



ABAA Research Projects with Air and Water Resistive Barriers

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LEARNING OBJECTIVES

- Describe the History of WRBs
- Introduce Current Trends with Water Resistive Barriers (WRBs)
- Discuss Code Compliance and Standards
- Review of Current and Proposed Test Methods
- Summarize Fastener Penetration Testing Status
- Discuss Other Potential Water Testing and Future Work

HISTORY



Felt Paper

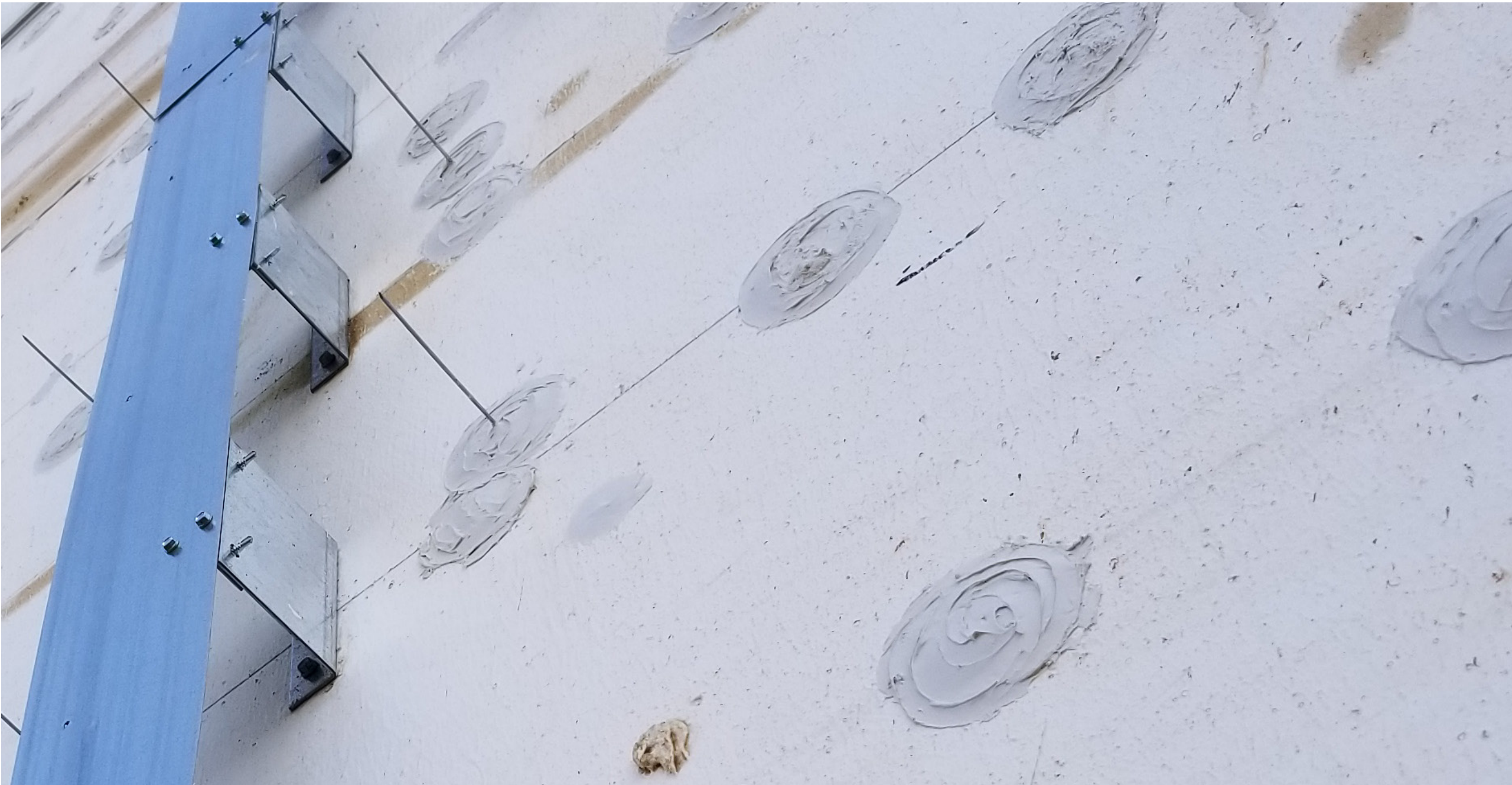


Mechanically Fastened and
Self Adhered Membranes

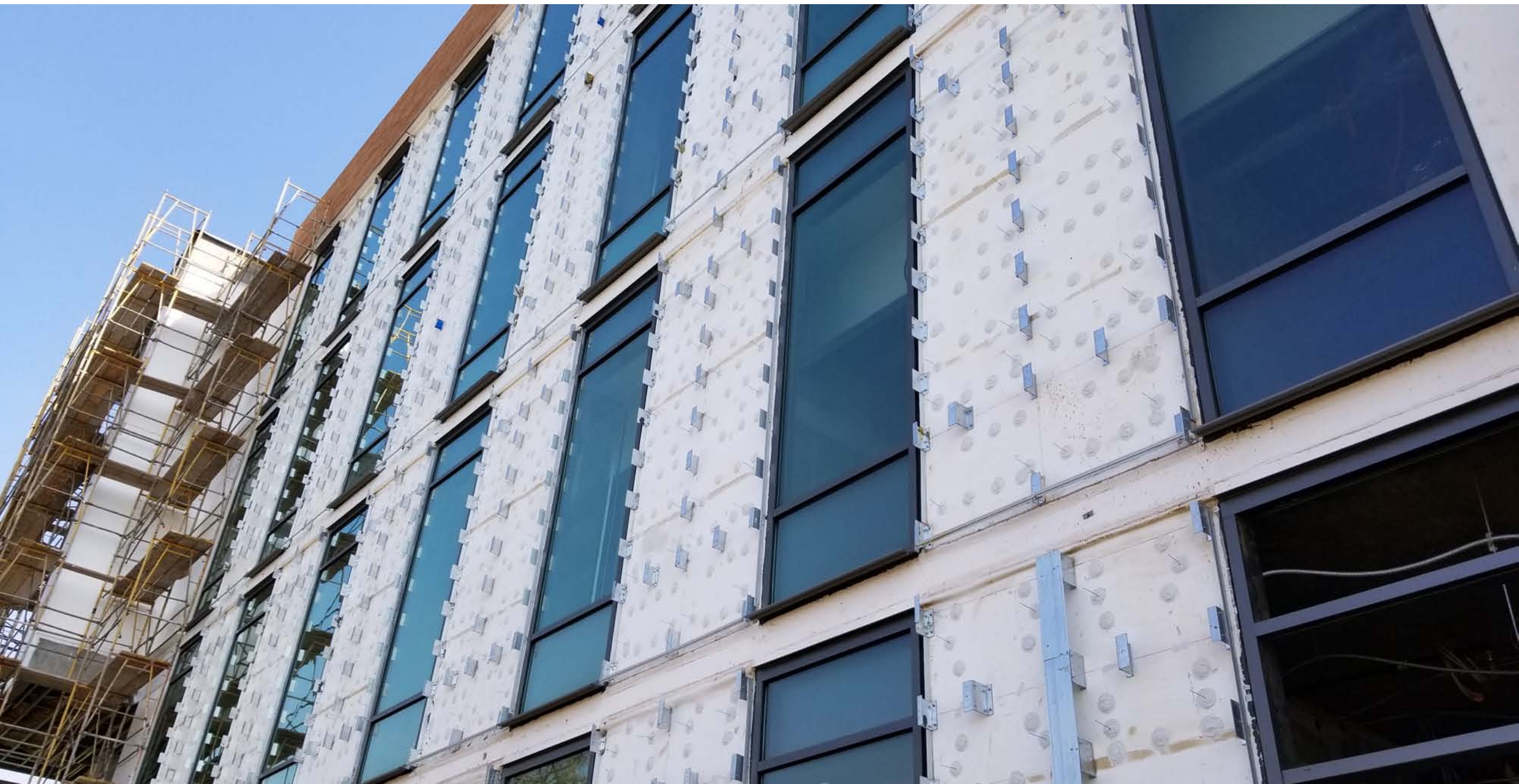


Fluid Applied

CURRENT TRENDS



CURRENT TRENDS



CURRENT TRENDS



CURRENT TRENDS



PROBLEM

WATER INFILTRATION

VISUAL ASSESSMENT



CONCEALED



CHALLENGES

def·i·ni·tion n.

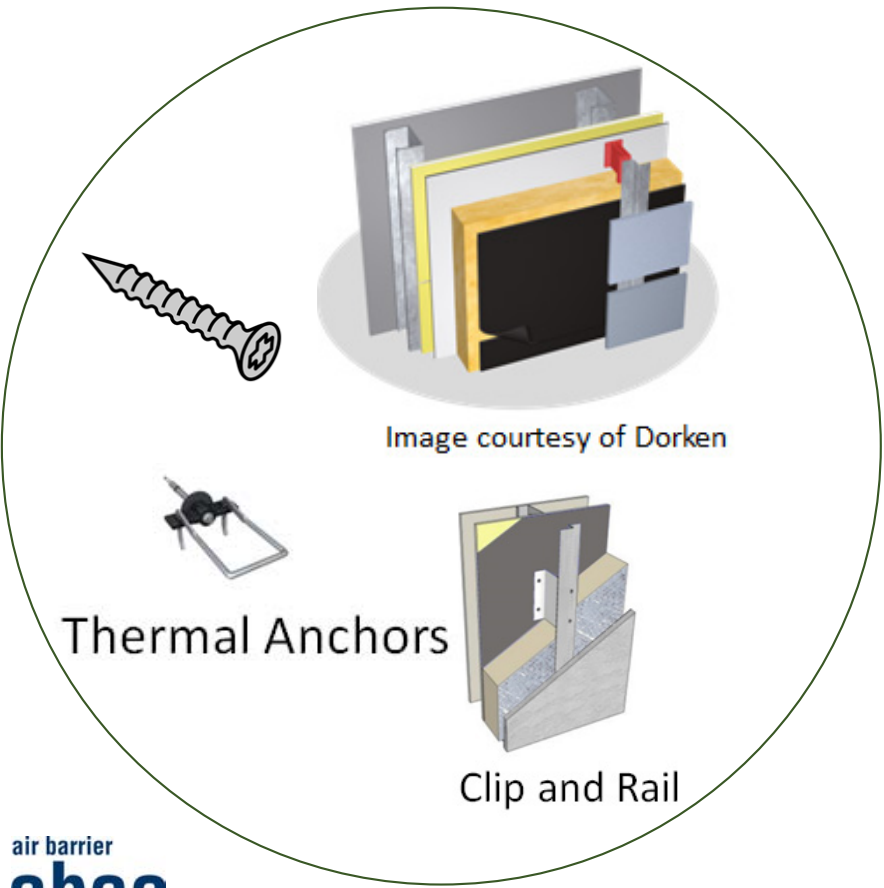
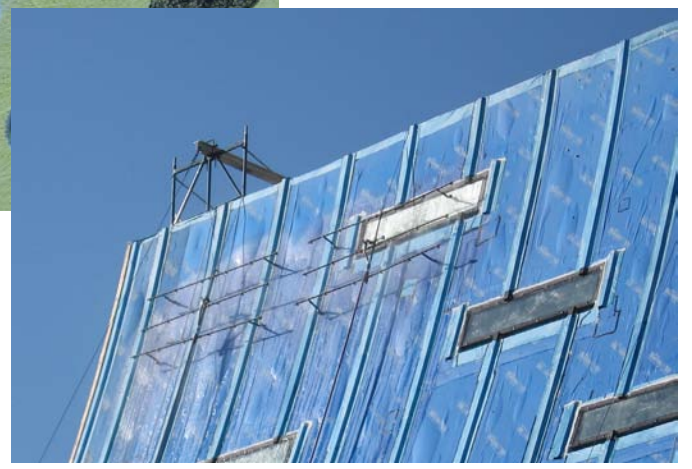
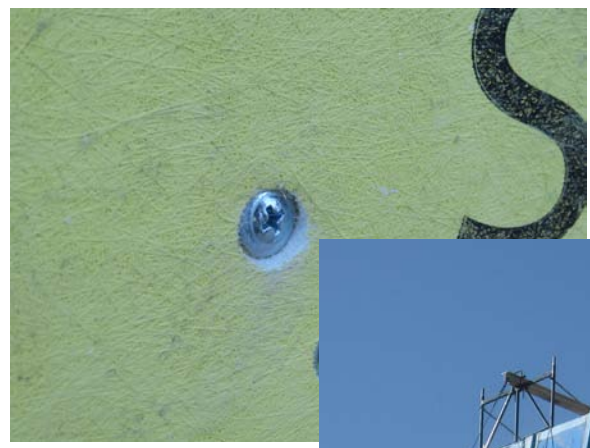
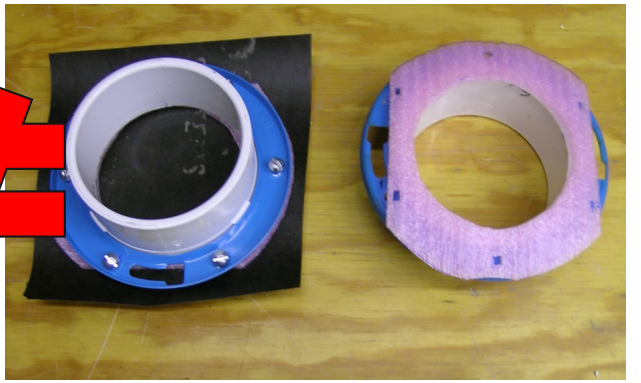
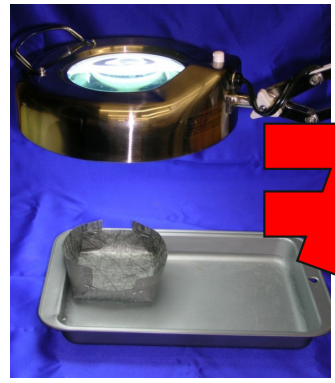
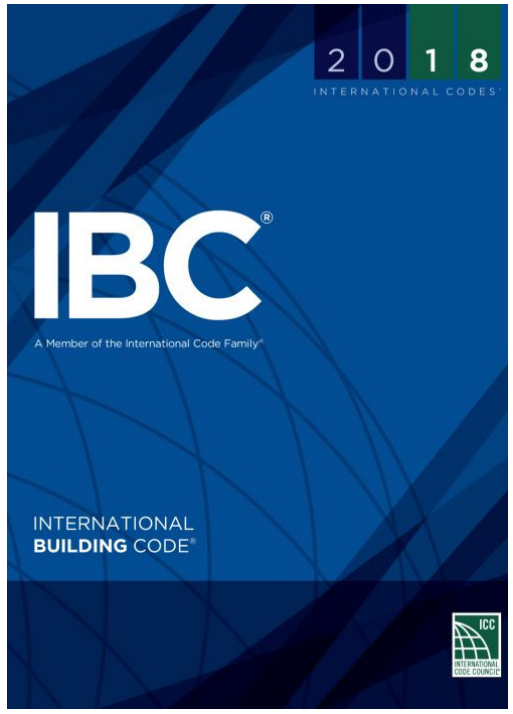


Image courtesy of Dorken

Thermal Anchors

Clip and Rail

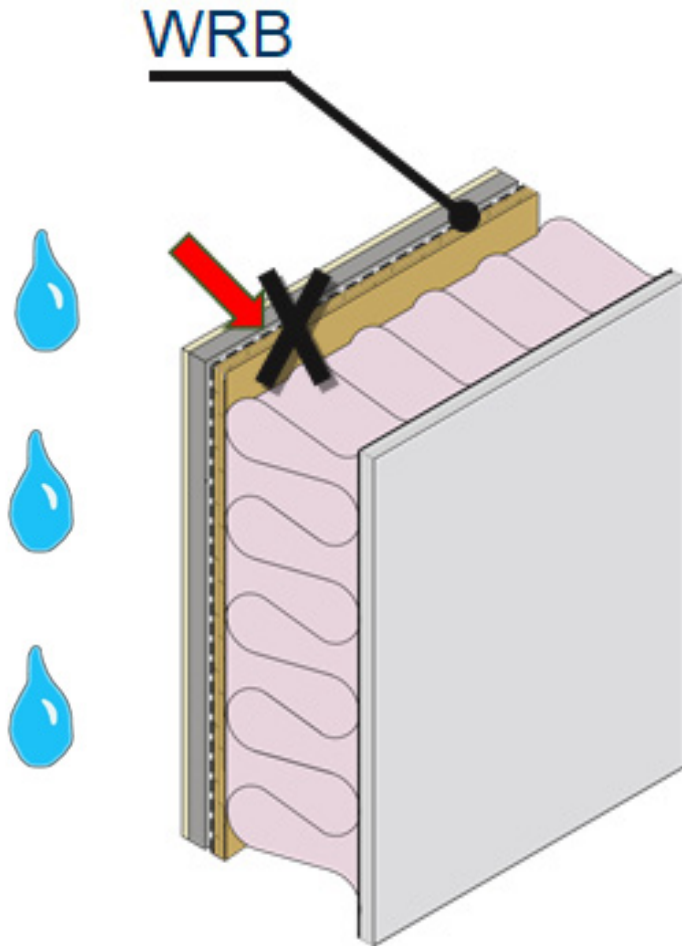


DEFINITION

2018

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WATER-RESISTIVE BARRIER. A material behind an *exterior wall covering* that is intended to resist liquid water that has penetrated behind the exterior covering from further intruding into the *exterior wall* assembly.



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COMPLIANCE

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1403.2 Weather protection.

Exterior walls shall provide the building with a weather-resistant *exterior wall envelope*. The *exterior wall envelope* shall include flashing, as described in Section 1405.4. The *exterior wall envelope* shall be designed and constructed in such a manner as to prevent the accumulation of water within the wall assembly by providing a *waterresistive barrier* behind the exterior veneer, as described in Section 1404.2, and a means for draining water that enters the assembly to the exterior. Protection against condensation in the *exterior wall* assembly shall be provided in accordance with Section 1405.3.

DIRECT REFERENCE

1404.2 Water-resistive barrier.

Not fewer than one layer of No.15 asphalt felt, complying with ASTM D226 for Type 1 felt or other approved materials, shall be attached to the studs or sheathing, with flashing as described in Section 1405.4, in such a manner as to provide a continuous *water-resistive barrier* behind the *exterior wall* veneer.

REFERENCED STANDARD

2510.6 Water-resistive barriers.

Water-resistive barriers shall be installed as required in Section 1404.2 and, where applied over wood-based sheathing, shall include a water-resistive vapor-permeable barrier with a performance at least equivalent to two layers of *water-resistive barrier* complying with ASTM E2556, Type I. The individual layers shall be installed independently such that each layer provides a separate continuous plane and any flashing (installed in accordance with Section 1405.4) intended to drain to the *water-resistive barrier* is directed between the layers.

ALTERNATE MATERIAL

[A] 104.11 Alternative materials, design and methods of construction and equipment.

The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved.

ASTM D226



1. Scope

1.1 This specification covers asphalt-saturated organic felts, with or without perforations, intended to be used with asphalts conforming to the requirements of Specification D312 in the construction of built-up roofs, and with asphalts conforming to the requirements of Specification D449 in the construction of water proofing systems.

This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.



Designation: D226/D226M – 17

Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing¹



D226/D226M – 17

TABLE 1 Physical Requirements of Asphalt-Saturated Roofing Felt

	Type I	Type II
Average breaking strength, min, kN/m [lbf/in.] of width:		
With fiber grain	5.3 [30]	7.0 [40]
Across fiber grain	2.6 [15]	3.5 [20]
Pliability at 25°C [77°F]		
The ten strips tested shall not crack when bent 90° at a uniform speed over a rounded corner of:	12.7-mm [½-in.] radius	19.1-mm [¾-in.] radius
Loss on heating at 105°C [221°F] for 5 h, max, %	4	4

TABLE 2 Dimensions and Masses of Asphalt-Saturated Roofing Felt

	Type I	Type II
Width of roll, mm [in.]	914 [36] ± 0.7 % or as agreed upon by purchaser and seller	
Area of roll, min, m ² [ft ²]	20.1 [216] or 40.1 [432] ^A	20.1 [216] ^A
Moisture, at point of manufacture, max % ^B	4.3	4.1
Net mass of saturated felt, min, g/m ² [lb/100 ft ²]	560 [11.5]	1270 [26]
Mass of saturant, min, g/m ² [lb/100 ft ²] ^C	303 [6.2]	732 [15.0]
Mass of desaturated felt, min, g/m ² [lb/100 ft ²]	254 [5.2]	488 [10.0]
Ash, max, %	10.0	10.0
Perforated felt, avg, area of individual hole, max, mm ² [in. ²]	32 [0.05]	...
Average venting area, min, %	0.1	...

^A Other areas as agreed upon by purchaser and seller.

^B At time of manufacture. Products with a higher moisture content at the time of installation may cause hot materials to foam, creating voids that may result in blisters.

^C The mass of saturant shall not be less than 1.2 times the mass of the dry felt for Type I with a saturation efficiency of not less than 70 %. The mass of the saturant shall not be less than 1.50 times the mass of dry felt for Type II.

Materials (Pycnometer Method)

¹ This specification is under the jurisdiction of ASTM Committee D08 on Roofing and Waterproofing and is the direct responsibility of Subcommittee D08.04 on Felts, Fabrics and Bituminous Sheet Materials.

Current edition approved June 15, 2017. Published July 2017. Originally approved in 1925. Last previous edition approved in 2009 as D226/D226M–09. DOI: 10.1520/D0226_D0226M-17.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

6.1 The material shall conform to the physical requirements prescribed in Table 1 and the dimensions and masses prescribed in Table 2.

6.2 The finished product shall not crack nor be so sticky as to cause tearing or other damage upon being unrolled at temperatures between 10 and 60°C [50 and 140°F].

6.3 Perforated felts shall conform to the same requirements as the plain type but shall also have uniformly spaced perforations.

ASTM E2556

This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.



Designation: E2556/E2556M – 10 (Reapproved 2016)

Standard Specification for Vapor Permeable Flexible Sheet Water-Resistive Barriers Intended for Mechanical Attachment¹

This standard is issued under the fixed designation E2556/E2556M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification is limited to vapor permeable flexible

the Dry Indicator Method

D828 Test Method for Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus

1. Scope

1.1 This specification is limited to vapor permeable flexible sheet materials which are intended to be mechanically attached and are generally installed behind the cladding system in exterior walls.

1.2 This specification is limited to the evaluation of materials and does not address installed performance. Although the fastening practices (type of fastener, fastening schedule, etc.) may affect the installed function of these materials, they are not included in this specification.

2. Referenced Documents

2.1 ASTM Standards:²

D226/D226M Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing

D779 Test Method for Determining the Water Vapor Resistance of Sheet Materials in Contact with Liquid Water by

AATCC Test Method 127 Water Resistance, Hydrostatic Pressure Test³

CGSB CAN2-51.32.M77 Sheathing Membrane, Breather Type⁴

Federal Specification UU-B-790a Federal Specification Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellent and Fire Resistant)⁵

¹ This specification is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.55 on Performance of Building Enclosures.

Current edition approved Dec. 1, 2016. Published December 2016. Originally approved in 2009. Last previous edition approved in 2010 as E2556/E2556M-10. DOI: 10.1520/E2556_E2556M-10R16.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from American Association of Textile Chemists and Colorists (AATCC), P.O. Box 12215, Research Triangle Park, NC 27709-2215, <http://www.aatcc.org>.

⁴ Available from Canadian General Standards Board (CGSB), 11 Laurier St., Phase III, Place du Portage, Gatineau, Quebec K1A 0S5, Canada, <http://www.tpsgc-pwgsc.gc.ca/oncg-cgsb>.

⁵ Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, <http://quicksearch.dla.mil>.



ASTM E2556

This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.



Designation: E2556/E2556M – 10 (Reapproved 2016)

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3.2.6 Water-Resistive Barrier (WRB), n —a material that is intended to resist liquid water that has penetrated the cladding system.

NOTE 1—Wall assemblies often include two lines of defense against rain water ingress. The cladding serves as the first line of defense and the water-resistive barrier as the second line of defense

NOTE 2—Water-resistive barriers are sometimes referred to as weather resistant barriers or sheathing membranes.

responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

¹ *Building Wall Systems to Resist Water Intrusion*
G154 Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials
2.2 Other Standards:
AATCC Test Method 127 Water Resistance: Hydrostatic

WATER-RESISTIVE BARRIER. A material behind an exterior wall covering that is intended to resist liquid water that has penetrated behind the exterior covering from further intruding into the exterior wall assembly.

Performance of buildings and is the direct responsibility of Subcommittee E08.02 on Performance of Building Enclosures.

Current edition approved Dec. 1, 2016. Published December 2016. Originally approved in 2009. Last previous edition approved in 2010 as E2556/E2556M-10. DOI: 10.1520/E2556-E2556M-10R16.

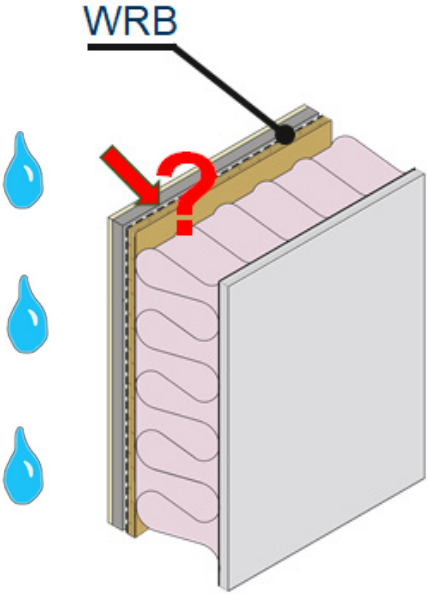
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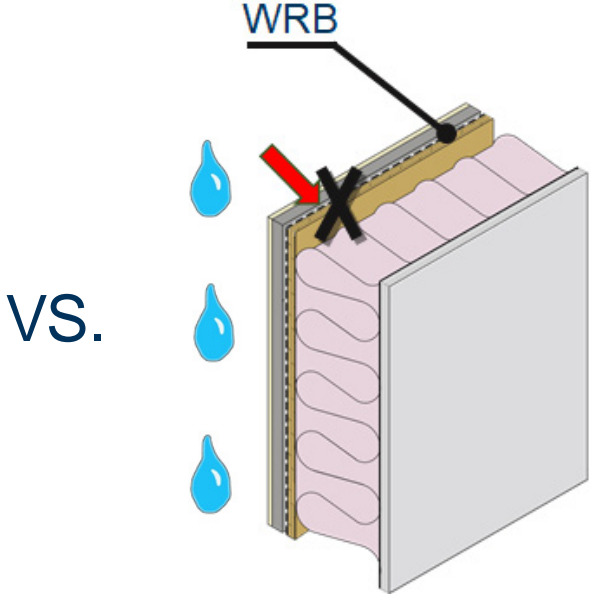
⁴ Available from Canadian General Standards Board (CGSB), 11 Laurier St., Phase III, Place du Portage, Gatineau, Quebec K1A 0S5, Canada, <http://www.tpsgc-pwgsc.gc.ca/ongc-cgsb>.

⁵ Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, <http://quicksearch.dla.mil>.

ASTM E2556



CODE DEFINITION



VS.

ASTM E2556



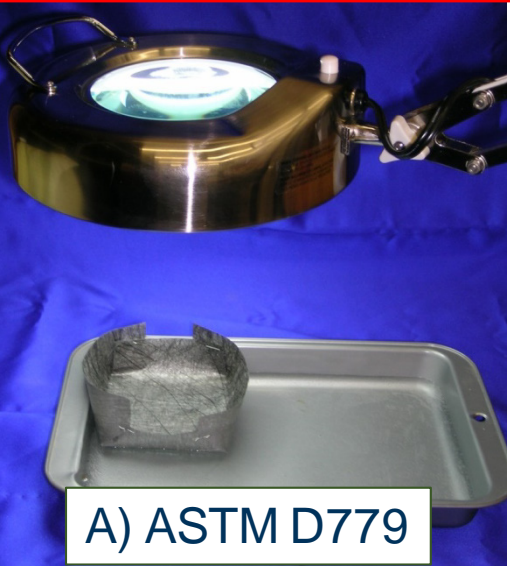
E2556/E2556M – 10

TABLE 1 Requirements for Water Resistive Barriers

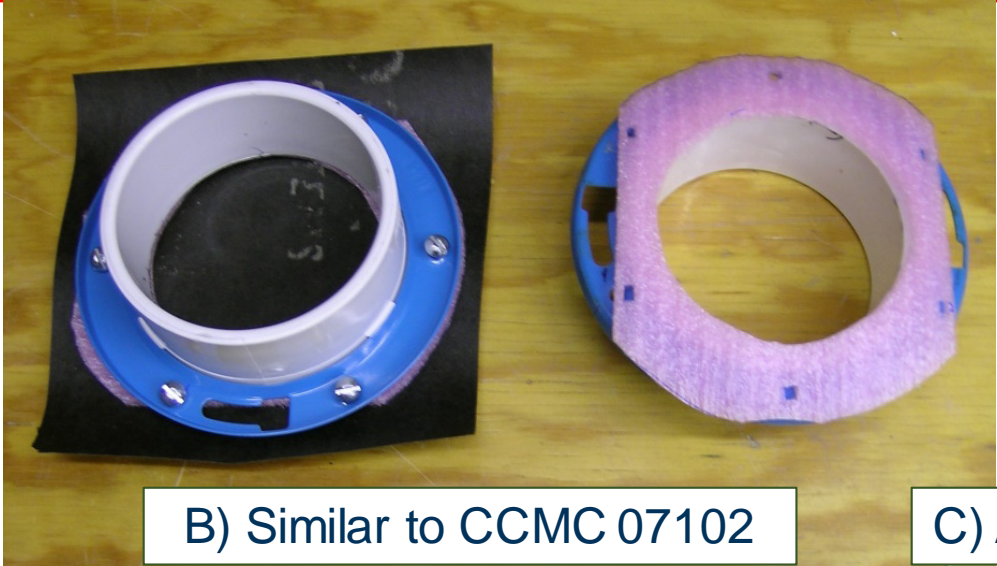
Test Requirement	Specimen Type	Test Method	Minimum Performance Requirements	
			Type I	Type II
Dry tensile strength or dry breaking force (choose 1)	(1) as manufactured and	Test Method D828 for paper and felt materials, or	3500 N/m (20 lb/in.) minimum (machine and cross direction)	
	(2) aged in accordance with A1.2	Test Methods D882 for polymeric materials, or	3500 N/m (20 lb/in.) minimum (machine and cross direction)	
		Test Method D5034 (Grab Method)	178 N (40 lbf) minimum (machine direction)	156 N (35 lbf) minimum (cross direction)

3.2.4 Type I WRB, *n*—water-resistive barrier with base-level water resistance (see Table 1).
3.2.5 Type II WRB, *n*—water-resistive barrier with enhanced water resistance (see Table 1).

Water resistance test (choose 1)	(1) as manufactured and (2) aged in accordance with A1.2	A) Test Method D779, or	10 min minimum	60 min minimum
		B) Water Resistance Ponding Test (A1.1), or	No water shall penetrate through the membrane in 120 min	not applicable
		C) AATCC Test Method 127 except that the specimens shall be held at a hydrostatic head of 55 cm (21.6 in.)	not applicable	No leakage is permitted to the underside of any specimen in 5 h



A) ASTM D779



B) Similar to CCMC 07102



C) AATCC 127

ALTERNATE MATERIAL

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[A]104.11 Alternative materials, design and methods of construction and equipment.

The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. An alternative material, design or method of construction shall be *approved* where the *building official* finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety. Where the alternative material, design or method of construction is not *approved*, the *building official* shall respond in writing, stating the reasons why the alternative was not *approved*.


[A]104.11.1 Research reports.

Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from *approved* sources.

[A]104.11.2 Tests.

Whenever there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the *building official* shall have the authority to require tests as evidence of compliance to be made without expense to the jurisdiction. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the *building official* shall approve the testing procedures. Tests shall be performed by an *approved agency*. Reports of such tests shall be retained by the *building official* for the period required for retention of public records.

ACCEPTANCE CRITERIA

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ACCEPTANCE CRITERIA FOR
WATER-RESISTIVE BARRIERS

AC38

Mechanically Fastened and
Self Adhered Sheet
Water Resistive Barriers

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ACCEPTANCE CRITERIA FOR WATER-RESISTIVE COATINGS USED AS
WATER-RESISTIVE BARRIERS OVER EXTERIOR SHEATHING

AC212

Water Resistive Coatings
over Sheathings

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ACCEPTANCE CRITERIA FOR WATER-RESISTIVE MEMBRANES
FACTORY-BONDED TO WOOD-BASED STRUCTURAL
SHEATHING, USED AS WATER-RESISTIVE BARRIERS

AC310

Water Resistive Membranes
Bonded to Sheathing

ICC-ES AC38



3.3.2 Water-resistance tests shall be conducted in accordance with ASTM D779. For Grade D barriers, where testing in accordance with ASTM D779 is not applicable, tests shall be conducted in accordance with the water ponding test set forth in either Section 4.2.1 or 4.2.2 of this criteria. For each of the three specified tests, the testing shall be conducted on both control and weathered specimens. Control specimens shall be conditioned at 73°F (23.7°C) and 50 percent relative humidity for a minimum of 40 hours. Weathered specimens shall be conditioned in accordance with Section 4.1 of this criteria.

For tests conducted under ASTM D779, minimum conditions of acceptance shall be as noted in Table 1 of this criteria. For tests conducted under Section 6.4.5 of CCMC 07102, conditions of acceptance shall be that no water shall transmit through the membrane. For tests conducted under Section 4.2 of this criteria, the condition of acceptance is that no leakage is permitted on the underside of any specimen.

4.2 Alternate Water-resistance Test Method: These test methods are applicable to polymeric-based barriers, and may be used in lieu of the water-resistance test method described in ASTM D 779.

4.2.1 Control specimens and weathered specimens that have been conditioned in accordance with Section 4.1 of this criteria shall be tested in accordance with AATCC Test Method 127, except that the specimens shall be held at a hydrostatic head of 55 cm for a period of five hours.

4.2.2 Water Ponding Test: A ring shall be constructed with a sample of the membrane fastened between two 200-millimeter-diameter aluminum rings using a rubber-type gasket. The membrane shall be placed between the rings and cupped to permit a depth of 30.5 mm of tap water to be exposed on 160 cm² of its surface. The test shall be conducted at room temperature (20±2°C and 65±3% RH). The ring shall be raised about 250 mm above a sheet of plain craft paper placed underneath the membrane to aid in monitoring any passage of water.

The membrane shall be maintained at constant conditions of temperature (20±2°C) and relative humidity (65±3%) and inspected at frequent intervals over a period of two hours. Ten test specimens shall be chosen at random from the membrane supplied.

No water seepage shall be observed through the membrane during the water ponding test. (Copied with permission from CCMC Guide MF07102, Technical Guide for Sheathing, Membrane, Breather-type, Section 6.4.5.

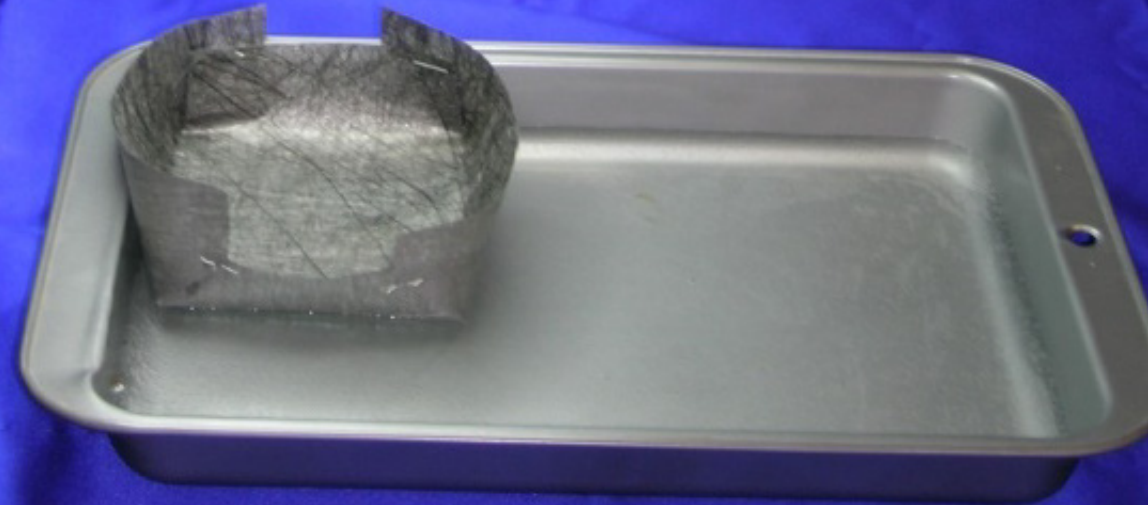
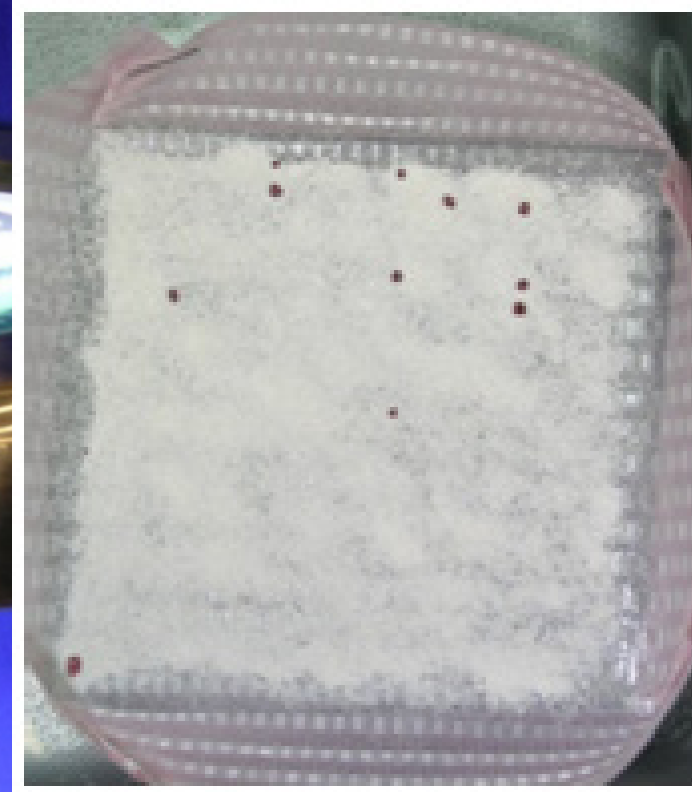
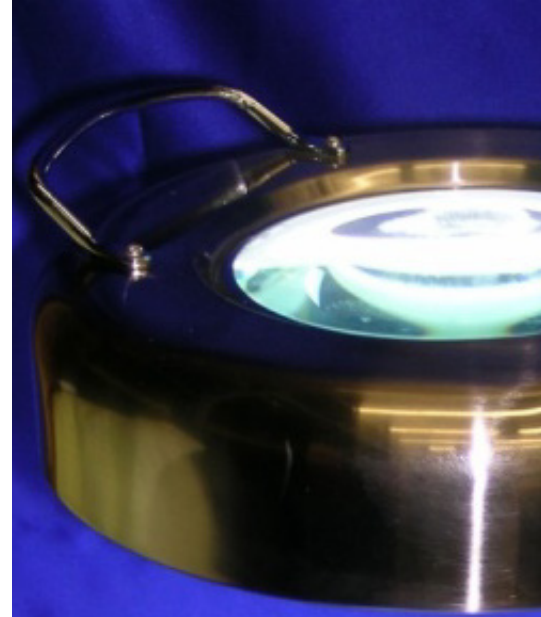
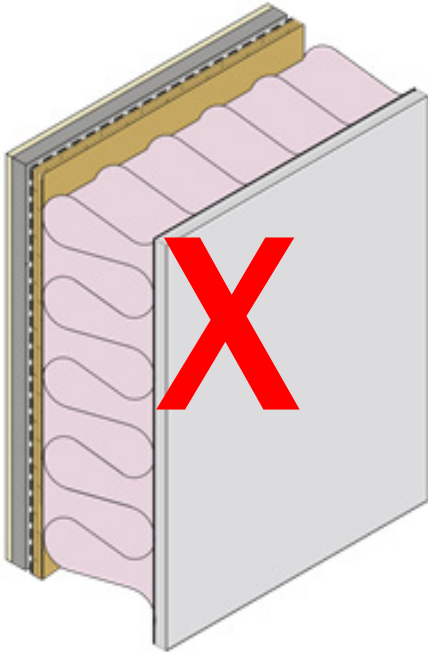
ASTM D779



Designation: D779 – 16

Standard Test Method for
Determining the Water Vapor Resistance of Sheet Materials
in Contact with Liquid Water by the Dry Indicator Method¹

5.2 This test method is of value for materials that come in contact with water on one face and where it is important to evaluate the length of time for water vapor to pass through the material.



AATCC 127

- 114mm (4.5in) Diameter Specimen
- 55cm (21.6in) Hydrostatic Head
- 5 Hour Duration
- Record When Water is Observed
- Some Water Infiltration Is Acceptable

2. Principle

2.1 One surface of the test specimen is subjected to a hydrostatic pressure, increasing at a constant rate, until three points of leakage appear on its other surface. The water may be applied from above or below the test specimen.



Image Courtesy of TESTEX

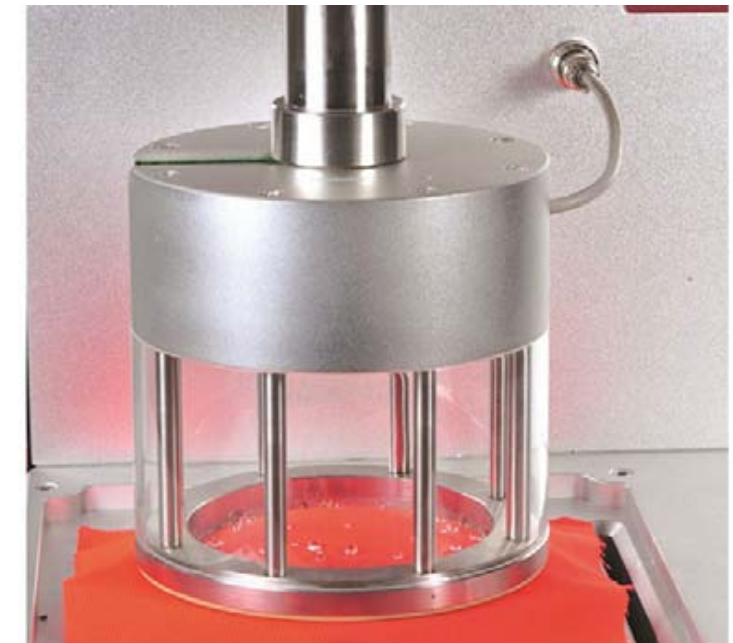


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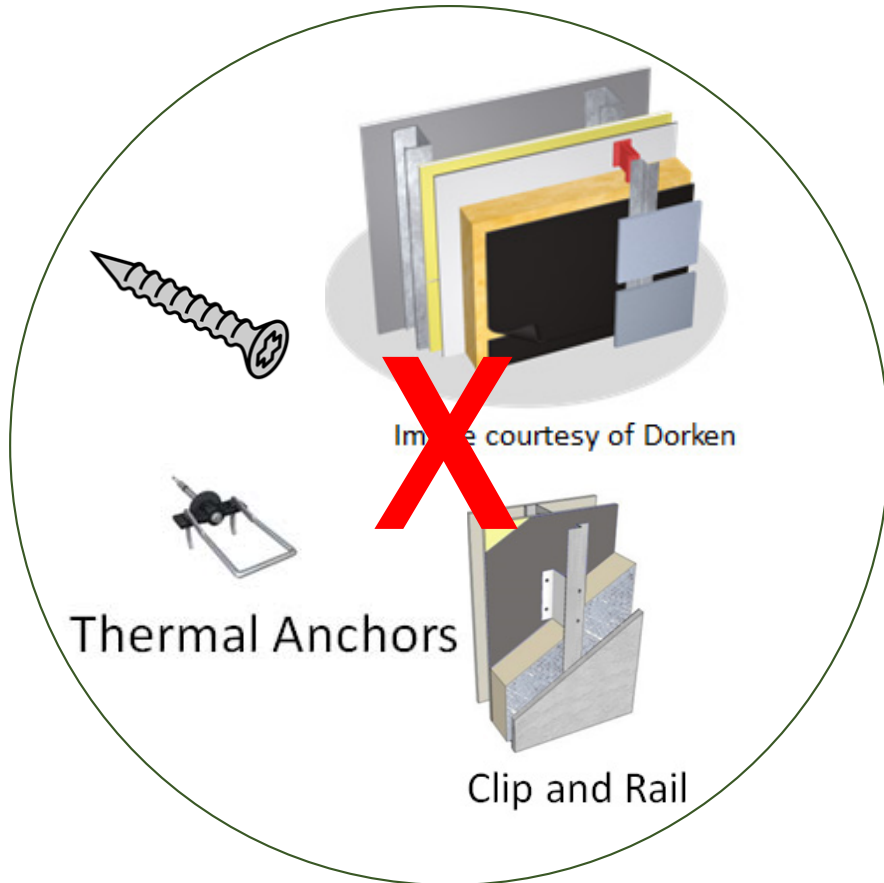
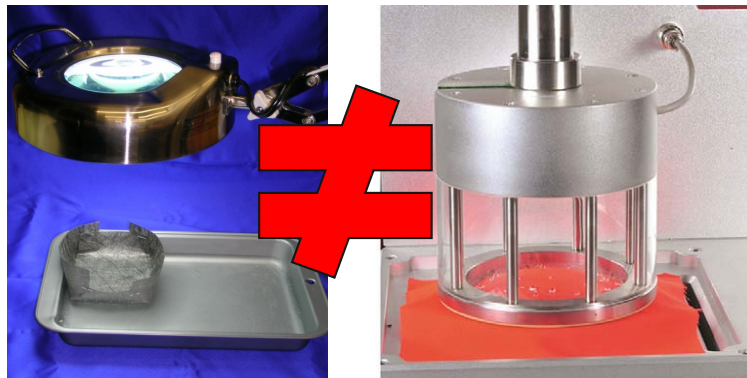
4.1 Weathering Tests: This test method applies to polymeric-based barriers.

4.1.1 General: Three samples, each measuring 18 inches by 48 inches (457 mm by 1219 mm), are required. One sample shall be used for preparing control specimens and shall be conditioned at 73°F (23.7°C) and 50 percent relative humidity for a minimum of 40 hours. Two samples shall be exposed to ultraviolet light, followed by exposure to accelerated aging in accordance with Section 4.1.2 and 4.1.3 of this criteria.

4.1.2 Ultraviolet Light Exposure: Two 18-inch-by-48-inch (457 mm by 1219 mm) samples shall be exposed to light from ultraviolet sunlamps for 210 hours (10 hours per day for 21 days) in an enclosure as depicted in Figure 1. Ultraviolet light exposure shall be directed on the sample surfaces that will be exposed to sunlight in normal application. Lamps and enclosure shall be adjusted so the specimen temperature is between 135°F and 140°F (57°C and 60°C). Sunlamp bulbs shall be General Electric Type H275 RUV (275 W) or equivalent bulbs, providing UV characteristics of 5.0 W/m²/nm irradiance at a wavelength of 315 to 400 nm at 1 meter.

4.1.3 Accelerated Aging: Three 10-inch-square (254 mm²) specimens shall be cut from the ultraviolet-light-exposed samples. The three specimens shall be subjected to 25 cycles of drying and soaking as follows:

1. Oven drying at 120°F (49°C) for three hours, with all surfaces exposed.
2. Immersion in room-temperature water for three hours, with all surfaces exposed.
3. After removal from the water, specimens are blotted dry, then air-dried for 18 hours at a 75°F ± 5°F (23.8°C ± 2.8°C) room temperature, with all surfaces exposed.





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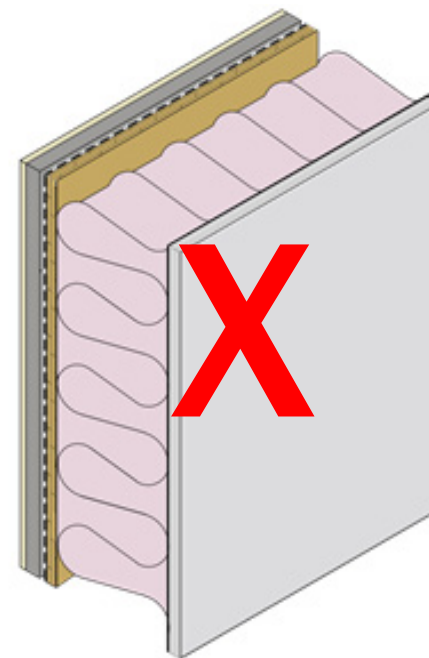
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ACCEPTANCE CRITERIA FOR
WATER-RESISTIVE BARRIERS

AC38

Mechanically Fastened and
Self Adhered Sheet
Water Resistive Barriers



ICC-ES AC212



4.5 Water-Penetration Testing: Three samples are prepared by applying the water-resistive barrier coating to the substrate. The substrate shall be attached to the supporting framework as required by the substrate manufacturer. The test samples shall be a minimum of 4 feet by 8 feet (1219 mm by 2438 mm) in size, and shall include a minimum of two vertical joints and one horizontal joint within the sheathing substrate. Joints within the substrates shall be a minimum of $\frac{1}{8}$ inch (3.2 mm) wide.

Each sample shall be tested in accordance with ASTM E331. A minimum 2.86 psf (137 Pa) air-pressure differential shall be maintained, across the test specimen, for 15 minutes.

4.5.1 Conditions of Acceptance: There shall be no visible water penetration at sheathing joints, as viewed from the back of the panel.

4.7.4 Water Penetration Testing:

4.7.4.1 Test shall be conducted on the same specimen used under Sections 4.7.1, 4.7.2, and 4.7.3. The sample shall be tested in accordance with ASTM E331. A minimum 2.86 psf (137 Pa) air pressure differential shall be maintained across the test specimen for 15 minutes.

4.7.4.2 Conditions of Acceptance: There shall be no visible water penetration at sheathing joints, as viewed from the back of the panel.

4.8 Weathering Test: Five specimens are prepared in accordance with Section 4.3.1, except the sides only shall be sealed with an impervious material that need not be the coating. These samples shall be exposed to light from ultraviolet light, followed by accelerated aging in accordance with Sections 4.8.1 and 4.8.2 of this criteria, respectively. Following exposure, the specimens shall be tested in accordance with Section 4.8.3 of this criteria.

4.8.1 Ultraviolet Light Exposure: The samples shall be exposed to light from ultraviolet sun lamps for 210 hours (10 hours per day for 21 days) in an enclosure. Ultraviolet light exposure must be directed on the entire sample surfaces that will be exposed to sunlight in normal application. Lamps and enclosure shall be adjusted so the specimen temperature is between 135°F and 140°F (57°C and 60°C). Sunlamp bulbs shall be General Electric Type H275 RUV (275 W) or equivalent bulbs, providing UV characteristics of 5.0 W/m²/nm irradiance at a wavelength of 315 to 400 nm at 1 meter. Bulbs shall be located 2 feet (610 mm) above samples.



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ACCEPTANCE CRITERIA FOR WATER-RESISTIVE COATINGS USED AS WATER-RESISTIVE BARRIERS OVER EXTERIOR SHEATHING

AC212

Water Resistive Coatings over Sheathings

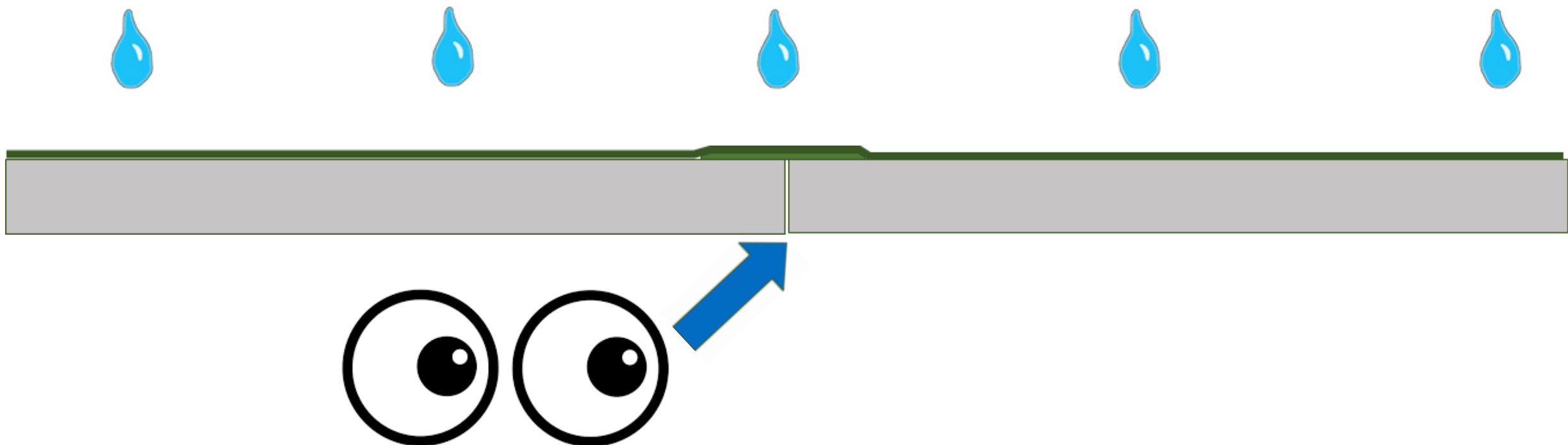
4.8.2 Accelerated Aging: The samples shall be subjected to 25 cycles of drying and soaking as follows:

1. Oven drying at 120°F (49°C) for three hours, with all surfaces exposed.
2. The coating surface shall be immersed in room temperature water for three hours.
3. After removal from the water, specimens are blotted dry, then air-dried for 18 hours at a 75°F ± 5°F (23.8°C ± 2.8°C) room temperature, with all surfaces exposed.

4.8.3 Hydrostatic Pressure Test: The samples shall be tested in accordance with AATCC Test Method 127-1985, except that the specimens shall be held at a hydrostatic head of 550 millimeters for a period of 5 hours.

4.8.4 Conditions of Acceptance: There shall be no cracking of the coating, or bond failure between the coating and the substrate. There shall be no water penetration on the plane of the exterior facing side of the substrate.

ASTM E331



4.5.1 Conditions of Acceptance: There shall be no visible water penetration at sheathing joints, as viewed from the back of the panel.

Water Resistance of In-Place Membrane	ASTM E331, Single, 60 mil wet coating spray-applied to CMU	No visible leakage to interior after 15 minutes water spray rack @ 6.24 PSF
---------------------------------------	--	---

AATCC 127

1. Purpose and Scope

1.1 This test method measures the resistance of a fabric to the penetration of water under hydrostatic pressure. It is applicable to all types of fabrics, including those treated with a water resistant or water repellent finish.

1.2 Water resistance depends on the repellency of the fibers and yarns, as well as the fabric construction.

1.3 The results obtained by this method may not be the same as the results obtained by the AATCC methods for resistance to rain or water spray.

4.8.4 Conditions of Acceptance: There shall be no cracking of the coating, or bond failure between the coating and the substrate. There shall be no water penetration on the plane of the exterior facing side of the substrate.


Water Resistance of In-place membrane	Rilem Tube – 60 wet mils on CMU AND AATCC 127, modified 60 wet mils on CMU and DensGlass 22 inch (55 cm) column of water	No water leakage through membrane
---------------------------------------	--	-----------------------------------



ICC-ES AC212

PRECONDITIONING?

4.6 Structural, Racking and Restraint Environmental Conditioning Tests (Limits product use to wall coverings demonstrating water-penetration resistance in accordance with ASTM E331 with a minimum 2.86 kPa (0.07 Pa) static air pressure differential)



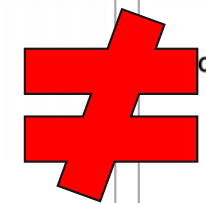
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ACCEPTANCE CRITERIA FOR
WATER-RESISTIVE BARRIERS

AC38

Mechanically Fastened and
Self Adhered Sheet
Water Resistive Barriers





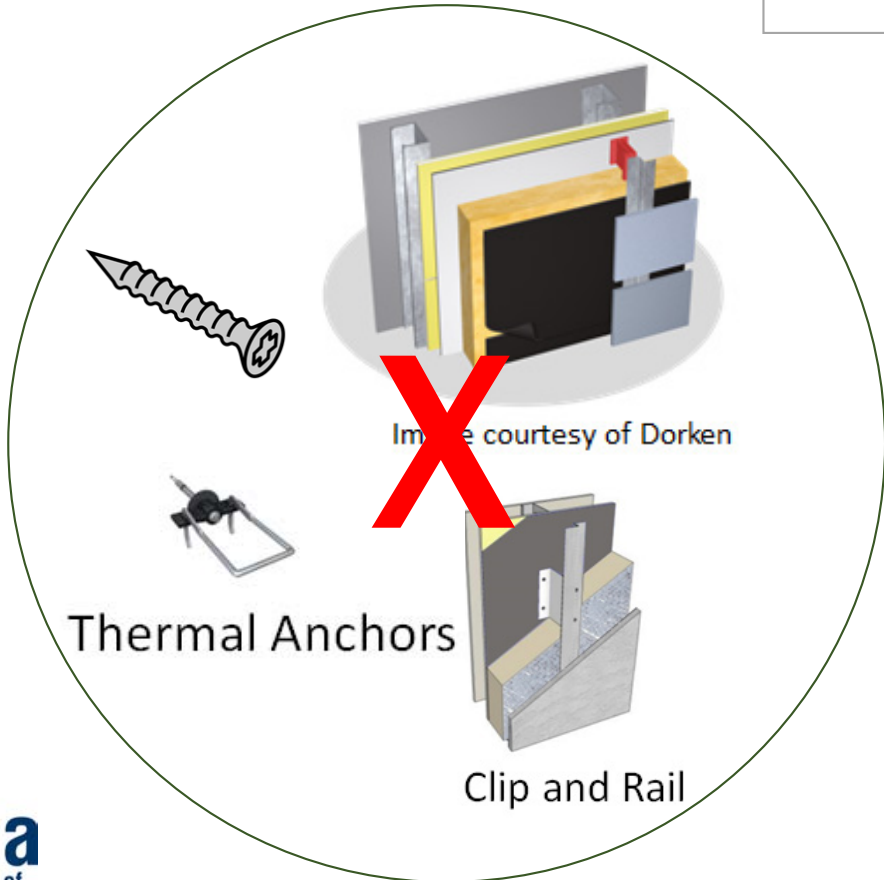
ICC EVALUATION SERVICE
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ACCEPTANCE CRITERIA FOR WATER-RESISTIVE COATINGS USED AS
WATER-RESISTIVE BARRIERS OVER EXTERIOR SHEATHING

AC212

Water Resistive Coatings
over Sheathings



Water Resistance of In-Place Membrane	ASTM E331, Single, 60 mil wet coating spray-applied to CMU	No visible leakage to interior after 15 minutes water spray rack @ 6.24 PSF
---------------------------------------	--	---



ICC-ES AC 310

4.5 Water Penetration Testing: Three samples shall be prepared. The substrate shall be attached to the supporting framework as required by the substrate manufacturer. The test samples shall be a minimum of 4 feet by 8 feet (1219 mm by 2438 mm) in size, and shall include a minimum of two vertical joints and one horizontal joint. Joints within the substrates shall be a minimum of $\frac{1}{8}$ inch (3.2 mm) wide.

The joints shall be treated as described in the information submitted under Section 2.1.2 of this criteria. Test assemblies shall include at least one opening, one penetration, one root-wall intersection and one wall sill.

Each sample shall be tested in accordance with ASTM E 331. A minimum 2.86 psf (137 Pa) air-pressure differential shall be maintained, across the test specimen, for 15 minutes.

4.5.1 Conditions of Acceptance: There shall be no visible water penetration at sheathing joints, as viewed from the back of the panel. In addition, there shall be no visible water penetration at nail penetrations.

4.7.3 Hydrostatic Pressure Test: A ring shall be constructed with a sample of the membrane fastened between two 200-millimeter-diameter aluminum rings using a rubber-type gasket. The membrane shall be placed between the rings and cupped to permit a depth of 1 inch (25.4 mm) of tap water to be exposed on 160 cm² of its surface. The test shall be conducted at room temperature (20±2°C) and 65±3% RH. The ring shall be raised about 250 mm above a sheet of plain craft paper placed underneath the membrane to aid in monitoring any passage of water.

The membrane shall be maintained at constant conditions of temperature (20±2°C) and relative humidity (65±3%) and shall be inspected at frequent intervals over a period of two hours. Ten test specimens shall be chosen at random from the membrane supplied.

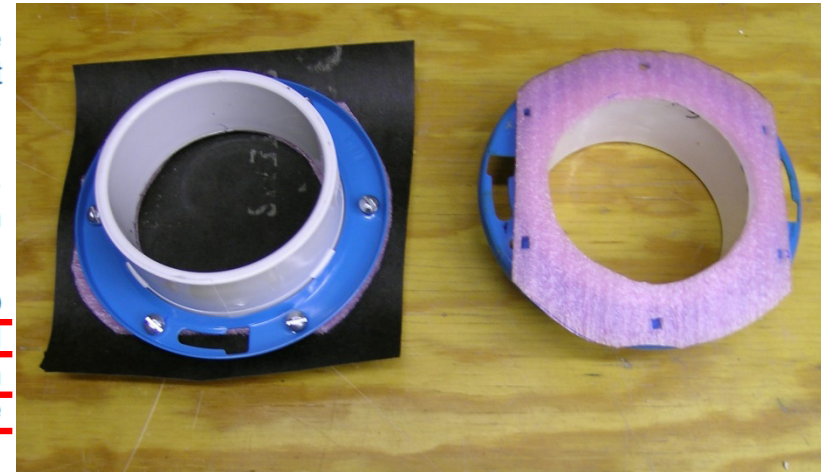
No water seepage shall be observed through the membrane during the water ponding test. (This test procedure has been copied with permission from CCMC Guide MF07102, Technical Guide for Sheathing, Membrane, Breather-type, Section 6.4.5. The CCMC Guide is published by the Canadian Construction Materials Centre.)

4.7.4 Conditions of Acceptance: There shall be no cracking of the membrane or tape when used, or bond failure or between the tape and the membrane. Condition of acceptance shall be that no water shall penetrate through the membrane or the taped joint.

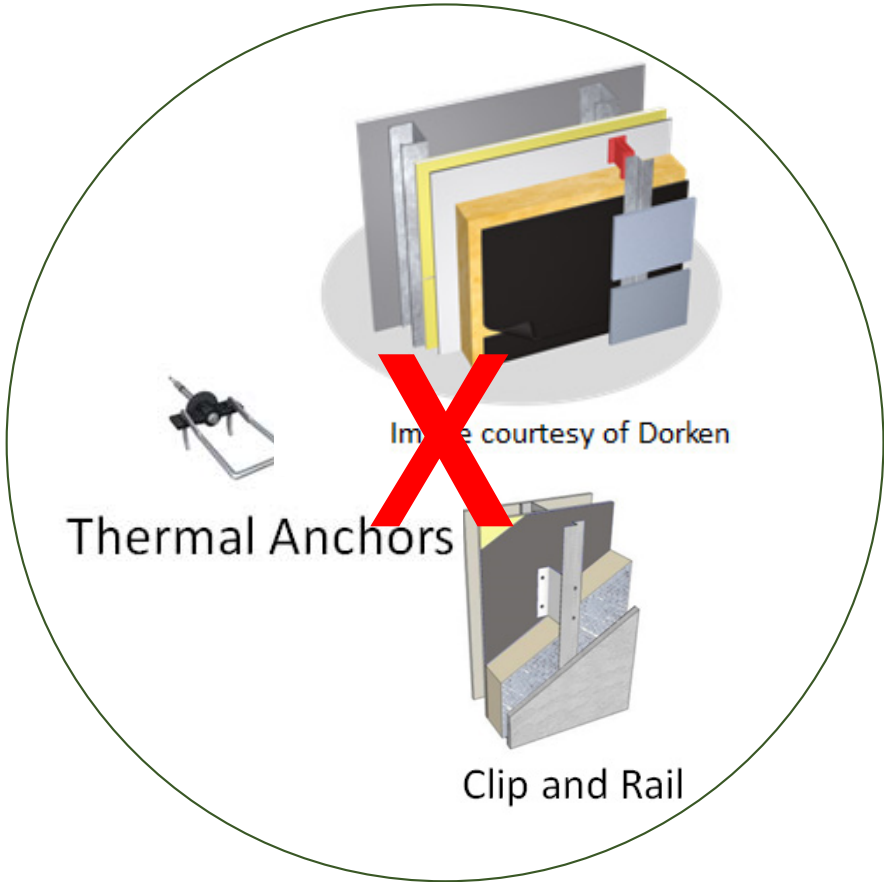
**ACCEPTANCE CRITERIA FOR WATER-RESISTIVE MEMBRANES
FACTORY-BONDED TO WOOD-BASED STRUCTURAL
SHEATHING, USED AS WATER-RESISTIVE BARRIERS**

AC310

Water Resistive Membranes Bonded to Sheathing



ICC-ES AC 310



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ACCEPTANCE CRITERIA FOR
WATER-RESISTIVE BARRIERS

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ACCEPTANCE CRITERIA FOR WATER-RESISTIVE COATINGS USED AS
WATER-RESISTIVE BARRIERS OVER EXTERIOR SHEATHING

AC212

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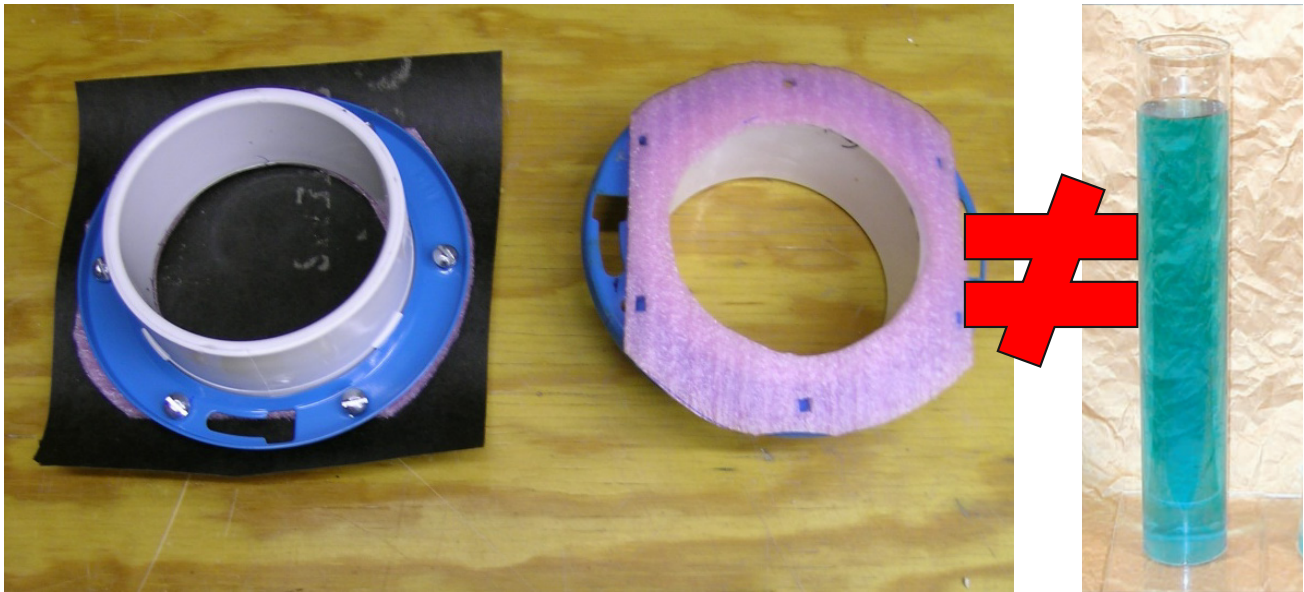
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ACCEPTANCE CRITERIA FOR WATER-RESISTIVE MEMBRANES
FACTORY-BONDED TO WOOD-BASED STRUCTURAL
SHEATHING, USED AS WATER-RESISTIVE BARRIERS

AC310

Water Resistive Membranes
Bonded to Sheathing

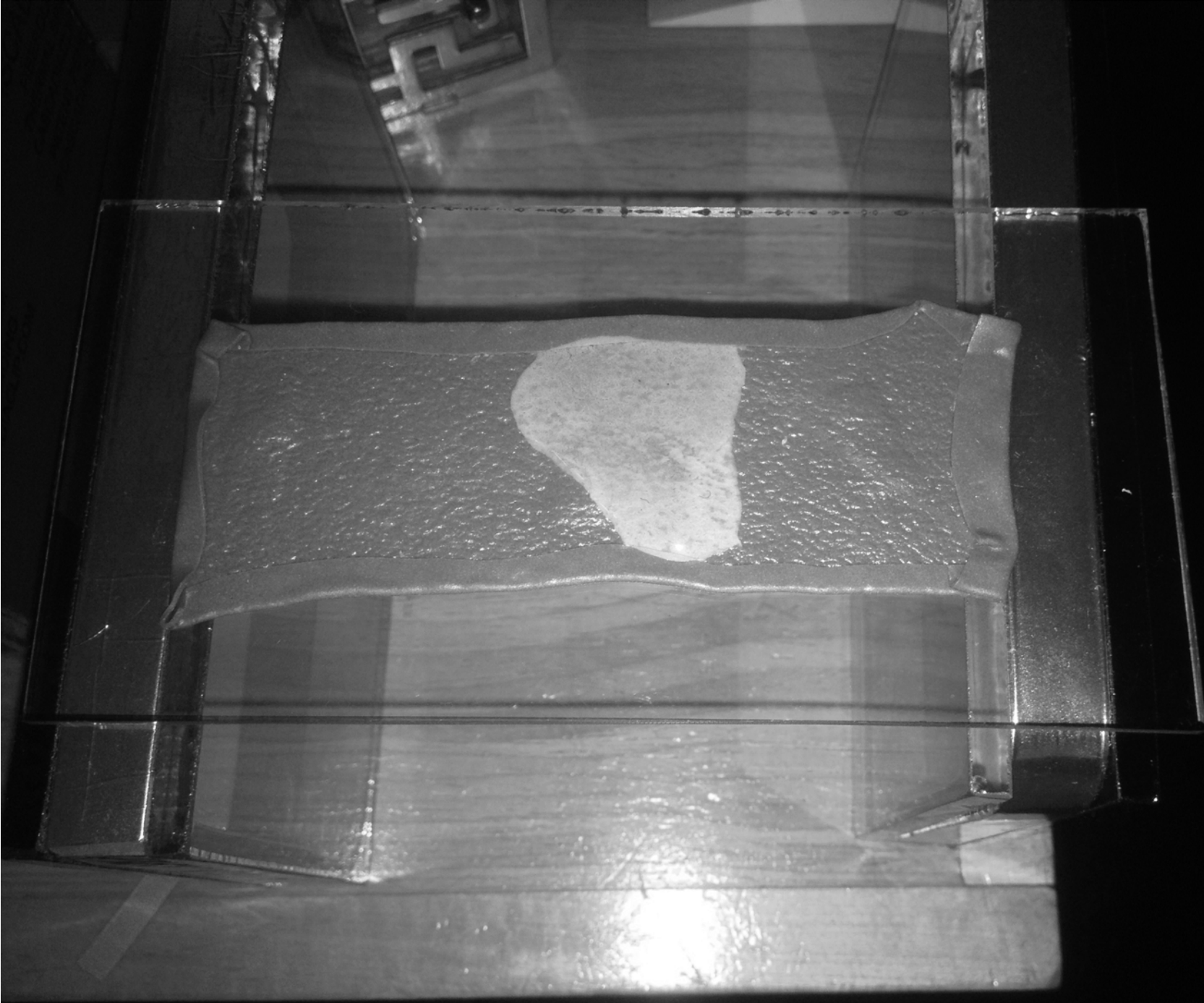


ACCEPTANCE CRITERIA

- Testing requirements are not equivalent between all AC's.
- Performance between types of WRB's are not equivalent.
- Inconsistent Preconditioning.
- Suggests varying Classes of Performance, but are not clearly indicated.
- Do not consistently address water infiltration at fastener penetrations.
- Does not completely address assembly water infiltration.
- AATCC 127 may not be applicable to Fluid Applied materials.
- D779 may not be applicable to Fluid Applied materials or Factory Bonded Membranes.
- Requirement to be Vapor Permeable.
- "Modified" Testing often reported.

CAPILLARY EXPERIMENT











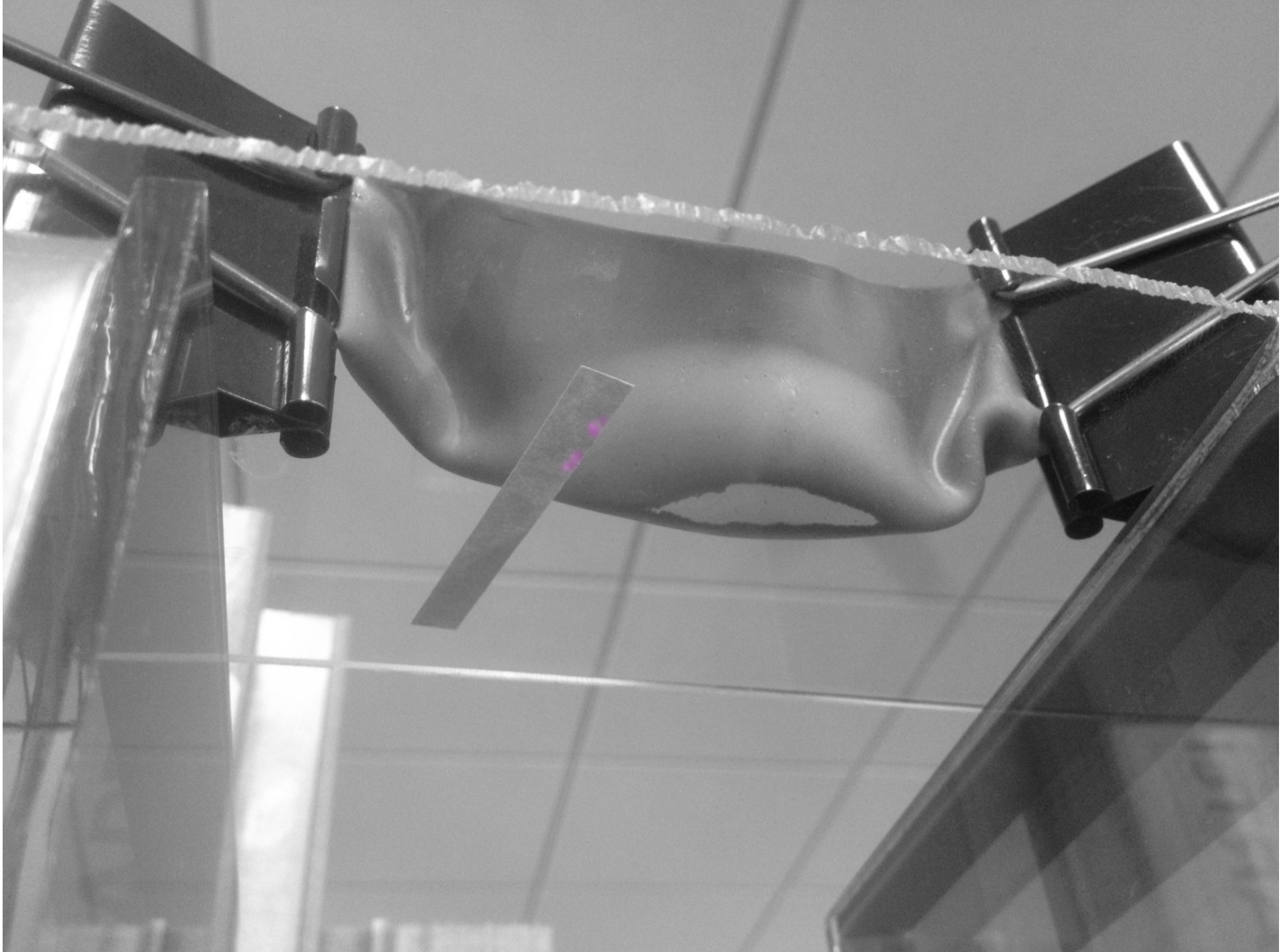
“BOAT” EXPERIMENT











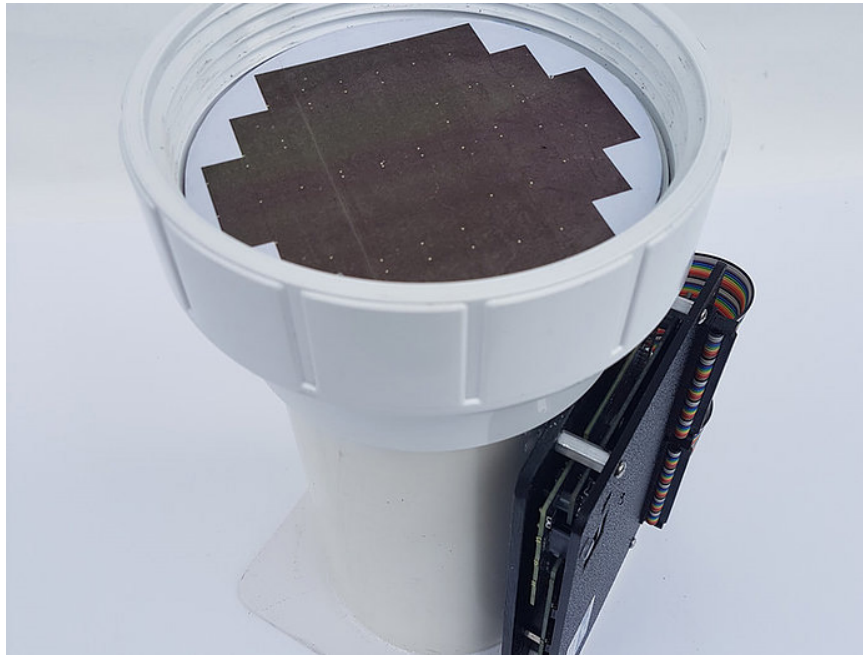
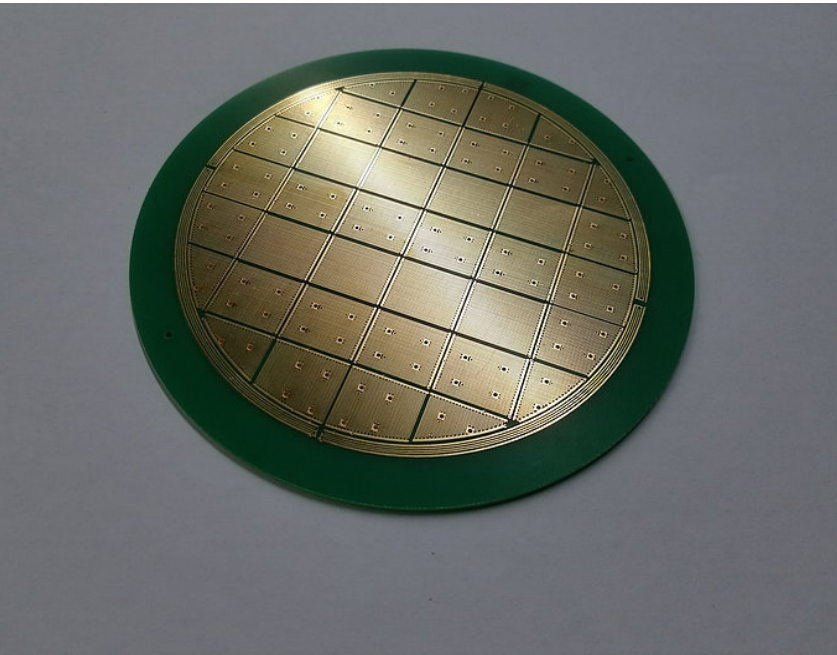
TO-DO LIST

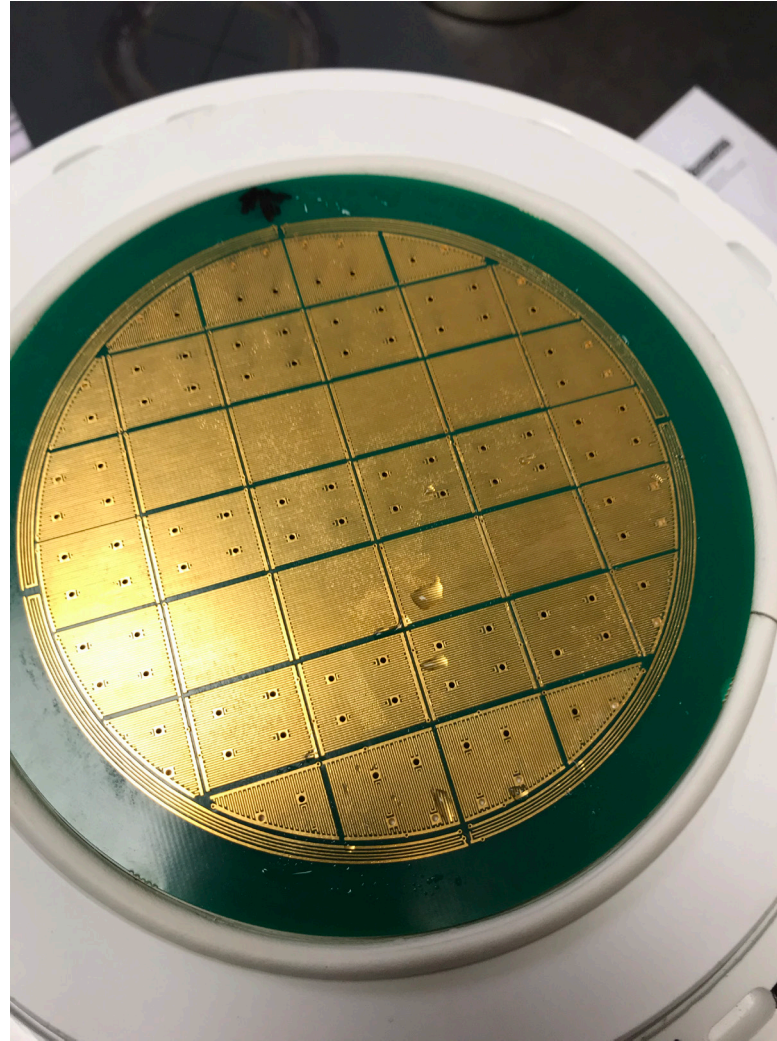


- Material Test Development
- Assembly Test Development

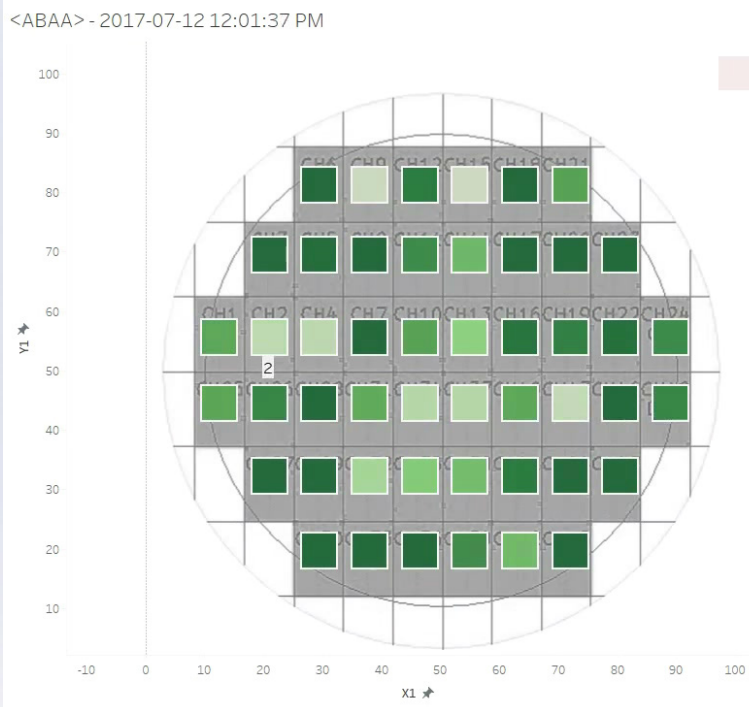
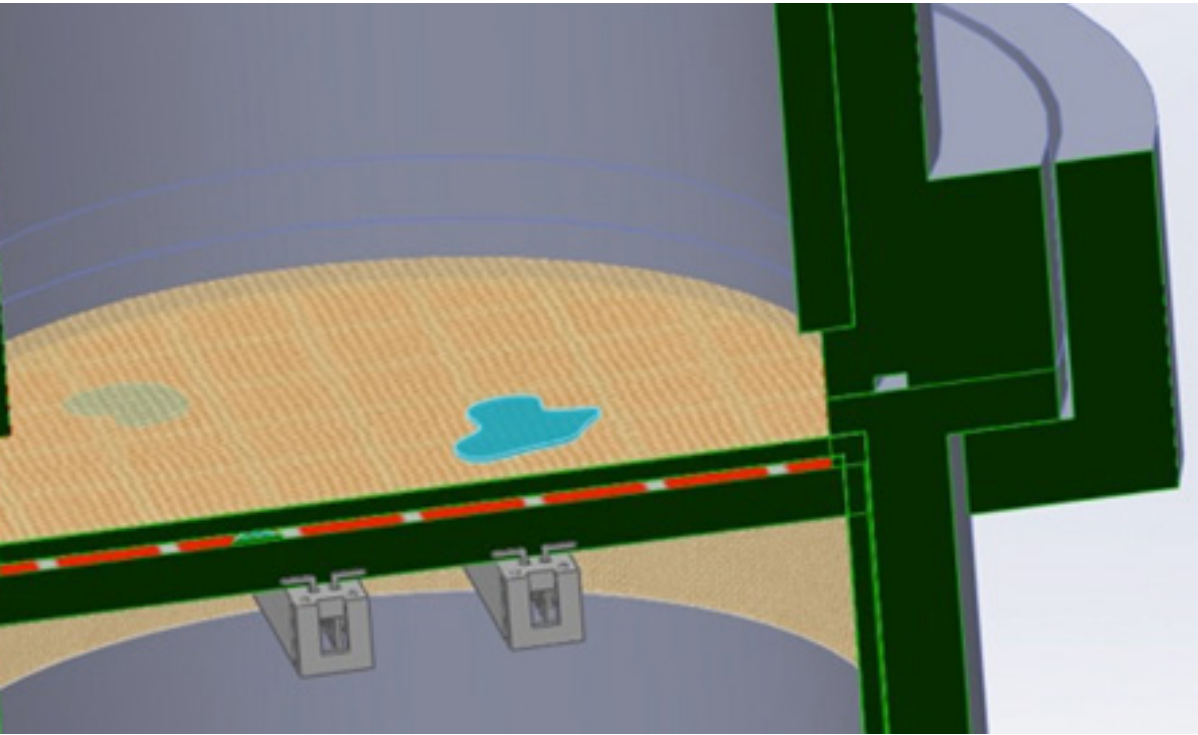
MATERIAL TEST DEVELOPMENT

MATERIAL TEST DEVELOPMENT



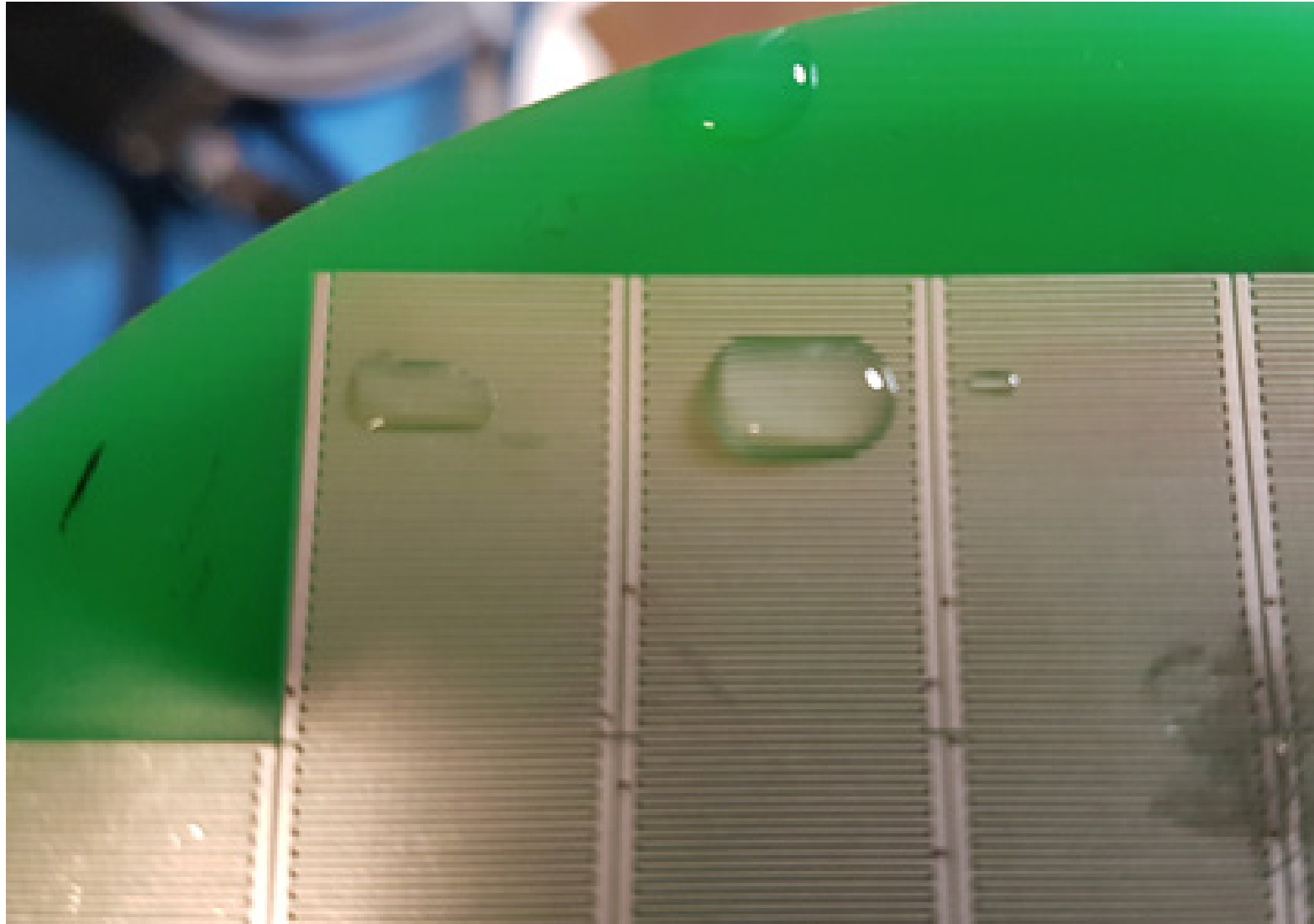
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MATERIAL TEST DEVELOPMENT



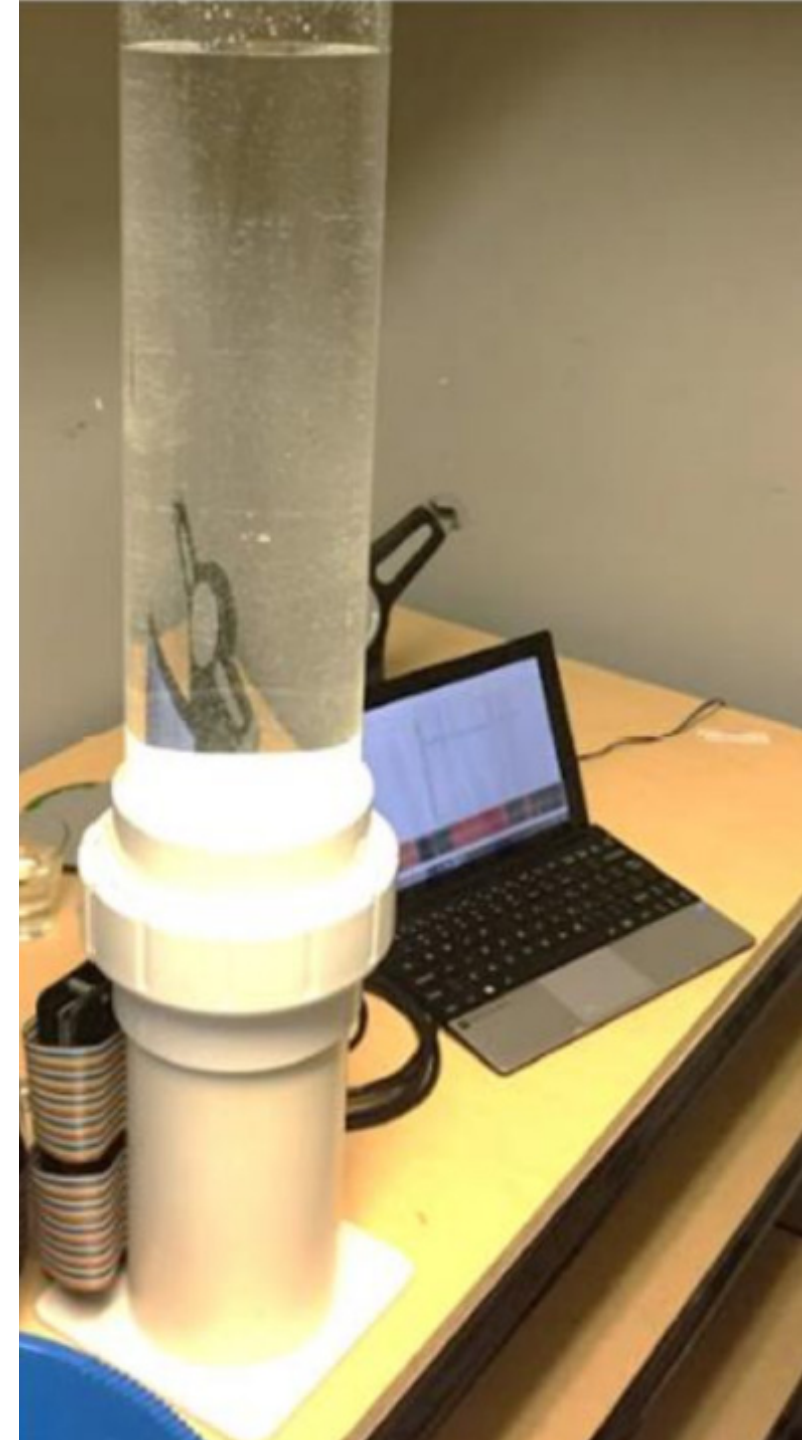
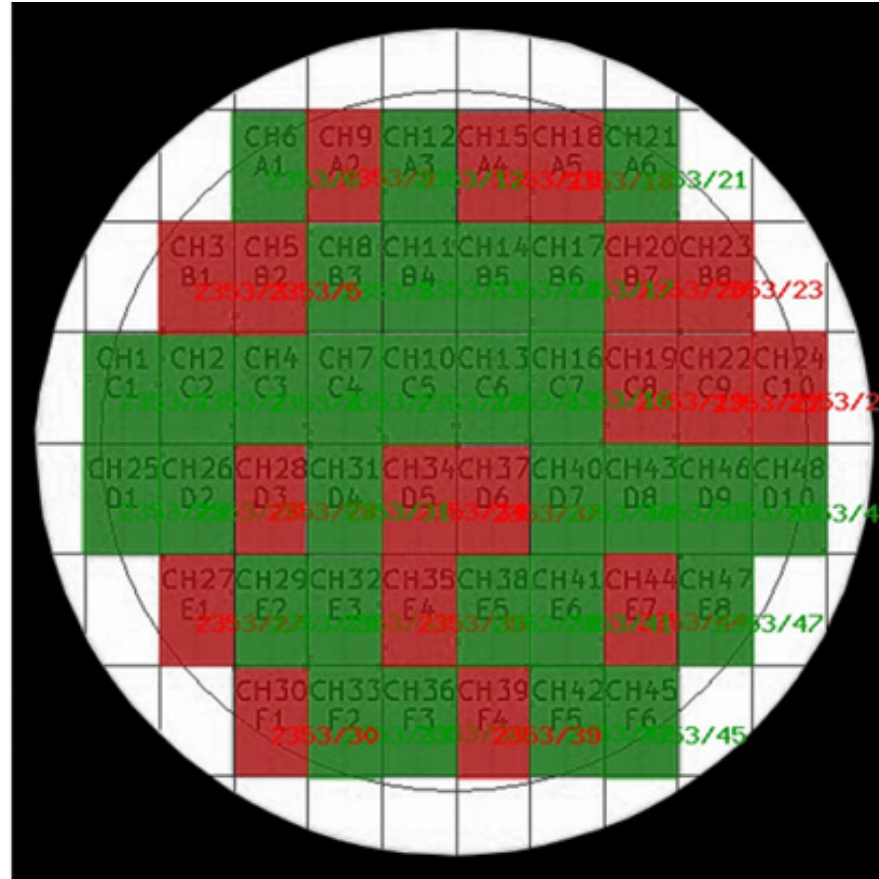
PROGRESS REPORT

- Test Setup
- Sample Preparation
- Separator at Sensor
- Sensor Failure Threshold
- Duration of Test
- Hydrostatic Pressure



MATERIAL CLASSIFICATIONS?

- Duration
- Pressure
- Results



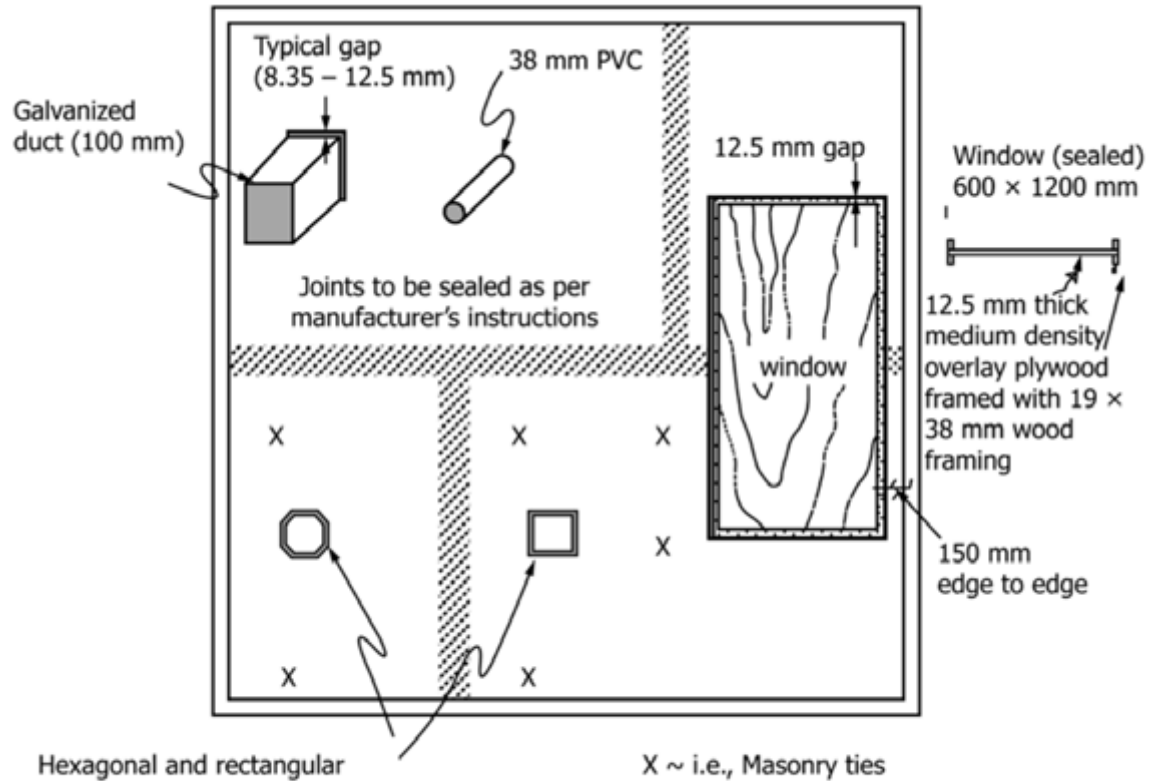
WRB WALL ASSEMBLY TEST DEVELOPMENT

DEVELOP WRB WALL ASSEMBLY TEST



Designation: E2357 – 18

Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies¹



Designation: E1105 – 15

Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference¹

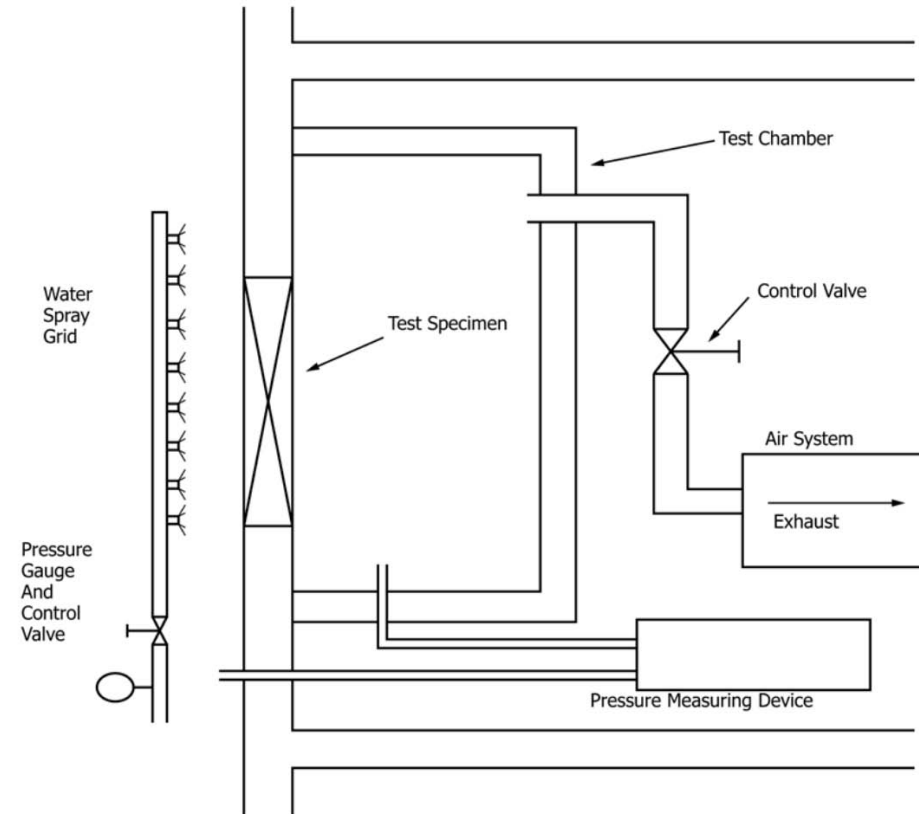
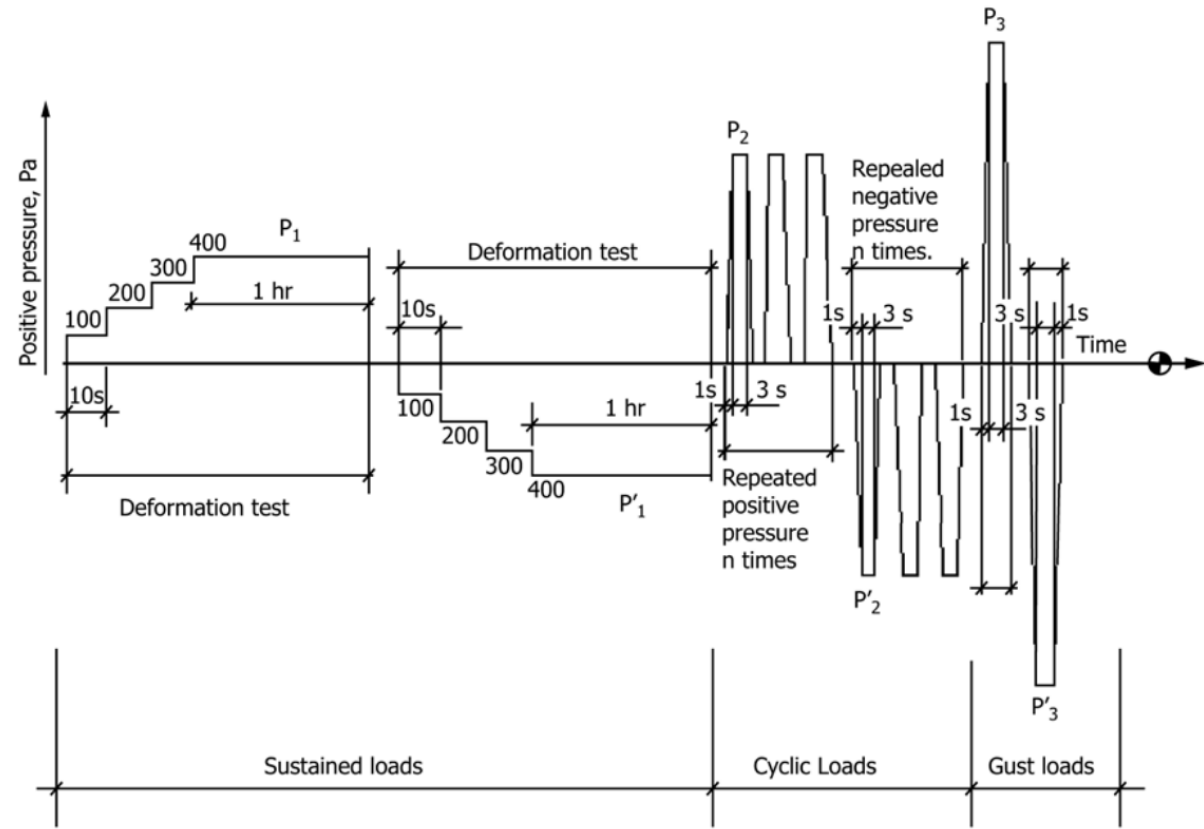


FIG. 1 General Arrangement of Water Penetration Test Apparatus

PRE-CONDITIONING

Structural (Wind) Loading Schedule



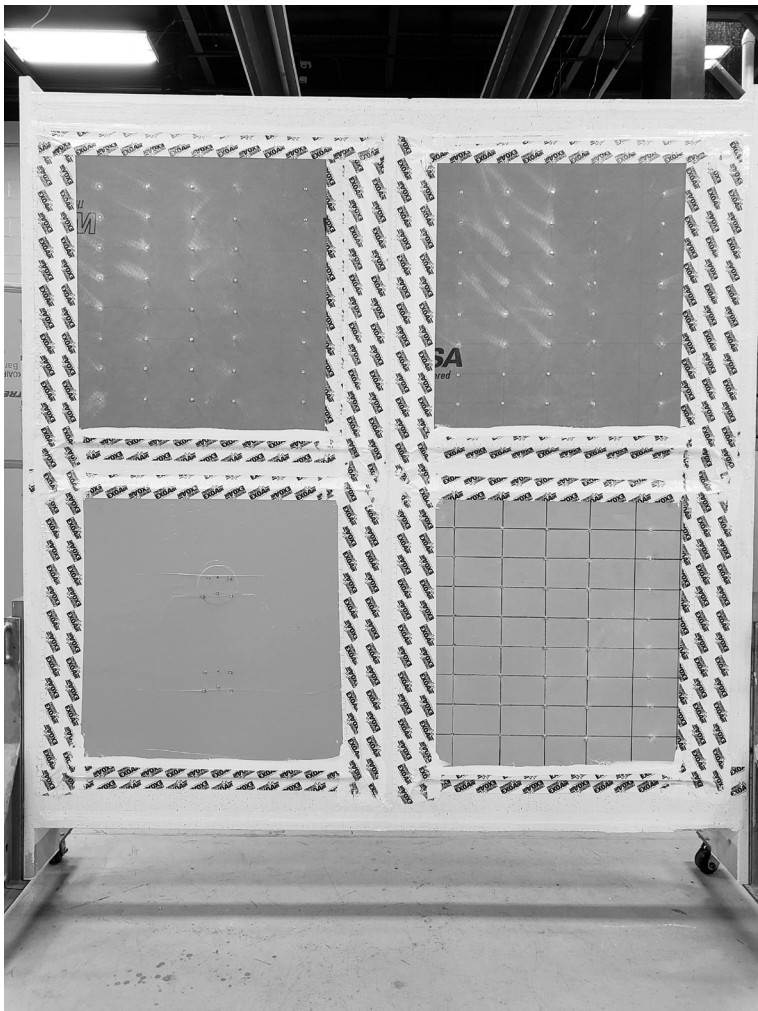
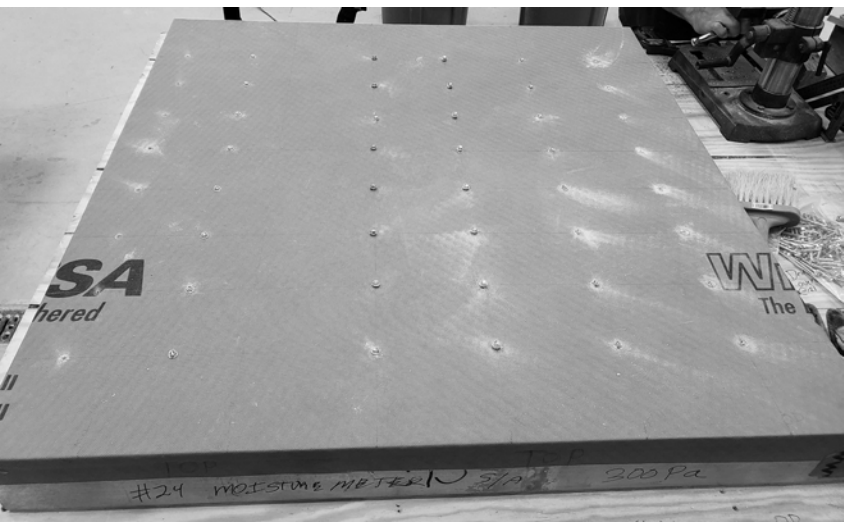
● air leakage rate and deflections to be established after structural loading

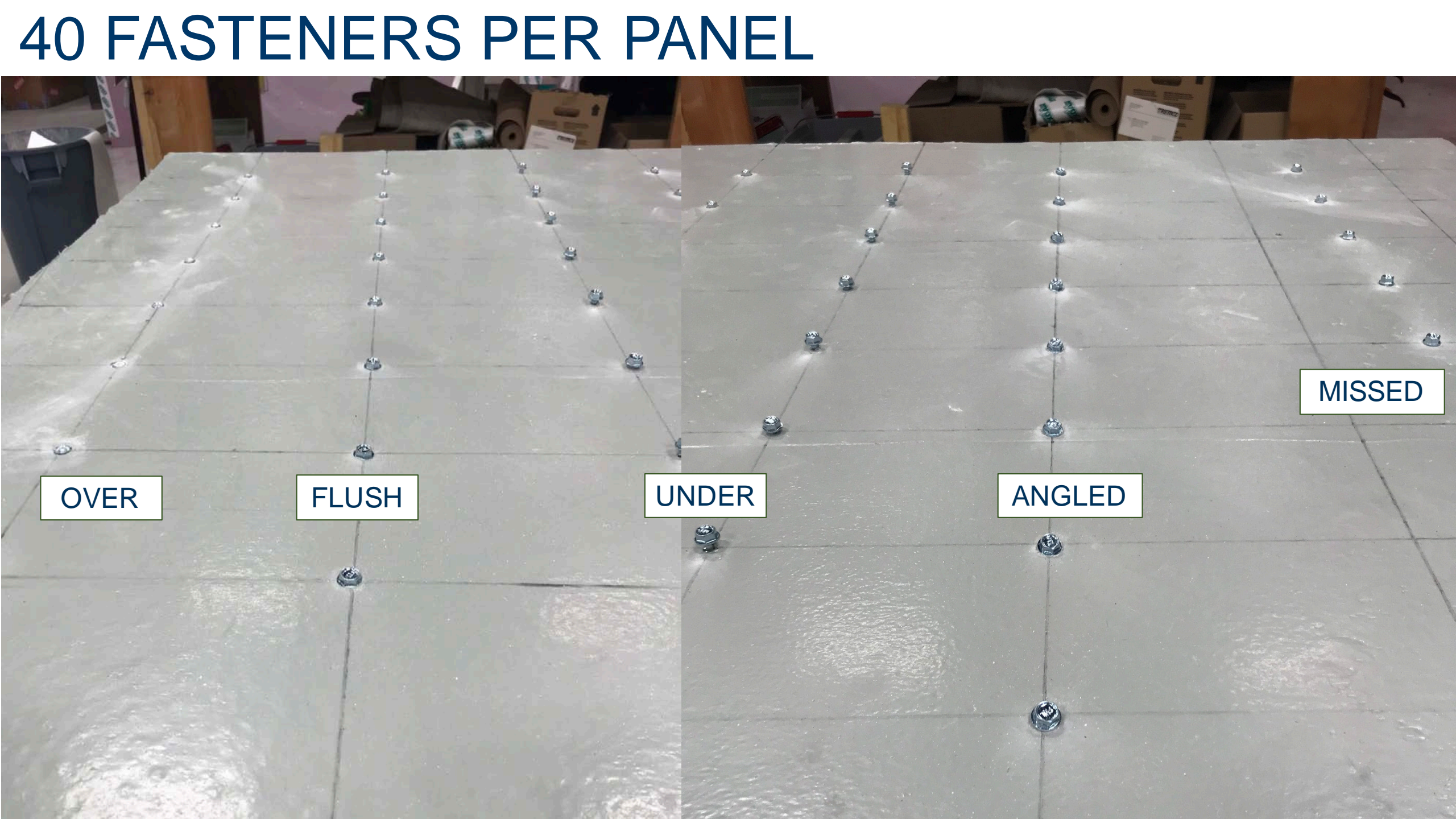
P_1, P'_1 sustained for 1 h ^A (Pa)	P_2, P'_2 2000 cycles ^B (Pa)	P_3, P'_3 gust wind (Pa)
400	530	800
600	800	1200

BUT FIRST, HOW TO DETECT LIQUID WATER?



24 SPECIMENS





40 FASTENERS PER PANEL

OVER

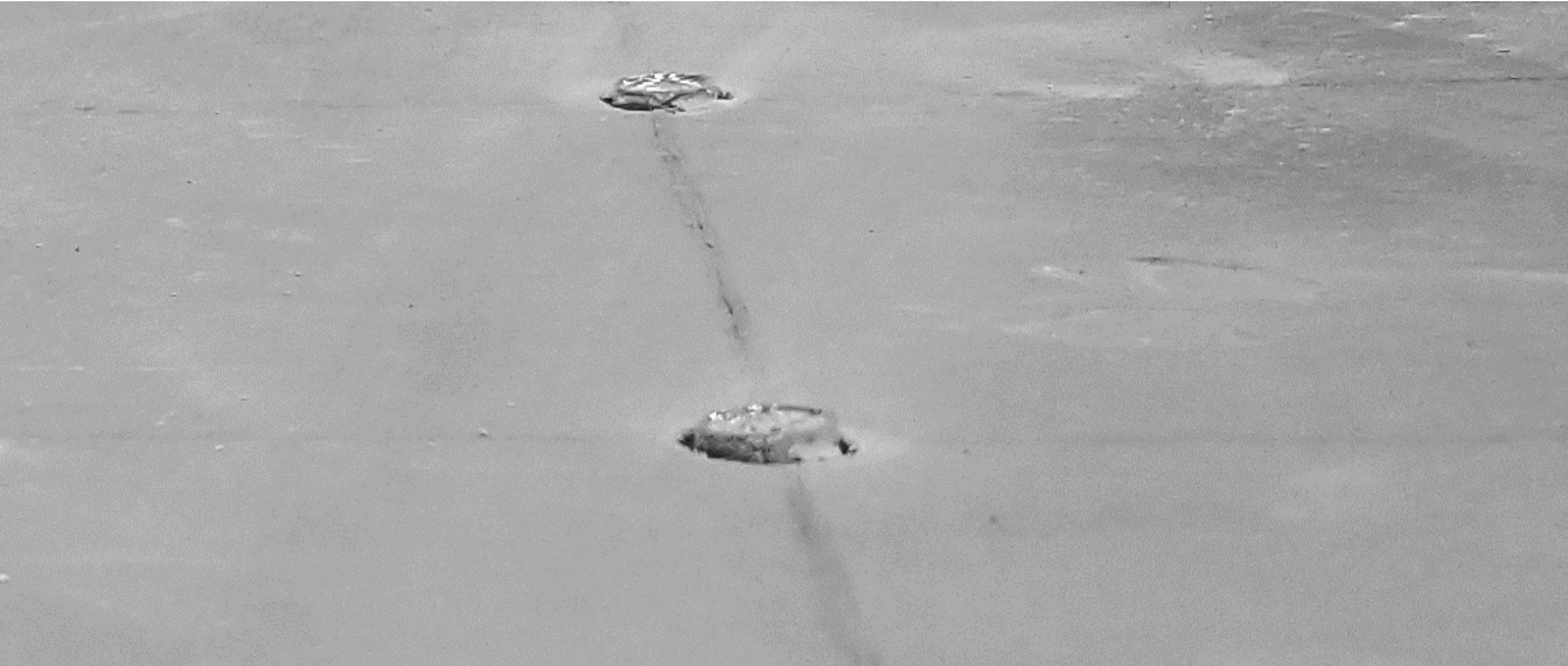
FLUSH

UNDER

ANGLED

MISSED

OVERDRIVEN



OVERDRIVEN



FLUSH



FLUSH



UNDERDRIVEN



UNDERDRIVEN



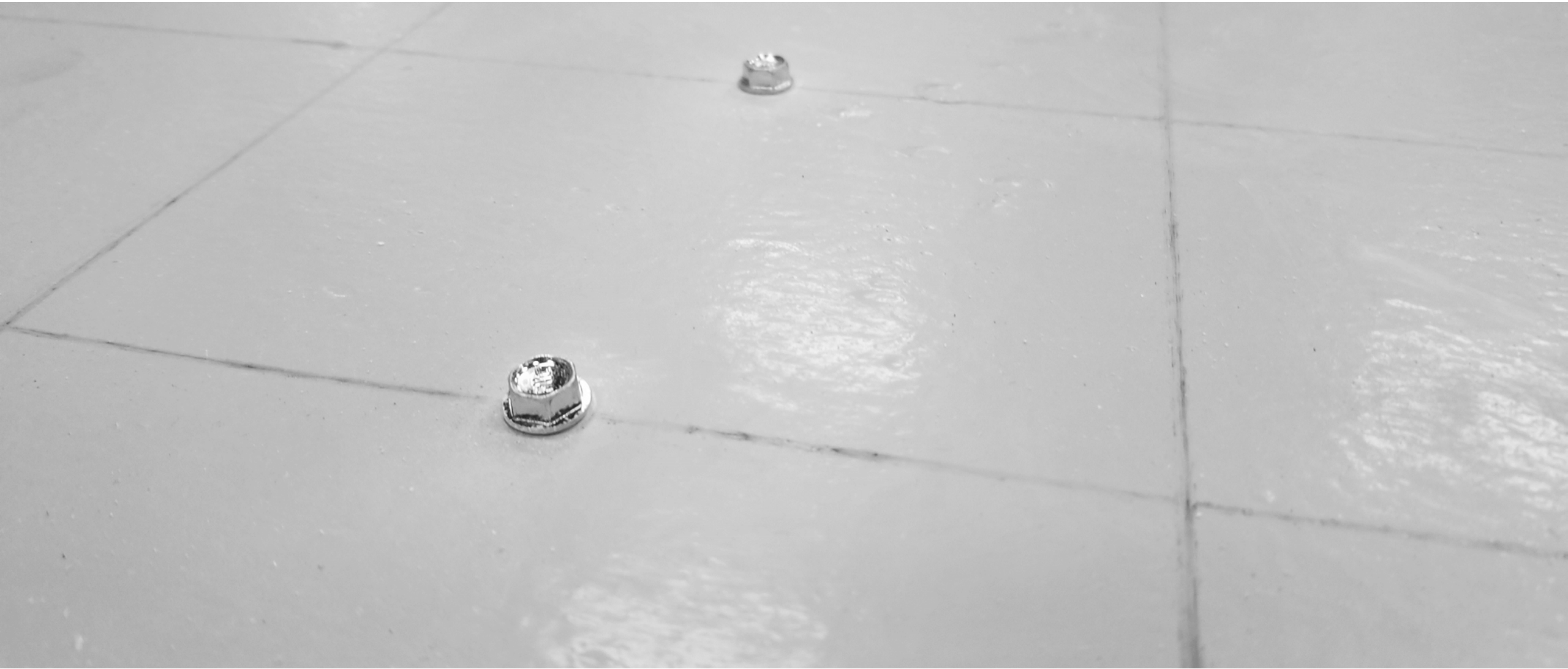
ANGLED

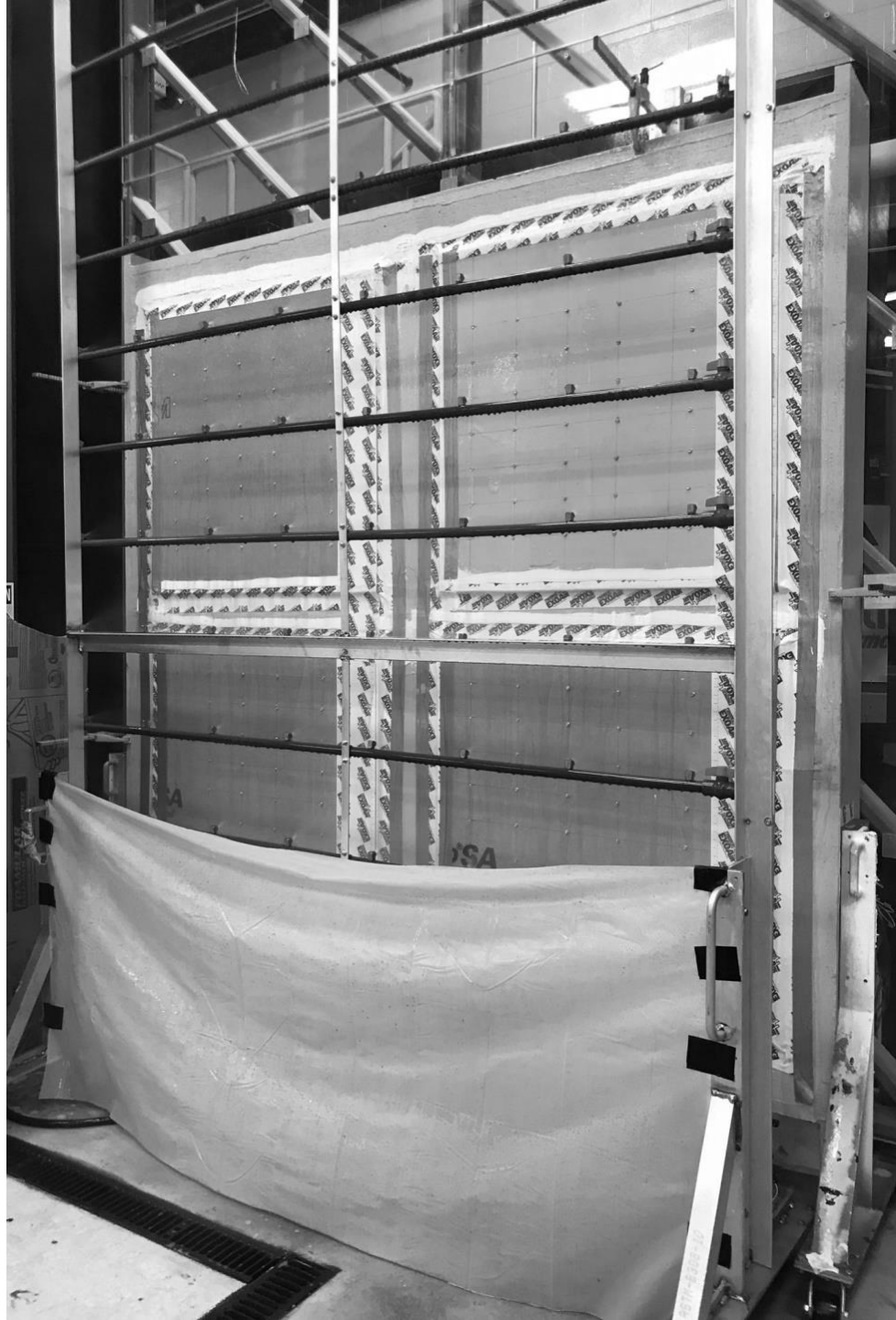
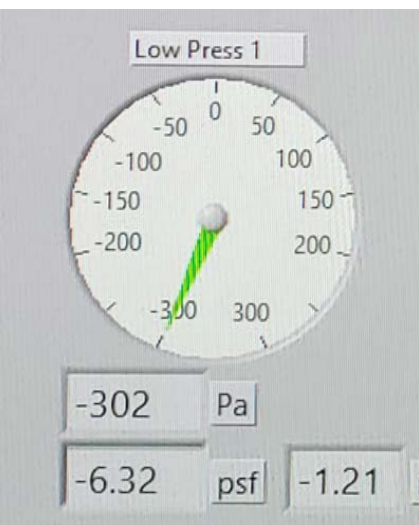


ANGLED



MISSED STUD





DETECTION METHODS

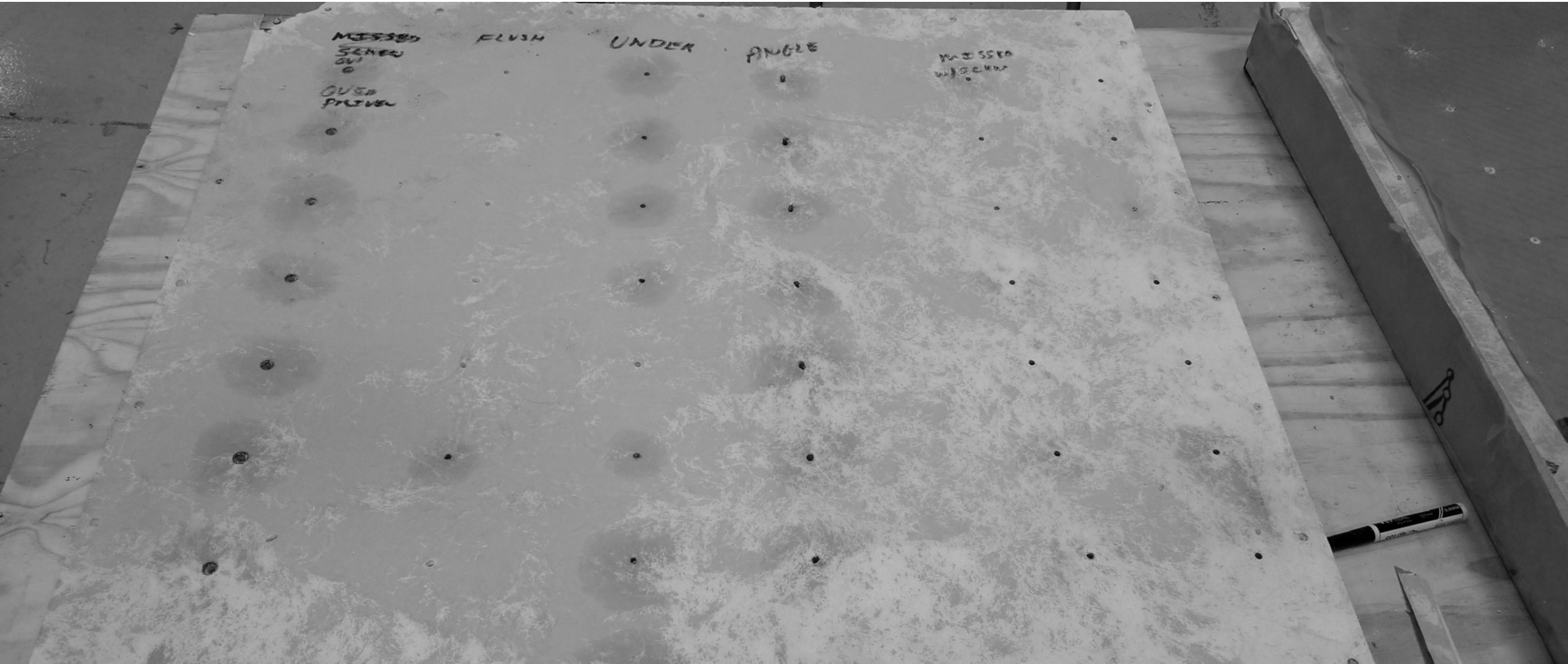
- Visual
- Indicator Paper Behind WRB
- Indicator Paper Behind Sheathing
- Indicator Paper in Fastener Hole
- Fluorescent Dye / UV Light
- RH Sensor
- Pin Probe During Testing
- Sensor Tape
- New Sensor
- Pin Probe After Testing



VISUAL



VISUAL



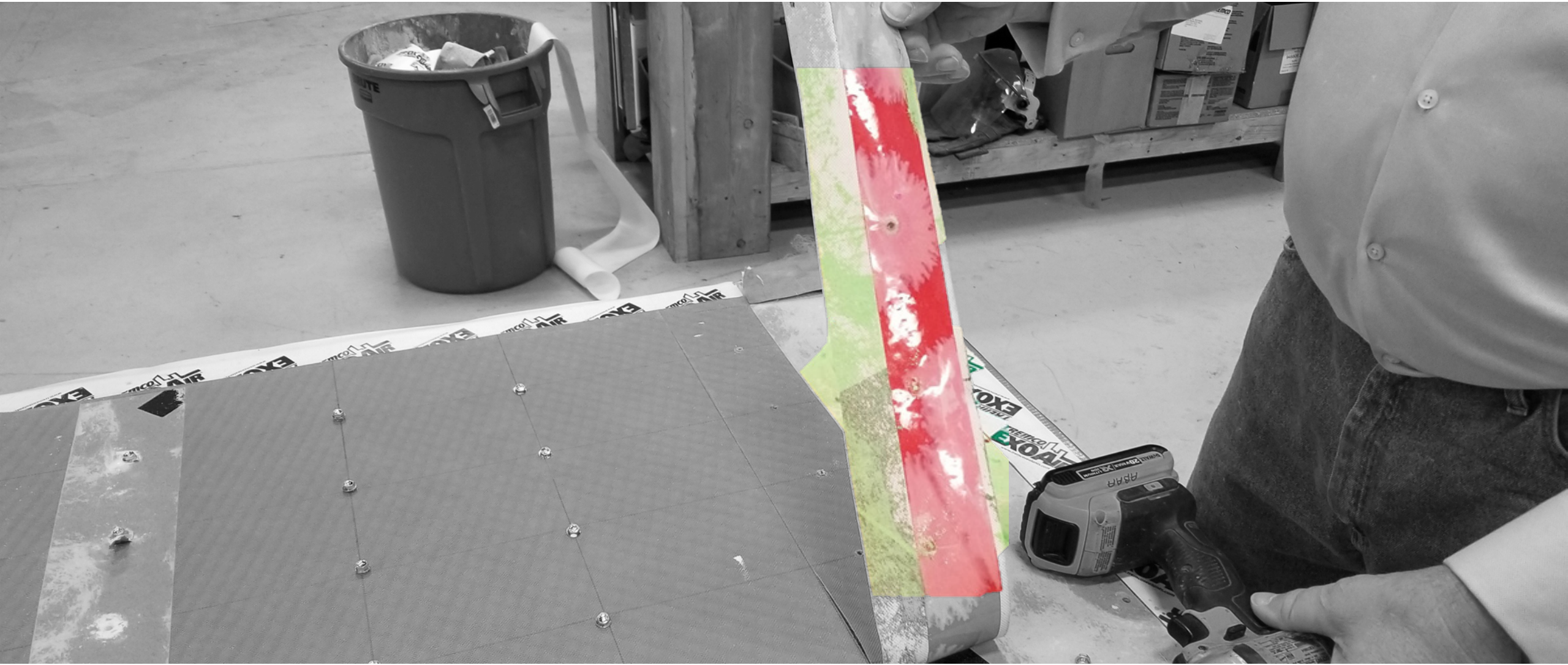
VISUAL



VISUAL / DYE



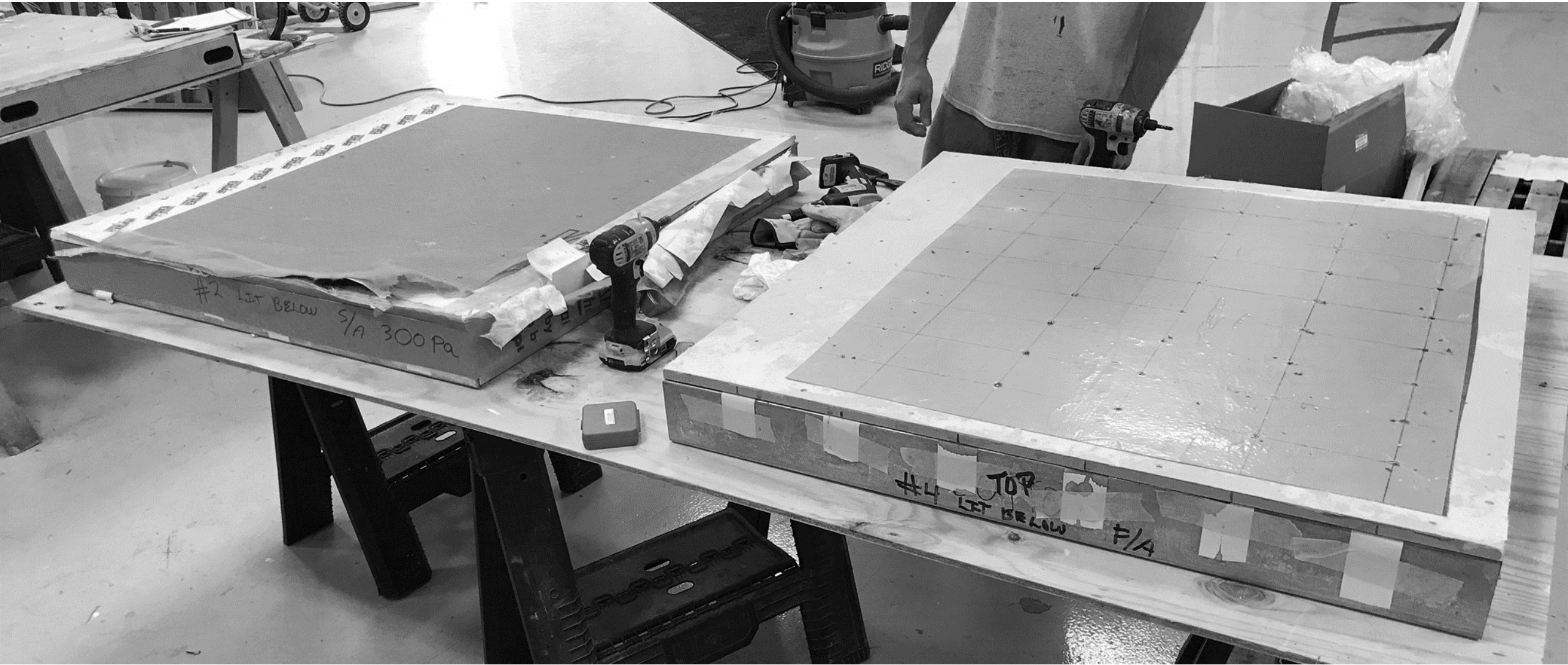
INDICATOR PAPER UNDER WRB



INDICATOR PAPER UNDER WRB



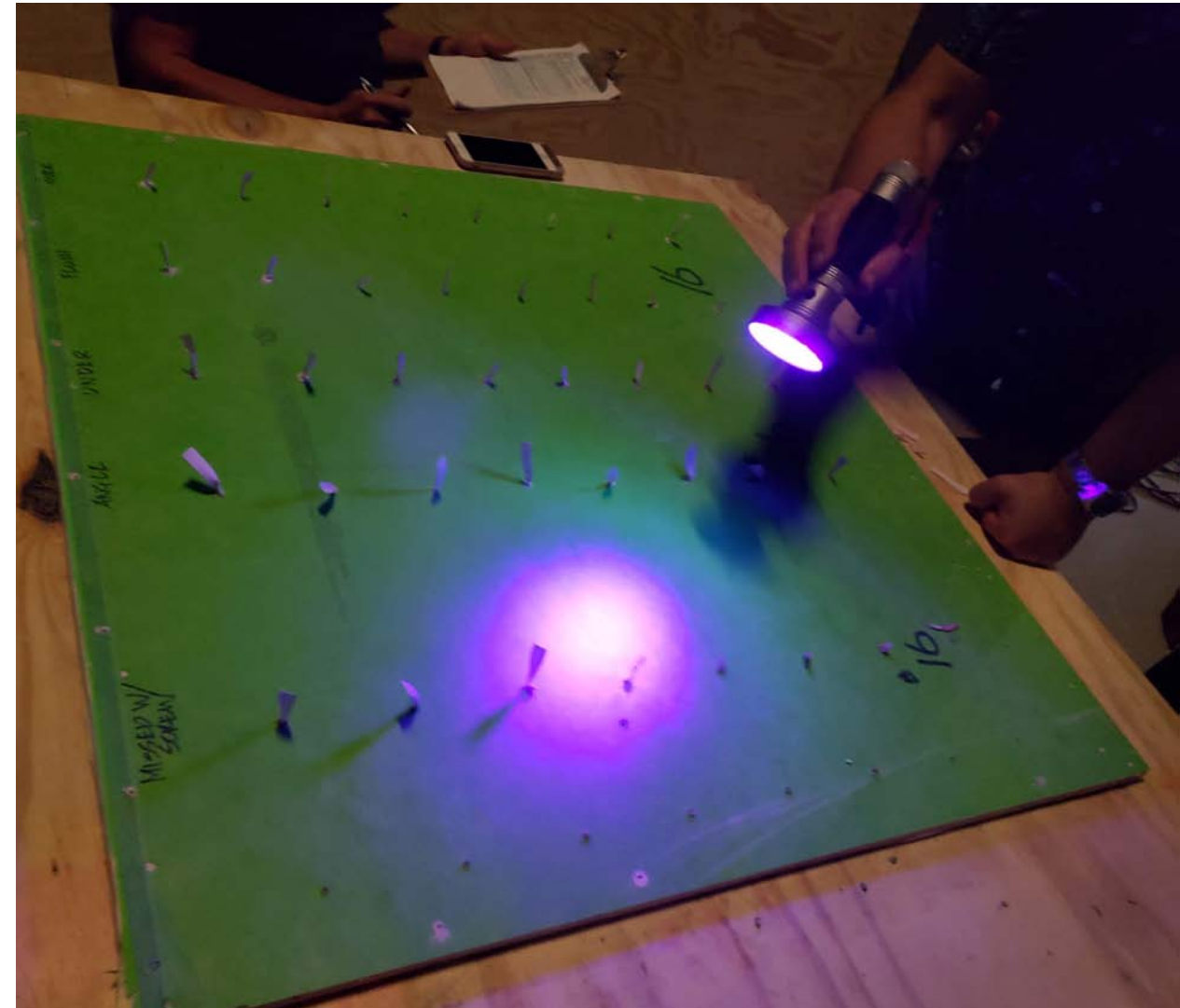
INDICATOR PAPER UNDER SHEATHING



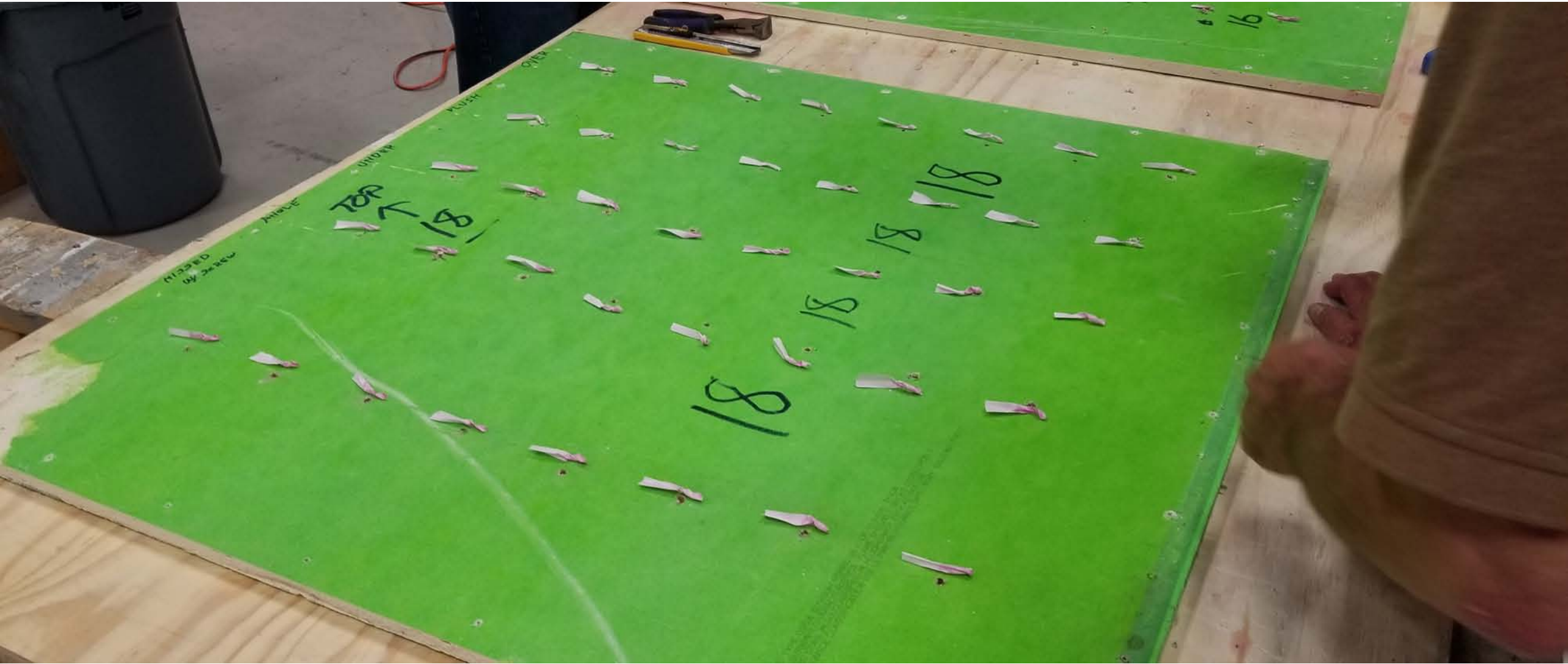
INDICATOR PAPER UNDER SHEATHING



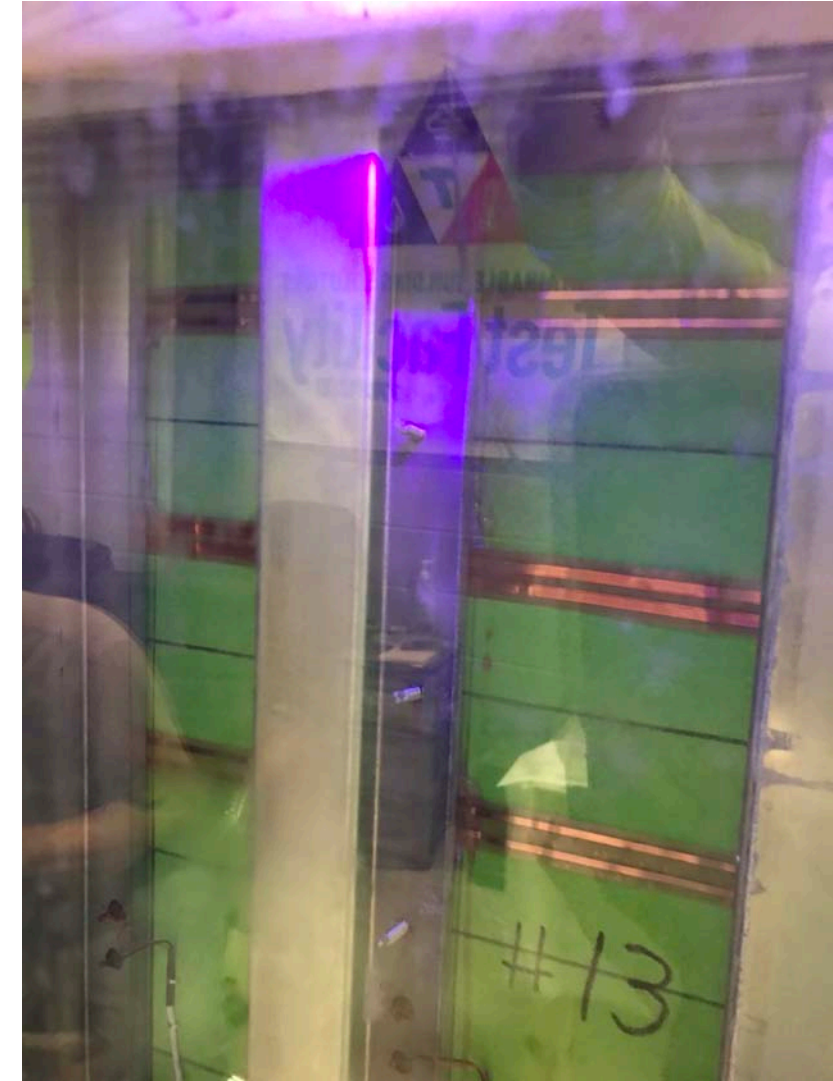
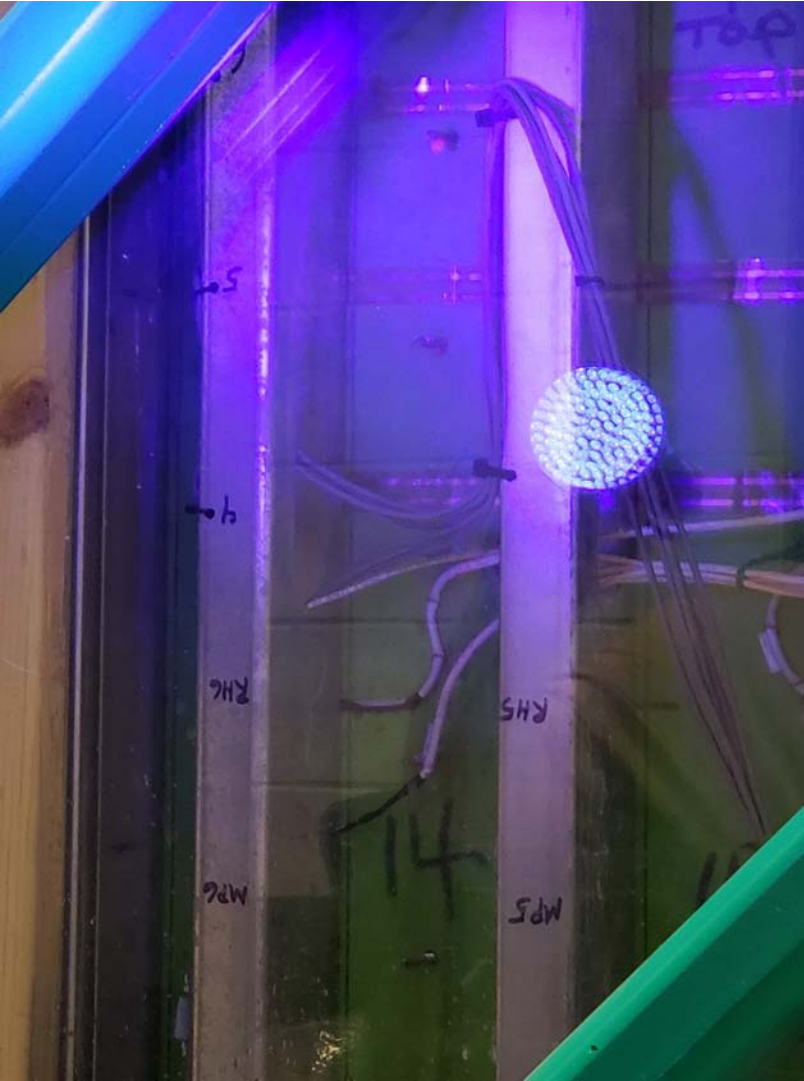
INDICATOR PAPER IN FASTENER HOLE



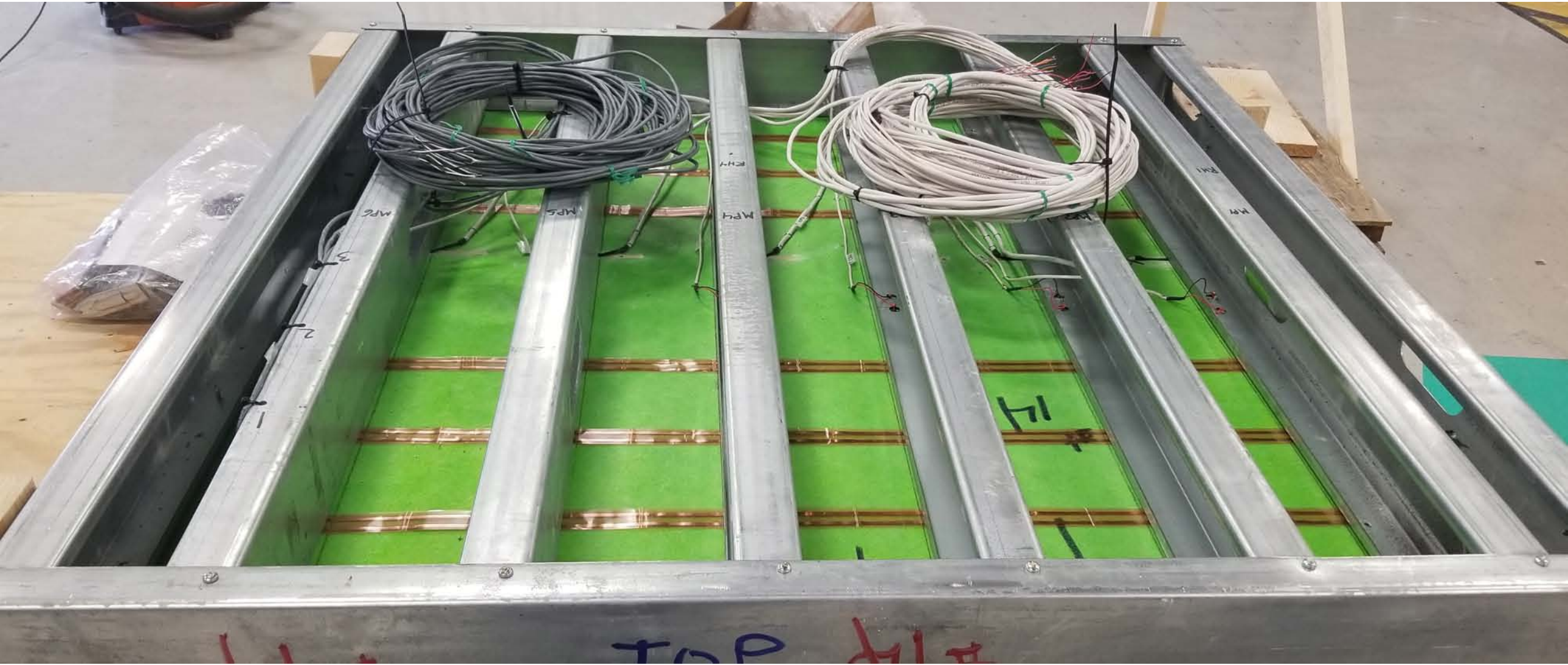
INDICATOR PAPER IN FASTENER HOLE



FLUORESCENT DYE / UV LIGHT



SENSORS



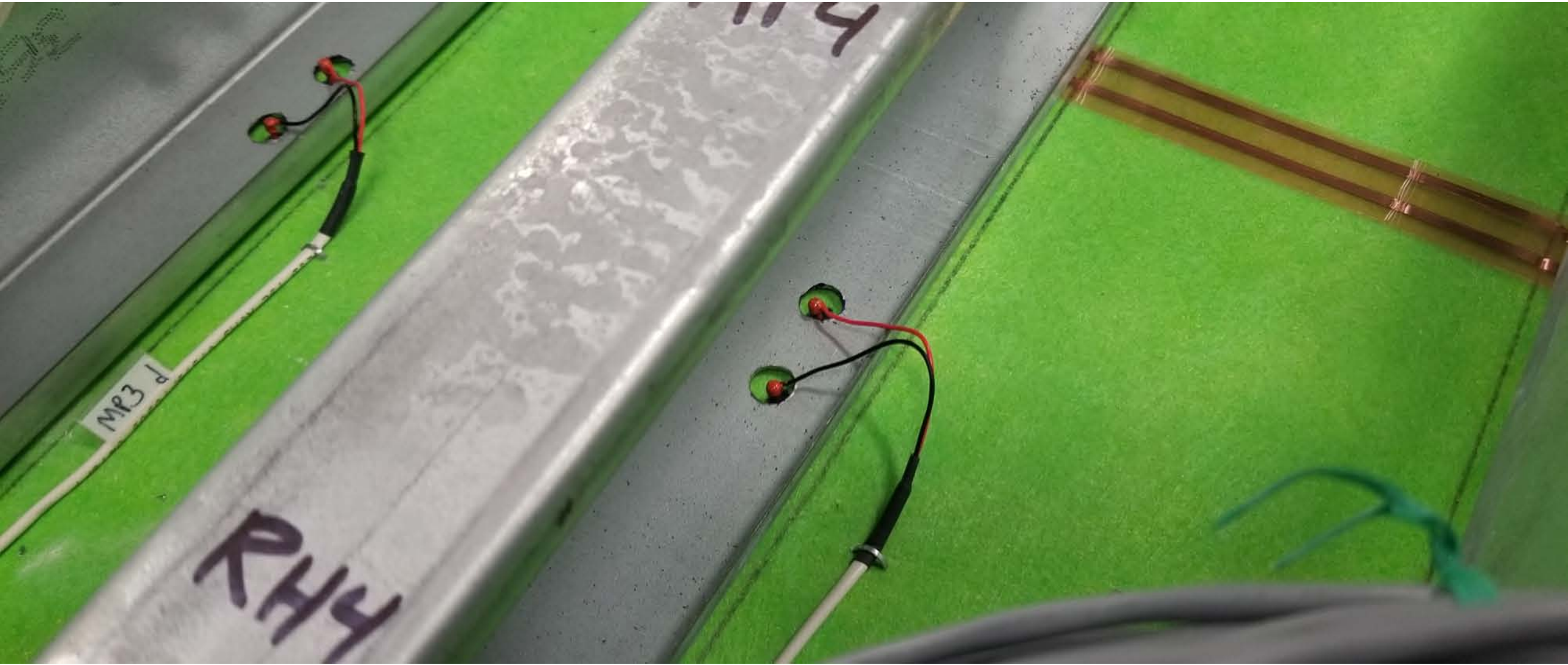
RH AND PIN SENSORS



RH SENSOR



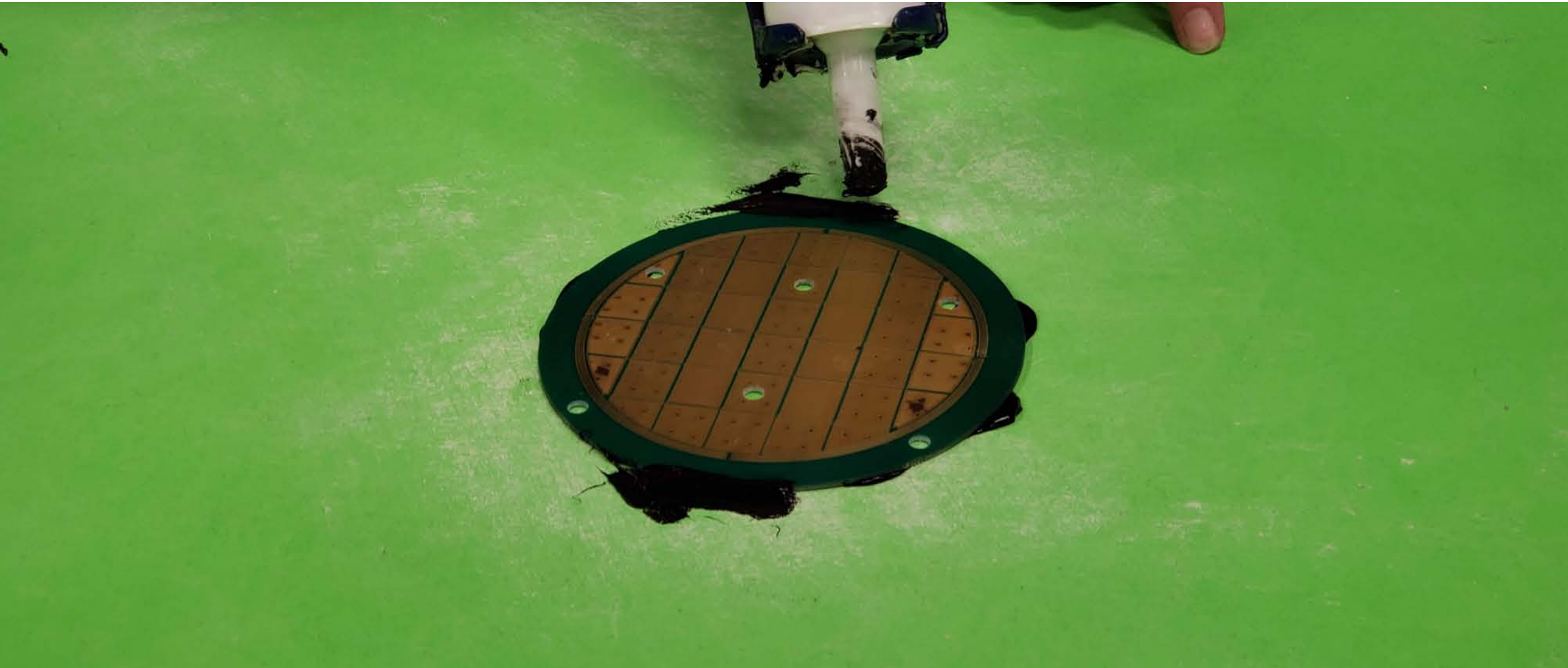
PIN PROBE TYPE 1



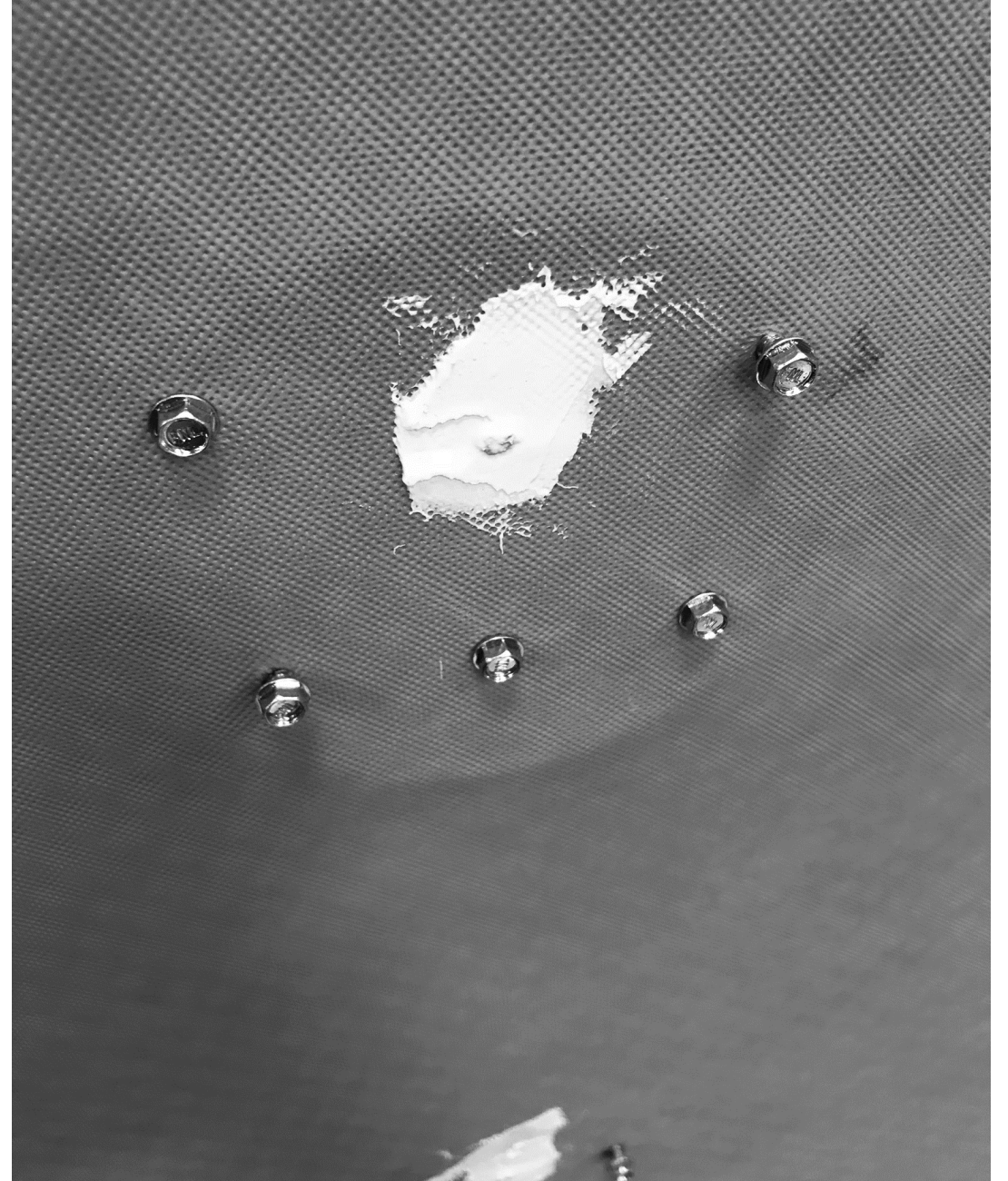
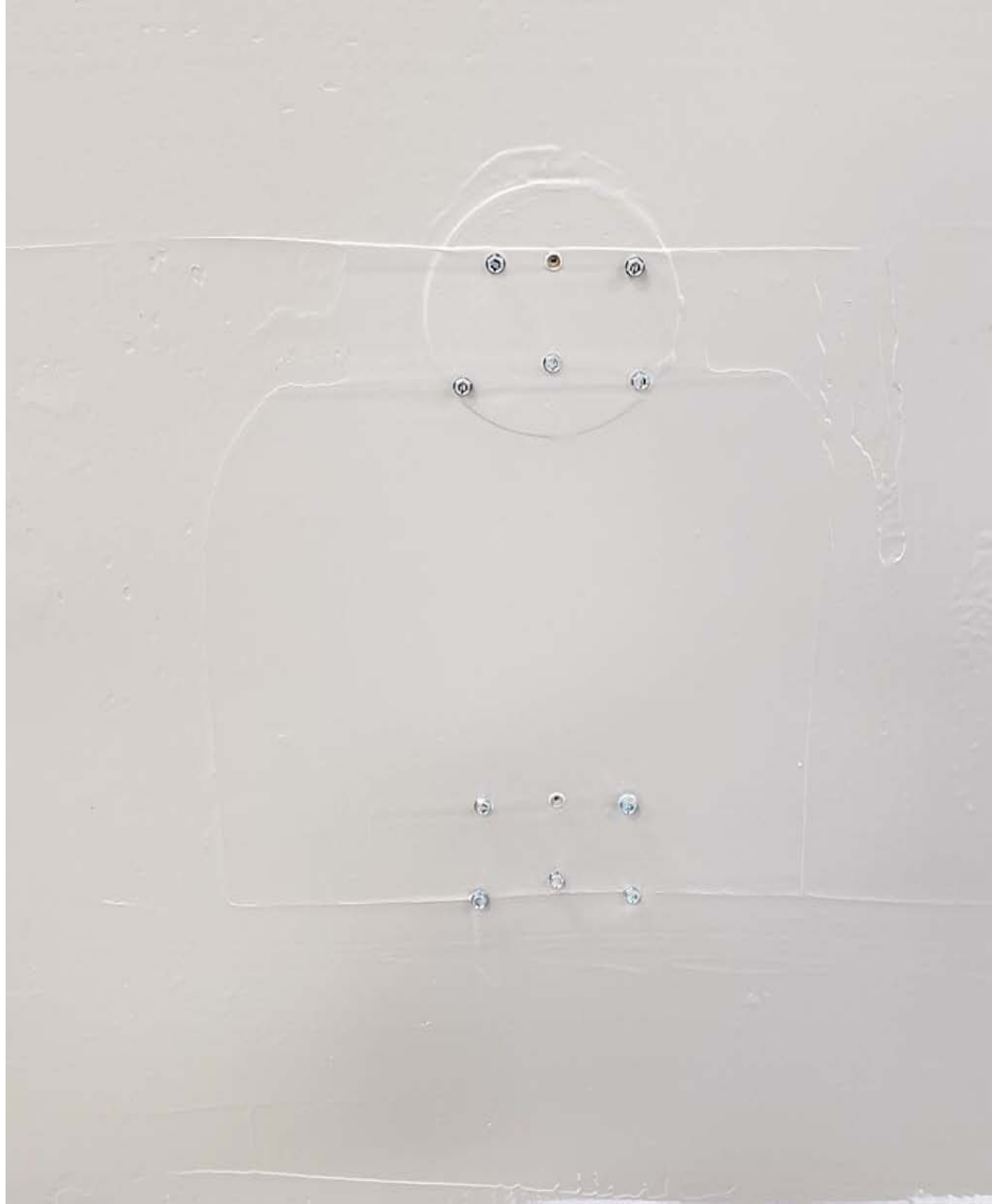
SENSORS



SENSOR PLATE



SENSOR PLATE



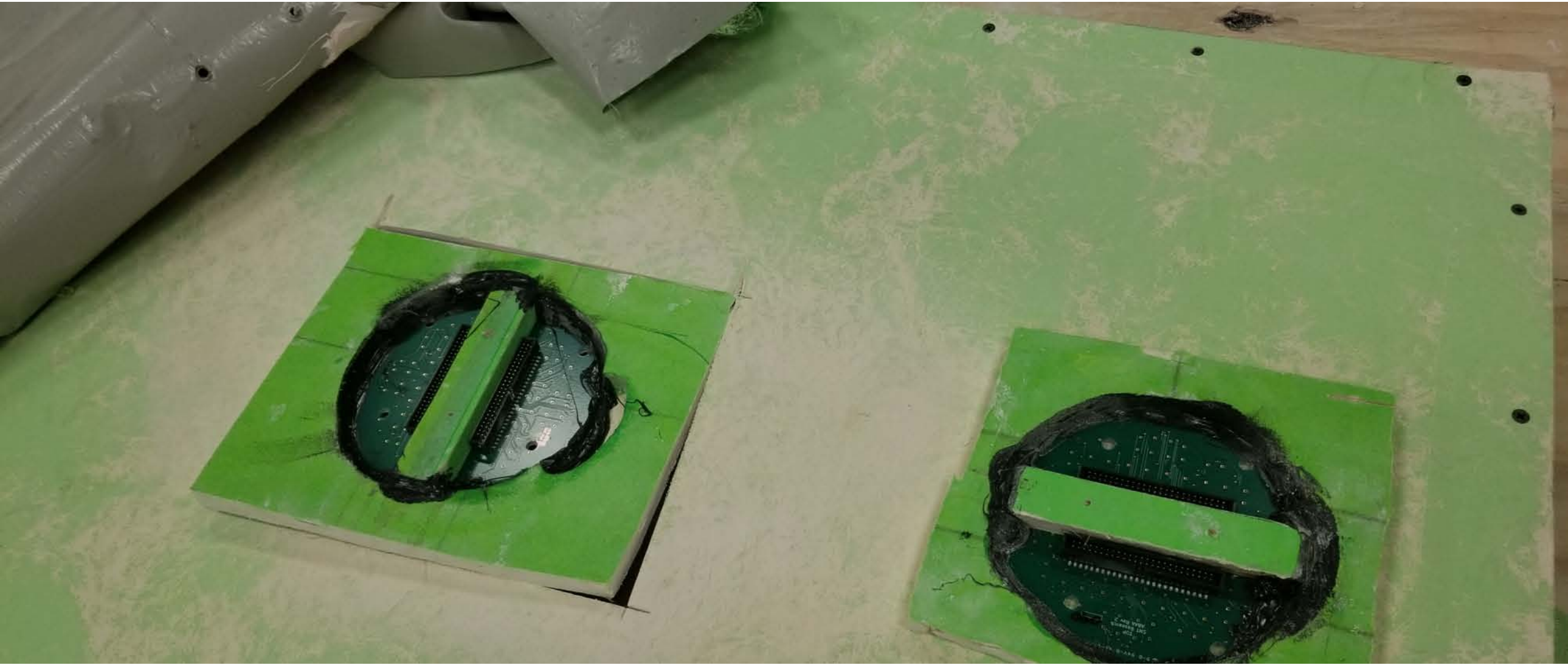
SENSOR PLATE



SENSOR PLATE



SENSOR PLATE



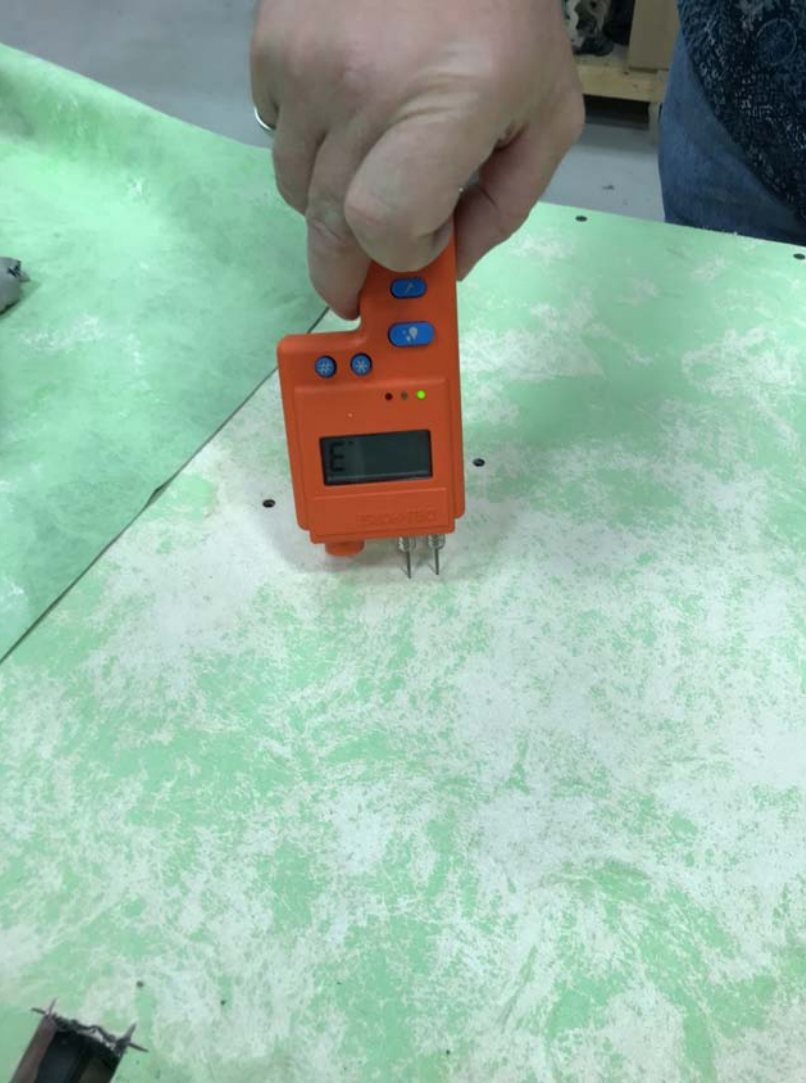
SENSOR PLATE



PIN PROBE AFTER TESTING

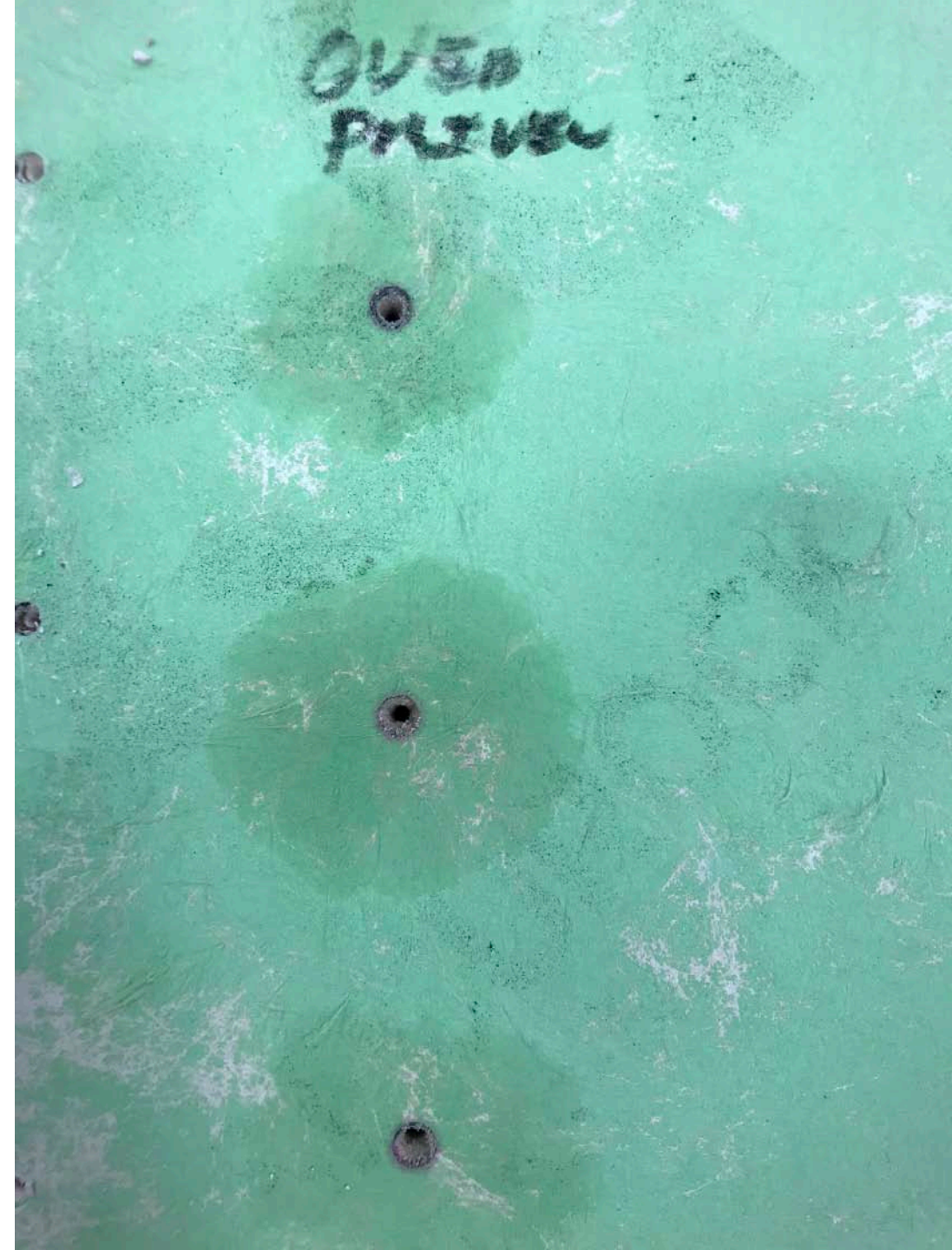


PIN PROBE AFTER TESTING



WHAT DID WE OBSERVE

- Indicator Paper not appropriate under Fluid Applied
- Indicator Paper behind sheathing was useful
- Indicator Paper in hole was not useful
- Visual was useful, but subjective and did not address time of penetration
- Dye was useful and UV was not
- RH and Pin Probe Sensor data still under review
- Sensor tape was useful but one ribbon creates limitations
- Sensor Plate still under review
- Pin Probe after Testing was labor intensive
- Final summary to be provided in ORNL Report



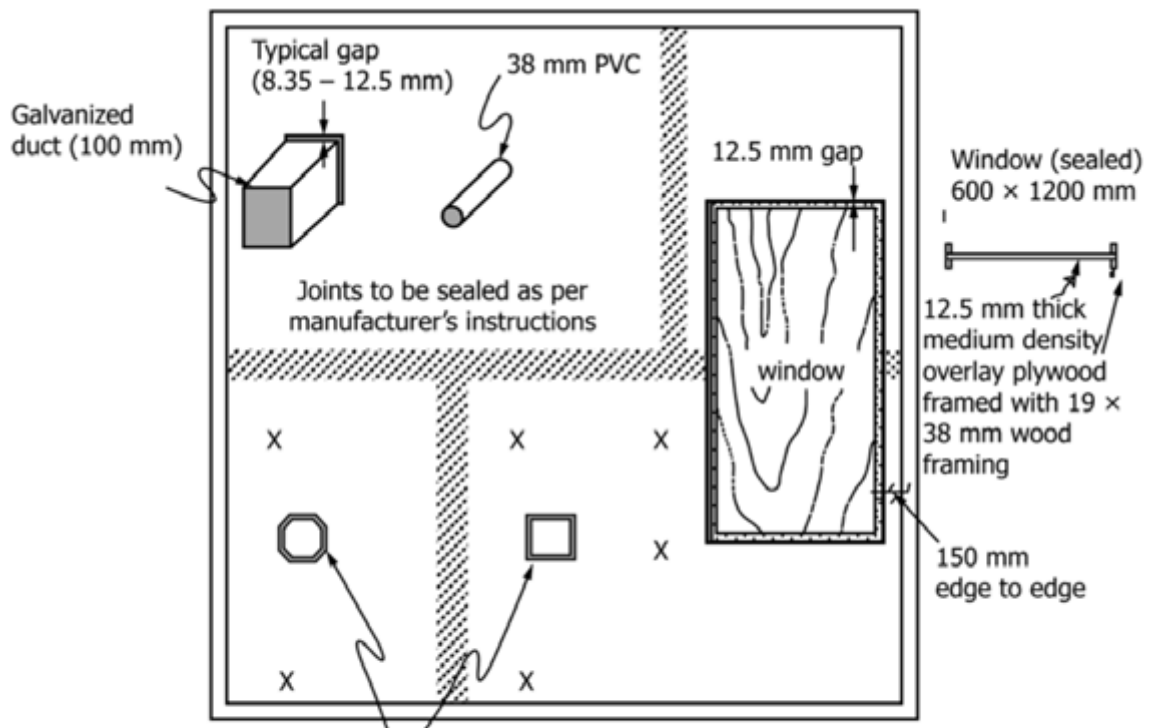
WHAT DO WE TEST?

WRB WALL ASSEMBLY TEST, BUT...



Designation: E2357 – 18

Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies¹



Hexagonal and rectangular external junction boxes installed in accordance with construction practice

X ~ i.e., Masonry ties



Designation: E1105 – 15

Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference¹

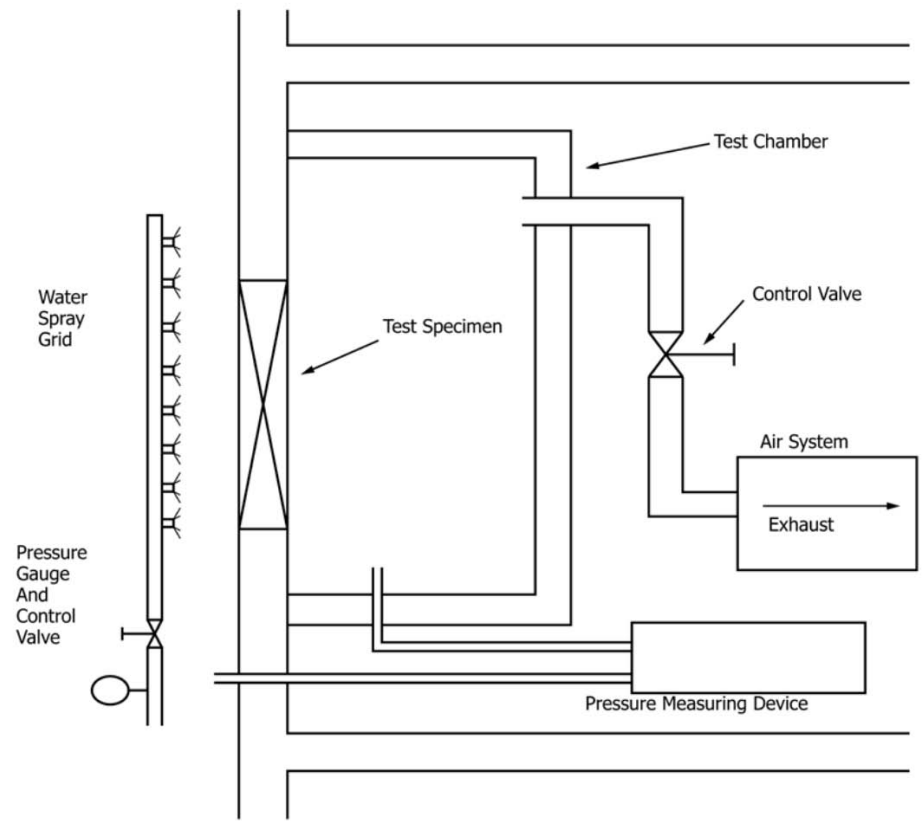
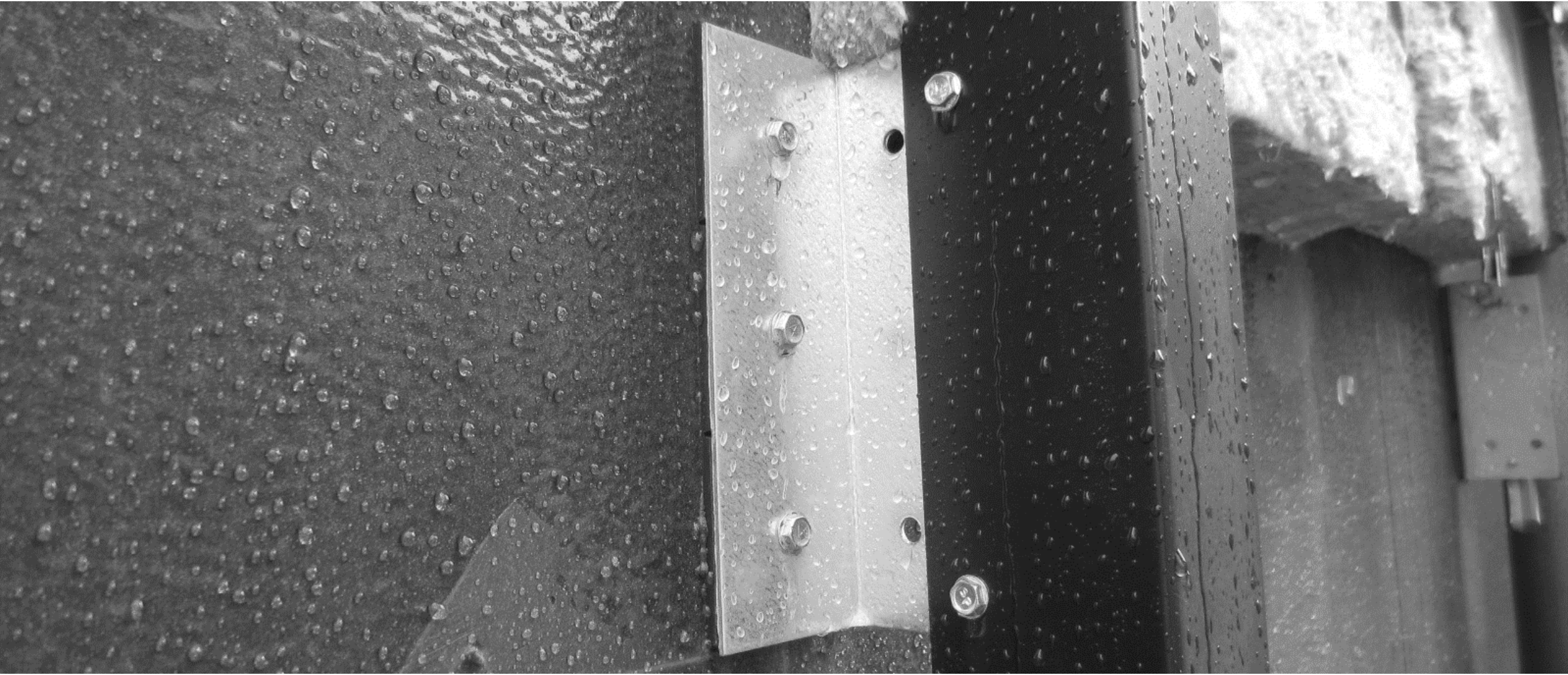


FIG. 1 General Arrangement of Water Penetration Test Apparatus

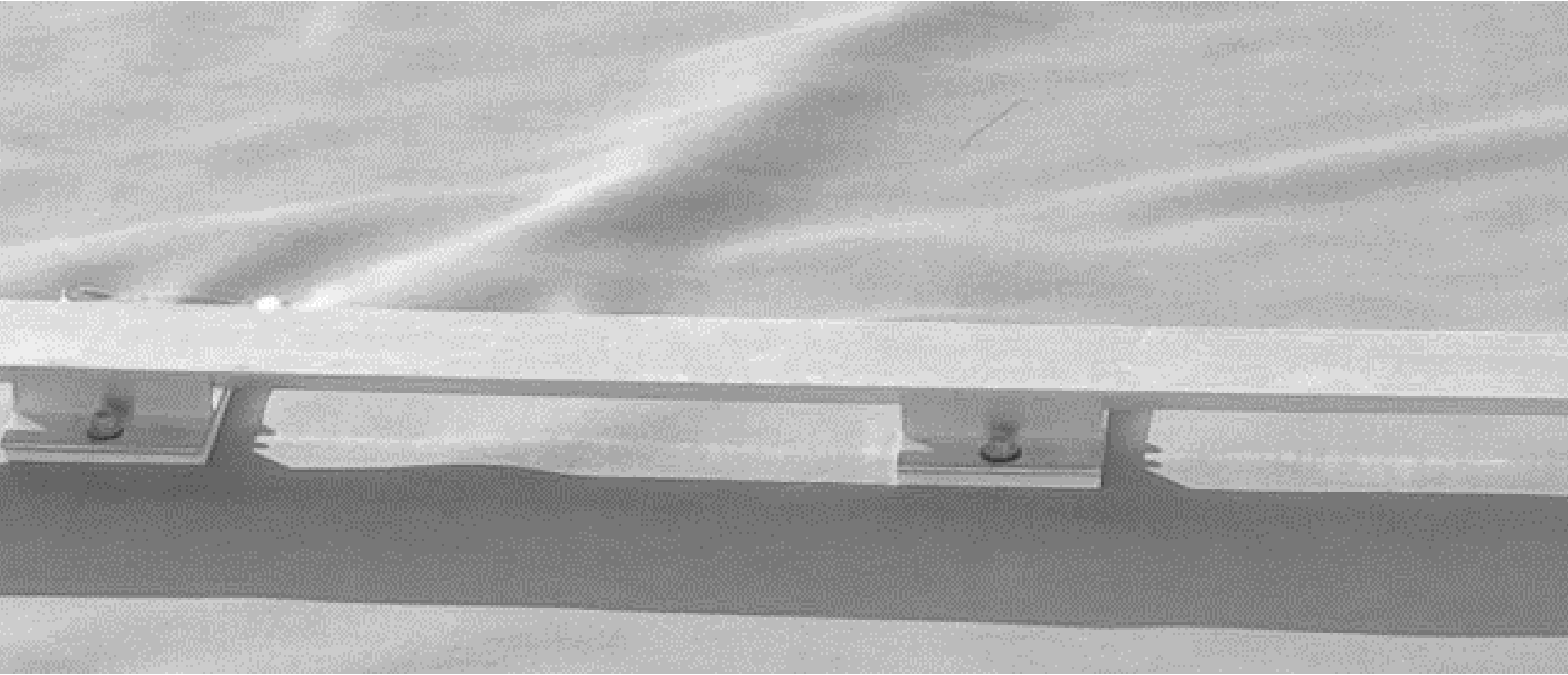
CLADDING ATTACHMENTS / METHODS



CLADDING ATTACHMENTS / METHODS



CLADDING ATTACHMENTS / METHODS



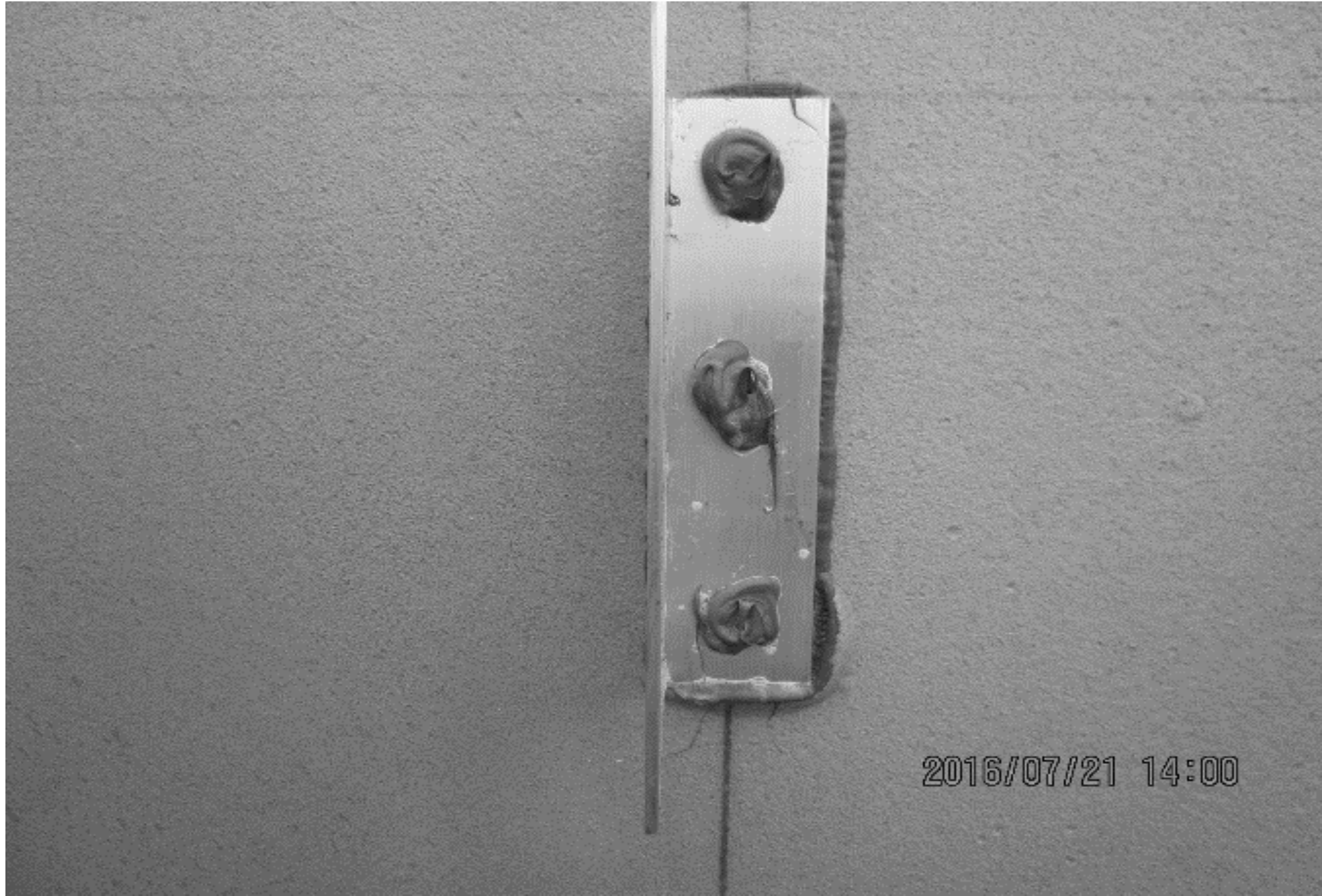
CLADDING ATTACHMENTS / METHODS



CLADDING ATTACHMENTS / METHODS



CLADDING ATTACHMENTS / METHODS

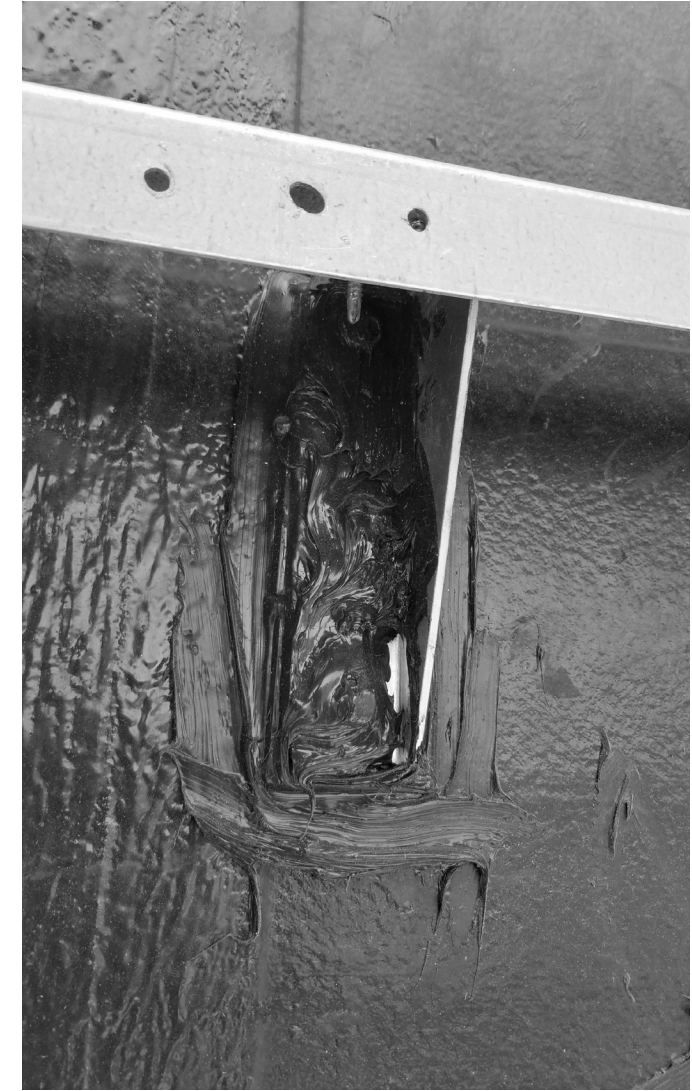


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CLADDING ATTACHMENTS / METHODS



CLADDING ATTACHMENTS / METHODS



CLADDING ATTACHMENTS / METHODS



CLADDING ATTACHMENTS / METHODS



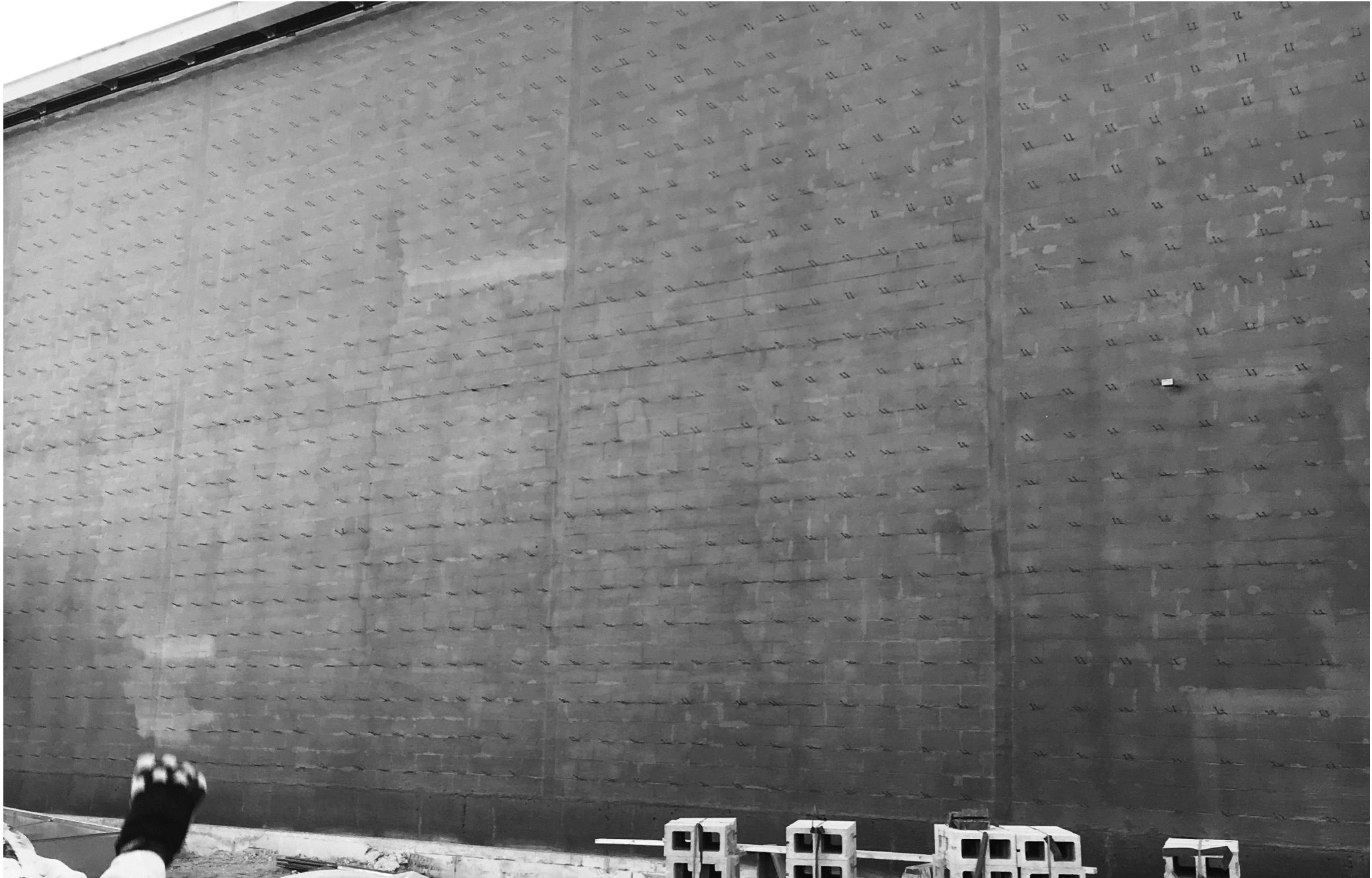
CLADDING ATTACHMENTS / METHODS



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CLADDING ATTACHMENTS / METHODS



CLADDING ATTACHMENTS / METHODS



CLADDING ATTACHMENTS / METHODS



Image by "The Stucco Guy"

WRB SUB-ASSEMBLY TEST

ASTM D1970 - 18

Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection¹

7.9 Capability to Seal Around Nail (Head of Water Test):

7.9.1 Perform Test Method D7349/D7349M, Protocol 4, with the following modifications:

7.9.1.1 Collect sample rolls in accordance with Specification D1970/D1970M rather than following the sample collection procedure referenced in Test Method D7349/D7349M.

7.9.1.2 Evaluate two specimens per sample roll.

7.9.1.3 For each test specimen, penetrate the test material and intervening material with two fasteners spaced 25 to 51 mm [1 to 2 in.] apart.

NOTE 4—Test Method D7349/D7349M, Protocol 4, prescribes the use of a shingle as an intervening material because the majority of steep roof installations use asphalt shingles as the roof cover. The scope of Specification D1970/D1970M includes shingle, tile, and metal roofs, and therefore, it is not prohibited to use other roof covers as intervening materials for research or investigative purposes.

7.9.2 *Report*—Report as a *pass* if all specimens evaluated by Test Method D7349/D7349M yield a passing result. Report as a *failure* if one or more specimens evaluated by Test Method D7349/D7349M do not yield a passing result.

ASTM D7349 - 15

Standard Test Method for Determining the Capability of Roofing and Waterproofing Materials to Seal around Fasteners¹

1.1 This qualitative test method determines the capability of asphalt-based roofing or waterproofing material to seal around a fastener that penetrates the material and prevent transmission of liquid water through the material at the penetration under defined conditions.

- 5-inch head of water
- Three day duration
- Pass/Fail based on visible water penetration.

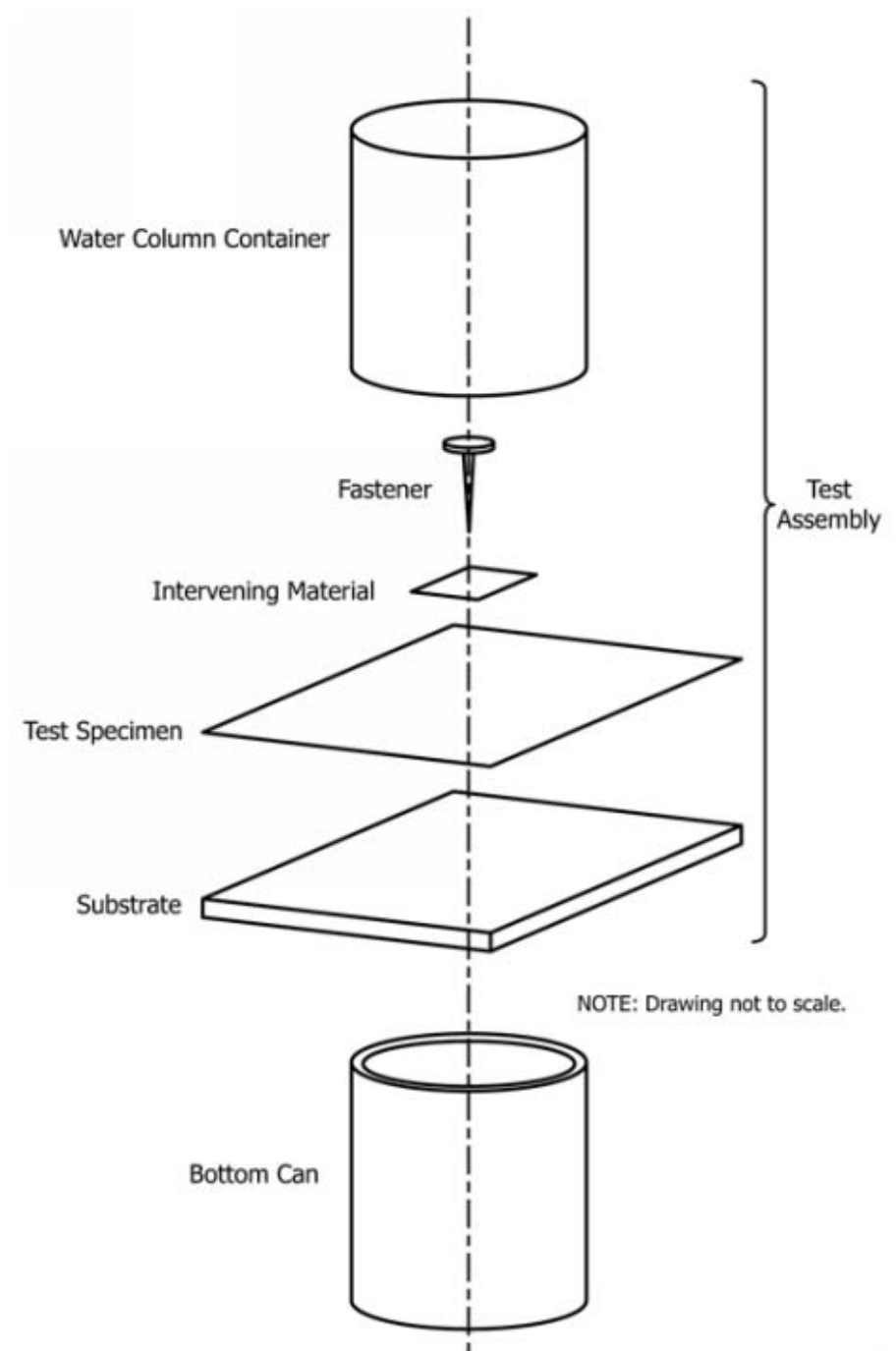


FIG. 1 Test Arrangement

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Voluntary Specification for
Self Adhering Flashing
Used for Installation of
Exterior Wall Fenestration
Products



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Modified D1970/D7349



1.2 inches of
hydrostatic head

24 hour duration

No intervening material

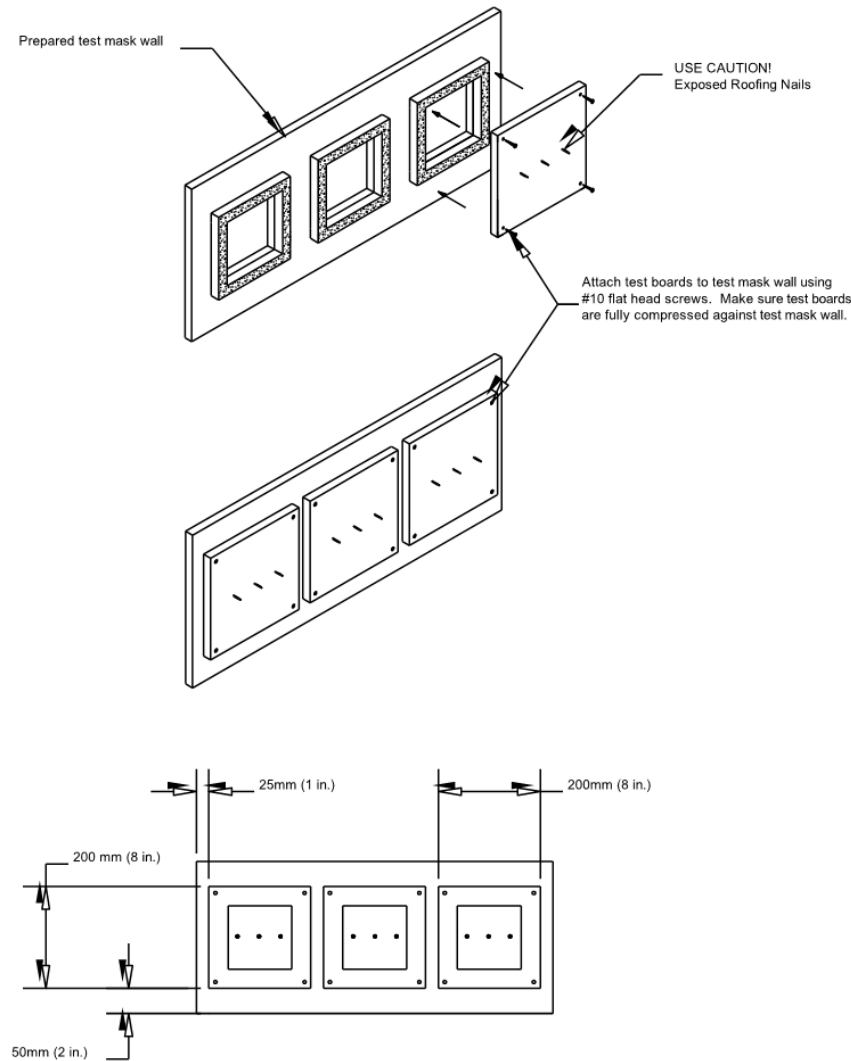
Nail heads are driven
within 1/8 inch of the
surface of the sample.

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Differential pressure equal to **1.5in** of water (375 Pa (7.8psf)) for **4 five minute cycles**.

Then repeat with differential pressure equal to **5in** of water (1385 Pa (28.9psf)).

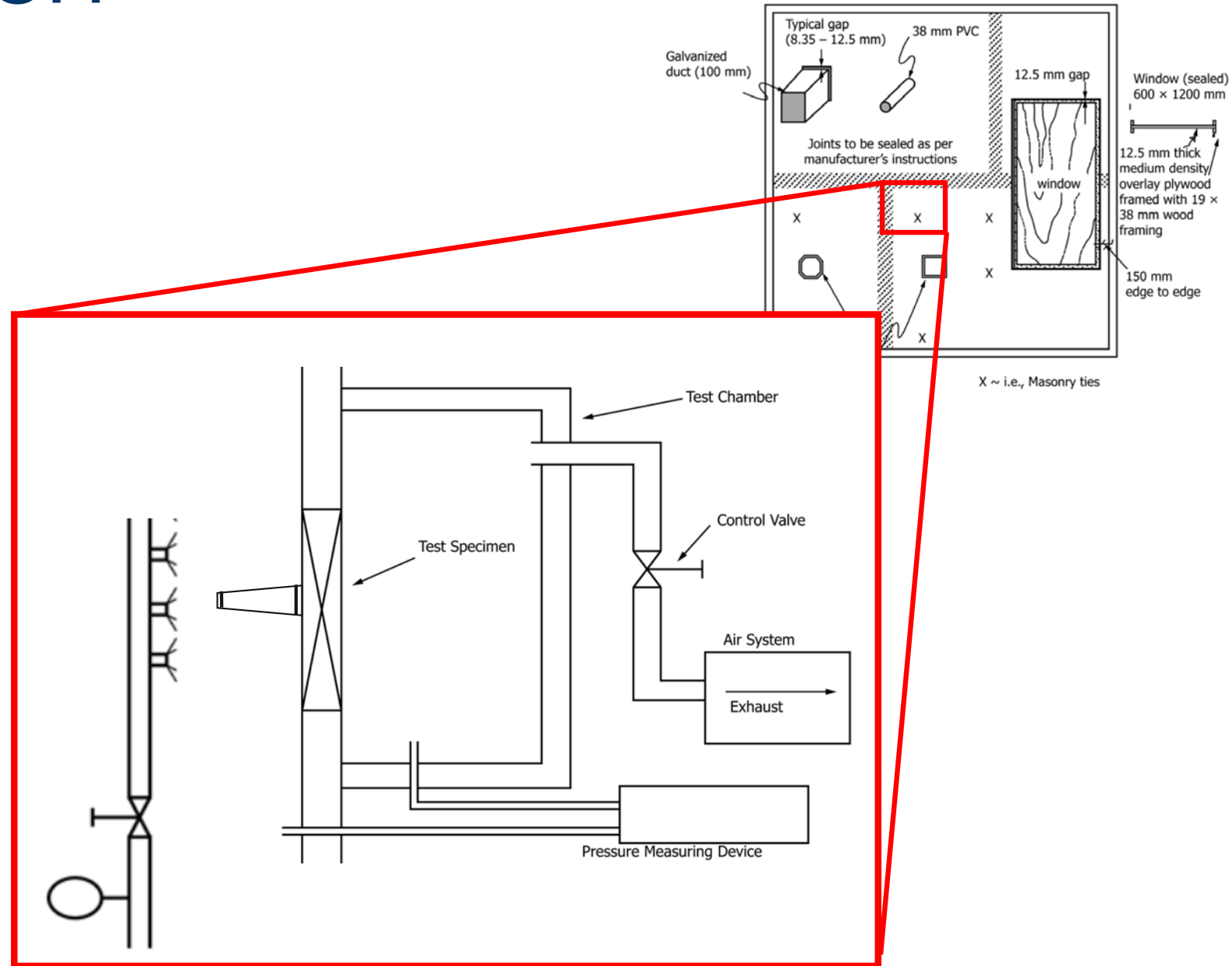
After testing, the membrane edges are lifted away from the substrate to reveal the back.

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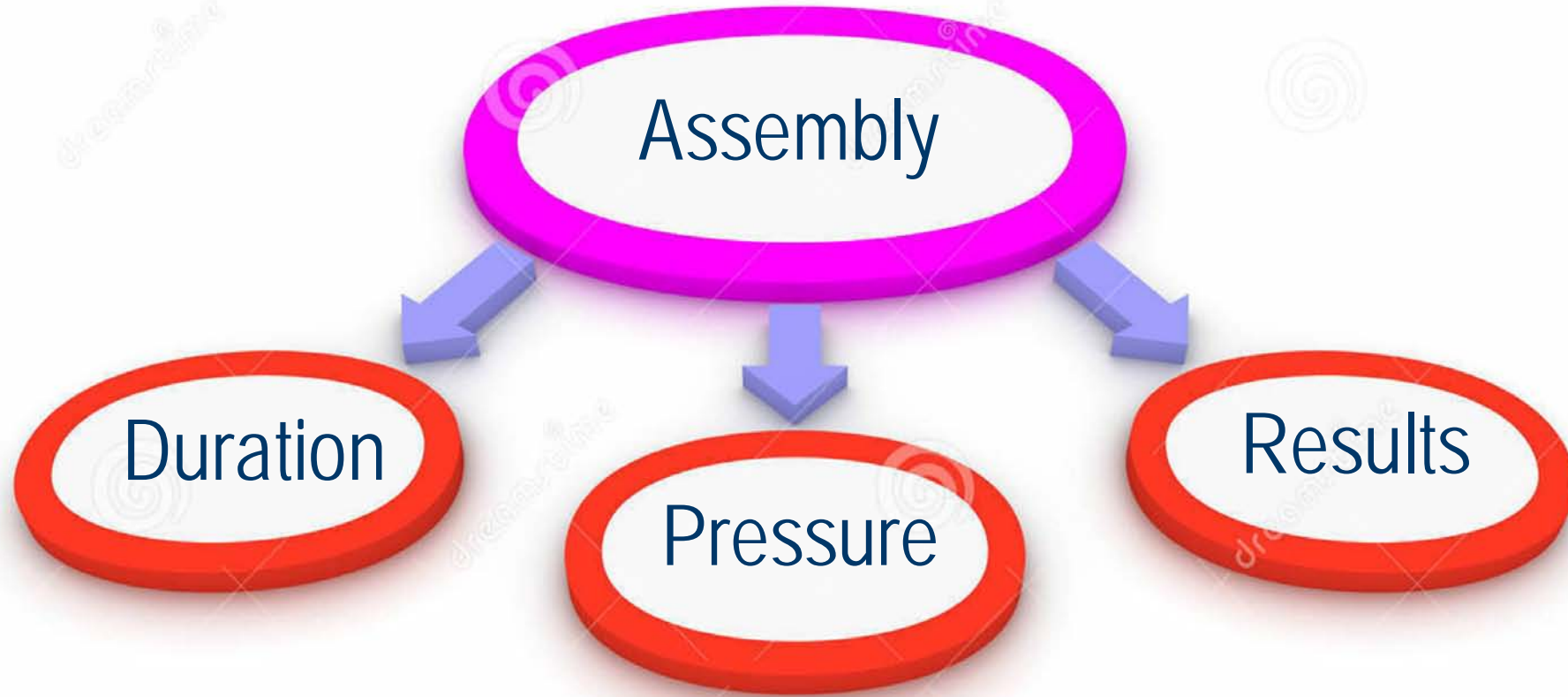
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FUTURE RESEARCH

- Proper Installation
- Improper Installation
- Multiple WRB'S Types
- Multiple Installation Methods
- Various Fasteners Types
- Various Cladding Attachments



ASSEMBLY CLASSIFICATIONS?



NEXT STEPS

- Complete Sensor Plate Round Robin Testing.
- Determine Thresholds for Water Penetration.
- Issue ORNL Report.
- Select Detection Method(s) for Large Scale Testing.
- Research and Develop Assembly Test.
- Research and Develop Sub-assembly Test.
- Discuss Product Classifications.

Andrew Dunlap

**Co-Chair of ABAA Research Committee
Principal**

Sarah Flock

**Co-Chair of ABAA Research Committee
Principal**



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