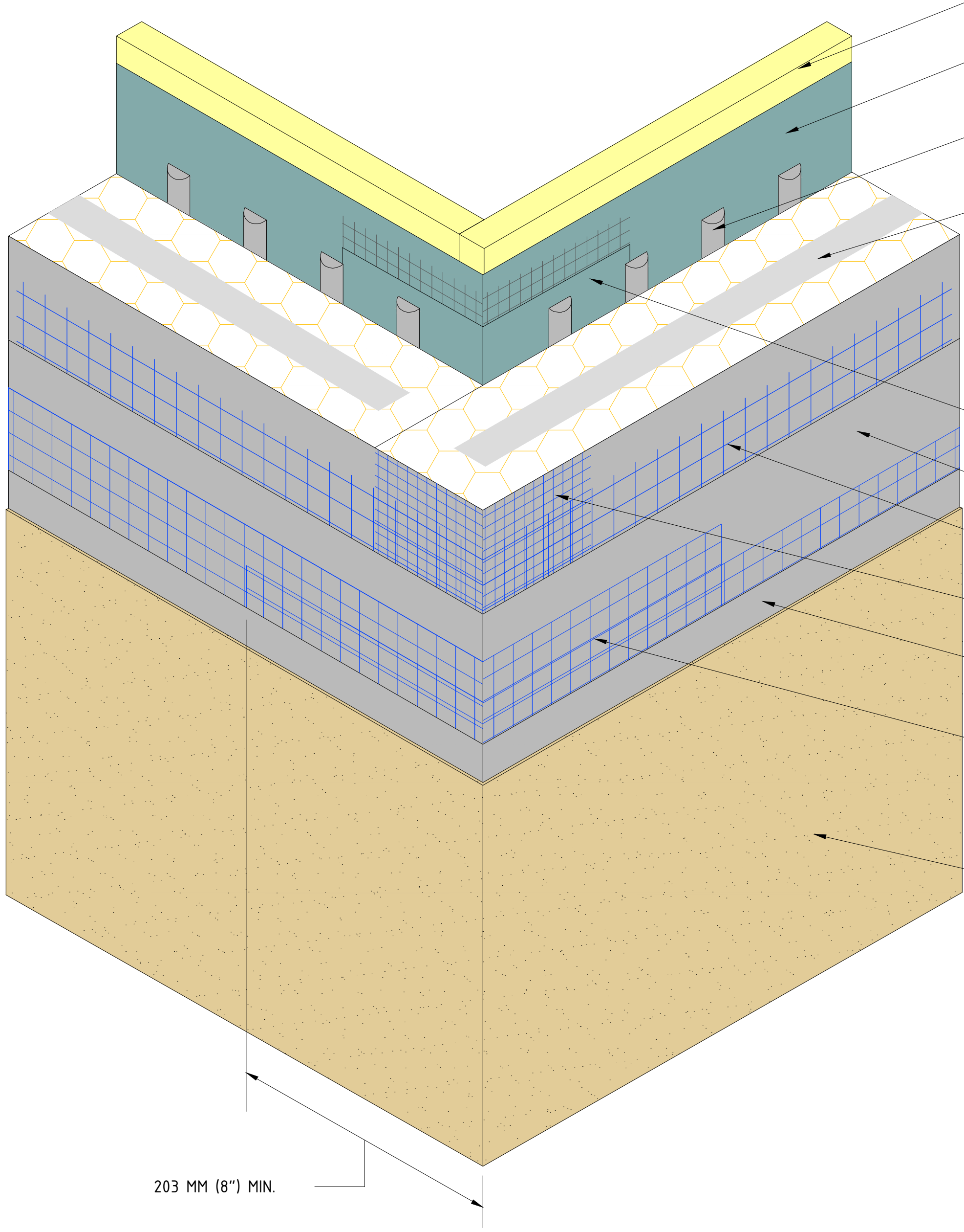

Outsulation® H.E. System®

Outside Corner - High Impact

NOTE:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. OUTSIDE INSULATION BOARD EDGES SHALL BE OFFSET.

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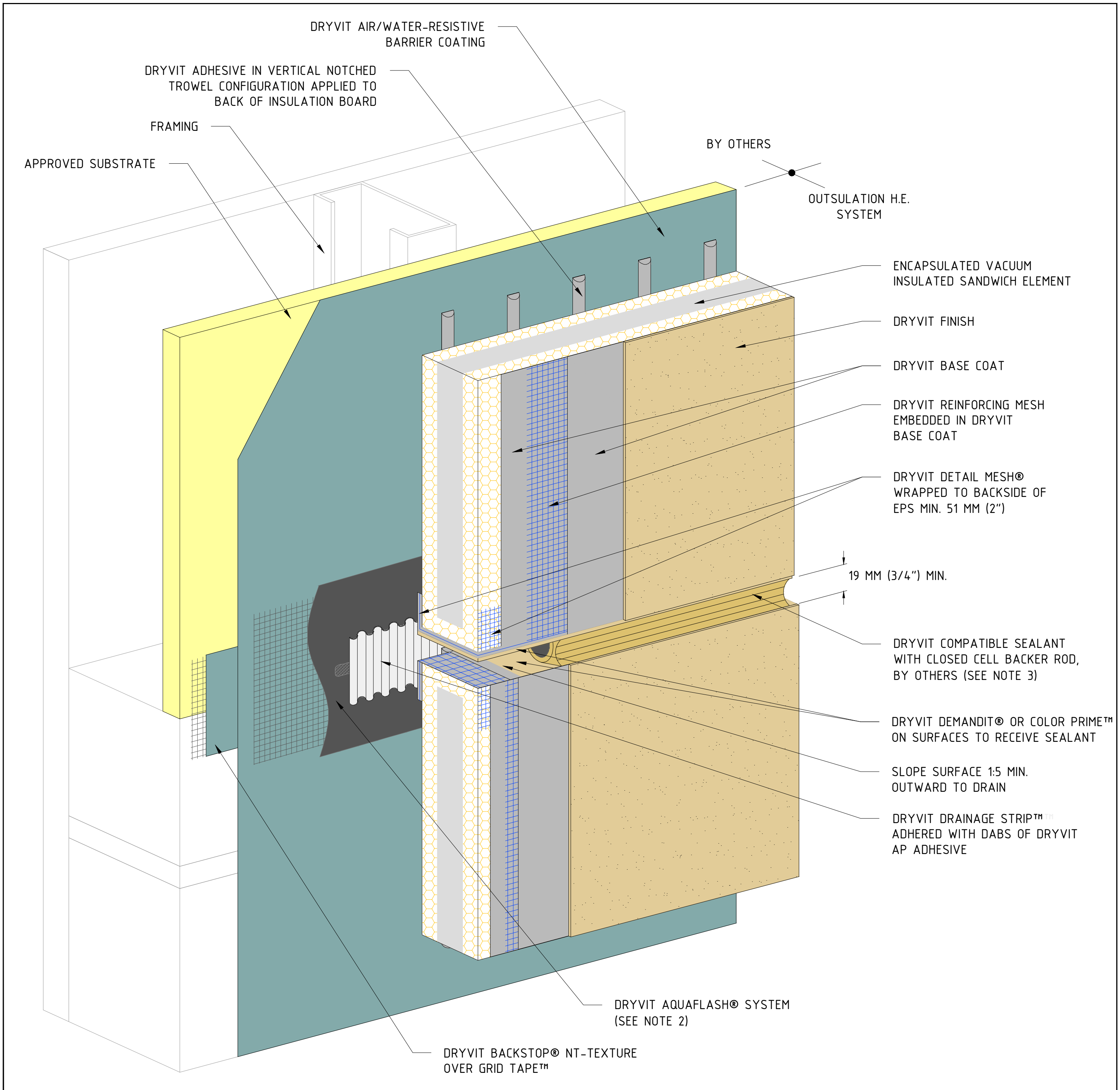

Outsulation® H.E. System®

Horizontal Joint- Substrate Change[4]

NOTE:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM OVER PREPARED JOINT AT CHANGE IN SUBSTRATE.

3. SEALANT SHALL NOT BE IN DIRECT CONTACT WITH ASPHALTIC ADHESIVE ON DRYVIT FLASHING TAPE. COVER DRYVIT FLASHING TAPE LAPS WITH POLYETHYLENE TAPE OR BACKER ROD.

4. REFER TO DETAIL OHE 0.0.23 FOR CONFIGURATION REQUIRING WEEPS.

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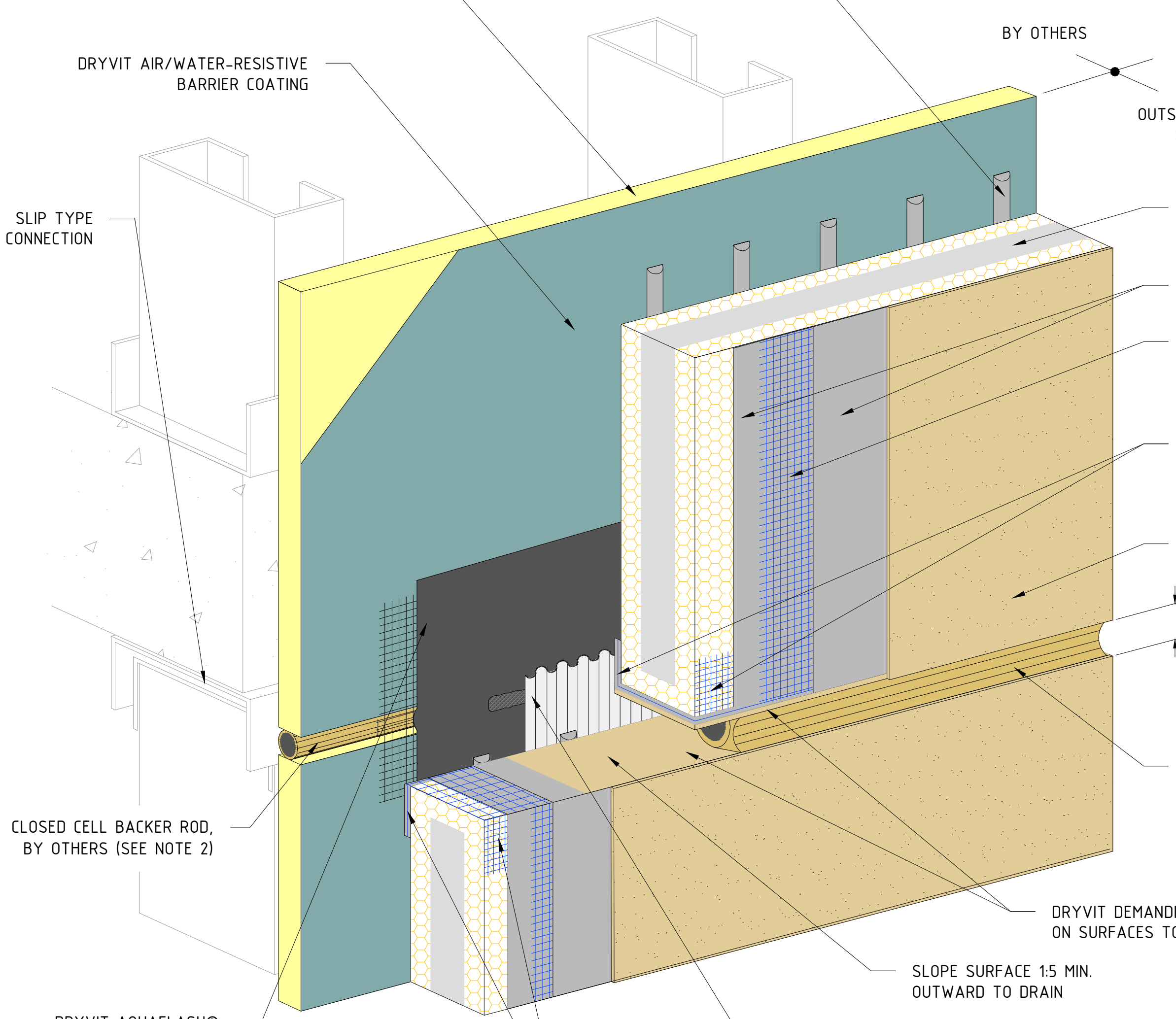

Outsulation® H.E. System®

Horizontal Slip Joint without Weeps

NOTE:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. LOCATE EXTERNAL SEALANT JOINT WITHIN 51 MM (2") OF BREAK IN SHEATHING.

3. EXPANSION JOINT IN THE OUTSULATION H.E. SYSTEM IS NECESSARY WHERE SIGNIFICANT DIFFERENTIAL MOVEMENT IS EXPECTED AT FLOOR LINES.

4. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM OVER PREPARED JOINT.

5. SEALANT SHOULD NOT BE IN DIRECT CONTACT WITH ASPHALTIC ADHESIVE ON DRYVIT FLASHING TAPE. COVER DRYVIT FLASHING TAPE LAPS WITH POLYETHYLENE TAPE OR BACKER ROD.

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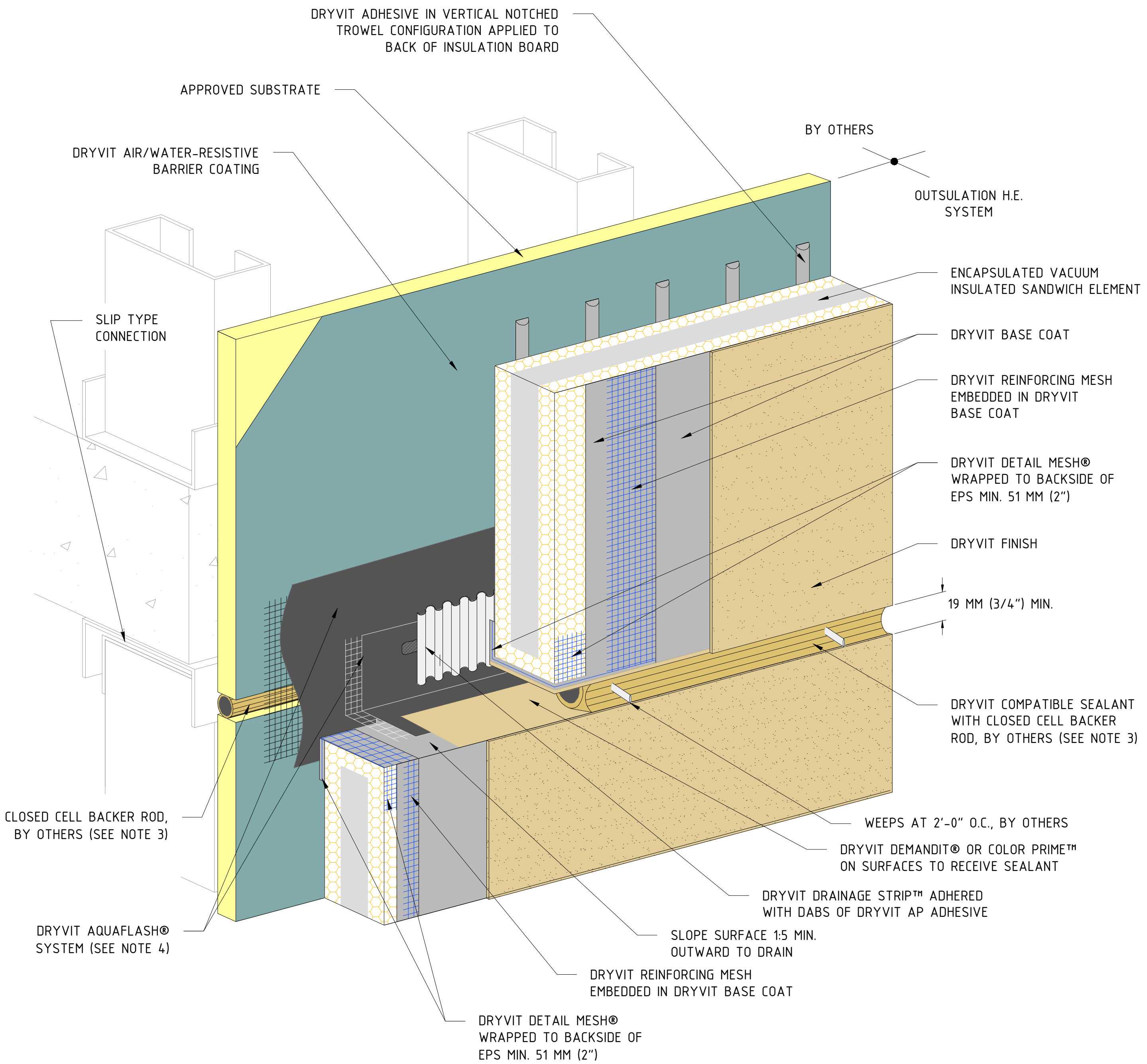

Outsulation® H.E. System®

Horizontal Slip Joint with Weeps

NOTE:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. EXPANSION JOINT IN THE OUTSULATION H.E. SYSTEM IS NECESSARY WHERE SIGNIFICANT DIFFERENTIAL MOVEMENT IS EXPECTED AT FLOOR LINES.

3. LOCATE EXTERNAL SEALANT JOINT WITHIN 51 MM (2") OF BREAK IN SHEATHING.

4. STOP AQUAFLASH SHORT OF SEALANT BOND LINE.

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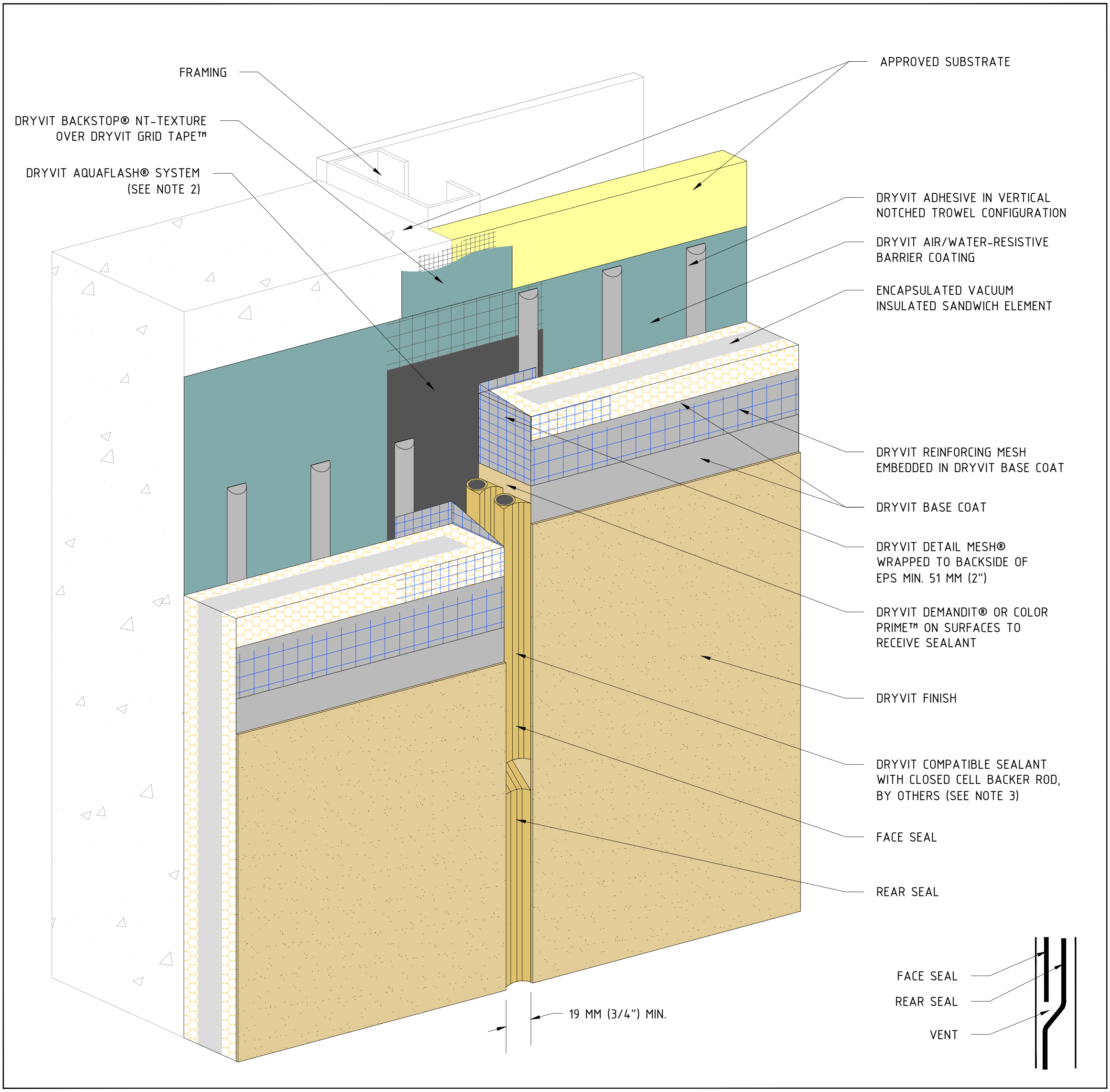

Outsulation® H.E. System®

Vertical Expansion Joint - Double Seal Option

NOTES:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.

3. SEALANT SHALL NOT BE IN DIRECT CONTACT WITH ASPHALTIC ADHESIVE ON DRYVIT FLASHING TAPE. COVER DRYVIT FLASHING TAPE LAPS WITH POLYETHYLENE TAPE OR BACKER ROD.

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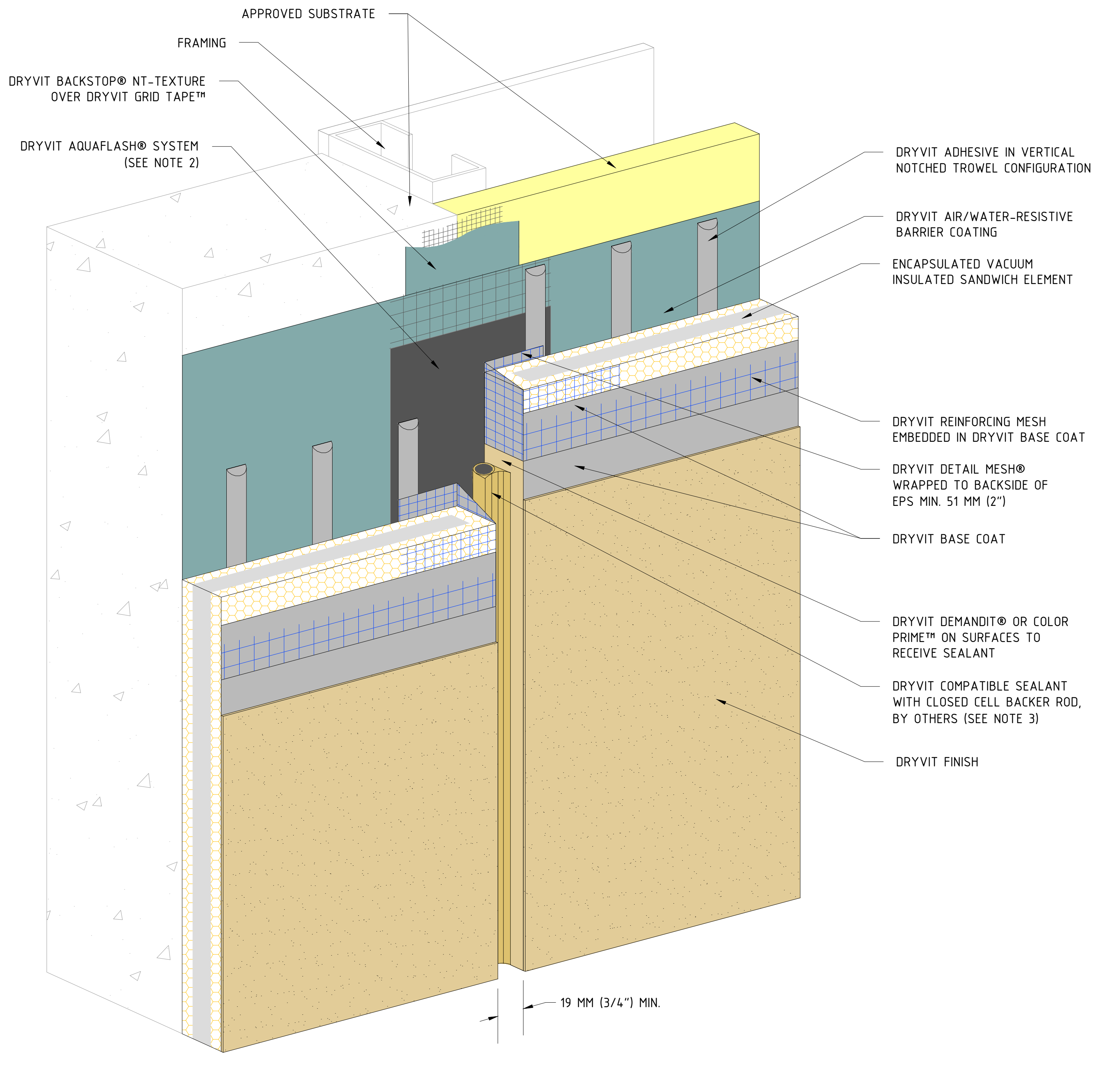

Outsulation® H.E. System®

Vertical Expansion Joint - Recessed Option

NOTES:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.

3. SEALANT SHALL NOT BE IN DIRECT CONTACT WITH ASPHALTIC ADHESIVE ON DRYVIT FLASHING TAPE. COVER DRYVIT FLASHING TAPE LAPS WITH POLYETHYLENE TAPE OR BACKER ROD.

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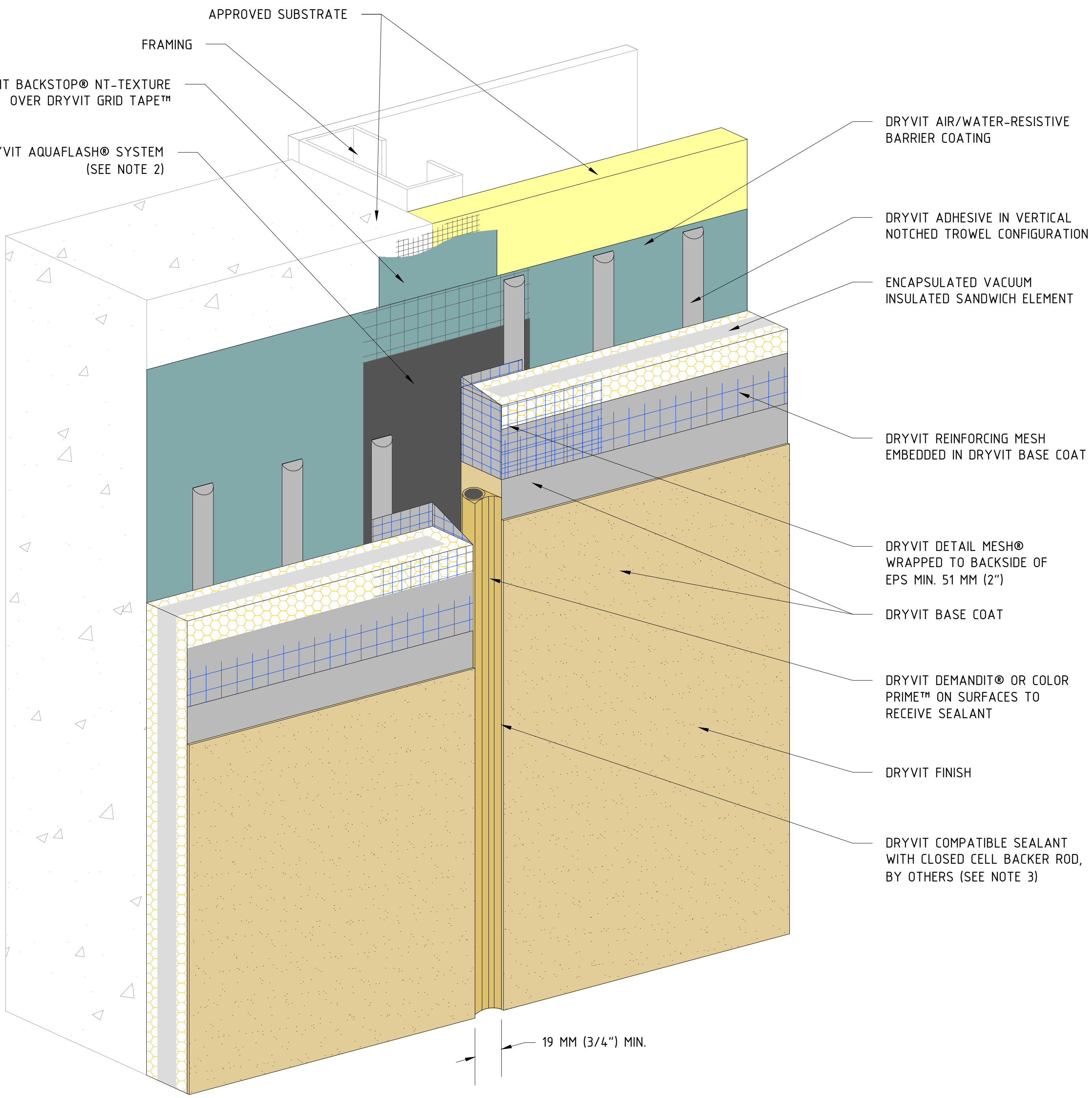

Outsulation® H.E. System®

Vertical Expansion Joint - Flush Option

NOTES:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.

3. SEALANT SHALL NOT BE IN DIRECT CONTACT WITH ASPHALTIC ADHESIVE ON DRYVIT FLASHING TAPE. COVER DRYVIT FLASHING TAPE LAPS WITH POLYETHYLENE TAPE OR BACKER ROD.

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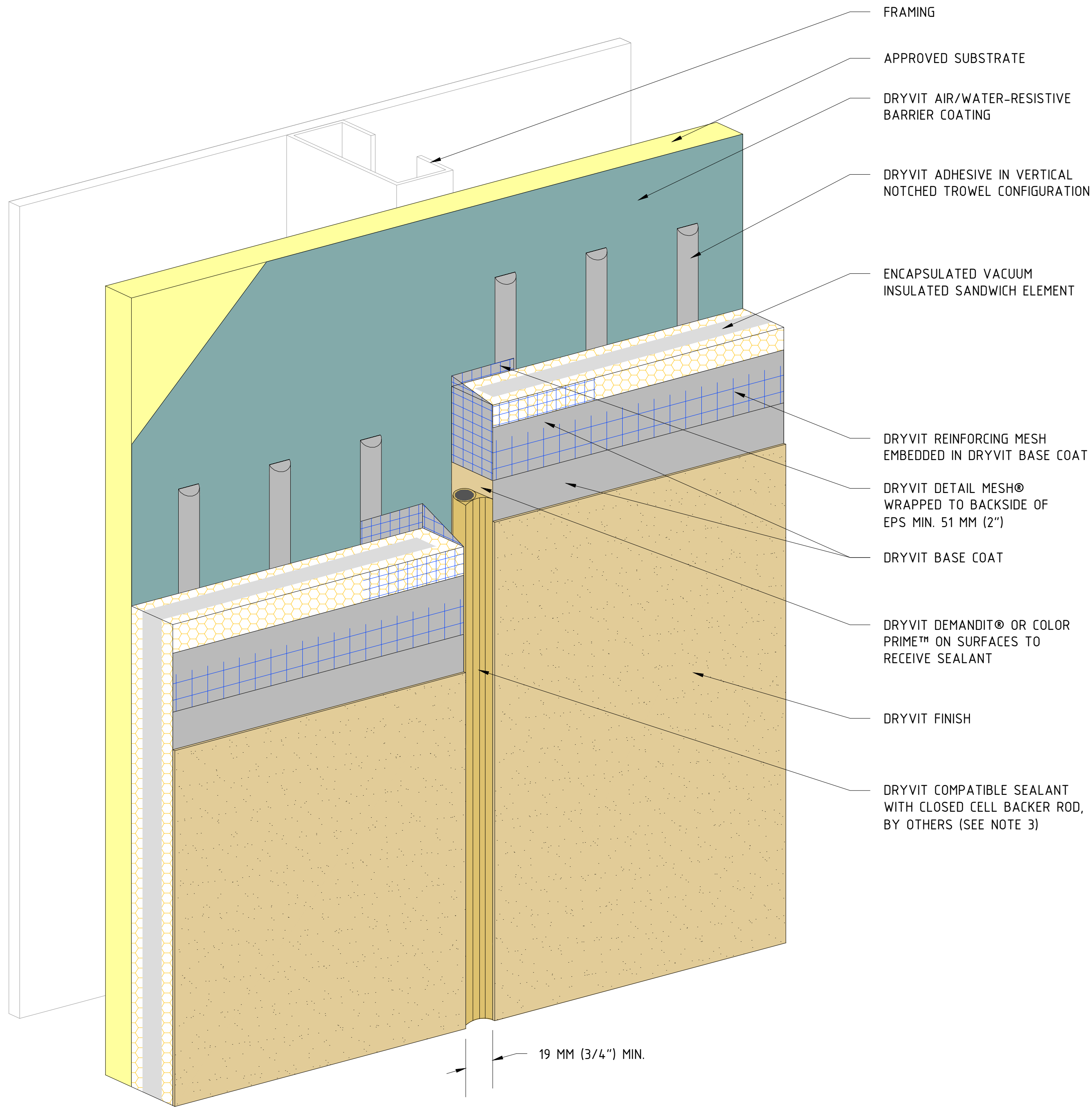

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Vertical Expansion Joint - EIFS[4]

NOTES:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.

3. SEALANT SHALL NOT BE IN DIRECT CONTACT WITH ASPHALTIC ADHESIVE ON DRYVIT FLASHING TAPE. COVER DRYVIT FLASHING TAPE LAPS WITH POLYETHYLENE TAPE OR BACKER ROD.

4. EIFS EXPANSION JOINTS ARE REQUIRED IN CONTINUOUS ELEVATIONS AT INTERVALS NOT EXCEEDING 23 M (75 FT).

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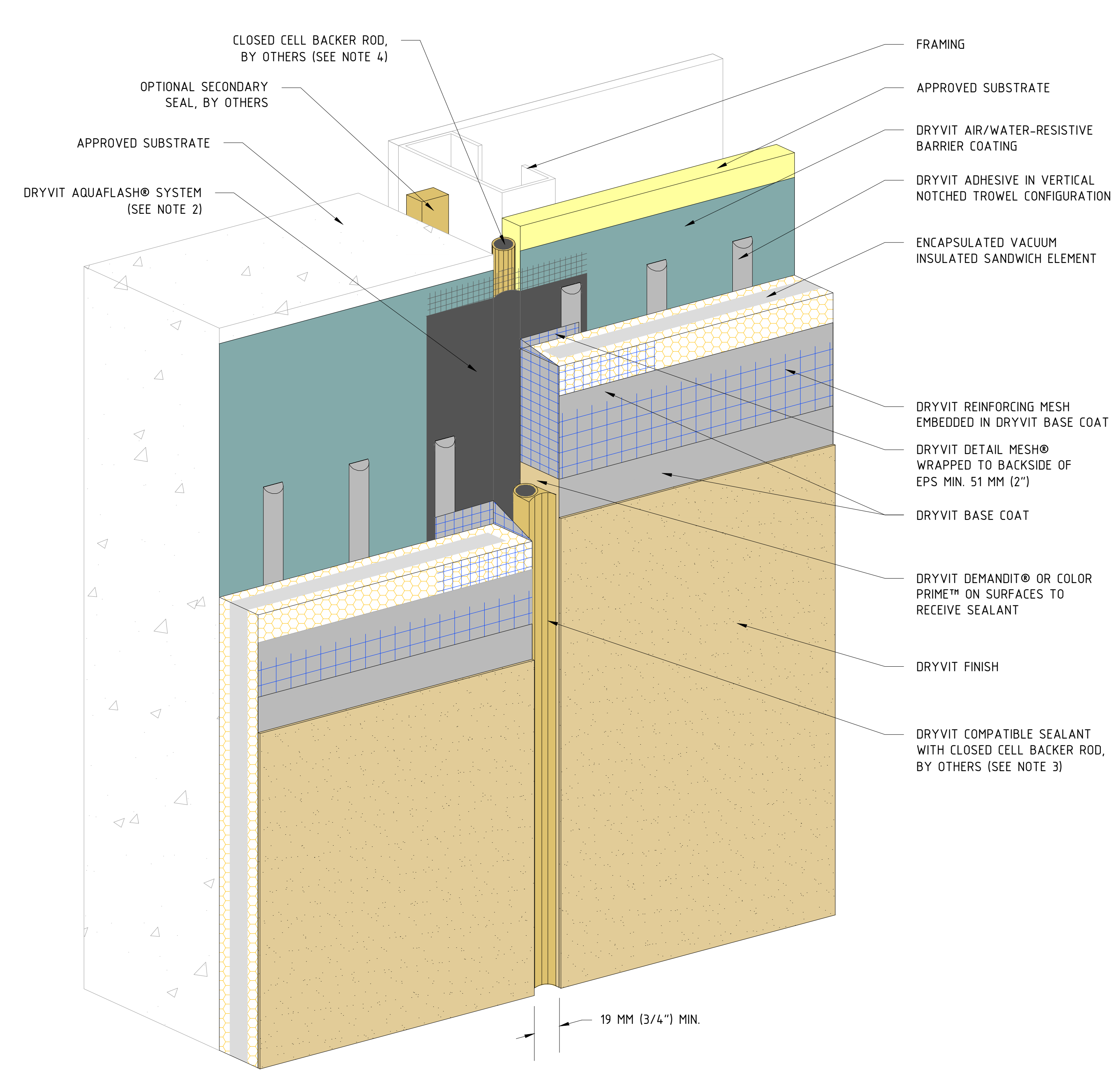

Outsulation® H.E. System®

Structural Expansion Joints

NOTES:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.

3. SEALANT SHALL NOT BE IN DIRECT CONTACT WITH ASPHALTIC ADHESIVE ON DRYVIT FLASHING TAPE. COVER DRYVIT FLASHING TAPE LAPS WITH POLYETHYLENE TAPE OR BACKER ROD.

4. LOCATE EXTERNAL SEALANT JOINT WITHIN 51 MM (2") OF SUBSTRATE JOINT.

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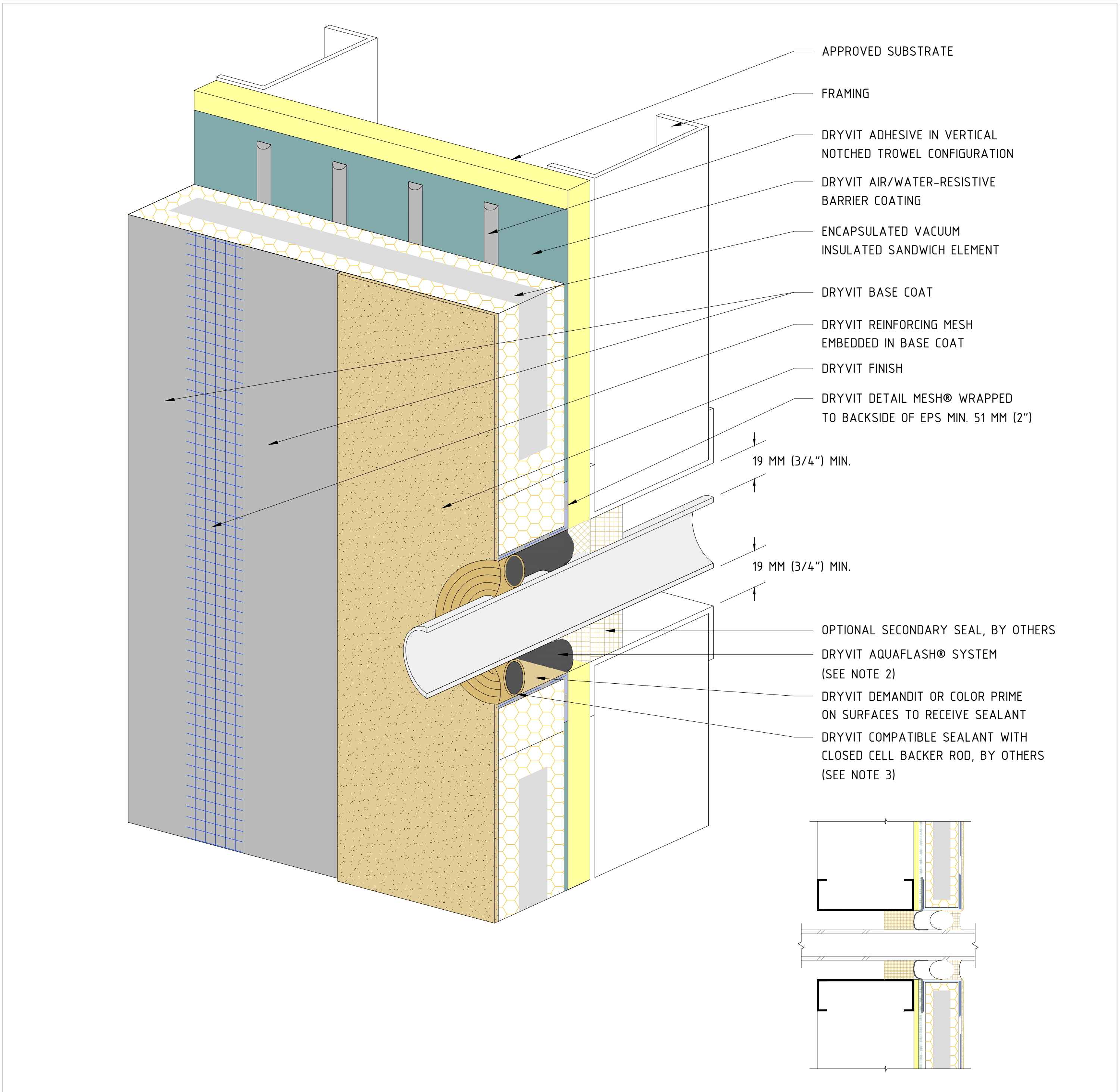

Outsulation® H.E. System®

Penetrations

NOTES:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.

3. SEALANT SHALL NOT BE IN DIRECT CONTACT WITH ASPHALTIC ADHESIVE ON DRYVIT FLASHING TAPE. COVER DRYVIT FLASHING TAPE LAPS WITH POLYETHYLENE TAPE OR BACKER ROD.

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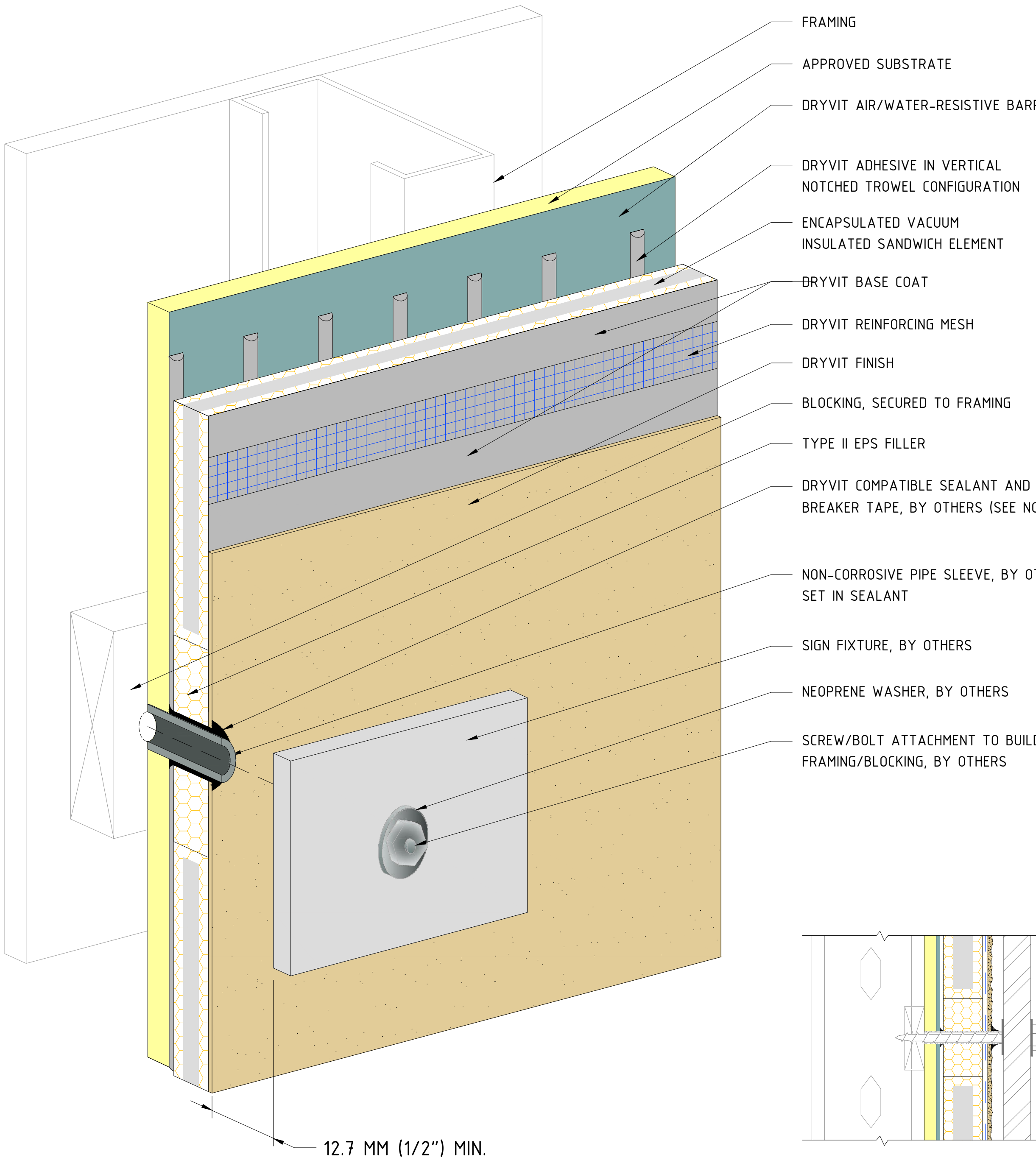
OHE 0.0.30



Outsulation® H.E. System®

Sign Attachment

NOTES:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. PERIMETER OF PIPE SLEEVE IS CAULKED TO PREVENT WATER ENTRY INTO WALL.

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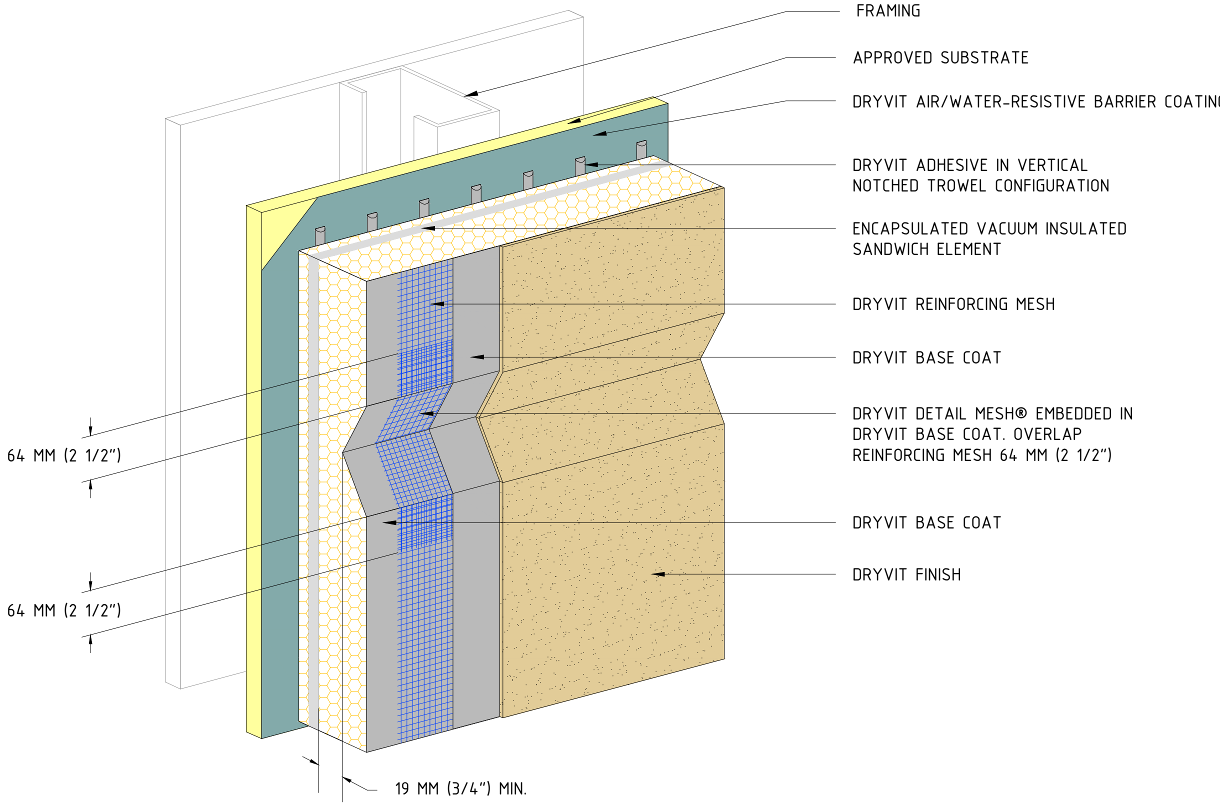

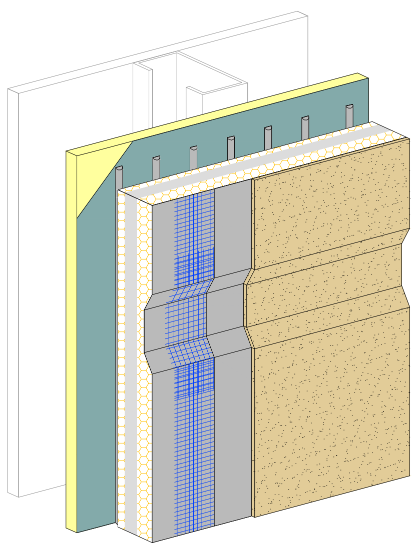

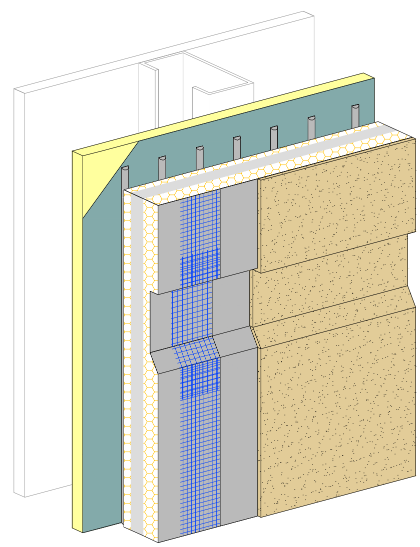

Outsulation® H.E. System®

Aesthetic Reveals

NOTES:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. SLOPE BOTTOM EDGE OF REVEALS FOR POSITIVE DRAINAGE.

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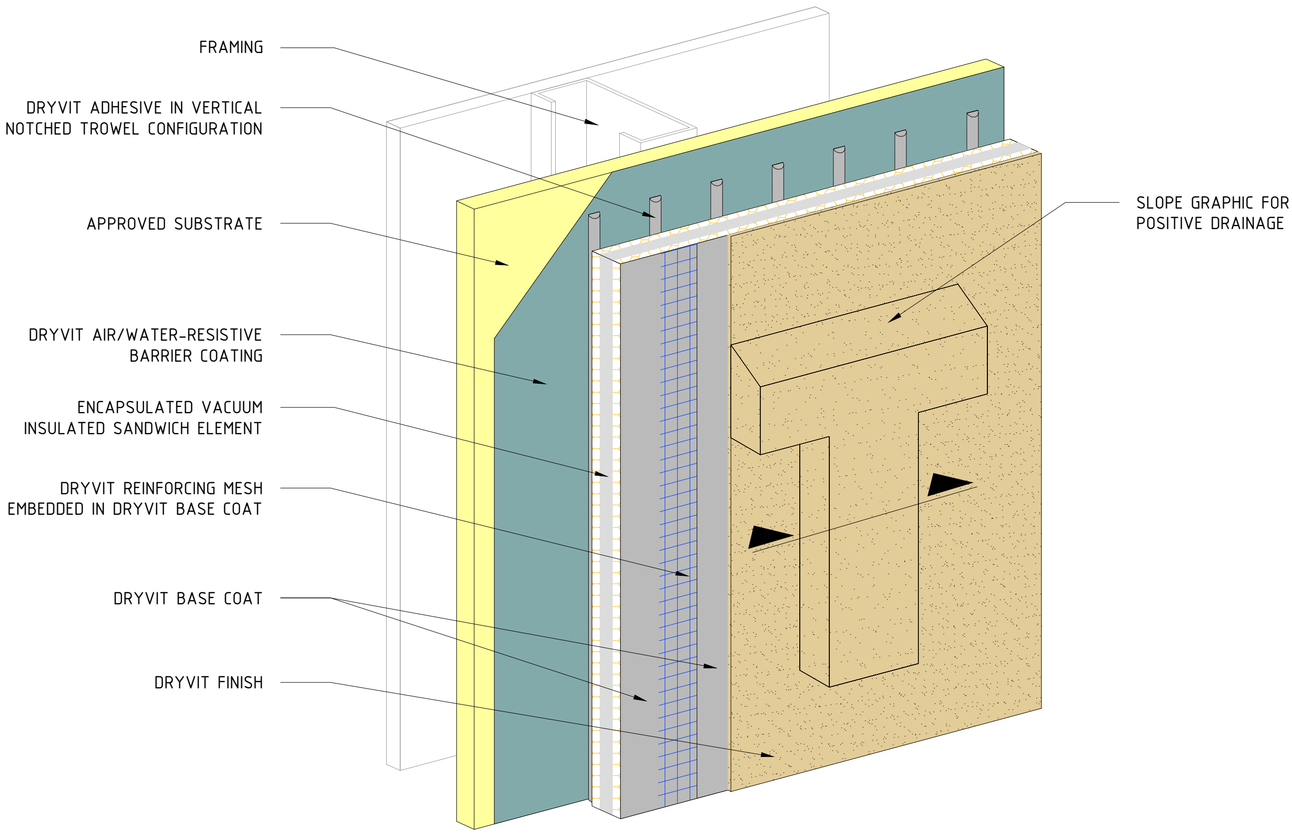
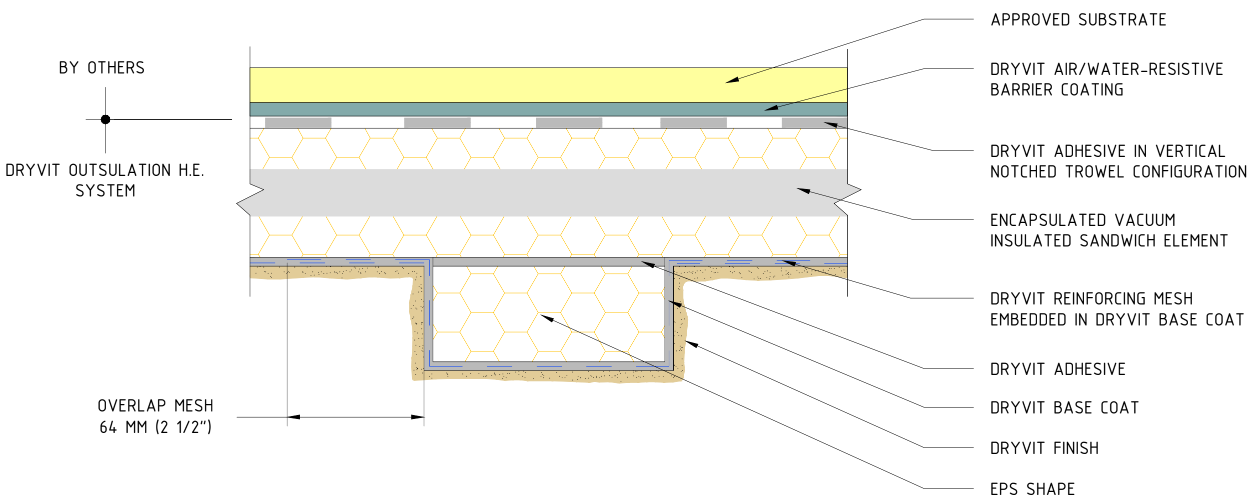
OHE 0.0.32





Outsulation® H.E. System®

Projecting Graphics

NOTES:
1. MAXIMUM THICKNESS OF EPS BUILT OUT SHAPES SHALL NOT EXCEED 330 MM (13 INCHES) AT ANY POINT MEASURED FROM THE SUBSTRATE.

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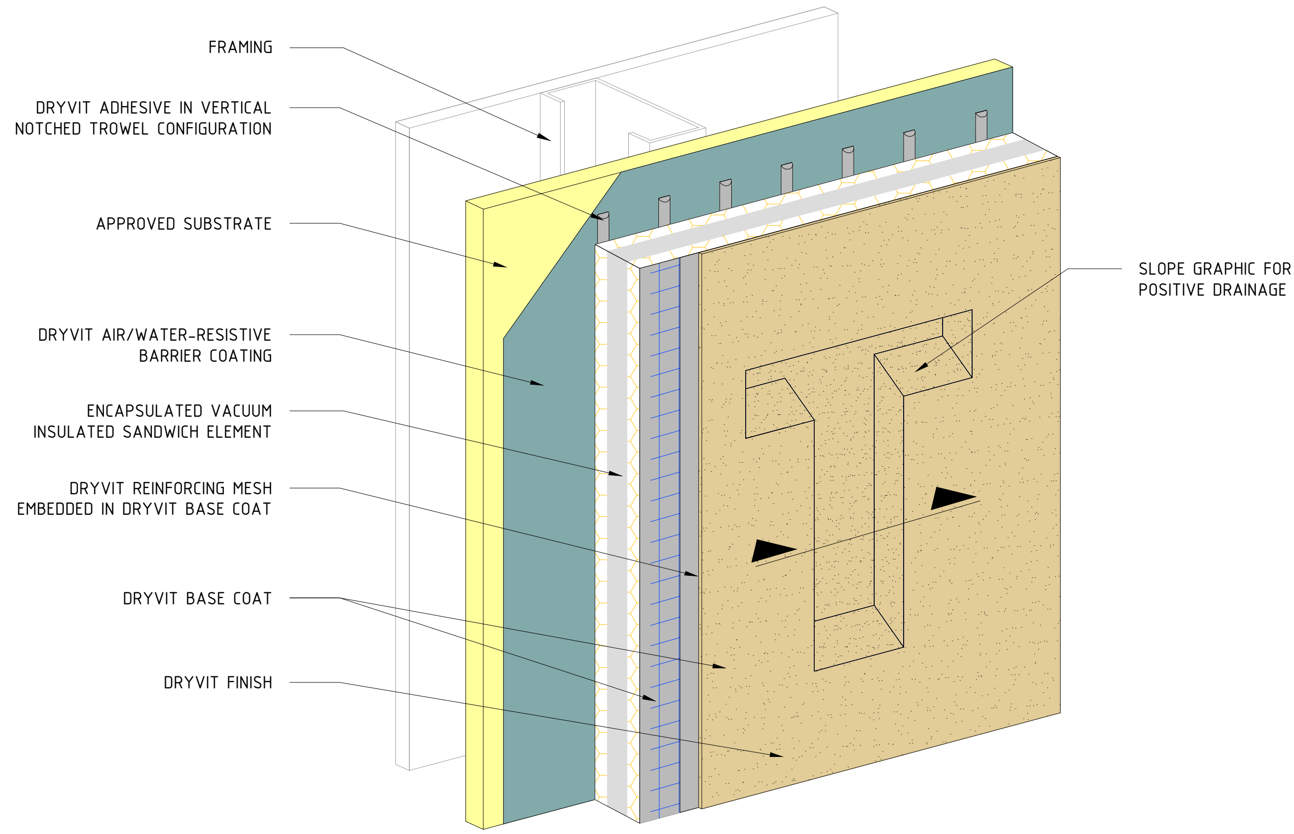

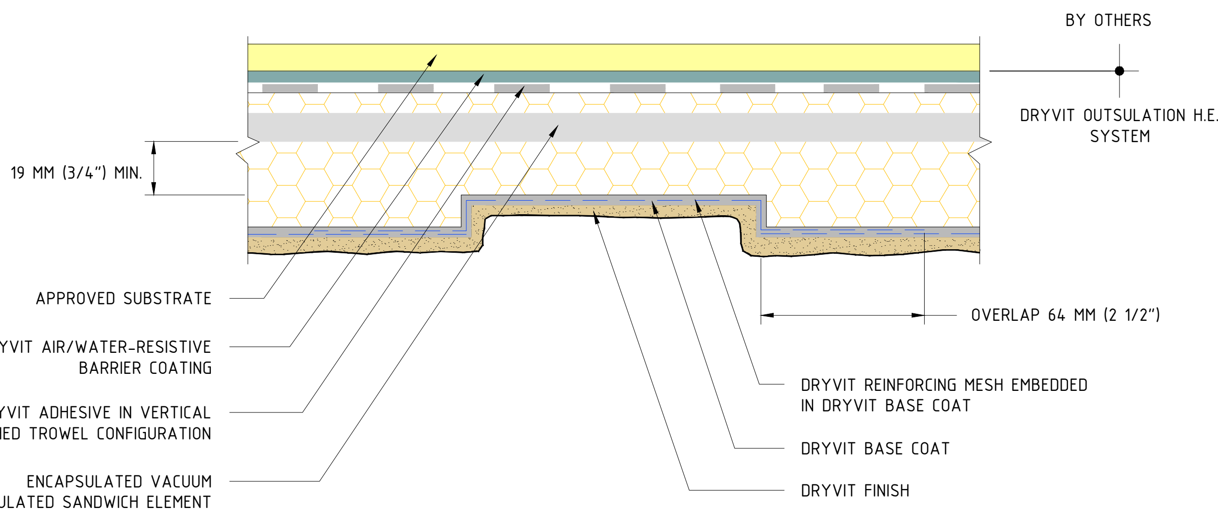

Outsulation® H.E. System®

Recessed Graphics

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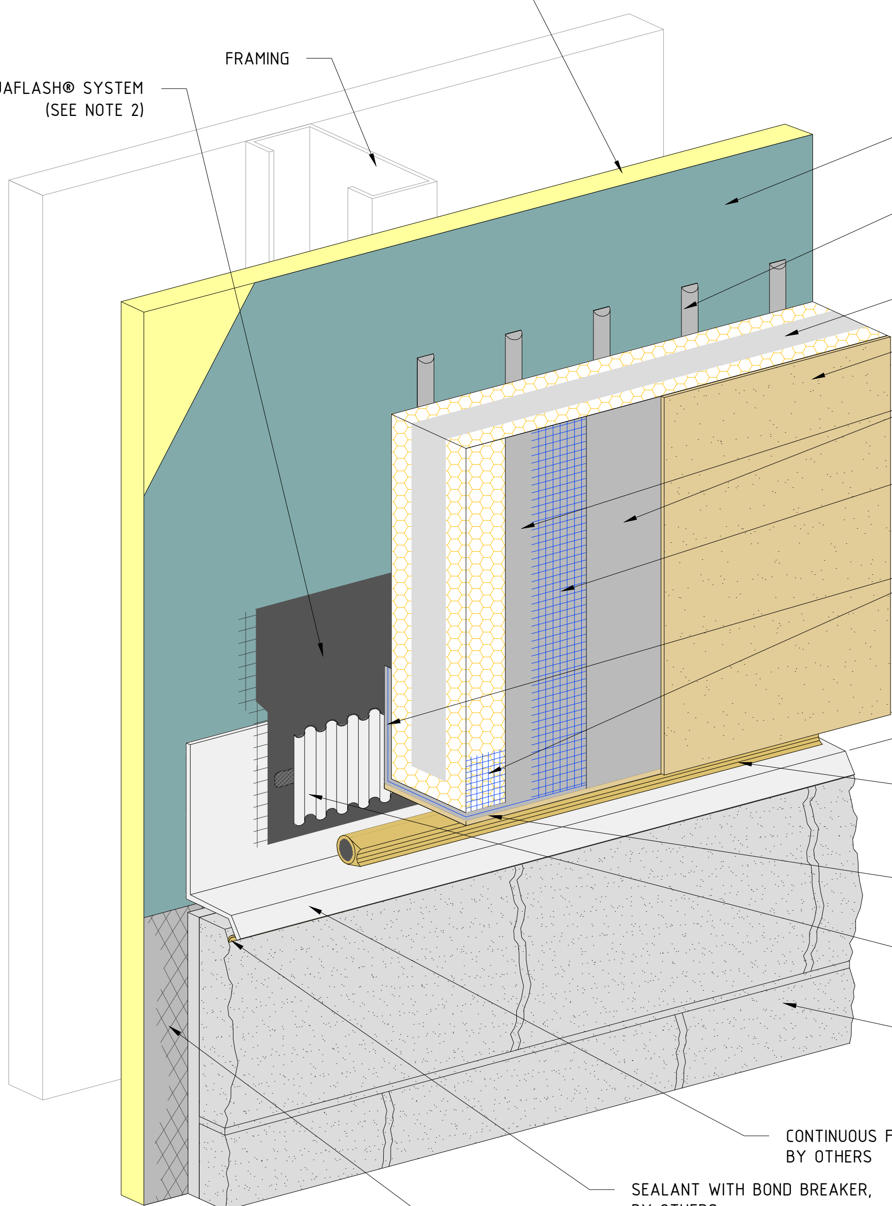

Outsulation® H.E. System®

Horizontal Joint at Stone Veneer

NOTES:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.

3. FOR INSTALLATION OF DRYVIT AIR/WATER-RESISTIVE BARRIER COATING BENEATH CLADDINGS OTHER THAN DRYVIT EIFS, REFER TO DRYVIT PUBLICATION DS840.

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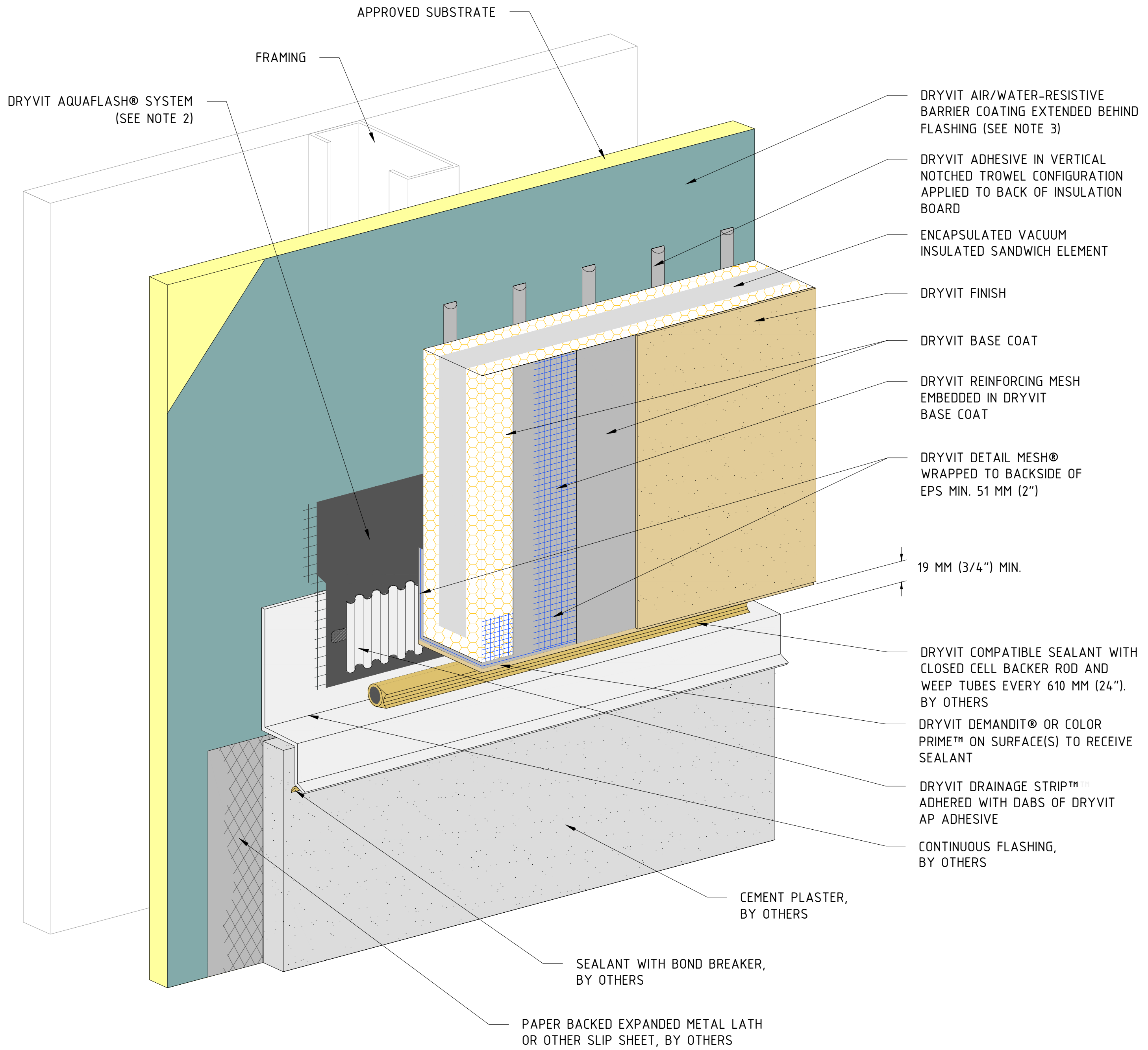

Outsulation® H.E. System®

Horizontal Joint at Stucco

NOTES:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

2. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.

3. FOR INSTALLATION OF DRYVIT AIR/WATER-RESISTIVE BARRIER COATING BENEATH CLADDINGS OTHER THAN DRYVIT EIFS, REFER TO DRYVIT PUBLICATION DS840.

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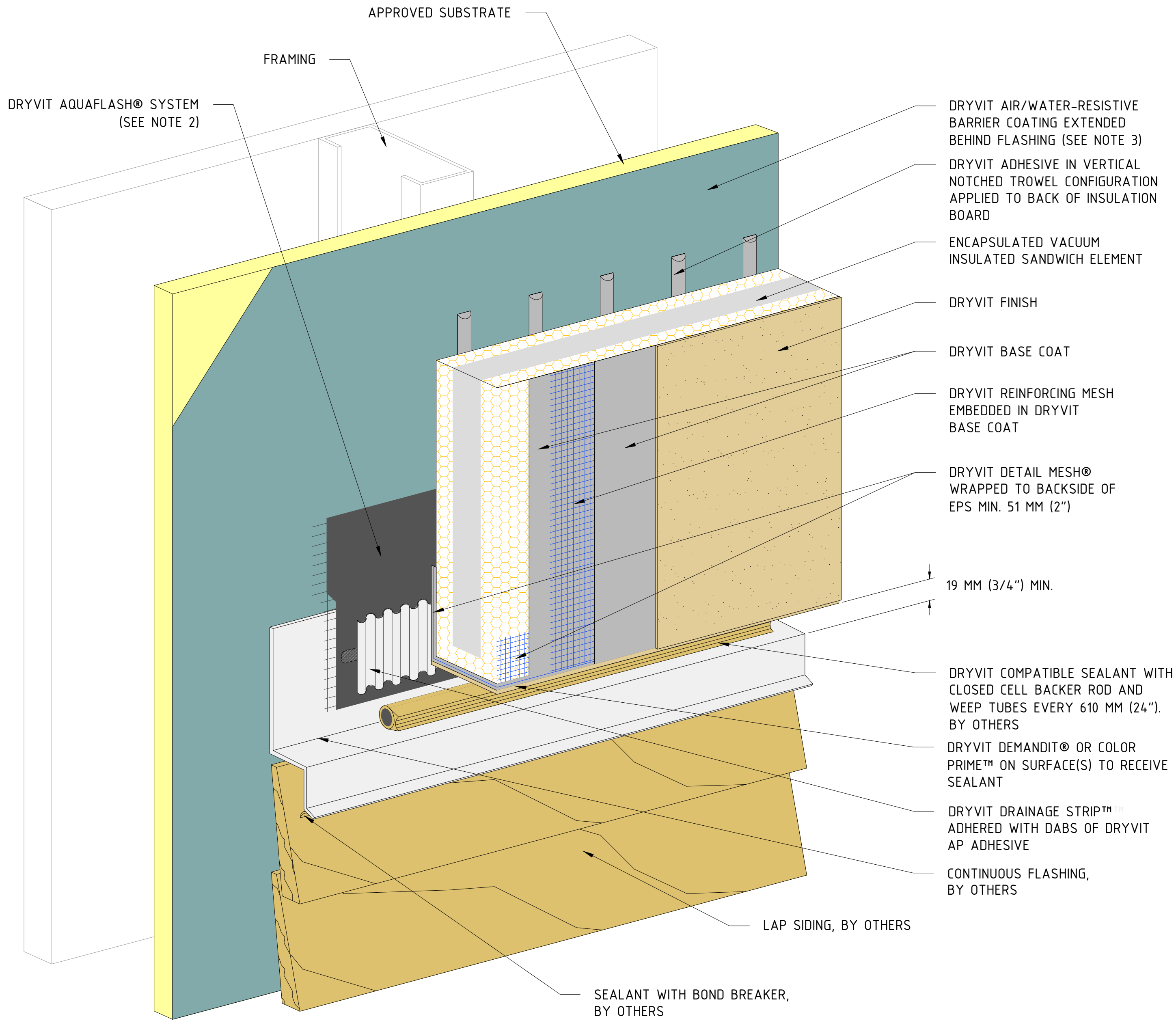

Outsulation® H.E. System®

Horizontal Joint at Wood Siding

NOTES:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

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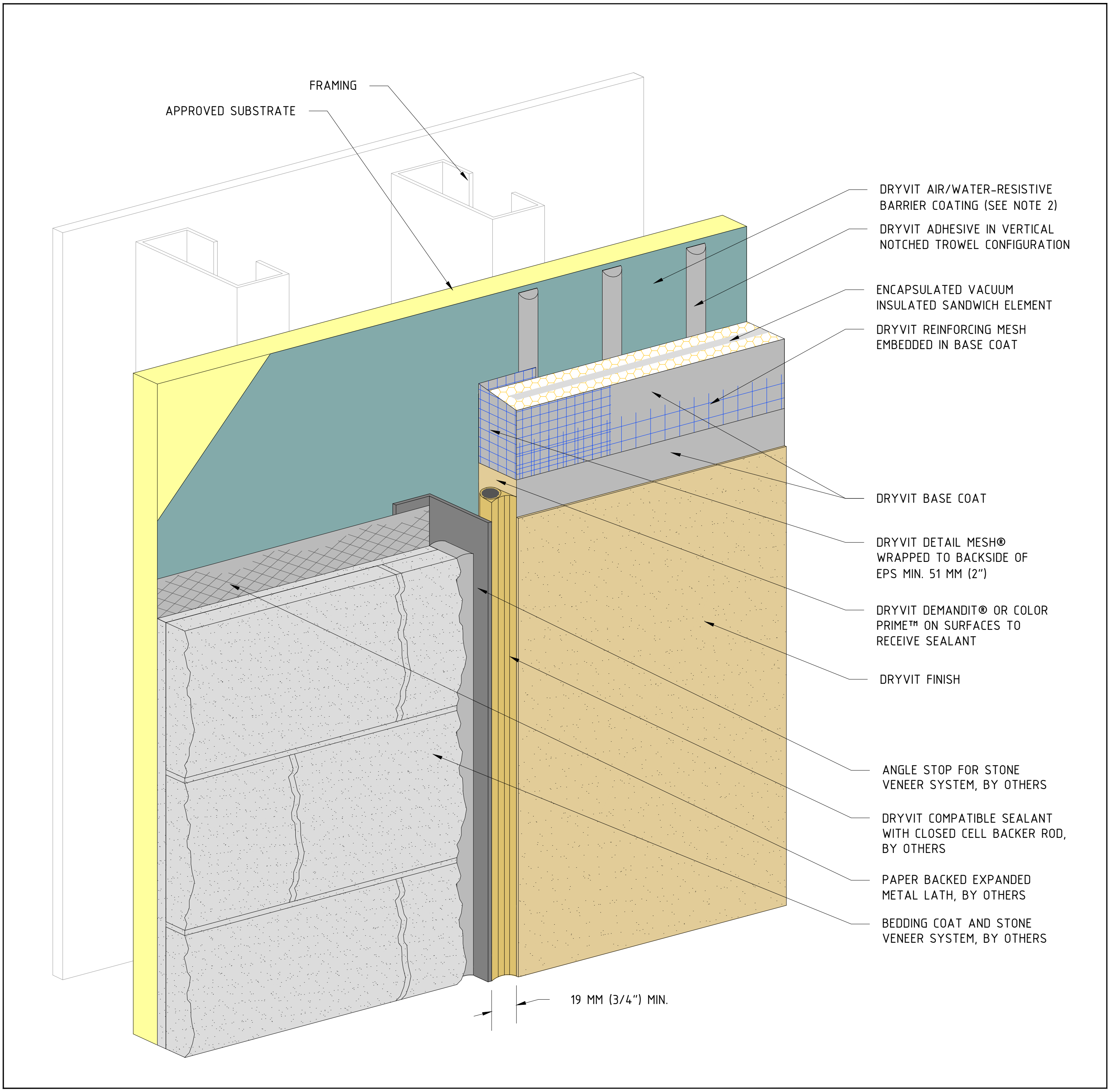

Outsulation® H.E. System®

Vertical Termination At Stone Veneer

NOTE:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.

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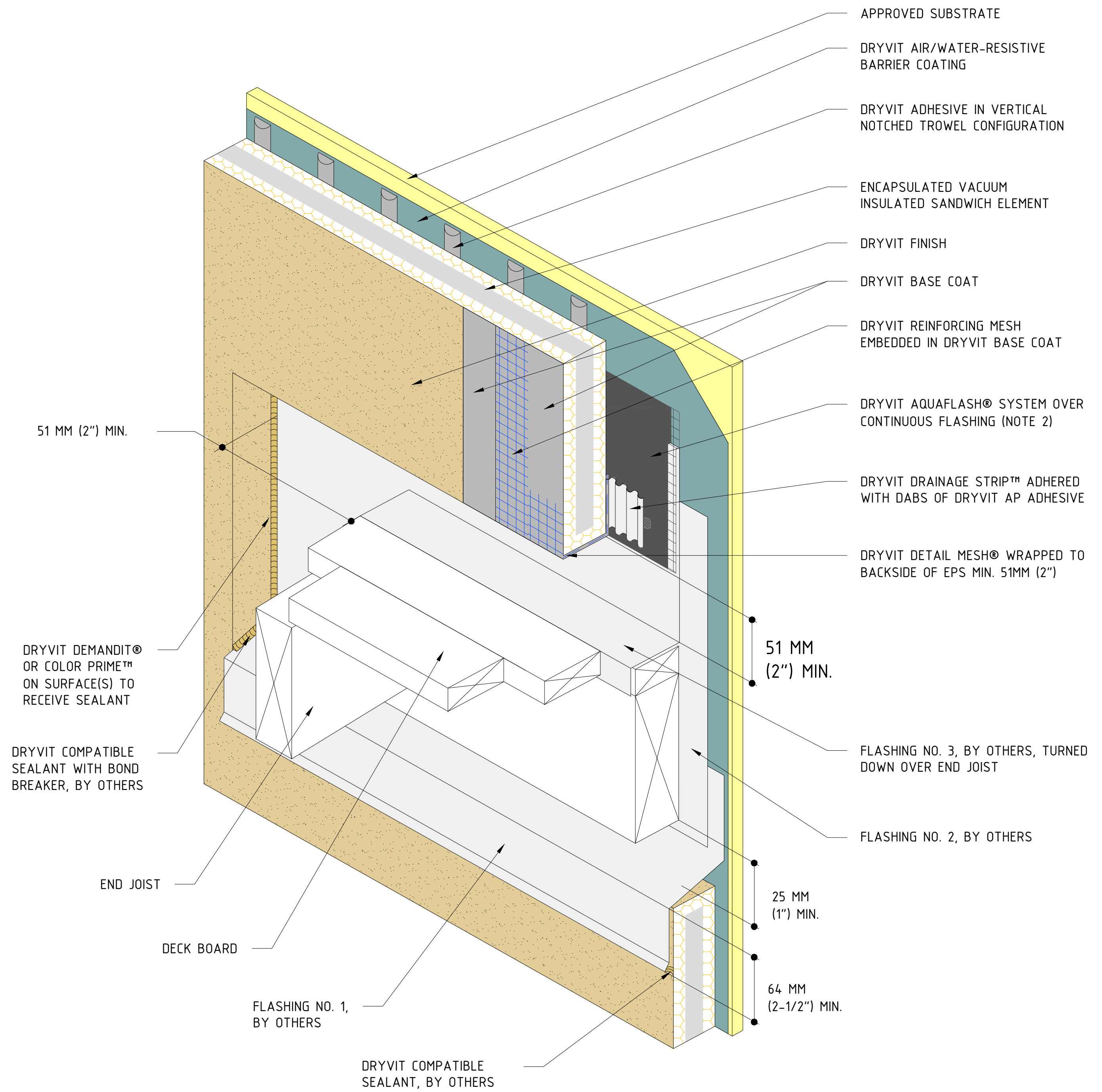

Outsulation® H.E. System®

Wood Framed Deck - Cut Away

NOTES:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.
2. DRYVIT FLASHING TAPE SURFACE CONDITIONER™ AND DRYVIT FLASHING TAPE™ MAY BE USED IN LIEU OF DRYVIT AQUAFLASH SYSTEM.
3. DETAIL DOES NOT APPLY TO CANTILEVERED DECKS. CANTILEVERED DECKS REQUIRE JOB SPECIFIC FLASHING DETAILS.

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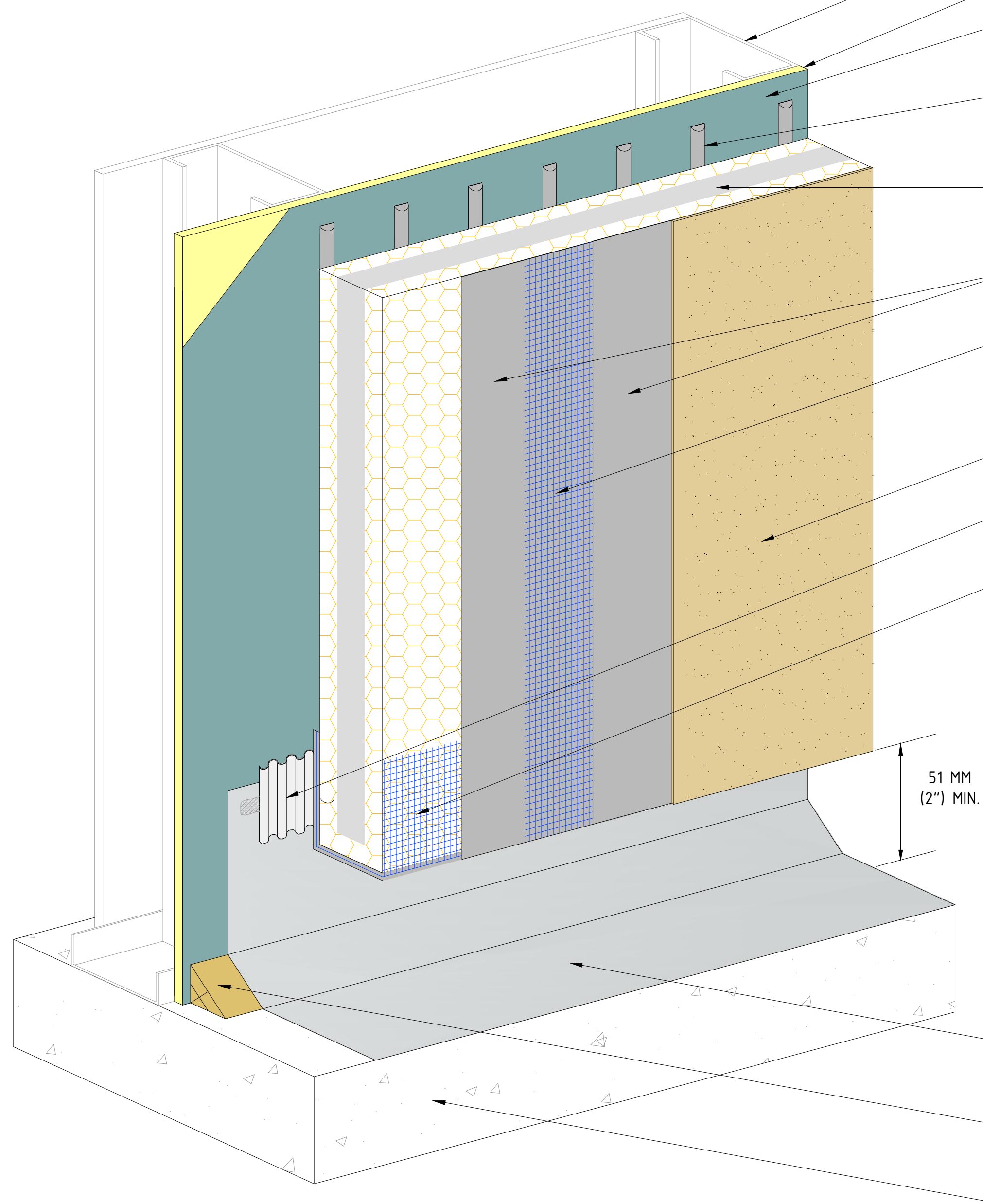

Outsulation® H.E. System®

Termination at Waterproof Deck

NOTES

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS

2. ENSURE BOTTOM EDGE OF DRAINAGE STRIP IS LEFT FREE TO DRAIN.

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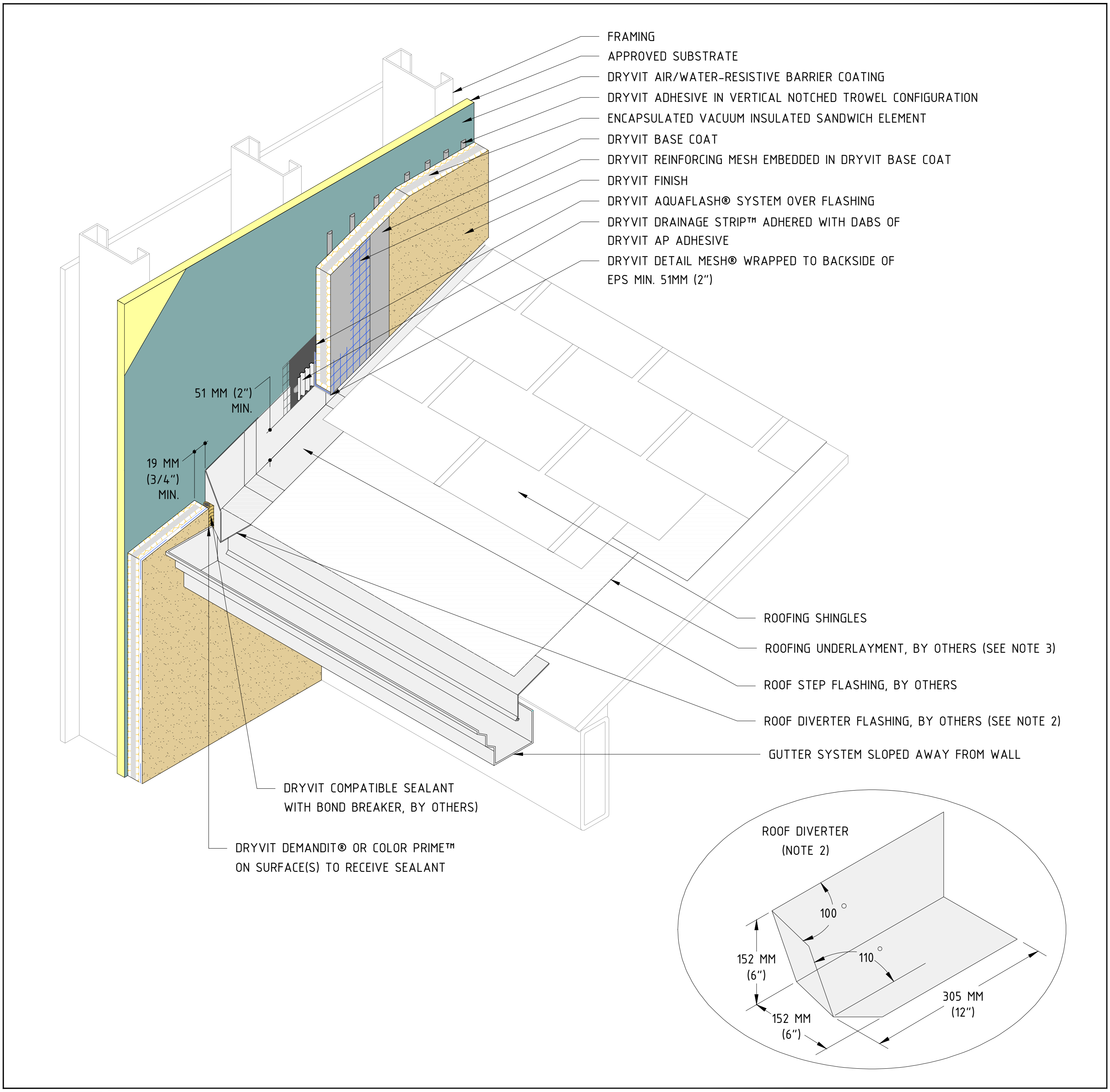

Outsulation® H.E. System®

Termination at Sloped Roof

NOTES:

1. EXTEND DIVERTER FLASHING (KICKOUT) A MINIMUM OF 25 MM (1") BEYOND FACE OF SYSTEM.

2. ROOF DIVERTER TO BE MADE FROM CORROSION RESISTANT MATERIAL MIN. 24 GAGE WITH WATER TIGHT SEAMS.

3. EXTEND ROOFING UNDERLAYMENT 127 MM (5") UP VERTICAL WALL BEHIND METAL FLASHING.

4. METAL FLASHINGS ARE 254 MM (10") X 51 MM (2") LONGER THAN THE EXPOSED PORTION OF THE ROOFING SHINGLE AND ARE BENT IN HALF TO ALLOW FOR TWO 127 MM (5") LEGS. ALTHOUGH NOT SHOWN, METAL FLASHINGS ARE STEP FLASHED (INTERWOVEN) WITH ROOFING SHINGLES.

OUTSULATION® H.E. SYSTEM™

An Exterior Wall Insulation and Finish System With Moisture Drainage Incorporating Vacuum Insulated Sandwich Elements (V.I.S.E.)

DS850

Outsulation H.E. System Application Instructions

Table of Contents

I. General Installation Requirements

A. Project Conditions

1. Storage
   a. Maximum storage temperature shall not exceed 38 °C (100 °F). Minimum storage temperature shall not be less than 4 °C (40 °F) with the exception of the following products:
      1) Demandit® and Revyvit®: 7 °C (45 °F).
      2) Ameristone™, TerraNeo®, Lymestone™, and Reflectit™: 10 °C (50 °F).
      3) Custom Brick™ Finish: refer to Custom Brick Polymer Specification, DS151.
      4) For other products, refer to specific product data sheets.
2. Application
   a. Application of wet materials shall not take place during inclement weather unless appropriate protection is provided.
   b. Protect materials from inclement weather until they are completely dry.
   c. Air and surface temperatures must be 4 °C (40 °F) or above and must remain so for a minimum of 24 hours or until dry at the time of Dryvit product application with the exception of the following products:
      1) Demandit® and Revyvit®: 7 °C (45 °F).
      2) Ameristone™, TerraNeo®, Lymestone™, and Reflectit™: 10 °C (50 °F).
      3) Custom Brick Finish: refer to Custom Brick Polymer Specification, DS151.
      4) For other products, refer to specific product data sheets.
      5) These temperatures shall be maintained with adequate air ventilation and circulation for a minimum of 24 hours (48 hours for Ameristone, TerraNeo and Lymestone) thereafter, or until the products are completely dry. Cool, humid conditions may require longer drying times.

B. Inspection of Substrate

1. Acceptable substrates for application of the Dryvit Outsulation H.E. System are listed in the Dryvit Outsulation H.E. System Specification, DS849.
2. The substrate must be securely fastened per contract documents.
3. The substrate attachment method must comply with all contract documents.
4. The substrate must be clean, dry, structurally sound, free of loose material, voids, projections, hot spots, release agents, coatings, or other materials that may affect adhesion.
5. There shall be no planar irregularities greater than 6.4 mm (1/4 in) within any 1.2 m (4 ft) radius.
6. Wood based sheathings require a 3.2 mm (1/8 in) gap between adjacent sheets per the guidelines published by the APA.

C. Flashing at System Terminations

1. General
   a. Ensure that flashing is installed in accordance with applicable code requirements and the contract documents. As a minimum, opening preparation is required as shown in the Outsulation H.E. System Installation Details, DS851.
2. Transition at Roof Lines
   a. Ensure the roof has positive drainage, i.e. all runoff shall be directed to the exterior and away from the structure.
   b. Roof flashing (by others) shall be installed in accordance with industry guidelines, manufacturer's instructions and contract documents.
   c. Runoff diverters (i.e. kickouts, crickets and saddles) (by others) shall be installed in accordance with industry guidelines, manufacturer's instructions and contract documents. Particular attention must be paid to the eaves/chimney intersections and sloped roof/wall intersections. Refer to the Dryvit Outsulation H.E. System Installation Details, DS851.
   d. Hold system a minimum of 203 mm (8 in) above flat roofs; 51 mm (2 in) above sloped roofs.
3. Openings
   a. Heads, jambs and sills of all openings shall be prepared with Dryvit Backstop® NT, AquaFlash®, Flashing Tape™ or other approved flashing material selected by the design professional prior to window/door, mechanical equipment, or other component installation. For proper application, refer to the Dryvit Outsulation H.E. System Installation Details, DS851.
      NOTE: Sill piece shall extend to the inside face of wall and continue a minimum of 102 mm (4 in) up at the jambs.
   b. Continuous flashing at heads of openings as indicated in contract documents. **NOTE: For windows or doors that do not have integral flashing, a field-applied flashing shall be installed (by others) in accordance with industry guidelines, manufacturer's instructions and contract documents. Refer to the Dryvit Outsulation H.E. System Installation Details, DS851.**
   c. Individual windows that are ganged to make multiple units require the heads to be continuously flashed and the joints between the units to be fully sealed.
4. Decks and Patios
   a. Wood decks shall be properly flashed prior to system application. See the Dryvit Outsulation H.E. System Installation Details, DS851.

b. Verify that the system terminates above poured decks, patios, landings, etc. and that they are properly sloped and waterproofed to direct water away from the walls.

5. Utilities
   a. Provisions must be made to ensure that the system terminates properly at lighting fixtures, electrical outlets, hose bibs, dryer vents, etc. Refer to the Dryvit Outsulation H.E. System Installation Details, DS851 for general information and guidance.
6. Grade Level Terminations
   a. Hold system a minimum of 203 mm (8 in) above finished grade.

D. Sealants
1. Dryvit materials shall be completely dry prior to installation of sealant materials (typically 48 - 72 hours). Humid or cool conditions may require longer drying times.
   Notify the general contractor and/or architect and/or owner of all discrepancies. Do not proceed until all unsatisfactory conditions have been corrected.

II. Materials Required for Completing Installation of the Outsulation H.E. System

A. Materials Supplied by Dryvit Systems, Inc.
1. AquaFlash and AquaFlash Mesh
2. Backstop NT – Texture, Smooth, or Spray, or Backstop DMS
3. Grid Tape™
4. Dryvit Flashing Tape and Flashing Tape Surface Conditioner™
5. AP Adhesive™
6. Drainage Track
7. Drainage Strip™
8. Starter Strip™- optional
9. Track - optional
10. Genesis®, Genesis® DM, Genesis® DMS, Primus®, Primus® DM, Dryflex®
11. NCB™
12. Genesis® FM
13. Rapidry™ DM 35-50, Rapidry™ DM 50-75, RapidPatch™
14. Standard Mesh, Standard Plus Mesh, Intermediate Mesh, Panzer® 15, Panzer 20, Corner Mesh, and Detail Mesh®
    a. It shall be colored blue for product identification bearing the Dryvit logo.
15. Dryvit Finishes
16. Dryvit Coatings and Primers
17. Encapsulated Vacuum Insulated Sandwich Elements
    NOTE: Materials listed above are those contained or referenced in the Outsulation H.E. Specification, DS849. Typically the project specification will identify the specific materials necessary to complete application.

B. Materials Supplied by Others
1. Portland Cement: Type I or II
2. Clean Potable Water
3. Expanded Polystyrene Encapsulated V.I.S.E. meeting ASTM C578 Type II

III. Mixing Instructions

A. General
1. No additives such as sand, aggregates, rapid binders, anti-freeze, accelerators, etc. shall be added to any Dryvit materials under any circumstances. **Such additives will adversely affect the performance of the material and void all warranties.**

B. Air/Water-Resistive Barrier Materials
1. AquaFlash
   a. Open the bucket with a utility knife or lid-off.
   b. AquaFlash is ready to use after an initial spin-up using a “Twister” paddle or equivalent mixing blade, powered by a 12.7 mm (1/2 in) drill, at 450 - 500 rpm. Do not add cement or any other additives.
2. Backstop NT
   a. Open the bucket with a utility knife or lid-off.
   b. Backstop NT is ready to use after an initial spin-up using a “Twister” paddle or equivalent mixing blade, powered by a 12.7 mm (1/2 in) drill, at 450 - 500 rpm. Do not add cement or any other additives.
3. Backstop DMS (can also be used as adhesive)
   a. See DS704 for mixing instructions

C. Adhesive and Base Coat
1. Primus, Genesis, or Genesis FM
   a. Open the bucket with a utility knife or lid-off.
   b. Due to shipping and storage, there may be some separation of materials. Prior to splitting the material and adding Portland cement, mix the material thoroughly. Use a “Twister” paddle or equivalent mixing blade

powered by a 12.7 mm (1/2 in) drill, at 500 - 1200 rpm only. **NOTE: A minimum 7 amp drill works best for Portland cement based materials. CAUTION: Do not over-mix or use other types of mixing blades as air entrapment and product damage may occur and result in workability and performance problems.**

c. Pour 1/2 of the freshly mixed material [approximately 13.5 kg (30 lbs)] into a clean plastic container.

d. Add 1/3 of a bag [approximately 13.5 kg (30 lbs)] of fresh, lump free Type I or II Portland cement. Either gray or white cement is acceptable. Add cement <u>slowly</u> and mix thoroughly. **Do not add large quantities of cement at one time.**

e. Clean potable water may be added to the mixture to adjust the workability.

1) Primus

a) Add as little water as possible, in small increments, and only after the Portland cement is thoroughly mixed. **Do not over water as this will degrade the performance and promote efflorescence.**

b) Mix the Primus material with Portland cement thoroughly; then wait five (5) minutes and mix again to break the initial set. Retempering with a small amount of water is permissible provided the mixture has not set. The mixture has a pot life similar to other Portland cement plaster material. Mix only as much material as can be conveniently used during a work period.

2) Genesis and Genesis FM

a) Add 950 ml (1 qt) of water prior to adding Portland cement. Additional water may be added to adjust workability.

b) Mix the Genesis material with Portland cement thoroughly; then wait ten to fifteen (10-15) minutes and mix again to break the initial set. Retempering with a small amount of water is permissible provided the mixture has not set. The mixture has a pot life similar to other Portland cement plaster material. Mix only as much material as can be conveniently used during a work period.

2. Primus DM

a. Pail Mixing

1) One 22.7 kg (50 lb) bag of material will produce approximately 19 L (5 gal) of Primus DM mixture. Add 5.7 L (1.5 gal) of clean potable water into a clean plastic container.

2) Add Primus DM slowly while mixing using a "Twister" paddle or equivalent mixing blade, powered by a 12.7 mm (1/2 in) drill, at 500 - 1200 rpm**. NOTE: A minimum 7 amp drill works best for Portland cement based materials.**

3) Thoroughly mix until uniformly wetted, adjusting consistency with a small amount of water or Primus DM material.

4) Allow the mixture to set a minimum of five (5) minutes then retemper, adding a small amount of water if necessary. Material must be free of lumps before using.

b. Mortar Mixer

1) Add 5.7 L (1.5 gal) of clean potable water for each 22.7 kg (50 lb) bag of Primus DM into a clean mortar mixer.

2) Add the Primus DM while the mixer is running. Let mix three to five (3 – 5) minutes, shut mixer off for five (5) minutes, then run mixer for another two to three (2 – 3) minutes to break the set and add a small amount of water if necessary to adjust the workability. The pot life is one to three (1 - 3) hours depending on weather.

3. Genesis DM

a. Pail Mixing

1) One bag of Genesis DM will produce approximately 19 L (5 gal) of Genesis DM mixture. To a clean 19 L (5 gal) pail, add 5.7 - 6.6 L (6 - 7 qt) of clean potable water.

2) Add the Genesis DM slowly while constantly mixing with a "Twister" paddle or equivalent mixing blade, powered by a 12.7 mm (1/2 in) drill, at 500 - 1200 rpm. **NOTE: A minimum 7 amp drill works best for Portland cement based materials.**

3) Thoroughly mix until uniformly wetted, adjusting consistency with a small amount of water or Genesis DM.

4) Let set for ten (10) minutes. Retemper, adding a small amount of water if necessary. Material must be free of lumps before using.

b. Mortar Mixer

1) Add 5.7 - 6.6 L (6 - 7 qt) of clean potable water for each 22.7 kg (50 lb) bag of Genesis DM into a clean mortar mixer.

2) Add the Genesis DM while the mixer is running. Let mix three to five (3 – 5) minutes, shut the mixer off for ten (10) minutes, then run mixer for another two to three (2 – 3) minutes to break the set adding a small amount of water if necessary to adjust workability. The pot life is one to one and one half (1 – 1 ½) hours depending on weather.

4. Genesis DMS

a. Sprayer

1) Connect a source of clean, cool potable water to a spray machine suitable for EIFS applications.

2) Regulate the water flow rate to provide the desirable mixing consistency of material. Material may thicken up upon leaving the mixing cylinder at a given water flow and loosen up after pumping. **NOTE: The consistency for application must be determined after pumping**.

b. Pail Mixing

1) One bag of Genesis DMS will produce approximately 19 L (5 gal) of Genesis DMS mixture. To a clean 19 L (5 gal) pail, add 6.6 - 8.5 L (7 - 9 qt) of clean, cool potable water.

2) Add the Genesis DMS slowly while continuously mixing with a “Twister” paddle or equivalent mixing blade, powered by a 12.7 mm (1/2 in) drill, at 500 - 1200 rpm. **NOTE: A minimum 7 amp drill works best for Portland cement based materials.**

3) Thoroughly mix until uniformly wetted, adjusting consistency with a small amount of water or Genesis DMS.

4) Let set for five (5) minutes. Retemper, adding a small amount of water if necessary. Material must be free of lumps before using.

c. Mortar Mixer

1) Add 6.6 - 8.5 L (7 - 9 qt) of clean, cool potable water for each 22.7 kg (50 lb) bag of Genesis DMS into a clean mortar mixer.

2) Add the Genesis DMS while the mixer is running. Let mix three to five (3 – 5) minutes, shut the mixer off for five (5) minutes, then run mixer for another two to three (2 – 3) minutes. Retemper, adding a small amount of water if necessary. Material must be free of lumps before using. The pot life is one to three (1 - 3) hours depending on weather.

5. Rapidry DM 35-50

a. Pail Mixing

1) One 22.7 kg (50 lb) bag of Rapidry DM 35-50 will produce approximately 19 L (5 gal) of Rapidry DM 35-50 mixture. To a clean Dryvit 19 L (5 gal) pail, add 6.1 L (6.5 qt) of clean potable water. As an alternative, on the inside of the Dryvit 19 L (5 gal) pail, draw a horizontal line which measures 113 mm (4 7/16 in) from the base of the pail and fill with water.

2) Add the Rapidry DM 35-50 slowly while mixing with a “Twister” paddle or equivalent mixing blade, powered by a 12.7 mm (1/2 in) drill, at 500 - 1200 rpm. **NOTE: A minimum 7 amp drill works best for Portland cement based materials.**

3) Thoroughly mix until uniformly wetted, adjusting consistency with a small amount of water or Rapidry DM 35-50 material. Material must be free of lumps before using.

b. Mortar Mixer

1) Add 6.1 L (6.5 qt) of clean potable water for each 22.7 kg (50 lb) bag of Rapidry DM 35-50 into a clean mortar mixer.

2) Add the Rapidry DM 35-50 while the mixer is running. Mix for three to five (3 - 5) minutes adjusting consistency with a small amount of water or Rapidry DM 35-50. Material must be free of lumps before using. The pot life is approximately 30 minutes depending on temperature.

6. Rapidry DM 50-75

a. Pail Mixing

1) One 20.4 (45 lb) bag of Rapidry DM 50-75 will produce approximately 19 L (5 gal) of Rapidry DM 50-75 mixture. To a clean Dryvit 19 L (5 gal) pail, add 5.2 L (5.5 qt) of clean potable water. As an alternative, on the inside of the Dryvit 19 L (5 gal) pail, draw a horizontal line which measures 97 mm (3 13/16 in) from the base of the pail and fill with water.

2) Add the Rapidry DM 50-75 slowly while mixing with a “Twister” paddle or equivalent mixing blade, powered by a 12.7 mm (1/2 in) drill, at 500 - 1200 rpm. **NOTE: A minimum 7 amp drill works best for Portland cement based materials.**

3) Thoroughly mix until uniformly wetted, adjusting consistency with a small amount of water or Rapidry DM 50-75 material.

4) Let set for five (5) minutes. Retemper, adding a small amount of water if necessary. Material must be free of lumps before using.

b. Mortar Mixer

1) Add 5.2 L (5.5 qt) of clean potable water for each 20.4 kg (45 lb) bag of Rapidry DM 50-75 into a clean mortar mixer.

2) Add the Rapidry DM 50-75 while the mixer is running. Mix for three to five (3 – 5) minutes, shut the mixer off for 5 minutes, then run mixer for another two to three (2 – 3) minutes to break the set adjusting consistency with a small amount of water or Rapidry DM 50-75. The pot life is approximately 30 minutes depending on temperature.

D. Base Coat only

1. NCB

a. Open the bucket with a utility knife or lid-off.

b. Mix NCB to a smooth, homogeneous consistency with a “Twister” paddle or equivalent mixing blade, powered by a 12.7 mm (1/2 in) drill, at 450 - 500 rpm. A small amount of clean potable water may be added to adjust workability.

2. Dryflex
   a. Open the bucket with a utility knife or lid-off.
   b. Due to shipping and storage, there may be some separation of materials. Prior to splitting the material and adding Portland cement, mix the material thoroughly. Use a "Twister" paddle or equivalent mixing blade, powered by a 12.7 mm (1/2 in) drill, at 500 - 1200 rpm. **NOTE: A minimum 7 amp drill works best for Portland cement based materials. CAUTION: Do not over-mix or use other types of mixing blades as air entrapment and product damage may occur and result in workability and performance problems.**
   c. Pour 1/2 of the freshly mixed material [approximately 10.21 kg (22.5 lbs)] into a clean plastic container.
   d. Add 1/4 of a bag [approximately 10.21 kg (22.5 lbs)] of fresh, lump free Type I or II Portland cement. Either gray or white cement is acceptable. Add cement slowly and mix thoroughly. **Do not add large quantities of cement at one time.**
   e. Clean potable water may be added to the mixture to adjust the workability. Add as little water as possible, in small increments, and only after the Portland cement is thoroughly mixed. **Do not over-water as this will degrade the performance and promote efflorescence. NOTE: It is advisable to mix the Dryflex material with Portland cement thoroughly; then wait five (5) minutes and mix again to break the initial set. Retempering with a small amount of water is permissible provided the mixture has not set. The mixture has a pot life similar to any Portland cement material. Mix only as much material as can be conveniently used during a work period.**

E. Primers
1. Color Prime™, Color Prime - W™, Primer with Sand™, and Weatherprime®
   a. Mix material with a "Twister" paddle or equivalent mixing blade, powered by a 12.7 mm (1/2 in) drill, at 450 - 500 rpm to a homogeneous consistency.

F. Finish
1. Quarzputz®, Quarzputz® E, Sandblast®, Freestyle®, Sandpebble®, Sandpebble® E, Sandpebble® Fine, Sandpebble® Fine E, Weatherlastic® Finishes, and DPR FM™ Finishes.
   a. Thoroughly mix the factory-prepared Dryvit finish with a "Twister" paddle or equivalent mixing blade powered by a 12.7 mm (1/2 in) drill, at 450 - 500 rpm, until a uniform, homogeneous consistency is attained. A small amount of clean potable water may be added to adjust workability. Always add the same amount of water to each pail within a given lot to avoid color variation.

   NOTE: If using a tint pack to color finish please refer to Tint Pack Mixing Instructions, DS750.

G. Specialty Finishes
1. Ameristone
   a. Mix Ameristone for approximately one (1) minute to ensure uniformity using a "Twister" paddle or equivalent mixing blade powered by a 12.7 mm (1/2 in) drill, at 450 - 500 rpm, just prior to application. **DO NOT OVERMIX.**
   b. Mix all pails for the same amount of time.
   c. If clean potable water is added as described in DS142 for various application techniques, the same amount must be added to each pail.
2. Stone Mist®
   a. Mix Stone Mist for one (1) minute to ensure uniformity using a "Twister" paddle or equivalent mixing blade, powered by a 12.7 mm (1/2 in) drill, 450 - 500 rpm, just prior to application. **DO NOT OVERMIX.**
3. TerraNeo
   a. Mix TerraNeo for one (1) minute just prior to application, to ensure uniformity using a "Twister" paddle or equivalent mixing blade, powered by a 12.7 mm (1/2 in) drill, at 450 - 500 rpm. **DO NOT OVERMIX**.
4. Lymestone
   a. Mix Lymestone with a "Twister" paddle or equivalent mixing blade, powered by a 12.7 mm (1/2 in) drill, at 450 - 500 rpm until a uniform workable consistency is attained.

   NOTE: If using a tint pack to color finish please refer to Tint Pack Mixing Instructions, DS750.
5. Custom Brick Finishes
   a. For Custom Brick finishes, refer to Dryvit Custom Brick Application Instructions, DS154, for complete mixing instructions.

   NOTE: If using a tint pack to color finish please refer to Tint Pack Mixing Instructions, DS750.
6. Reflectit™
   a. Refer to Reflectit Data Sheet DS705 and Application Instructions DS124 for complete instructions.

H. Coatings and Sealers
1. Demandit, Revyvit, Weathercoat™, and Weatherlastic® Smooth
   a. Mix material with a "Twister" paddle or equivalent mixing blade, powered by a 12.7 mm (1/2 in) drill, at 450 - 500 rpm to a homogeneous consistency.
2. Tuscan Glaze™
   a. Mix Tuscan Glaze with a "Twister" paddle or equivalent mixing blade, powered by a 12.7 mm (1/2 in) drill, at 450 - 500 rpm to a homogeneous consistency, immediately prior to application. As an alternate, boxing of buckets is acceptable. **Continuously** agitate throughout application to ensure color consistency.

3. SealClear™
   a. Stir material thoroughly before using and stir often during the application process. As an alternate, boxing of buckets is acceptable.

IV. Rough Opening Preparation Options

A. AquaFlash System Option

1. AquaFlash must be installed to provide a continuous barrier from the air/water-resistive barrier/sheathing substrate onto the framing edges at discontinuities and terminations such as openings, expansion joints, tops of parapets, etc. Refer to Dryvit Outsulation H.E. System Installation Details, DS851.
2. Surface Preparation
   a. Apply only when air and surface temperatures are above 4 °C (40 °F).
   b. The surface to receive the AquaFlash System must be clean, dry, smooth and free of any condition that will hinder adhesion.
   c. Clean loose dust or dirt from the surface by wiping with a clean, dry cloth or brush.
3. AquaFlash System Application
   a. Rough Openings (Windows, Doors, Others)
      1) Cut AquaFlash Mesh to proper length [rough opening plus 102 mm (4 in)] extending 51 mm (2 in) past each jamb – Figure 1.

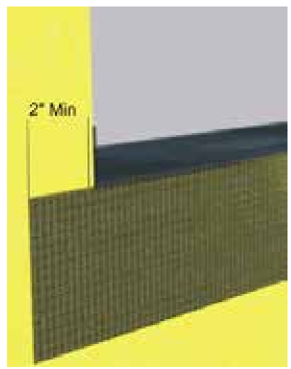

Figure 1

      2) Begin at the sill of an opening. Using a brush or 19 mm (3/4 in) nap roller, apply a liberal coat of AquaFlash Liquid material to the air/water-resistive barrier/substrate surface. **NOTE: The AquaFlash System must extend to the interior face of the wall opening.**
      3) Immediately lay the AquaFlash Mesh into the wet material and brush smooth adding additional material to completely embed the mesh - Figure 2.

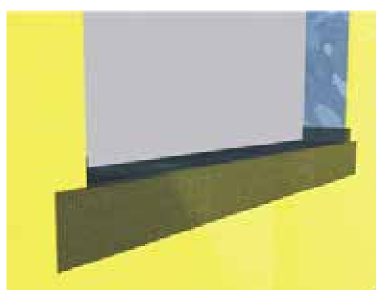

Figure 2

      4) Install the AquaFlash System at the jambs in the same manner overlapping onto the sill material a minimum of 51 mm (2 in) – Figure 3.

51 mm
(2 in) Min.

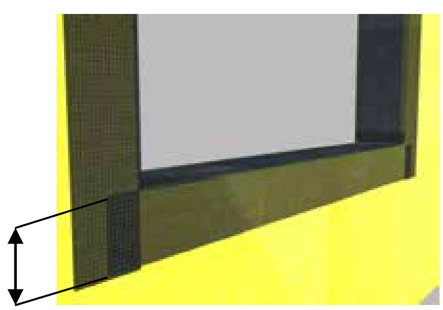

Figure 3

5) Install the AquaFlash System at the head overlapping the jamb pieces a minimum of 51 mm (2 in) – Figure 4.

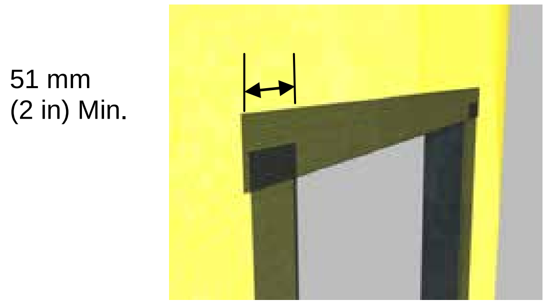

Figure 4

6) Install diagonal "butterflies" consisting of AquaFlash Liquid and AquaFlash Mesh at each sill/jamb corner – Figure 5.

Figure 5

7) Allow material to set for approximately 15 minutes then apply a second liberal coat of AquaFlash Liquid and smooth out to ensure a continuous film free of voids, pinholes, or other discontinuities.

4. Sill Pan Flashing (Exposed)
   a. Install a watertight pan flashing at all sill locations - Figure 6.
   b. The flashing shall extend between the framing members of the rough opening and shall be sized to protect the sill, sheathing and the surface of the Outsulation H.E. System. It must include vertical legs at the back and sides to ensure proper collection of water. **NOTE: All flashing shall be continuous, have watertight seams, and shall be configured to shed all water to the exterior of the system.**
   c. The flashing shall extend a minimum of 64 mm (2 1/2 in) down over the face of the Outsulation H.E. System - Figure 6.

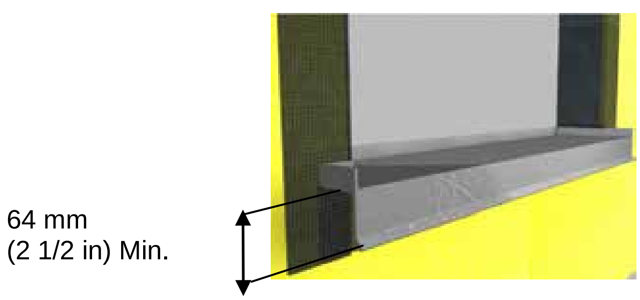

Figure 6

5. Sill Pan Flashing (Concealed) for use with nail-on-windows (refer to Dryvit Outsulation H.E. System Installation Details, DS851)
   a. Install a watertight pan flashing at all sill locations.
   b. The flashing shall extend between the framing members of the rough opening and shall be sized to protect the sill and sheathing. It must include vertical legs at the back and sides to ensure proper collection of water. It shall extend a minimum of 102 mm (4 in) below the opening and have a sloped horizontal leg which continues over the top edge of the Outsulation H.E. System. **NOTE: All flashing shall be continuous, have watertight seams, and shall be configured to shed all water to the exterior of the system.**
6. Installation of AquaFlash Over Metal or PVC Flashing Materials
   a. The AquaFlash System may be applied directly over clean galvanized, painted metal, or PVC flashing.
   b. Prepare rough opening as described in Section IV.A.3.

c. Install flashing material per contract documents.
d. Clean the surface of the flashing to ensure that it is free of dirt, dust, oil, or other contaminants that may interfere with adhesion. **NOTE: PVC products should be lightly abraded to break the surface skin and provide tooth for the coating.**
e. Cut AquaFlash Mesh to proper length [flashing plus 102 mm (4 in) extending 51 mm (2 in) beyond each end of flashing] - Figure 7.

Figure 7

f. Using a brush or 19 mm (3/4 in) nap roller, apply a liberal coat of AquaFlash Liquid material to the flashing and adjacent air/water-resistive barrier/substrate surface.
g. Immediately lay the AquaFlash Mesh into the wet material and brush smooth adding additional material to completely embed the mesh.
h. Allow material to set for 15 minutes then apply a second liberal coat of AquaFlash Liquid and smooth out to ensure a continuous film free of voids, pinholes, or other discontinuities and allow to dry.

B. Dryvit Backstop NT Option
1. Surface Preparation
a. Apply only when air and surface temperatures are above 4 °C (40 °F).
b. The surface to receive the Backstop NT must be clean, dry, smooth and free of any other condition that will hinder adhesion.
c. Remove loose dust or dirt from the surface by wiping with a clean, dry cloth or brush.
2. Dryvit Backstop NT Application
NOTE: Backstop NT may be applied to the sill of the opening but it must also be covered with either the Dryvit AquaFlash System or Dryvit Flashing Tape.
a. Rough Openings (Windows, Doors, Others)
1) Apply Dryvit Grid Tape along the jambs and head of the opening as well as all sheathing joints that may intersect the opening and lap onto face of wall a minimum of 51 mm (2 in). Add additional pieces of Grid Tape at the inside corners of the opening to maintain continuity – Figure 8.

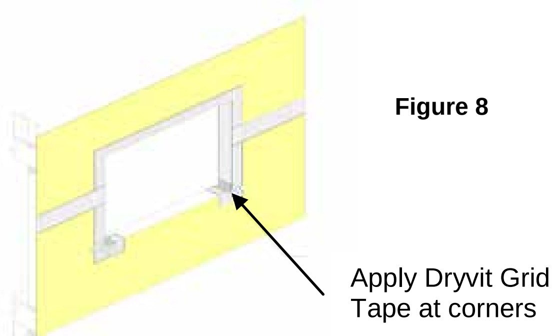

Figure 8

2) Using a stainless steel trowel apply Backstop NT – Texture over the Grid Tape extending to the inside face of the opening and onto the face of the exterior sheathing a minimum of 152 mm (6 in) – Figure 9.

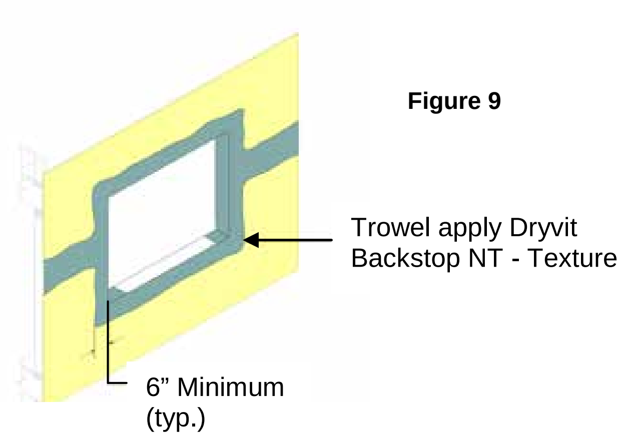

Figure 9

3) Apply Dryvit AquaFlash System or Flashing Tape at sill in accordance with Sections IV.A.3 and IV.C respectively. **NOTE: AquaFlash System or Flashing Tape must extend up the jambs a minimum of 102 mm (4 in) – Figure 10.**

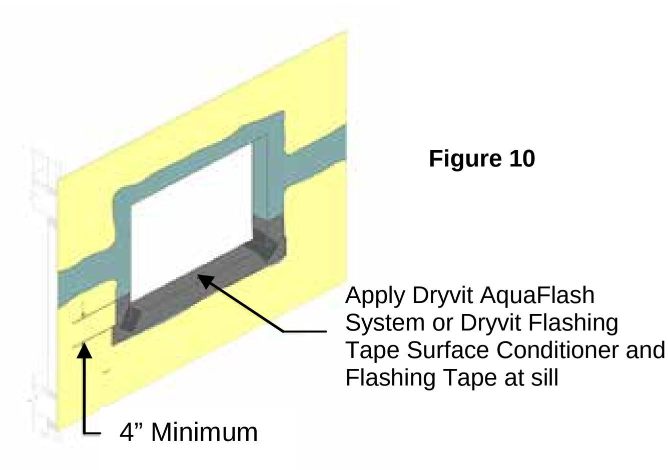

Figure 10

4) Install the specified component (i.e. window, etc.) and associated flashings per manufacturer’s directions and contract documents. Then apply Backstop NT – Texture, Smooth or Spray to the remainder of the wall surface as described in Section VI and lap over the previously installed material (do not lap over Flashing Tape if specified) around openings – Figure 11.

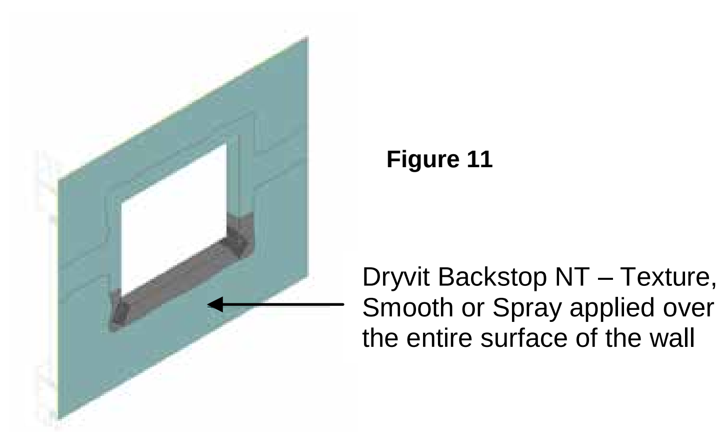

Figure 11

C. Dryvit Flashing Tape Option

Caution: The Dryvit Flashing Tape and Surface Conditioner must be handled properly. Refer to the Material Safety Data Sheets for proper handling, storage, health and environmental considerations.

NOTE: **When Dryvit Flashing Tape is specified for rough opening preparation the air/water-resistive barrier must be installed prior to preparing the opening (see Section VI).**

NOTE: Coordinate the Dryvit Flashing Tape application with the encapsulated V.I.S.E. installation. Apply only enough Dryvit Flashing Tape that can be covered with the encapsulated V.I.S.E. in the same work period.

1. Dryvit Flashing Tape must be installed to provide a continuous barrier from the air/water-resistive barrier/sheathing substrate onto the framing edges at discontinuities and terminations such as openings, expansion joints, tops of parapets, etc. Refer to Dryvit Outsulation H.E. System Installation Details, DS851.
2. Surface Preparation
   a. Apply only when air and surface temperatures are above 4 °C (40 °F).
   b. The surface to receive the Dryvit Flashing Tape must be clean, dry, smooth and free of any condition that will hinder adhesion.
   c. Clean loose dust or dirt from the surface by wiping with a clean, dry cloth or brush.
3. Dryvit Flashing Tape Surface Conditioner Application
   a. Pour the desired amount of surface conditioner into a clean container to prevent contamination.
   b. Apply to the surfaces, which are to receive the Dryvit Flashing Tape, using a brush or roller. Sufficient surface conditioner should be applied to condition the surface to a dust free state suitable for the application of the Dryvit Flashing Tape. It should not be applied so heavily that it puddles or runs. Application of excess material will not improve adhesion but will extend the drying time.
   c. Allow to dry until the surface is slightly tacky. Low temperatures and high humidity conditions may require longer drying times. Conditioning should be limited to areas that can be covered with Dryvit Flashing Tape within the same day.
4. Dryvit Flashing Tape Application
   a. General
      1) Cut the Dryvit Flashing Tape to the appropriate length. Peel the release paper to expose the rubberized asphalt adhesive and align the tape into position before touching the wall.
      2) Position the tape on the wall face so that it covers the Backstop NT 51 mm (2 in) and the remainder is turned into the opening.
      3) Move along the opening being careful to put the tape as evenly as possible and avoiding fish-mouths along the edges. If wrinkles develop, cut out the affected area and replace.
      4) Apply pressure to the tape so that it is firmly in contact with the wall surface. Press the tape into place with a hand roller as soon as possible to ensure continuous and intimate contact with the surface.
      5) End laps that occur must maintain a minimum overlap of 51 mm (2 in).
      6) Apply Dryvit Flashing Tape so that it completely covers the stud edges extending to the interior face of the opening. Additional strips of Dryvit Flashing Tape may be needed.
      7) Cold weather application may require the use of a heat gun to warm the wall surface in order to obtain good initial adhesion.
   b. Sill/jamb intersections and similar conditions
      1) Apply the Dryvit Flashing Tape as shown in the detail below - Figure 12.
      2) Apply sill piece first, then apply the corner splice piece. The jamb piece is applied next, lapping over the splice piece.

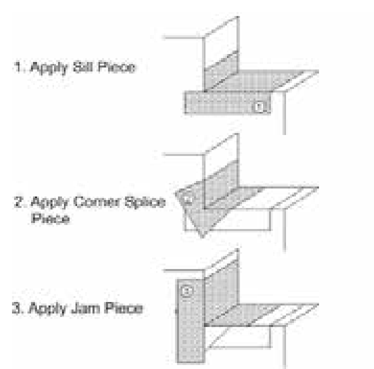

Figure 12

   c. Head/jamb intersections
      1) The jamb pieces are applied first, followed by the corner splice pieces. The head piece is applied last.
   d. Lap additional pieces of Dryvit Flashing Tape as necessary to cover the returns to the inside edge of the stud or track.

V. Substrate Expansion Joint Bridging Options

A. AquaFlash System Option

1. Surface Preparation
   a. Apply only when air and surface temperatures are above 4 °C (40 °F).
   b. The surface to receive AquaFlash System must be clean, dry, smooth and free of any condition that will hinder adhesion. c. Clean loose dust or dirt from the surface by wiping with a clean, dry cloth or brush.
2. AquaFlash System Application
   a. The width of the AquaFlash Mesh must overlap each side of the joint a minimum of 51 mm (2 in) - Figure 13.
   b. Clean the joint to allow for the installation of a backer material. Install a closed cell polyethylene backer rod sized a minimum of 50% larger than the joint width. Install so that the backer rod is recessed or projects a minimum of 6.4 mm (1/4 in) from the wall surface.

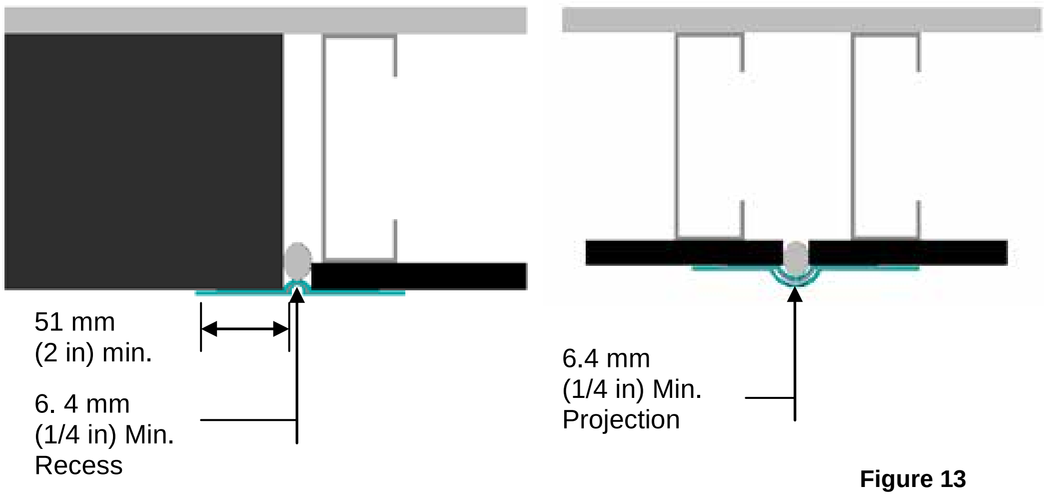

Figure 13

   c. Using a brush or 19 mm (3/4 in) nap roller, apply a liberal coat of AquaFlash Liquid material to the backer rod and adjacent substrate surface to the width of the AquaFlash Mesh - Figure 14.

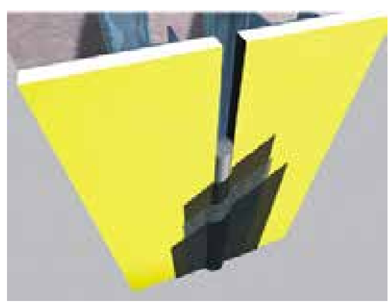

Figure 14

   d. Immediately lay the AquaFlash Mesh into the wet material and brush smooth adding additional material to completely embed the mesh.
   e. Allow material to set for 15 minutes then apply a second liberal coat of AquaFlash Liquid and smooth out to ensure a continuous film free of voids, pinholes, or other discontinuities.

B. Dryvit Flashing Tape and Flashing Tape Surface Conditioner Option

NOTE: **When Dryvit Flashing Tape is specified for substrate expansion joint bridging, the air/water-resistive barrier must be installed prior to preparing the joint (see Section VI).**

NOTE: Coordinate the Dryvit Flashing Tape application with the encapsulated V.I.S.E. installation. Apply only enough Dryvit Flashing Tape that can be covered with the encapsulated V.I.S.E. in the same work period.

1. Surface Preparation
   a. Apply only when air and surface temperatures are above 4 °C (40 °F).
   b. The surface to receive Dryvit Flashing Tape Surface Conditioner and Dryvit Flashing Tape must be clean, dry, smooth and free of any condition that will hinder adhesion.
   c. Clean loose dust or dirt from the surface by wiping with a clean, dry cloth or brush.
2. Dryvit Flashing Tape Surface Conditioner Application
   a. Pour the desired amount of surface conditioner into a clean container to prevent contamination.

b. Apply to the surfaces, which are to receive the Dryvit Flashing Tape, using a brush or roller. Sufficient surface conditioner should be applied to condition the surface to a dust free state suitable for the application of the Dryvit Flashing Tape. It should not be applied so heavily that it puddles or runs. Application of excess material will not improve adhesion but will extend the drying time.

c. Allow to dry until the surface is slightly tacky. Low temperatures and high humidity conditions may require longer drying times. Conditioning should be limited to areas that can be covered with Dryvit Flashing Tape within the same day

3. Position the Dryvit Flashing Tape so that it is centered over the joint. Adhere to one side of the joint, and then adhere the adjacent side. Allow enough slack in the tape to account for any joint movement.

VI. Air/Water-Resistive Barrier Application

A. When using Backstop DMS refer to DS704

B. Ensure that the wall surface and ambient temperature are above 4 °C (40 °F) and rising at the time of Backstop NT application. **WARNING: Do not apply the Dryvit materials in the rain. The underlying wall materials and substrate surface must be dry prior to applying the air/water-resistive barrier.**

C. Sheathing Substrates:

1. Prior to applying the Backstop NT over a sheathing substrate, check to ensure that:

a. The sheathing is of a type listed in the Backstop NT Specification, DS180.

b. The sheathing is structurally sound, free of loose material, voids, projections or other conditions that may interfere with the installation of the Backstop NT material.

c. The sheathing is clean, dry and free of grease, oil, paint and other foreign material.

1) Exterior grade gypsum sheathing facing paper shall not show signs of deterioration and shall be firmly bonded to the core.

2) Plywood or OSB moisture content shall not exceed 19% as measured by a probe type moisture meter.

d. There are no planar irregularities greater than 6.4 mm (1/4 in) within any 1.2 m (4 ft) radius. **SHEATHING WITH GAPS OR DAMAGE EXCEEDING 6.4 MM (1/4 IN) IN ANY ONE DIRECTION MUST BE REPLACED. NOTE: Notify the general contractor and/or architect and/or owner of all discrepancies. Do not proceed until all unsatisfactory conditions have been corrected. NOTE: OSB sheathing requires that joints and fasteners be treated with Backstop NT - Texture. A minimum of two (2) coats of Backstop NT - Smooth or Backstop NT – Spray are required for the field of the wall. Backstop NT - Texture is not recommended for application in the field of the board.**

D. Concrete or Masonry Substrates

NOTE: Backstop NT - Texture or Backstop NT – Spray are recommended for use over concrete and masonry.

1. Prior to applying the Backstop NT over a concrete or masonry substrate, check to ensure that:

a. All cracks are repaired using appropriate procedures and materials.

b. The substrate is structurally sound, free of loose material, voids, projections or other conditions that may interfere with the installation of the Backstop NT material.

c. The substrate is clean, dry, free of grease, oil, paint, form release agents, efflorescence and other foreign materials that may inhibit adhesion.

d. There are no planar irregularities greater than 6.4 mm (1/4 in) within any 1.2 m (4 ft) radius.

1) **Mortar joints that are NOT struck flush or heavily textured masonry units shall be skim coated with Dryvit Genesis®, Genesis® DM or Genesis® DMS prior to the application of Backstop NT – Texture or Backstop NT - Spray**.

a) Mix Genesis, Genesis DM or Genesis DMS in accordance with the appropriate Product Data Sheet.

b) With a stainless steel trowel, apply a coat of the Genesis mixture, Genesis DM mixture or Genesis DMS mixture over the substrate to fill the mortar joints and surface texture to provide a uniform smooth surface for the application of the Backstop NT material.

c) Allow the skim coat to completely dry prior to applying the Backstop NT – Texture or Backstop NT - Spray.

E. Usage Application Chart:

Backstop NT (BSNT) – Texture, Smooth, and Spray Usage/Application Chart			
			Approx. Coverage Per Pail[e,h,i]
Exterior Grade Gypsum Sheathing			
Joints[a]	**BSNT - Texture**	**Trowel**	**91 m (300 lin. ft.)**
Face[f]	**BSNT - Texture**	**Trowel, FoamPRO #58 Roller[b] or Texture Sprayer**	**23-28 m^2 (250-300 ft^2)**
	BSNT - Smooth[c,h]	**12.7 mm (1/2 in) Nap Roller or Texture Sprayer**	**46 m^2 (500 ft^2)**
	BSNT - Spray[i]	**Airless Spray**	
Fiberglass Faced Exterior Gypsum Sheathing			
Joints[a]	**BSNT - Texture**	**Trowel**	**91 m (300 lin. ft.)**
Face[f]	**BSNT - Texture**	**Trowel or Texture Sprayer**	**23-28 m^2 (250-300 ft^2) [includes joints]**
	BSNT - Smooth[c,h]	**19 mm (3/4 in) Nap Roller or Texture Sprayer**	**37 m^2 (400 ft^2)**
	BSNT - Spray[i]	**Airless Spray**	
Exposure 1, Exterior Grade, and Fire Retardant Treated Plywood; and Exterior Cement Board			
Joints[a]	**BSNT - Texture**	**Trowel**	**91 m (300 lin. ft.)**
Face[f]	**BSNT - Texture**	**Trowel, FoamPRO #58 Roller[b] or Texture Sprayer**	**23-28 m^2 (250-300 ft^2)**
	BSNT - Smooth[c,h]	**12.7 mm (1/2 in) Nap Roller or Texture Sprayer**	**37 m^2 (400 ft^2)**
	BSNT - Spray[i]	**Airless Spray**	
APA Exposure 1 Rated Oriented Strand Board (OSB)			
Joints[a]	**BSNT - Texture**	**Trowel**	**91 m (300 lin. ft.)**
Face[f]	**BSNT - Smooth[h]**	**12.7 mm (1/2 in) Nap Roller or Texture Sprayer**	**33-37 m^2 (350-400 ft^2) applied in 2 coats**
	BSNT - Spray[i]	**Airless Spray**	
Concrete and Masonry			
Face	**BSNT - Texture[d]**	**Trowel[g]**	**16.7 m^2 (180 ft^2)[g] applied in 1 coat**
	BSNT – Texture[d]	**FoamPRO #58 Roller[b] or Texture Sprayer**	**11-14 m^2 (125-150 ft^2)[g] applied in 2 coats, backrolled**
	BSNT - Spray	**Airless Spray**	

[a] Tape the joints with Dryvit Grid Tape prior to application of Backstop NT - Texture at joints and screw heads.
[b] Up to 1 pint (16 oz) of water may be added to a 60 lb pail of Backstop NT - Texture for roller or spray applications only. The FoamPRO #58 roller cover (FoamPRO Mfg., Inc., www.foampromfg.com) is available at home supply stores.
[c] Because of application methodology and absorptive surface differences, two coats may be required to obtain this coverage.
[d] Due to variations in types of concrete/masonry, apply a 6 ft x 6 ft test area with coverage as indicated in the chart, before proceeding with the entire job. If there are voids in the dried BSNT - Texture, particularly at the mortar joints, the job should be parged with Genesis®, 24 hours prior to BSNT - Texture application. **Backstop NT shall NOT be used as a skim coat for parging CMU joints or heavy textured units**.
[e] Backstop NT - Texture should be applied at the recommended coverage rates to form a continuous film free of voids at a dry film thickness of approximately 12 mils (the approximate diameter of the aggregate component).
[f] Backstop NT - Texture (with up to 1 pint water addition per 60 lb. pail) or Smooth may be sprayed and backtrowelled/backrolled.
[g] Coverage may vary depending on the texture and porosity of the substrate. Coverage assumes a smooth, dense surface.
[h] At 400 ft^2/pail, Backstop NT – Smooth achieves a dry film thickness (DFT) of 12 mils when applied in two coats. Each coat is applied at a minimum wet film thickness (WFT) of 13 mils.
[i] At 400 ft^2/pail, Backstop NT – Spray is applied at a minimum wet film thickness (WFT) of 11 mils.

Refer to Product Data Sheets for Complete Mixing and Application Instructions

F. Application of Backstop NT

1. Dryvit Grid Tape (not required with concrete and masonry substrates.)
    a. For sheathing substrates, apply the Dryvit Grid Tape along all joints in the sheathing, as well as inside corners, outside corners, and exposed edges at terminations that will not be covered with Dryvit AquaFlash or Dryvit Flashing Tape.
    b. Center the Dryvit Grid Tape on the sheathing joints, edges, etc. with the pressure sensitive adhesive backing in contact with the sheathing surface. Press into position with hand pressure until adhesion is achieved.
    c. Apply only enough Dryvit Grid Tape as can be covered with Backstop NT - Texture in the same day.
2. Dryvit Backstop NT - Texture Application
    NOTE: Backstop NT Texture is <u>NOT</u> recommended for use over the face of OSB.
    a. General: Backstop NT - Texture can be applied using a roller, trowel or spray equipment over the listed substrates, as noted in the usage chart above. Backstop NT - Texture should be applied at the recommended coverage rate to achieve a continuous film at a minimum dry film thickness of approximately 0.3 mm (12 mils).
    b. Roller Application
        1) Apply Dryvit Grid Tape as described in Section VI.F.1 above. Mix the Backstop NT - Texture material as described in Section III. Using a stainless steel trowel or spatula, apply a layer of Backstop NT - Texture over the Dryvit Grid Tape and spot all fastener heads – Figure 15. **NOTE: Dryvit Grid Tape is not necessary over fastener heads.**

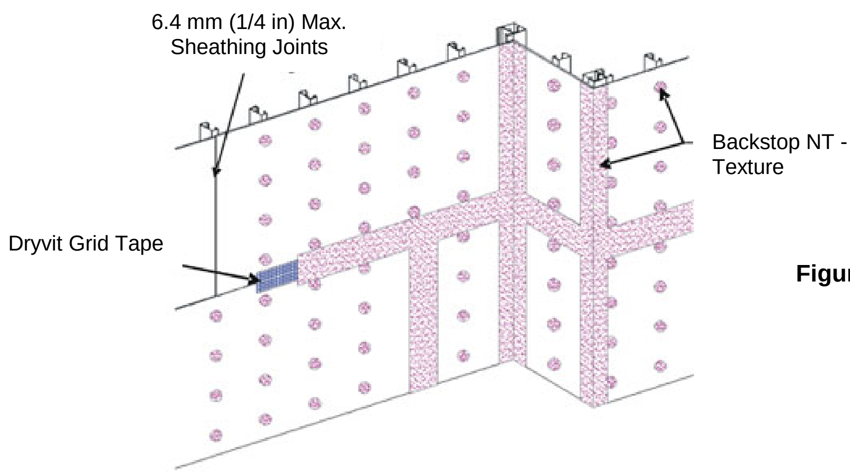

Figure 15

        2) Allow to dry for a minimum of 2 hours or until dry to the touch. **NOTE: Cool, humid conditions may require longer drying times.**
            a) Because of the absorption characteristics, plywood substrates may require a second pass to fill any voids at the sheathing joints. After the first pass has dried, check the joints and spot any voids that may be present with additional Backstop NT - Texture material and allow to dry.
        3) Use a coarse, open-cell foam roller cover with a 9.5 mm (3/8 in) foam nap (FoamPro #58 roller). Apply a uniform, continuous film of Backstop NT - Texture over the entire surface of the sheathing, concrete or masonry, including the previously treated areas – Figure 16. **NOTE: If the roller pulls material back out of the sheathing joints, it indicates that the joint material is not sufficiently dry.**

a) For concrete and masonry, ensure that a continuous film of uniform thickness is applied across the entire surface and across mortar joints. Minimum 2 coats are required allowing a minimum of 2 hours between coats. Cool, damp weather may require longer time between coats.

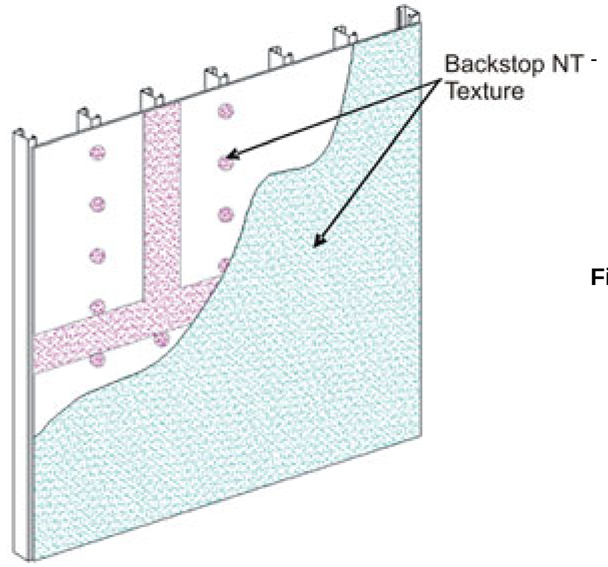

Figure 16

4) While the Backstop NT - Texture is still wet, using a trowel or spatula, smooth out the Backstop NT - Texture around all window and door perimeters and other areas that will later receive Dryvit Flashing Tape – Figure 17.

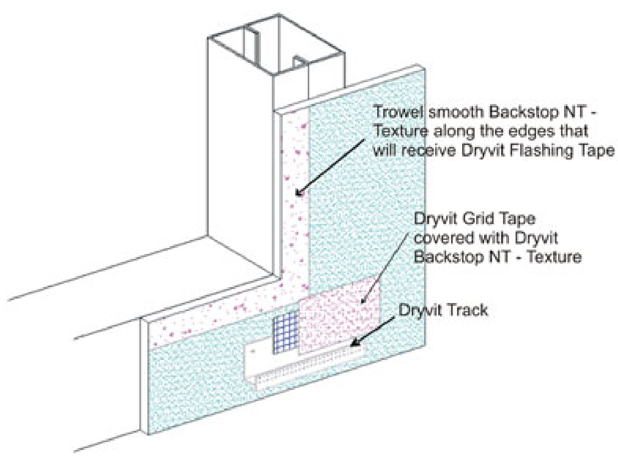

Figure 17

5) The Backstop NT - Texture material should be applied in a uniform, continuous film at the recommended coverage rate. **NOTE: Substrates with a surface texture or high porosity will require additional material.**

c. Trowel Application

1) Apply Dryvit Grid Tape as described in Section VI.F.1 above. Mix the material, as described in Section III and using a stainless steel trowel or spatula, apply a layer of Backstop NT - Texture over the grid tape. Spotting of fasteners is not necessary when applying Backstop NT - Texture using a trowel. Allow to dry for a minimum of 2 hours or until dry to the touch.

2) Using a stainless steel trowel, apply a continuous coating of Backstop NT - Texture material onto the entire surface. The material should be applied at a smooth, uniform, continuous film approximately equal to the thickness of the aggregate.

d. Spray/Back-rolling Application

1) Apply Dryvit Grid Tape as described in Section VI.F.1 above. Mix the material as described in Section III and using a stainless steel trowel or spatula, apply a layer of Backstop NT - Texture over the grid tape and spot all fastener heads. Allow to dry for a minimum of 2 hours or until dry to the touch.

2) Because of the absorption characteristics, plywood substrates may require a second pass to fill any voids at the sheathing joints. After the first pass has dried, check the joints and spot any voids that may be present with additional Backstop NT - Texture material and allow to dry.

3) Using a hand held hopper gun or other suitable spray equipment; spray a layer of Backstop NT - Texture onto the wall surface. Using a coarse, open-cell foam roller cover with a 9.5 mm (3/8 in) foam nap (FoamPRO #58 roller), roll the material to create a smooth continuous film. **NOTE: If the roller pulls material back out of the sheathing joints, it indicates that the joint material is not sufficiently dry.**

4) While Backstop NT - Texture is still wet, using a trowel or spatula, smooth out the Backstop NT - Texture around all window and door perimeters and other areas that will later receive Dryvit Flashing Tape – Figure 17.

5) Backstop NT - Texture material should be applied in a uniform, continuous film at the recommended coverage rate. **NOTE: Substrates with a surface texture or high porosity will require additional material.**

3. Backstop NT - Smooth Application

a. General: Dryvit Backstop NT - Smooth can be applied using a roller or sprayed and back-rolled over the acceptable sheathing substrates. **NOTE: OSB sheathing requires that joints and fasteners be treated with Backstop NT - Texture. A minimum of two (2) coats of Backstop NT - Smooth are required for the field of the wall. Backstop NT - Texture is not recommended for application in the field of the board.**

b. Sheathing Substrates: All fastener heads shall be spotted and joints treated with Backstop NT - Texture and Dryvit Grid Tape in accordance with Section VI.F.1 prior to Backstop NT - Smooth application.

c. Roller Application

1) Using the appropriate nap roller (see Usage Application Chart), apply the Backstop NT - Smooth over the entire wall surface, including previously treated joints. **NOTE: If the roller pulls material back out of the sheathing joints, it indicates that the joint material is not sufficiently dry.**

2) Backstop NT - Smooth material should be applied in a uniform, continuous film at the recommended coverage rate – Figure 18. **NOTE: Sheathing substrates with a surface texture or high porosity will require additional material.**

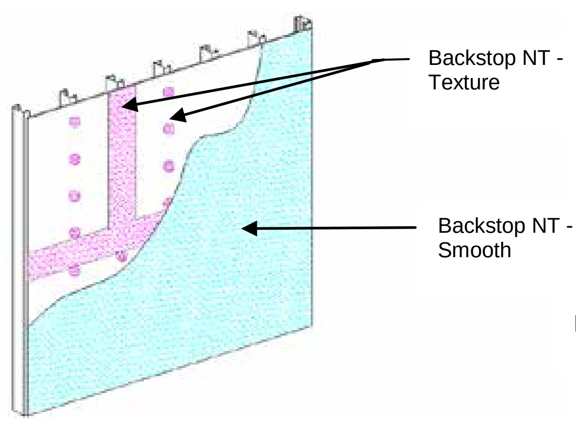

Figure 18

d. Spray/Back-rolling Application

1) Backstop NT - Smooth may be applied to the wall using a hopper gun or texture spray equipment and back-rolled using the appropriate nap roller (see Usage Application Chart).

2) Allow the Backstop NT - Smooth to completely dry, check the wall to ensure that the Backstop NT - Smooth is continuous and touch up any visible voids with additional Backstop NT - Smooth material.

e. Allow the Backstop NT - Smooth to completely dry prior to installation of the Dryvit EIF system.

3. Backstop NT - Spray Application
   a. General: Dryvit Backstop NT - Spray can be applied using appropriate spray equipment over the acceptable sheathing substrates.
      1) Airless spray equipment must be capable providing minimum 3000 psi and minimum material flow of 1 gallon per minute with a minimum .021 spray tip.
      NOTE: OSB sheathing requires that joints and fasteners be treated with Backstop NT - Texture. A minimum of two (2) coats of Backstop NT - Spray are required for the field of the wall. Backstop NT - Texture is not recommended for application in the field of the board.
   b. Sheathing Substrates: All fastener heads shall be spotted, and joints treated with Backstop NT - Texture and Dryvit Grid Tape in accordance with Section VI.F.1 prior to Backstop NT - Spray application.
      1) Backstop NT - Spray material should be applied in a uniform, continuous film at the recommended coverage rate free of voids and pinholes – Figure 19. **NOTE: Sheathing substrates with a surface texture or high porosity will require additional material.**

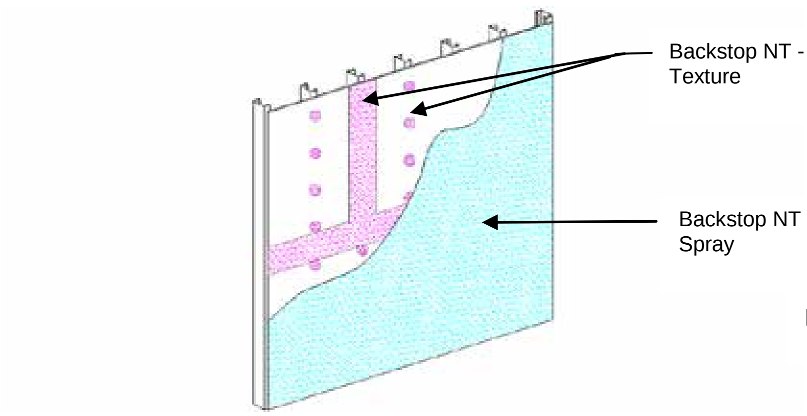

Figure 19

   c. Concrete/Masonry Substrates
      1) Backstop NT - Spray may be applied to the wall using appropriate airless spray equipment and back-rolled using the appropriate nap roller (see Usage Application Chart).
      2) Allow the Backstop NT - Spray to completely dry, check the wall to ensure that the Backstop NT - Spray is continuous and touch up any visible voids with additional material.
   d. Allow the Backstop NT - Spray to completely dry prior to installation of the Dryvit EIF system.

VII. Accessories

A. Installation of the Dryvit Drainage Strip or Drainage Track
1. Dryvit Drainage Strip (Optional - not required when Drainage Track is specified)
   a. Dryvit Drainage Strip shall be used at the base of the walls and shall be installed at the heads of all penetrations and at expansion/control joints as shown in Outsulation H.E. System Installation Details, DS851.
   b. Using a chalk line, strike a level line at the base of the wall, head of opening or expansion/control joint to use as reference in applying the Dryvit Drainage Strip.
   c. Install the Dryvit Drainage Strip by applying dabs of Dryvit's AP Adhesive at 305 mm (12 in) on center on the dry Backstop NT air/water-resistive barrier.
   d. Position the Dryvit Drainage Strip on the chalk line and press firmly against the substrate to ensure firm contact between the adhesive and the wall surface. Staples or other fasteners may be used if necessary to maintain position until the encapsulated V.I.S.E. is installed.
2. Dryvit Drainage Track (Optional - not required when Drainage Strip is specified)
   a. Dryvit Drainage track usage is limited to the base of the system at finished grade level.
   b. Using a chalk line, strike a level line at the base of the wall that coincides with either the top or bottom of the nailing flange.
   c. Install the Dryvit Drainage Track by applying a continuous horizontal bead of Dryvit's AP Adhesive on the wall side of the track's nailing flange.
   d. Position the track on the chalk line and press firmly against the substrate to ensure firm and continuous contact between the adhesive and the wall surface. **NOTE: Do not overlap tracks, they shall be butted tightly.**

e. Secure the track to the wall using corrosion resistant fasteners attached into the underlying framing members. **NOTE: It is recommended that the surface of the Drainage Track be lightly sanded to improve adhesion of Backstop NT or AquaFlash.**

f. Install the AquaFlash System, Backstop NT and Grid Tape or Flashing Tape on the flange of the Drainage Track and the adjacent wall in order to ensure water-tightness at the flange/wall interface. See Section IV for proper application.

VIII. Encapsulated Vacuum Insulated Sandwich Elements (V.I.S.E.) Installation

A. When using Backstop DMS refer to DS704

B. System Terminations

1. Attach Detail Mesh around the perimeter of all openings, penetrations, and other system terminations by stapling or applying a ribbon of adhesive mixture on the substrate and embedding the Detail Mesh into the wet mixture. **NOTE: Back wrapping is not required at the base of the wall when using the Dryvit Drainage Track**.
2. Position the Detail Mesh so that a minimum of 64 mm (2 1/2 in) will extend onto the face of the encapsulated V.I.S.E. Keep the mesh, which is not embedded, clean.

C. Inspection Encapsulated V.I.S.E.

1. Prior to installation, the encapsulated V.I.S.E. shall be checked to ensure that:
   a. It is shipped in a packaging bearing the Dryvit name. Encapsulated V.I.S.E. shall be obtained from Dryvit Systems, Inc. or its authorized distributors, and made exclusively by manufacturers listed by Dryvit Systems, Inc.
   b. The encapsulated V.I.S.E. meets the following tolerances:
      1) Length: Plus or minus 1.6 mm (1/16 in).
      2) Width: Plus or minus 1.6 mm (1/16 in).
      3) Thickness: Plus or minus 1.6 mm (1/16 in)
      4) Squareness: Shall not deviate from square by more than 0.8 mm (1/32 in) in 305 mm (12 in) of total length or width.
      5) Edge Trueness: Shall not deviate more than 0.8 mm (1/32 in) in 305 mm (12 in).
      6) Face Flatness: Shall not exhibit any bowing of more than 0.8 mm (1/32 in) in the length.

      WARNING: Any encapsulated V.I.S.E. not meeting the above requirements should be rejected and not installed.

D. Methods of Applying the Dryvit Adhesive

1. Mix the Dryvit adhesive in accordance with Section III.C
   a. Cementitious Adhesive
      1) Notched Trowel Method
         a) With a notched trowel, 9.5 mm (3/8 in) wide, 12.7 mm (1/2 in) deep notches spaced 38 mm (1 1/2 in) apart, apply the adhesive mixture to the backside of the encapsulated V.I.S.E. Holding the trowel at a 45° angle, apply firm pressure to the encapsulated V.I.S.E. in order to scrape the excess adhesive from between the adhesive beads. **NOTE: Apply the adhesive so that the ribbons run vertically when the encapsulated V.I.S.E. is placed on the wall.**
      2) Ribbon and Dab Method
         a) Using a stainless steel trowel, install a ribbon of the adhesive mixture, 51 mm (2 in) wide by 9.5 mm (3/8 in) thick around the entire perimeter of the encapsulated V.I.S.E. Place eight (8) dabs of the adhesive mixture 9.5 mm (3/8 in) thick by 102 mm (4 in) in diameter approximately 203 mm (8 in) on center to the interior area of the encapsulated V.I.S.E. **NOTE: The ribbon and dab method of applying the adhesive mixture shall not be used, nor is it recognized by the building codes when applying the Outsulation H.E. System over a sheathing substrate. Installations over a sheathing substrate shall use the notched trowel method described above.**
      3) Push Box Method
         a) A push box may also be used to install the adhesive mixture on the encapsulated V.I.S.E. Contact Dryvit Systems, Inc. for complete details for construction of a push box. **NOTE: Apply the adhesive so that the ribbons run vertically when the encapsulated V.I.S.E. is placed on the wall.**
   b. Non-cementitious Adhesive
      1) AP Adhesive - recommended for use in limited areas only, such as metal surfaces, including steel lintels, metal flashing, etc.
         a) Cut the smallest opening possible in spout (just large enough so adhesive can flow easily when gunned). It is intended to be applied in thin beads [approximately 9.5 mm (3/8 in)].
2. When using Backstop DMS refer to DS704

E. Encapsulated V.I.S.E. Installation

1. Prior to installing the encapsulated V.I.S.E., ensure that the surface of the Backstop NT is uniform in thickness, continuous, clean, dry and free of any voids, pinholes or foreign materials that will affect adhesion of the encapsulated V.I.S.E..
2. Begin installation of the encapsulated V.I.S.E. from a permanent or temporary support. Do not use nails or other fasteners to provide temporary support.

3. When sheathing is used as a substrate, offset the encapsulated V.I.S.E. joints from the sheathing joints a minimum of 203 mm (8 in) in both vertical and horizontal directions. Install the encapsulated V.I.S.E. with their long edges oriented horizontally.
4. Apply the adhesive to the encapsulated V.I.S.E. as described in Section VIII.D.
   a. When using Primus, Genesis, Primus DM, Genesis DM, Genesis DMS or Genesis FM as the adhesive, butter the edge of the encapsulated V.I.S.E. at all terminations in order to properly embed the previously installed Detail Mesh used for back wrapping. Back wrapping is necessary to provide encapsulation and to create the proper surface for application of sealant. **NOTE: The application of the adhesive mixture to the edge of the encapsulated V.I.S.E. is <u>only</u> done when wrapping with the Detail Mesh.**
   b. Genesis DMS may be applied to the substrate surface in a vertical notched trowel pattern as described in Section VIII.D.1.a.1). Refer to Genesis DMS Data Sheet, DS471.
5. Position the encapsulated V.I.S.E. horizontally on the substrate. Press the board gently to the substrate and slide it into position. Apply firm pressure over the entire surface of the encapsulated V.I.S.E. to ensure uniform contact and high initial grab.
6. Using a margin trowel, clean the encapsulated V.I.S.E. edges of any adhesive mixture. Ensure that the encapsulated V.I.S.E. joints are butted tightly and faces are level and flush. **CAUTION: Do not allow adhesive to remain in board joints.**
7. Install subsequent rows of encapsulated V.I.S.E. in a running bond pattern (vertical joints staggered).
8. Stagger vertical joints at inside and outside corners. Make sure the corners are straight and plumb.
9. To ensure an overall flat surface, tamp the encapsulated V.I.S.E. surface with a board that overlaps two to four rows of insulation.
10. If for any reason the encapsulated V.I.S.E. joints are not butted tightly, slivers of insulation board must be installed to fill any gaps. ALL GAPS GREATER THAN 1.6 mm (1/16 in) MUST BE SLIVERED. **Tip: In order to create a tight fit, it is recommended that a wider joint be cut with a hot groover or similar tool to allow for a more precise fitting sliver. Do not install adhesive on sliver edges.**
11. Windows, Doors, Mechanical Equipment and <u>all</u> Wall Penetrations
    a. At openings, align the encapsulated V.I.S.E.s so that the edges (vertical and horizontal joints) do not coincide with the corners of the opening (refer to Dryvit Outsulation H.E. System Installation Details, DS851).
    b. Attach Detail Mesh around the perimeter of the opening as described in Section VIII.B.
    c. Hold the encapsulated V.I.S.E. back from the window/door frame or mechanical equipment to allow for differential movement, proper system edge preparation, and sealant installation as shown in the Dryvit Outsulation H.E. System Installation Details, DS851.
12. Expansion Joints
    a. Attach Detail Mesh around the perimeter of the opening as described in Section VIII.B.
    b. When abutting dissimilar materials, leave a minimum 19 mm (3/4 in) separation between the encapsulated V.I.S.E. and abutting material to allow for differential movement, proper system edge preparation and sealant installation.
    c. When the Outsulation H.E. System is installed at a substrate transition, leave a minimum 19 mm (3/4 in) separation between the encapsulated V.I.S.E. to allow for differential movement, proper system edge preparation and sealant installation.
13. **IMPORTANT:** Once the encapsulated V.I.S.E. and Detail Mesh are in place, wait a minimum of 24 hours prior to working on the surface of the encapsulated V.I.S.E. to prevent any movement which may weaken the bond of the adhesive mixture to the substrate. **NOTE: Be sure to protect the installed encapsulated V.I.S.E. from rain, freezing or inclement weather for a period of 24 hours.**
14. Any irregularities in the encapsulated V.I.S.E. surface must be sanded flat. Sanding is accomplished with a light circular motion. **The entire wall area must be sanded.** Use grade 20 grit sandpaper or coarser, in conjunction with hand, electric or air rasps. **NOTE: Do not sand parallel to the encapsulated V.I.S.E. joints**. **CAUTION: The contractor shall take precautions to contain EPS dust from rasping operation in accordance with contract documents. Use of vacuum rasps are recommended to minimize introduction of EPS dust into the environment.**
15. Remove all loose pieces of encapsulated V.I.S.E. and dust from the sanding operation using a brush, broom, or compressed air. Use OSHA required masks to protect against inhaling EPS dust.
16. All Detail Mesh that was previously installed for back wrapping the encapsulated V.I.S.E. shall be embedded in the base material mixture at this time.
    a. With a stainless steel trowel, apply any of Dryvit's cementitious base material mixture to the face (and edge if not previously coated) of the encapsulated V.I.S.E. and embed the Detail Mesh in the wet mixture. **NOTE: It is not recommended to use NCB to embed reinforcing mesh at EPS edges that will receive sealant.**
17. Aesthetic Reveals
    a. Reveals are limited to maximum depth of 19 mm (3/4 in).
    b. To install an aesthetic reveal, snap a straight line using a chalk line to mark the position.

c. Position a straight edge such as a steel stud or track against the encapsulated V.I.S.E. in the proper location to guide the appropriate cutting tool (router, hot knife, or hot groover). **CAUTION: The thickness of the EPS in the bottom of the reveal must not be less than 19 mm (3/4 in).**

d. Use Detail Mesh to ensure continuity of reinforcing mesh through aesthetic reveals continuing a minimum of 64 mm (2 1/2 in) on each side of the reveal.

1) Apply the base material mixture in the reveal and on the adjacent encapsulated V.I.S.E. surfaces.
2) Embed the Detail Mesh into base coat mixture on one side of the reveal only.
3) Use a sled or special tool configured to the profile of the reveal. Embed the Detail Mesh into the base coat mixture through the reveal being careful not to cut the mesh.
4) Embed the Detail Mesh into the base coat mixture on the other side of the reveal. Ensure that the mesh is fully embedded and that all excess material is removed from the reveal.
5) Using a damp brush, smooth out any irregularities in the base coat.

CAUTION: If the mesh is cut in the reveal, a new piece of mesh must be installed over the cut

18. Where Corner Mesh is specified for additional impact resistance at outside corners, the Corner Mesh shall be embedded in the base coat mixture and allowed to set prior to installing the overall reinforced base coat over the face of the wall.
19. Corners of all openings such as windows, doors, mechanical equipment and all penetrations shall be reinforced with Detail Mesh placed diagonally to the opening as illustrated in Figure 20.

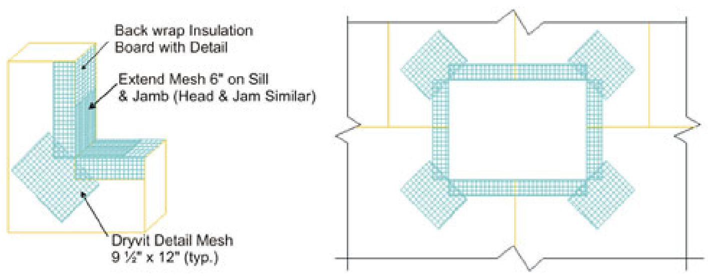

Figure 20

IX. Installation of Reinforcing Mesh and Base Coat

A. General

1. **Do not apply the Dryvit materials in the rain. The encapsulated V.I.S.E. must be dry prior to applying the base coat material.**
2. Prior to installing the reinforced base coat, inspect the surface of the encapsulated V.I.S.E. for:
   a. Flatness: Use a minimum 2.4 m (8 ft) straight edge. Sand any high areas and out-of-plane board joints flat, as described in Section VIII.E.14 and 15. **CAUTION: Do not build up low areas with base coat mixture to form a flat surface.**
   b. Damage and foreign materials: correct deficiencies as necessary.
   c. Surface degradation due to weathering or UV, visible as discoloration. Sand affected areas to remove deterioration while maintaining the flatness of the surface.

B. Mix the base coat material as described in Section III.C and D.

C. Prior to installing the reinforcing mesh, it should be inspected to ensure that it has been furnished by Dryvit Systems, Inc.

1. Dryvit reinforcing mesh is available in the following widths and lengths:
   a. Standard - 1.2 m x 45.7 m (48 in x 150 ft); 1.8 m x 45.7 m (72 in x 150 ft)
   b. Standard Plus, and Intermediate - 1.2 m x 45.7 m (48 in x 150 ft)
   c. Panzer 15 - 1.2 m x 22.9 m (48 in x 75 ft)
   d. Panzer 20 - 1.2 m x 22.9 m (48 in x 75 ft)
   e. Corner - 235 mm x 45.7 m (9 1/4 in x 150 ft)
   f. Detail - 241 mm x 45.7 m (9 1/2 in x 150 ft)
2. It shall be colored blue for product identification bearing the Dryvit logo.

D. Installation of Dryflex base coat in high exposure areas such as sloped surfaces, window sills, etc.

1. Using a stainless steel trowel, apply the Dryflex mixture on the surface of the encapsulated V.I.S.E. in a uniform thickness of approximately 2.4 mm (3/32 in). Apply the Dryflex continuously over the sloped surface and continue minimum 152 mm (6 in) onto the vertical areas.
2. Immediately place the reinforcing mesh against the wet Dryflex mixture. With the curve of the mesh against the wall, trowel from the center to the edges, avoiding wrinkles, until the mesh is fully covered and not visible. The

overall minimum base coat thickness shall be sufficient to **fully embed** the reinforcing mesh. The recommended method is to apply the base coat in two (2) passes.
NOTE: The reinforcing mesh can be continued across the transition from Dryflex base coat to standard base coat.

3. Allow the Dryflex to cure a minimum of 24 hours or until dry.

E. Base Coat Application

1. Standard Base Coat (single layer of Standard, Standard Plus or Intermediate Reinforcing Mesh)
    a. The base coat shall be applied such that the resulting overall minimum base coat thickness is sufficient to **fully embed** the reinforcing mesh. The recommended method is to apply the base coat in two (2) passes.
    b. Double pass method (recommended)
        1) Using a stainless steel trowel, apply the base coat mixture on the entire surface of the encapsulated V.I.S.E. to an area slightly larger than the width and length of a piece of reinforcing mesh, in a uniform thickness of 1.6 mm (1/16 in). **NOTE: The reinforcing mesh may be installed either vertically or horizontally.**
        2) Immediately place the reinforcing mesh against the wet base coat mixture. With the curve of the mesh against the wall, trowel from the center to the edges avoiding wrinkles, until the mesh is fully embedded and not visible. Trowel smooth to a uniform thickness slightly more than the thickness of the reinforcing mesh.
        NOTE: The reinforcing mesh shall be continuous at corners and mesh edges lapped not less than 64 mm (2 1/2 in). Do not lap the reinforcing mesh within 203 mm (8 in) of a corner. Tip: Corners and edges normally require light strokes with a small damp brush to smooth out irregularities.
        3) Allow the base coat mixture to take up until firm to the touch. Trowel a second tight coat of the base coat mixture over the first coat to **fully cover** the reinforcing mesh - Figure 22. The result should be such that the reinforcing mesh is approximately centered within the base coat thickness. Do not allow the first pass to completely dry prior to the second pass application or an excessive amount of base coat mixture will be necessary to fully coat the wall surface.

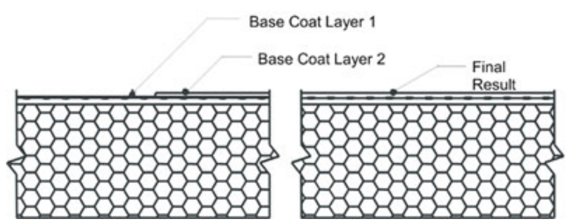

Figure 21

    c. Single pass method (optional)
        1) Using a stainless steel trowel, apply the base coat mixture on the entire surface of the encapsulated V.I.S.E. to an area slightly larger than the width and length of a piece of reinforcing mesh, in a uniform thickness of 1.6 mm (1/16 in). **NOTE: The reinforcing mesh may be installed either vertically or horizontally.**
        2) Immediately place the reinforcing mesh against the wet base coat mixture. With the curve of the mesh against the wall, trowel from the center to the edges avoiding wrinkles, until the mesh is fully embedded and not visible. Trowel smooth to a uniform thickness slightly more than the thickness of the reinforcing mesh.
        NOTE: The reinforcing mesh shall be continuous at corners and mesh edges lapped not less than 64 mm (2 1/2 in). Do not lap the reinforcing mesh within 203 mm (8 in) of a corner. Tip: Corners and edges normally require light strokes with a small damp brush to smooth out irregularities.
    d. Protect completed work from water penetration and runoff.
    e. Allow the base coat to cure a minimum of 24 hours before proceeding with application of finish coat. Cool, damp conditions may require longer drying times. Do not apply finish to a wet or damp base coat.

2. Panzer Mesh Base Coat (Panzer 15 or Panzer 20 used in conjunction with Standard or Standard Plus Reinforcing Mesh). **Panzer Mesh is recommended for use at all ground floor locations and at high traffic areas. Refer to contract documents.**
    a. Using a stainless steel trowel, apply the base coat mixture on the entire surface of the encapsulated V.I.S.E. to an area slightly larger than the width and length of a piece of reinforcing mesh, in a uniform thickness of approximately 3.2 mm (1/8 in).
    b. Immediately place the reinforcing mesh against the wet base coat mixture. With the curve of the mesh against the wall, trowel from the center to the edges avoiding wrinkles until the mesh is fully covered and not visible.
    c. Continue in the same manner until the entire area requiring Panzer Mesh is covered.
    CAUTION: Do not lap the Panzer Mesh. Adjacent pieces are to be tightly butted.
    d. Protect completed work from water penetration and runoff.
    e. Allow the Panzer base coat to cure a minimum of 24 hours prior to applying Dryvit's Standard or Standard Plus Reinforcing Mesh.

f. Apply the second layer of reinforcing mesh in accordance with Section IX.E.1.c. Offset the edges of the Standard or Standard Plus Reinforcing Mesh from the edges of the Panzer Mesh a minimum of 203 mm (8 in). **Tip: If Panzer Mesh is installed horizontally, we recommend the Standard or Standard Plus Mesh be installed vertically and vice versa.**

X. Sealant Joint Preparation

A. All Outsulation H.E. base coat surfaces which will be in contact with sealant must be coated with either Color Prime or Demandit.
1. Mix Color Prime or Demandit in accordance with Section III.E and H respectively.
2. Using a small brush, apply Color Prime or Demandit to the base coat surface that is to be in contact with the sealant and extending to the joint edge.
3. Allow the Color Prime or Demandit to dry a minimum of 48 hours prior to applying the sealant primer and sealant. Cool damp weather may require longer drying times.
4. Refer to sealant manufacturer's installation instructions for the proper application of the sealant.

XI. Dryvit Primers

A. Prior to applying the Dryvit primers, the base coat shall have cured a minimum of 24 hours and shall be dry and hard. Cure time may be longer depending on environmental conditions. **NOTE: Refer to Product Data Sheets when applying over other materials.**

B. Inspect the base coat for any irregularities such as trowel marks, board lines, rough corners and edges, improper reinforcing mesh embedment as well as efflorescence. **NOTE: Correct all irregularities and remove all efflorescence prior to applying the Dryvit primer.**

C. Color Prime and Weatherprime
1. Mix to a smooth homogeneous consistency in accordance with Section III.E.
2. Apply with a brush, roller, or airless spray equipment. Refer to Color Prime or Weatherprime Data Sheets, DS410 or DS436 respectively for complete instructions.

D. Color Prime W
1. Mix to a smooth homogeneous consistency in accordance with Section III.E.
2. Application with airless spray equipment is recommended. Refer to Color Prime W Data Sheet, DS474 for complete instructions.

E. Primer with Sand
1. Mix to a smooth homogeneous consistency in accordance with Section III.E.
2. Application with a roller is recommended. Refer to Primer with Sand Data Sheet, DS477 for complete instructions.

XII. Dryvit Finish

A. Prior to applying the Dryvit finish, the base coat shall have cured a minimum of 24 hours and shall be dry and hard. Cure time may be longer depending on environmental conditions.

B. Inspect the base coat for any irregularities such as trowel marks, board lines, rough corners and edges, improper reinforcing mesh embedment as well as efflorescence. **NOTE: Correct all irregularities and remove all efflorescence prior to applying the Dryvit finish.**

C. Application
1. General
   a. Important: All Dryvit finishes must be installed continuously to a natural break such as corners, expansion joints, or tapeline. Mechanics must maintain a wet edge. Whenever possible, order enough material in a single batch to complete the project to avoid potential color variations from batch to batch. Sufficient personnel and scaffolding must be provided to continuously finish a distinct wall area or otherwise cold joints will result. Scaffolding must be spaced a minimum of 458 mm (18 in) from the wall to prevent staging lines. On hot windy days, the wall may be fogged with clean potable water to cool the wall and facilitate finish installation. As with other plaster materials, installation work should precede the sun. For example, work the shady or cool side of the building. If this is not possible, scaffold should be shaded with a tarp or nursery shade cloth. Do not introduce water to the finish material once it is installed on the wall. This will cause color variations. Each mechanic must use the same tool and hand motion and match the texture of the mechanics above, below and on each side. Use finish from a single batch number whenever possible.
   b. Do not apply Dryvit materials in the rain. The base coat must be dry prior to applying the Dryvit finish or coatings.
   c. Do not apply textured Dryvit finish material in sealant joints. Refer to Section X for proper sealant joint preparation.
2. Quarzputz, Quarzputz E, Sandblast, Weatherlastic Quarzputz
   a. Mix the Dryvit finish as described in Section III.F.
   b. Using a clean stainless steel trowel, apply a coat of the Dryvit finish in a uniform thickness on the dry base coat. **NOTE: The Dryvit Quarzputz finish shall be applied and leveled to a uniform thickness no greater than the largest aggregate. The Sandblast finish is applied and leveled to a thickness of approximately 1 1/2 times the largest aggregate.**

c. The texture is achieved by uniform hand motion and/or tool that produces the texture to match the approved sample. Each mechanic must use the same tool and hand motion to ensure that the texture achieved is uniform over the entire wall area.

3. Sandpebble, Sandpebble E, Sandpebble Fine, Sandpebble Fine E, Weatherlastic Sandpebble, Weatherlastic Sandpebble Fine, Sandpebble FM and Sandpebble Fine FM
   a. Mix the Dryvit finish as described in Section III.F.
   b. Using a clean, stainless steel trowel, apply an even coat of the finish to a thickness slightly thicker than the largest aggregate size.
   c. Pull across using a horizontal trowel motion to develop a uniform thickness no greater than the largest aggregate of the material.
   d. The texture is achieved by a uniform hand floating motion with a clean stainless steel trowel; wipe the trowel and wet it lightly. Apply light pressure in a circular motion.
4. Freestyle
   a. Mix the Dryvit finish as described in Section III.F.
   b. Using a clean, stainless steel trowel, apply the Freestyle finish on the base coat in a thickness not greater than 1.6 mm (1/16 in). The texture is either pulled out of this base to a thickness of no greater than 6.4 mm (1/4 in) or the texture may be achieved by adding more Freestyle finish to the base coat using the same texturing motions that are used with other plaster materials, such as, a skip trowel finish. Numerous other aesthetically pleasing textures can be created to match approved samples. **NOTE: The maximum thickness of Freestyle finish texture shall not exceed 6.4 mm (1/4 in).**
5. Weatherlastic Adobe
   a. Using a brush, roller or airless spray equipment, apply a coat of color coordinated Color Prime (see Section III.E for mixing instructions) at the recommended coverage to the cured base coat and allow to dry.
   b. Mix the Weatherlastic Adobe finish material as described in Section III.F.
   c. Using a stainless steel trowel, apply a coat of Weatherlastic Adobe approximately 1.6 mm (1/16 in) to the wall surface. Allow the Weatherlastic Adobe finish to take-up.
   d. Using a stainless steel trowel, apply a second coat of Weatherlastic Adobe to obtain the desired texture. **Tip: An atomizing spray bottle may be used to apply a mist of water to the surface in the finishing step.**
6. Ameristone
   a. Mix the Ameristone finish as described in Section III.G.1.
   b. Apply Ameristone finish in accordance with Ameristone Application Instructions, DS142.
7. Stone Mist
   a. Mix the Stone Mist finish as described in Section III.G.2.
   b. Apply Stone Mist finish in accordance with Stone Mist Data Sheet, DS420.
8. TerraNeo
   a. Mix the TerraNeo finish as described in Section III.G.3.
   b. Apply TerraNeo finish in accordance with TerraNeo Data Sheet, DS481.
9. Lymestone
   a. Mix the Lymestone finish as described in Section III.G.4.
   b. Apply Lymestone finish in accordance with Lymestone Data Sheet, DS472.
10. Custom Brick
    a. Refer to Dryvit Custom Brick Application Instructions, DS154 for complete installation instructions.
11. Reflectit
    a. Refer to Reflectit product Data Sheet, DS705 and Application Instructions DS124.

XIII. Coatings and Sealers

A. Demandit and Weathercoat

1. Mix to a smooth homogeneous consistency in accordance with Section III.H.1.
2. Apply with a brush, roller, or airless spray equipment.
3. When applying with a roller, a maximum 19 mm (3/4 in) nap, polyester or polyester blend with nylon or lambswool, with beveled ends and a phenolic core is recommended. A 458 mm (18 in) wide roller frame with a 57 mm (2 1/4 in) inside diameter is also recommended.
4. Apply in one continuous coat, maintaining a wet edge as the application proceeds to a natural break. The roller cover must be kept fully loaded as the application proceeds. **CAUTION: Do not stretch out the application by rolling with a dry roller. The last leveling roller strokes should always be in the same direction. Do not cut in around openings prior to overall application, but rather, do the cut-in work as the application proceeds.**
5. Do not allow Demandit or Weathercoat to dry on roller covers. Roller covers with dried coating do not apply the coating evenly.
6. Changing color requires the application of two coats.

B. Revyvit
1. Mix the Revyvit to a smooth homogeneous consistency in accordance with Section III.H.1.
2. Apply the Revyvit with a brush or 12.7 mm – 15.9 mm (1/2 in - 5/8 in) nap roller.
3. Roll or brush in multiple directions and then lightly finish in one direction to ensure that no lap marks remain.
4. A second coat may be required for heavy textured surfaces or when there is a contrast of colors. Apply the second coat as described in paragraph XIII.B.2 and 3 above. **CAUTION: Do not attempt to apply Revyvit in one heavy coat. Two coats are recommended. Apply the second coat only after the first coat is completely dry. Important: Texture changes will exist after Revyvit is applied over existing Dryvit finishes. The degree of change is a function of the thickness and the number of coats of Revyvit.**

C. Weatherlastic Smooth
1. Mix the Weatherlastic Smooth to a smooth, homogeneous consistency in accordance with Section III.H.1.
2. Apply a minimum 11 mils dry film thickness (22 mils wet film thickness). This is achieved by applying the Weatherlastic Smooth in two (2) 11 mil wet coats. Under average drying conditions, 21 °C (70 °F), 50% RH, two (2) hours drying time between coats should be adequate.
3. For cutting-in and trim, a nylon bristle brush is recommended.
4. Roller Application
   a. A minimum 254 mm (10 in) roller cover with a 32 mm - 38 mm (1 1/4 in - 1 1/2 in) nap is recommended.
   b. Completely saturate the roller cover and keep the roller loaded with coating to avoid foaming. Do not dry-roll or over-roll as this will cause excessive entrapment of air within the coating.
   c. A second coat is applied in a similar manner after the first coat has adequately dried.

5. Spray Application
   a. Application by airless spray equipment or mastic pump and gun allows application of coating at total required application rate with a minimum of stipple or thickness variations.
   b. Equipment should have the capacity to pump 7.6 L (2 gal) of coating per minute.
   c. Material hose should be minimum 12.7 mm (1/2 in) inside diameter for spraying coating through more than a 15 m (50 ft) length. Minimum bursting of 3600 N (800 lbs) is recommended. **Tip: Orifice sizes of 0.53 mm - 0.81 mm (0.021 in - 0.032 in) will be required depending on equipment used.**
   d. Cross apply coating holding spray gun perpendicular to, and approximately 1 m (3 ft) from the wall surface. Avoid excessive material build-up by holding spray gun away from the wall when pulling the trigger, then bringing gun across area to be coated. Maintain a wet edge and avoid starting and stopping in the middle of the wall. Do not attempt to overreach spray pattern as this may result in appearance of irregular spray pattern. Place scaffolding and equipment to facilitate quick application without numerous interruptions.
   e. A 10 % loss from overspray should be anticipated.
   f. Backrolling sprayed areas is recommended to control pinholing on spray applications over porous surfaces.

D. Tuscan Glaze
1. Mix Tuscan Glaze to a smooth homogenous consistency in accordance with Section III.H.2. Continuously agitate throughout application to ensure color consistency.
2. Tuscan Glaze is best applied on large areas using a Hudson-type sprayer or airless spray equipment. For smaller areas, Tuscan Glaze is best applied with a paint pad or, depending on the desired results, a roller, paint brush or sponge. Job site mock-ups are required and should represent the actual job site application techniques.
3. Apply Tuscan Glaze evenly in light strokes. If sagging or running occurs, use a sponge or paint pad to correct immediately. Watch for brush or roller lines. If brush or roller lines appear, use a damp sponge, a paint pad or rag to make them disappear before the Tuscan Glaze starts to dry. The wall may be blotted with a camelback sponge to achieve the desired mottled appearance. Check walls throughout the application to insure that uniformity and the desired appearance is achieved.

E. SealClear
1. Mix SealClear to a smooth, homogeneous consistency in accordance with Section III.H.3.
2. For application instructions, refer to the SealClear Data Sheet, DS426.

XIV. Maintenance and Repair

A. Refer to DryvitCARE EIFS Repair Procedures, DS498.

DISCLAIMER

Information contained in this specification conforms to standard detail and product recommendations for the installation of the Dryvit Outsulation H.E. System products as of the date of publication of this document and is presented in good faith. Dryvit Systems, Inc. assumes no liability, expressed or implied, as to the architecture, engineering or workmanship of any project. To insure that you are using the latest, most complete information, contact Dryvit Systems, Inc., at:

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