Interim Report:

PHASE II: Experimental Evaluation of Pressure Equalization Factors and Wind Resistance of Vinyl Siding Systems Using a Multi-Chamber Pressure Test Bed

Project #: P0150335

Submitted to:

Florida Department of Emergency Management
Office of Inspector General
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DISCLAIMER

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1 BACKGROUND

The University of Florida (UF) conducted damage surveys after Hurricane Irma to assess the impact of the Florida Building Code (FBC) on residential building performance. During Hurricane Irma (2017) 278 houses with vinyl siding cladding were assessed and 53% of those were associated with vinyl siding failures. The assessment was performed using Fulcrum, a mobile smartphone application developed by Spatial Networks (2017) which provided a standardized damage assessment procedure following methodologies from (Gurley et al. 2017). The report identified and recommended more profound studies on the premature failures of vinyl siding systems since Hurricane Irma was not a design level event (Prevatt et al. 2018).

Due to the COVID-19 pandemic the UF work is being conducted from home office locations. At this time, we have halted experimental research within the laboratory due to mandatory restrictions. This interim report assumes the situation will be resolved within a timeframe that allows for conducting our experimental studies. Should this situation change, the project team will discuss alternative options with FBC.

2 RESEARCH AIMS

The aim of this research is to investigate a laboratory-based experimental method that will reproduce the spatial pressure distribution and simultaneous temporal changes that occur on vinyl cladding systems installed on real residential-scale buildings. The goal is to establish an approach for determining appropriate Pressure Equalization Factors (PEF) to be used in wind resistance design of vinyl siding systems. As a discontinuous cladding system, the joints between individual vinyl cladding panels allow air flow and pressure equalization to occur, which modulates the net pressure loading on the cladding system. The PEF value is a modifier to the external design wind pressure, determined from the ASCE 7 minimum design load provisions or from wind tunnel tests. The current wind resistance test standard for vinyl siding systems is the ASTM D5206 test protocol. Recent research by the Insurance Institute for Business and Home Safety (IBHS), Florida International University and others have provided new data on the variability of PEFs on buildings, which may warrant updates to the test standard for vinyl siding.

3 PROJECT TASK ITEMS

There are six tasks within the scope of this project. The progress on each task, and our proposed schedule to conclude it is described below:

3.1 Task A. Convene Research Advisory Group

A Research Advisory Group was formed to provide input and support to the research team. The Advisory Group consists of the following persons:

NAME	ORGANIZATION
Matthew Dobson	Vinyl Siding Institute
Sara Krompholz	Vinyl Siding Institute
Stan Hathorn	Royal Building Products
Zach Priest	PRI Construction Materials Technologies
Anne Cope	IBHS
Murray Morrison	IBHS
T. Eric Stafford	IBHS (T. Eric Stafford & Associates, LLC)
Greg Kopp	Western University
Neil J. Sexton	CertainTeed LLC

The Advisory Group met on 6 February 2020 and meeting notes are attached in Appendix A.

3.2 Task B. Performance Characteristics of Multi-chamber Pressure Test Bed

The experimental testing proposed will be conducted at the University of Florida's Powell Structures Laboratory, using the Spatio-temporal Pressure Loading Actuator (SPLA). The multi-chamber pressure test bed was constructed in Phase 1 of this project during FY2018-2019. A link to the final report for that work can be found here (https://bit.ly/ufWIND-02-2020). To date we have done the following:

- Installed a vinyl siding panel system, instrumented with pressure transducers measuring the gap pressure (between vinyl siding and wood sheathing)
- Developed a method for sealing chambers using latex sheets adhered to siding and wrapped onto the aluminum frame of test chamber
- Developed control software in LabView software (by National Instruments) to control the four pressure loading actuators
- Developed performance characteristics of the wood wall without plastic sheet between wood studs and wood sheathing substrate.

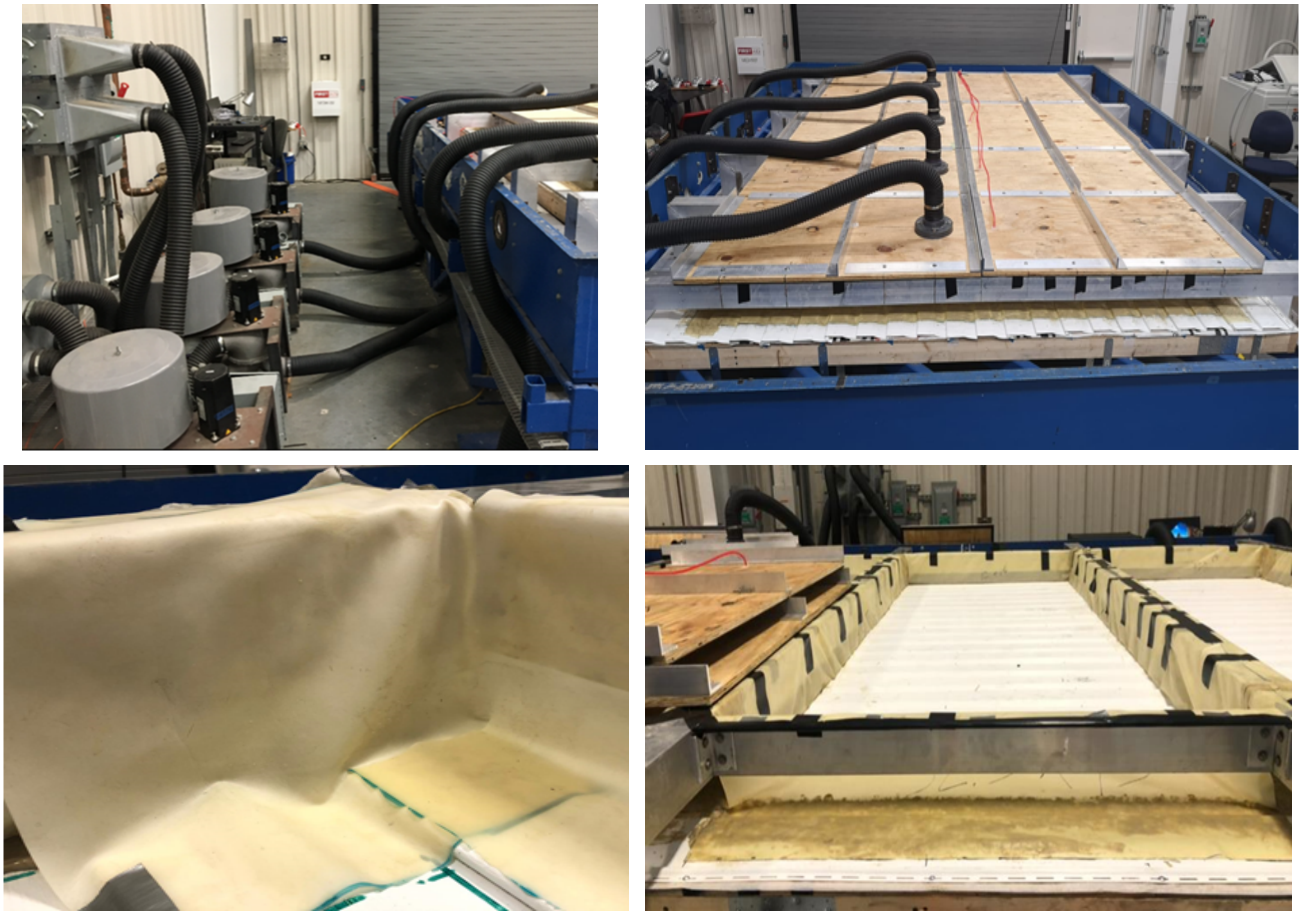


Figure 1. Details of the Experimental test bed and specimen installation. Figure 1a- the four PLAs attached to pressure chambers, Figure 1b – overview of test bed set up with first vinyl siding panel; Figure 1c – corner detail showing the overlapping and sealing of latex to vinyl siding panel and to test frame; Figure 1-d – overview of a single pressure chamber showing installed latex edge seals prior to placing top cover.

3.3 Task C. Literature Review

- The reviewed literature during Phase 1 of the project continues to be augmented as new research enters the public domain. We created a private portal accessible to the Advisory Group so that our literature research is available to them.
- The Advisory Group commits to searching for additional literature and information (such as damage survey data from previous hurricanes that they may have access to). The Research team continues to seek additional performance observations of vinyl siding systems following recent hurricanes from others that we will use to augment our existing database.
- The initial effort focused on understanding previous pressure test protocols used by IBHS and Western University as a starting point.

- Our analysis of the existing database of vinyl siding systems observed by the Research team will include effects of wind angle (relative to orientation of the building) as a potential factor for consideration.

3.4 Tasks D and E : Testing

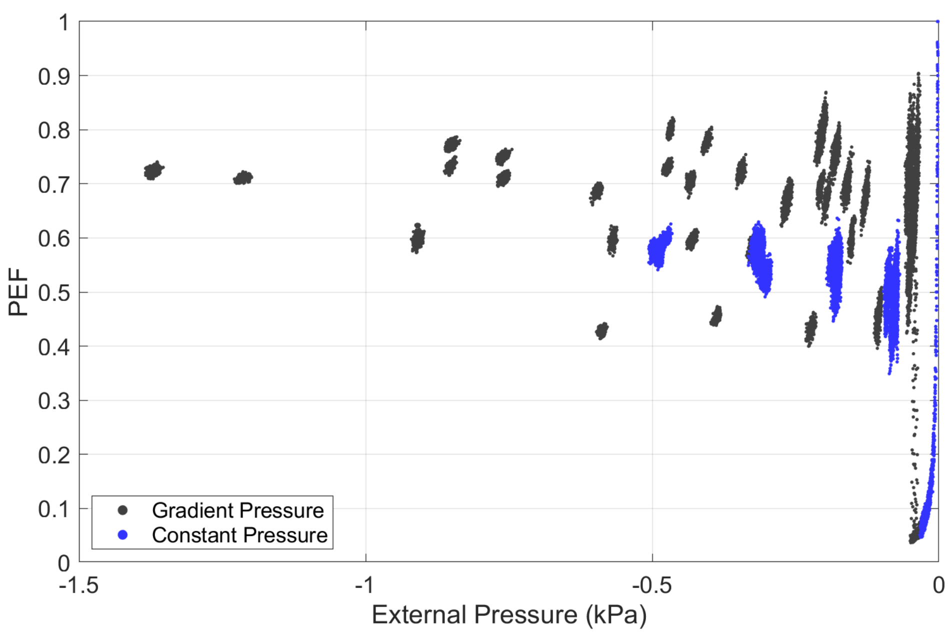
- An updated test matrix is proposed in Section 1.5. and reflects feedback provided by the Advisory Panel following the 8 February 2020 meeting. All told we anticipate six test specimens, including two each single hem, double hem and curled hem vinyl siding specimens.
- We conducted an initial two-day round of preliminary testing on 17 and 18 February 2020 to better establish performance characteristics of the test setup and inform development of the full test matrix. This test series was not part of the complete test matrix but did generate preliminary data that will be presented in 1.2.5
- The preliminary results confirmed functioning of the control equipment and that instrumentation can capture the net pressures thereby enabling the PEFs to be determined.
- The Advisory Group members are invited to witness future testing and the Research team will coordinate the schedules to provide prior information. Further we requested suggestions from the Advisory Group members from the Vinyl siding industry, of names of certified vinyl siding installers who may assist with installation in accordance with respective manufacturer's specifications.

3.5 Task F. Preliminary Results

- Preliminary testing was conducted by applying a series of static pressure tests, including both spatially-varying and spatially-uniform pressure distributions across the four pressure chambers. Tests were conducted with the cavity (gap between vinyl siding and wood sheathing) both open to atmosphere at the ends of the test specimen, and nominally sealed.
- With the cavity open to atmospheric, the SPLA was able to generate static differential pressures up to –1.5 kPa across the vinyl siding with the SPLA only at ~50% of maximum capacity. We anticipate being able to apply spatially-varying or uniform static suction pressures exceeding 2-3 kPa across the vinyl siding.
- Pressure Equalization Factors (PEF) were calculated by using two differential pressure readings with respect to atmospheric pressure for each chamber pressure and for each box pressure

$$PEF = \frac{Chamber\ Pressure - \ Cavity\ Pressure}{Chamber\ Pressure}$$

- Preliminary PEFs obtained from static spatially-uniform (i.e., constant) and spatially-varying (i.e., gradient) pressures are plotted in Figure 1. Each dot in Figure 1 represents the PEF in a chamber at a given moment in time; each cluster represents a specific pressure magnitude and spatial distribution. The PEFs were obtained using a mix of pressure magnitudes and distributions.
- PEFs from preliminary testing as described above displayed an asymptotic trend towards a value of approximately 0.7, with slightly lower PEFs for the constant pressure case as compared to the gradient pressure case. Again, these are preliminary data demonstrating the performance of the SPLA and should be treated as research data only.
- Additional testing showed that the PEFs are a function of the background leakage in the test volume, highlighting the need for benchmark testing to quantify this leakage before each test. This finding has been incorporated into the proposed test matrix.



3.6 Dynamic Load Traces

The following stages of this experiment will now concentrate on the addition of dynamic pressure traces as the loading function applied and evaluation of different test specimens according to the presented test matrix.

4 VINYL SIDING SPECIMENS

Three vinyl siding products are proposed for this study (shown in Figure 2), including vinyl siding systems with high wind rating. We plan to test single-hem, double-hem and curled hem systems.

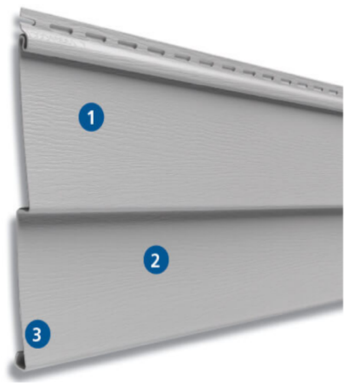
	1. Georgia-Pacific Vision Pro double 5 in. latch lap • Approved by the Miami-Dade County Product Control Section • 0.04 in. panel thickness and ½ in. panel projection • Single nail hem • Rated to 40 psf wind load.
	2. Mastic “Carvedwood” 44 CW250 double 5 in. latch lap • Approved by the Miami-Dade County Product Control Section • 0.042 in. panel thickness and 5/8 in. panel projection • Curl nail hem • Rated to 60 psf wind load.
	3. Mastic “Quest” QT50 double 5 in. latch lap • Approved by the Miami-Dade County Product Control Section • 0.044 in. panel thickness and 3/4 in. panel projection • Double nail hem • Rated to 60 psf wind load

Figure 2. Three types of vinyl siding selected for testing

5 PROPOSED TEST MATRIX AND PRESSURE TRACE LIBRARY

The proposed test matrix will subject each specimen to a series of static and dynamic pressure traces. Uniform pressure tests will replicate the current ASTM D 5206, *Test Method for WindLoad Resistance of Rigid Plastic Siding.* Other tests will employ spatially varying external pressure distributions, that following upon results developed by IBHS and Western University. Details of the proposed test matrix are included in Appendix A. We anticipate conducting the test series at three peak-pressure levels of 0.5 kPa, 1.0 kPa, and 1.5 kPa to explore whether the magnitude of external pressure has any effect on distribution or magnitude PEF values.

The last test on each panel will be the ASTM D 5206 which is a destructive test to failure, used to confirm the performance of our testbed set and for correlating with existing documented performances.

Table 1. Proposed Test Matrix

Level	Description	Trace ID
Level 1 – peak pressure magnitude = -0.5 kPa	Benchmark	SID-L1-B-1
	Uniform static tests	SID-L1-US-n*
	Benchmark	SID-L1-B-2
	Spatially-varying static tests	SID-L1-VS-n*
	Benchmark	SID-L1-B-3
	Spatially-varying sine wave tests	SID-L1-VSW-n*
	Benchmark	SID-L1-B-4
	Spatially-varying wind traces – Run2071 – side wall	SID-L1-SVW-2071S
	Benchmark	SID-L1-B-5
	Spatially-varying wind traces – Run2071 – leeward wall	SID-L1-SVW-2071L
	Benchmark	SID-L1-B-6
	Spatially-varying wind traces – Run279 – side wall	SID-L1-SVW-279S
	Benchmark	SID-L1-B-7
	Spatially-varying wind traces – Run279 – leeward wall	SID-L1-SVW-279L
Level 2 – peak pressure magnitude = -1.0 kPa	Benchmark	SID-L2-B-1
	Uniform static tests	SID-L2-US-n*
	Benchmark	SID-L2-B-2
	Spatially-varying static tests	SID-L2-VS-n*
	Benchmark	SID-L2-B-3
	Spatially-varying sine wave tests	SID-L2-VSW-n*
	Benchmark	SID-L2-B-4
	Spatially-varying wind traces – Run2071 – side wall	SID-L2-SVW-2071S
	Benchmark	SID-L2-B-5
	Spatially-varying wind traces – Run2071 – leeward wall	SID-L2-SVW-2071L
	Benchmark	SID-L2-B-6
	Spatially-varying wind traces – Run279 – side wall	SID-L2-SVW-279S
	Benchmark	SID-L2-B-7
	Spatially-varying wind traces – Run279 – leeward wall	SID-L2-SVW-279L
ev el 3	Benchmark	SID-L3-B-1
	Uniform static tests	SID-L3-US-n*

Level	Description	Trace ID
	Benchmark	SID-L3-B-2
	Spatially-varying static tests	SID-L3-VS-n*
	Benchmark	SID-L3-B-3
	Spatially-varying sine wave tests	SID-L3-VSW-n*
	Benchmark	SID-L3-B-4
	Spatially-varying wind traces – Run2071 – side wall	SID-L3-SVW-2071S
	Benchmark	SID-L3-B-5
	Spatially-varying wind traces – Run2071 – leeward wall	SID-L3-SVW-2071L
	Benchmark	SID-L3-B-6
	Spatially-varying wind traces – Run279 – side wall	SID-L3-SVW-279S
	Benchmark	SID-L3-B-7
	Spatially-varying wind traces – Run279 – leeward wall	SID-L3-SVW-279L
	Benchmark	SID-D5206-B1
-	ASTM D5206	SID-D5206

Notes:
- SID indicates the specimen ID
- n* indicates a specific configuration within the trace family

6 NEXT STEPS AND SCHEDULE

Preliminary tests performed helped identify the pressure chambers peak pressure response characteristics, as well as how the set-up can be improved. The addition of the polyurethane sheet in Section 3.2 will possibly help to increase peak pressure in each chamber. The same sheet will be used to seal the perimeter of the underside cavity. The provided values for PEFs from the preliminary testing are highly dependent on the air leakage characteristics of the underside cavity and are not intended to be suggested PEFs at this time. Currently, software modifications are being finalized and pressure transducers capable of capturing the dynamic fluctuations are being installed to the test assembly.

The Advisory Group will have three additional meetings, one of which we hope will include opportunity to observe one day of the test series at the Powell Structures Laboratory, for those who are able to travel.

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Miller, C. S., Kopp, G. A., Morrison, M. J., Kemp, G., and Drought, N. (2017). "A Multichamber, Pressure-Based Test Method to Determine Wind Loads on Air-Permeable, Multilayer Cladding Systems." *Frontiers in Built Environment*, 3, 7.

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Appendix A: Memorandum of First Meeting

From: David O. Prevatt, Xinyang Wu

To: Advisory Group Members

Date: 8 February 2020

Project: PHASE II: Experimental Evaluation of Pressure Equalization Factors and Wind Resistance of Vinyl Siding Systems Using a Multi-Chamber Pressure Test Bed

Subject: Notes of Advisory Group Meeting Held on 6 February 2020

Attendees: *University of Florida:* David O Prevatt (DOP), Oscar La Fontaine (OL), Xinyang Wu (XW); *Auburn University:* David B Roueche (DBR); *Vinyl Siding Institute:* Matt Dobson (MD), Stan Hathorn (ST), Sara Krompholz (SK), Neil Sexton (NS); *IBHS:* Eric Stafford (ES); *Western University:* Greg Kopp (GK); **ABSENT:** Zach Priest (ZP) PRI

This provides notes of the above meeting. First meeting introducing the project goals, deliverables, review of progress with experimental setup. David O. Prevatt (DOP), David Roueche (DBR) and Oscar Lafontaine (OL) presented slides (click here for view).

1. Background updates of Phase I of project presented by DOP. DBR presented summary data and case study of previous studies of post Hurricane Irma and Hurricane Michael. Part of broader assessment, using cluster sampling techniques looking broadly at all cladding system types. Relatively high number of vinyl siding failures
    a. From building damage survey, 87 structures with vinyl siding cladding identified and damage ratios established.
    b. The complete dataset of 1,200 houses in Hurricane Irma, and 740 in Hurricane Michael. Reports available in Documents folder.
    c. MD: Suggest the Research Team explains total dataset numbers in their future reports (e.g. total number of houses, number of cladding types, explain damage ratio details etc.)
    d. DBR showed possible hypothesis of failures on found homes with vinyl siding cladding failure on building surfaces close to adjacent houses (i.e. wind speed up? Venturi effects?)
    e. GK points out observation of loose house wrap (Tyvek, underlayment) behind siding. Can this change allow interior pressure into gap and the pressure equalization effects assumed?
    f. MD mentions pattern of vinyl siding failure along soffit line. Information on fasteners are crucial to performance. Fastener length, spacing, fasteners missing. thinks the vinyl siding fasteners information is crucial, like length of fastener and quantity of fastener missing and penetration of fastener 1-1/4 in (min). Basically, some of the encountered failures may be due to installation issues instead of the actual vinyl siding capacity failure.
2. SH: In the slides 15, the Industry-accepted term is nail hem (both single and double nail hem possible)
3. GK: UWO chamber for the(Miller et al. 2017) study used hard exterior sides of pressure chambers (poly-sheet?), and flexible latex material used only for interior walls separating adjacent chambers. Vinyl siding completely enclosed (and not attached to exterior chamber walls.
    a. DOP: current test setup has vinyl siding sample (and wood wall) extending beyond the exterior chamber walls. UF's specimen then sealed using latex material to top side of vinyl.

4. DBR presented a protested text matrix (see ppt) including 2 repeats. Include ASTM D5206 and Pressure Equalization factors (PEF) test measurement on standard and high-wind vinyl siding systems.
    a. intermediate testing, developing pressure time histories from the Tokyo Polytechnic University (TPU) wind tunnel pressure database to represent Hurricane Michael orientation of wind direction, on side wall, leeward wall, cornering wind angles leeward wall (45 degree). he proposed two questions:
        i. Focus: what ultimately is an approach to considers spatial pressure variation, achievable in most standard test laboratories?
        ii. Can the test rig simulate pressures at failure or observed strengths from Hurricane Michael?
5. GK: For a leaky system requires considerable fan power to achieve failure. UWO experiments utilized up to 3 PLAs on a single pressure box to achieve air flow required at high pressures.
6. Discussion on various available grades of vinyl siding systems in use in Florida and elsewhere.
    a. Is there a difference between high wind versus builder grade?
    b. Is 0.04 in thickness a common lower wind grade?
    c. 0.05 in most strong product but hard to find
    d. 0.046 in is a solid product available widely, are these both double hems and single hems?
    e. What is the curl hem vinyl siding?
7. SH: Few single nail hem products meet current Florida FBC requirements. Curl hem and double hem vinyl siding is designed for high-wind rated. Note: current code includes product design requirements using PEFs of 0.5. Previously a PEF of 0.36 was used.
8. ES: According to FEMA/MAT team report for Hurricane Michael, most of vinyl siding installed in Florida were single nail hem, he didn’t see any double hem vinyl-siding products.
9. UF will inform Advisory Group prior to testing dates in case others wish to witness tests in person.
10. UF to discuss with SH and MD on particular vinyl siding systems they used previously in IBHS tests as well as at University of Western Ontario and coordinate systems where possible.

Appendix B: Revised Test Matrix and Pressure Trace Library

From: David Roueche, Jinyi Wei

To: UF Team

Date: 19 March 2020

Project: FBC Vinyl Siding Phase II

Subject: Revised Test Matrix and Pressure Trace Library

Introduction

Vinyl siding specimens will be experimentally tested at the University of Florida using the Spatio-Temporal Loading Actuator (SPLA) to research pressure equalization factors in vinyl siding under various wind pressure loading scenarios. Previous correspondence with the UF team has indicated that three vinyl specimens will be constructed, each using a specific vinyl siding product (hereafter simply referred to as product) – (1) Georgia Pacific Vision Pro (standard single hem vinyl siding), (2) Ply Gem Mastic Carvedwood 44 (curl vinyl siding), and (3) Ply Gem Mastic Quest 50 (double-hem vinyl siding). The objective of this memorandum is to provide a suitable test matrix to ensure the desired research products are obtained through the testing. The test matrix will define the pressures that will be applied through each of the four pressure chambers to the vinyl siding specimen via the SPLA.

Constraints in Forming the Test Matrix

The following points provide constraints and objectives considered in developing the test matrix:

- Each product must be tested in accordance with ASTM D5206 *Test Method for Windload Resistance of Rigid Plastic Siding* to evaluate the maximum sustained static pressure and the ultimate (i.e., failure) pressure.
- Previous testing of pressure equalization effects in vinyl siding (e.g. Miller et al., 2017) have not explicitly evaluated to what degree the Pressure Equalization Factors (PEFs) are affected by changes in the maximum magnitude of the applied external pressures over a wide range. The consistency of the PEFs over a range of pressures approaching the failure pressure should be evaluated.
- It is desired to research the simplest test setup required to generate accurate PEFs. Therefore, PEFs resulting from both static and dynamic spatially-varying and uniform pressures should be obtained.

- Preliminary testing (Februrary 18-19, 2020 at the University of Florida) demonstrated that air leakage from atmospheric to the gap between the vinyl siding and wood sheathing affects the obtained PEFs. The area of leak gaps from atmospheric pressure relative to the area of the through gaps (airflow paths across the vinyl siding) controls whether the gap pressure remains at atmospheric or is affected by the applied external pressure within the pressure chamber(s). Benchmarks are needed to quantify the extent of system leakage present in the test volume, with recognition that system leakage may change from one test to the next on the same specimen.
- Post-hurricane reconnaissance following Hurricanes Irma (2017) and Michael (2018) found some evidence that vinyl siding failures were more likely to occur on side walls under normal or cornering flows. These observations should be considered in developing the spatio-temporal pressure histories.

Proposed Library of Pressure Traces

Each specimen will undergo a series of static and dynamic, uniform and spatially varying pressure traces reflecting the constraints and objectives described above. Each trace will be produced in the form of a tab-delimited text file with pressures in kPa for each pressure chamber using a time step of 50 ms. Prior to each trace being run on a specimen, a benchmark trace will be run to document the system level leakage levels and ensure consistent system performance from run to run. The various pressure traces will be defined for three levels of pressure – Level 1, with a peak pressure magnitude (highest suction pressure at any time in any chamber) of 0.5 kPa, Level 2, peak pressure of 1.0 kPa, and Level 3, peak pressure of 1.5 kPa. Level 3 may not be feasible for spatially-temporally varying pressure traces due to limitations of the SPLA. The various pressure traces that are to be attempted at each Level are proposed below. The total run time of all testing for each specimen, assuming all traces can be performed, should be approximately 30 minutes, including benchmark traces. Actual test time will vary.

Benchmark Traces

The pressure trace for each of the four pressure chambers will linearly increase from 0 to 0.5 kPa, at a rate of 0.1 kPa per second, then maintain the 0.5 kPa pressure for 15 seconds, and finally return to 0 kPa at a rate of 0.1 kPa per second. The 0.5 kPa pressure will be used for Levels 1, 2 and 3.

Spatially Uniform Static Traces

The pressure traces will follow that of ASTM D5206, which consists of applying a uniform pressure difference across the specimen in increments of 5 lbf/ft2 (0.25 kPa), holding for 30 s before increasing the next 5 lbf/ft2 (0.25 kPa) until the specified pressure for the given level (e.g., 0.5 kPa for Level 1, 1.0 kPa for Level 2, 1.5 kPa for Level 3) is achieved.

Spatially Varying Static Traces

Spatially varying pressures will be applied such that pressures are held constant in each chamber, but at different magnitudes in each chamber. Possible spatially-varying static pressure patterns include (1) Peak Level pressure (e.g., 1.0 kPa) in Zone 1 with 75% of the peak in Zone 2, 50% in Zone 3 and 25% in Zone 4; and (2) Peak Level pressure in Zones 1 and 2 with 50% of the peak in Zones 3 and 4. Pressures will be held constant at each step for 30 seconds.

Spatially Varying Sine Wave Traces

Pressure sine waves will be traced in each pressure chamber with varying magnitudes, phase shifts, and angular frequencies (< 1 Hz). The highest magnitude pressures and angular frequencies will be in Zone 1, with decreasing pressures in Zone 2 and decreasing pressures and angular frequencies in Zones 3 and 4. Each spatially varying sine wave trace will have a duration of 1 minute.

Spatially-temporally Varying Wind Traces

A previous memo (Generating Pressure Time Histories from TTU WERFL Building Data, dated 2/22/2020, attached below) detailed the wind pressure traces that will be used from the Texas Tech University Wind Engineering Research Field Laboratory (WERFL). The only modification that will be made is to extend the dataset to include a leeward wall case to the original sidewall case for WERFL Run 2071 (Angle of Attack: 355°), and also include a leeward and sidewall case for WERFL Run 279 (Angle of Attack: 10°). Each wind trace will have a duration of 3 minutes, for a total of 12 minutes of wind traces with three intermediate benchmark traces at 20 seconds each, giving a total run time of approximately 13 minutes.

Memo_WERFL%20Pr
essure%20Time%20Hi

ASTM D5206

The pressure traces will follow that of ASTM D5206, which consists of applying a uniform pressure difference across the specimen in increments of 5 lbf/ft2 (0.25 kPa), holding for 30 s before increasing the next 5 lbf/ft2 (0.25 kPa) and continuing until failure of the specimen. Failure is defined as meeting any of the following criteria:

- Siding nail tab is torn or disengaged from fastener.
- Permanent buckling of siding.
- Fastener withdrawal from frame.
- Permanent disengagement of locks

Proposed Test Matrix

Level	Description	Trace ID
Level 1 – peak pressure magnitude = -0.5 kPa	Benchmark	SID-L1-B-1
	Uniform static tests	SID-L1-US-n*
	Benchmark	SID-L1-B-2
	Spatially-varying static tests	SID-L1-VS-n*
	Benchmark	SID-L1-B-3
	Spatially-varying sine wave tests	SID-L1-VSW-n*
	Benchmark	SID-L1-B-4
	Spatially-varying wind traces – Run2071 – side wall	SID-L1-SVW-2071S
	Benchmark	SID-L1-B-5
	Spatially-varying wind traces – Run2071 – leeward wall	SID-L1-SVW-2071L
	Benchmark	SID-L1-B-6
	Spatially-varying wind traces – Run279 – side wall	SID-L1-SVW-279S
	Benchmark	SID-L1-B-7
	Spatially-varying wind traces – Run279 – leeward wall	SID-L1-SVW-279L
Level 2 – peak pressure magnitude = -1.0 kPa	Benchmark	SID-L2-B-1
	Uniform static tests	SID-L2-US-n*
	Benchmark	SID-L2-B-2
	Spatially-varying static tests	SID-L2-VS-n*
	Benchmark	SID-L2-B-3
	Spatially-varying sine wave tests	SID-L2-VSW-n*
	Benchmark	SID-L2-B-4
	Spatially-varying wind traces – Run2071 – side wall	SID-L2-SVW-2071S
	Benchmark	SID-L2-B-5
	Spatially-varying wind traces – Run2071 – leeward wall	SID-L2-SVW-2071L
	Benchmark	SID-L2-B-6
	Spatially-varying wind traces – Run279 – side wall	SID-L2-SVW-279S
	Benchmark	SID-L2-B-7
	Spatially-varying wind traces – Run279 – leeward wall	SID-L2-SVW-279L
Level 3 – peak pressure magnitude = -1.5 kPa	Benchmark	SID-L3-B-1
	Uniform static tests	SID-L3-US-n*
	Benchmark	SID-L3-B-2
	Spatially-varying static tests	SID-L3-VS-n*
	Benchmark	SID-L3-B-3
	Spatially-varying sine wave tests	SID-L3-VSW-n*
	Benchmark	SID-L3-B-4
	Spatially-varying wind traces – Run2071 – side wall	SID-L3-SVW-2071S
	Benchmark	SID-L3-B-5
	Spatially-varying wind traces – Run2071 – leeward wall	SID-L3-SVW-2071L
	Benchmark	SID-L3-B-6
	Spatially-varying wind traces – Run279 – side wall	SID-L3-SVW-279S
	Benchmark	SID-L3-B-7
	Spatially-varying wind traces – Run279 – leeward wall	SID-L3-SVW-279L
	Benchmark	SID-D5206-B1
-	ASTM D5206	SID-D5206

Notes:
- SID indicates the specimen ID
- n* indicates a specific configuration within the trace family