Proof positive. The Science Behind the System.

The DensElement™ Barrier System
An Integrated Water-Resistive and
Air Barrier Sheathing Solution

Dens Element™ BARRIER SYSTEM
GP
Georgia-Pacific

Rigorous Testing.
Optimal Performance.

All-in-One Water-Resistive and Air Barrier Solution Met All The Challenges

Understanding design considerations, limitations and realistic performance is critical for the successful deployment of any new product. The research and development teams at Georgia-Pacific Gypsum recognize this as a risk potential and require scientific proof of success before introducing innovative, new systems, like the patented DensElement™ Barrier System. Rigorous testing of the various assemblies and the individual components of the system is a crucial step prior to a real-world launch.

The following tables demonstrate only a sampling of the specific experiments performed on the system to replicate potential real world exposure. This exhaustive testing resulted in the evidence needed for the International Code Council to confirm the performance of the DensElement™ Barrier System as a combination exterior wall sheathing, water-resistive and air barrier (WRB-AB) system (ESR-3786).

A New Chemistry

AquaKOR™ Technology

Conventional fluid-applied water-resistive barriers (WRB) coat the entire face of a commercial building's exterior sheathing. Instead of simply duplicating this traditional approach, Georgia-Pacific Gypsum engineers and chemists went to the drawing board to develop the most robust system.

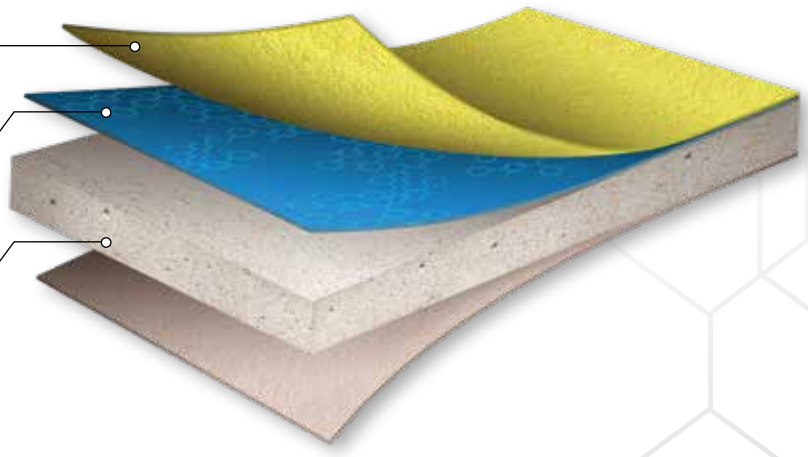
The DensElement™ Barrier System is the result. Retaining fiberglass gypsum mats on its exterior and fusing a WRB layer within the core – through a proprietary method known as AquaKOR™ Technology – tests reveal that this enhanced gypsum sheathing retains the physical properties of typical gypsum sheathing while simultaneously providing the full benefits of a WRB plus a continuous air barrier when the joint/seams, fasteners, penetrations and other openings are sealed properly.

Engineering the WRB within the sheathing's core also guarantees continuity of application. As such, the mil thickness of fluid-applied membranes is no longer a consideration factor for installation error.

Fiberglass Mats
Provide superior moisture and mold resistance – identical to the long-trusted and preferred GOLD DensGlass® Sheathing mat

AquaKOR™ Technology
Chemically bonded between the gypsum core and fiberglass mat to create a consistent, permeable WRB-AB

Gypsum Core
Identical fire-resistance properties and dimensional stability as DensGlass® Sheathing



System Assembly

DENSELEMENT™ BARRIER SYSTEM ASSEMBLY TESTING			
TEST	**DESCRIPTION**	**MEETS OR EXCEEDS**	**RESULTS**
DensElement™ Testing in Accordance with ICC-ES AC212			
ASTM C297 Standard Test Method for Flatwise Tensile Strength of Sandwich Construction	Provides information on the strength and quality of core-to-facings bonds; Pull strength must meet 15 psi	✓	> 19 psi Exceeded requirement by > 25%
ASTM D2247 Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity	Water resistance tested over a treated joint for 24-hours per day for 14 days at 100% relative humidity and 100°F	✓	No signs of panel cracking, crazing, blistering, erosion or other deleterious effects were observed
Freeze-ThawTesting per ICC-ES AC212 Water-Resistive Coatings Used as Water-Resistive Barriers Over Exterior Sheathing	Samples subjected to 10 freeze-thaw cycles with temperatures ranging from -20°F to 120°F; this is a pass/fail test	✓	No cracking or delamination of the WRB surface
ASTM E96 Standard Test Method for Water Vapor Transmission of Materials	Obtain reliable values of water vapor transfer through permeable and semipermeable materials, expressed in suitable units	✓	> 30 perms System has high vapor permeability. Tested using the Wet Cup Method to measure weight loss due to water vapor from the cup transmitting through the material to the test atmosphere and humidity of the test chamber.
ASTM E331 Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference	Water penetration testing of the assembly; test includes windows, brick ties, penetrations; no visible water penetration allowed at sheathing joints or nail penetrations	✓	No leaks! Two separate wall assemblies tested for robustness; windows, transitions, penetrations and brick ties passed all inspections
ASTM E331 (4-Stage)	ASTM E331 is performed twice in ICC-ES AC 212. First as a stand-alone test, second as a part of a 4-part test. In this 4-stage event, water penetration was tested after the DensElement™ Barrier System was subjected to three other test methods – loading, racking and environmental conditioning – as described below		
STAGE 1 **ASTM E1233** Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Cyclic Air Pressure Differential	The first stage of conditioning for the ASTM E331 test – transverse load testing (panel deflection test); no failure of WRB allowed; this is a pass/fail test	✓	**No WRB failure!** Per IBC code requirements, DensElement™ Barrier System endured 10 specified deflection cycles with no WRB failure (deflection specified per IBC table 1603.4)
STAGE 2 **ASTM E72** Standard Test Methods of Conducting Strength Tests of Panels for Building Construction	The second stage of conditioning for the ASTM E331 test – racking test (panel strength test); no failure of WRB allowed during or after racking; this is a pass/fail test	✓	**No WRB failure!** System was racked at 1/8" net deflection
STAGE 3 **Restrained Environmental Conditioning of Panel with WRB-AB**	The third stage of conditioning for the ASTM E331 test – system subjected to water and heat after being deflected and racked; no failure of WRB allowed; this is a pass/fail test	✓	**No WRB failure!** System subjected to 5 cycles of 24-hour water spray and 24-hour radiant heat on panels that were tested structurally
STAGE 4 **ASTM E331** Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference	The final stage of testing using the components that have already undergone stage 1-3 testing; the system was then tested to determine its resistance to water penetration under uniform static air pressure differences	✓	**No leaks!** Assembly tested in chamber using a 5 gal/hr water spray with 137 Pa (2.84 psf) static air pressure

DENSELEMENT™ BARRIER SYSTEM ASSEMBLY TESTING

	TEST	DESCRIPTION	MEETS OR EXCEEDS	RESULTS
	Hydrostatic Pressure Test (3-Stage) per ICC-ES AC212 Water-Resistive Coatings Used as Water-Resistive Barriers Over Exterior Sheathing	In this 3-stage event, hydrostatic pressure was tested after the DensElement™ Barrier System was subjected to two other test methods – UV light exposure and accelerated aging – as described below		
STAGE 1	**Ultraviolet (UV) Light Exposure**	The first stage of conditioning for the hydrostatic head test – a sample with a joint was exposed to high heat for an extended period; this is a pass/fail test	✓	**No WRB failure!** System subjected to 21 cycles of UV light at 135°F to 140°F for 10 hours per day, followed by conditioning for 14 hours per day for a total of 210 hours; no delamination
STAGE 2	**Accelerated Aging**	The second stage of conditioning for the hydrostatic head test – the previous sample with a joint was taken from the UV exposure test and subjected to 25 accelerated aging cycles	✓	**No WRB failure!** System subjected to high heat oven drying and soaked in water for 18 hours at room temperature; no delamination
STAGE 3	**Hydrostatic Pressure Test per AATCC Test Method 127-1985** for Water Resistance	The final stage of testing uses the components that have already undergone stages 1-2; the system was then tested for leakage and to verify performance and durability	✓	**No leaks!** Assembly tested under 550 mL of water in a 22-in. column for 5 hours; column had 6-in. diameter and spanned a full joint plus 1-in. of sheathing on either side
	Additional Testing for ABAA Material/System Evaluation			
	ASTM D1970 (modified) Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection	ASTM D1970, is to confirm DensElement™ Barrier System meets a waterproofing standard by laying it flat, driving two nails into it, and backing out the nails a quarter of an inch. The bottom is cut out of a one gallon can, and it is sealed with silicone around the two nails. Water is added to the can, and it is left for a period of time.	✓	No leaks allowed where fasteners penetrate through DensElement™ Sheathing- Pass
	ASTM D4541-09-e1 Standard test method for pull-off strength of coatings (DensElement™ mat surfacing in this case) using portable adhesion testers.	The pull-off strength of the mat on DensElement™ Sheathing is a performance property that may be referenced. This test method serves as a means for uniformly preparing and testing the facer surface, and evaluating and reporting the results.	✓	Exceeds minimum 16 psi pull-off requirement by approx 25%
	Additional Testing for EIMA Policy			
	ASTM E2273 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies	Standard Test Method for Determining the Drainage Efficiency of Exterior Insulation and Finish Systems (EIFS) Clad Wall Assemblies	✓	DensElement™ Barrier System exceeded 90% drainage on three EIFS assemblies from three EIFS manufacturers
	Additional Testing for Energy Code (IECC) Compliance			
	ASTM E2357 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies	Simulates the performance of various air barrier materials/accessories when combined into an assembly; results will assign an air leakage rating for the assembly	✓	Exceeded IECC requirements by 75% for assembly code requirements of 0.04 cfm/ft2 at 75 Pa with below code air infiltration rates of 0.01 cfm/ft2 at 75 Pa
	Additional Testing for IBC CHAPTER 14 Compliance			
	NFPA 285 Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components	Provides a standardized fire test procedure for evaluating the suitability of exterior, non-load bearing wall assemblies and panels used as components of curtain wall assemblies that are constructed using combustible materials or that incorporate combustible components for installation on buildings where the exterior walls are required to be non-combustible	✓	Wall assembly engineering evaluations completed for the DensElement™ Barrier System compliance with NFPA 285
	Additional Testing for ICC-ES ESR 3786: AC310 Section 4.5			
	Water Penetration Testing ASTM E331 test with addition of a roof-wall intersection	Assembly with additional roof-wall intersection must pass ASTM E331 criteria	✓	No leaks

Component Testing

SHEATHING COMPONENT TESTING			
TEST	**DESCRIPTION**	**MEETS OR EXCEEDS**	**RESULTS**
DensElement™ Testing Accordance with ICC-ES for ICC ES ESR 3786			
ASTM C473 Standard Test Method for Physical Testing of Gypsum Panel Products	Test methods cover (1) flexural strength; (2) core, end, and edge hardness; (3) nail pull resistance; (4) humidified deflection; (5) end squareness; (6) nominal thickness; (7) recessed- or tapered-edge depth; (8) width; (9) length; (10) water resistance of core-treated water repellant gypsum panel products; and (11) surface water resistance of gypsum panel products with water-repellant surfaces	✓	Gypsum physical properties testing as covered in ASTM C1177
ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials	Provides comparative measurements of surface flame spread and smoke density measurements with that of select fiber-cement board surfaces under specific fire exposure conditions	✓	Best score of 0 - Flame Spread 0 - Smoke Developed
ASTM E136 Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C	Assists in indicating those materials which do not act to aid combustion or add appreciable heat to an ambient fire; materials passing the test are permitted to limited flaming and other indications of combustion	✓	Non-combustible
AAMA 714 Voluntary Specification for Liquid-Applied Flashing Used to Create a Water-Resistive Seal Around Exterior Wall Openings in Buildings	Establishes minimum performance requirements for liquid-applied flashing used to provide a water-resistive seal around exterior wall openings in buildings that includes fenestrations, such as windows and doors, as well as other through-wall penetrations	✓	PROSOCO FastFlash® liquid flashing approved for use and listed in ICC-ES ESR-3786
Additional Testing for ABAA Material/System Evaluation			
ASTM E2178 Standard Test Method for Air Permeance of Building Materials	Measurement of the air permeance of flexible sheet or rigid panel-type materials; results may be useful in determining suitability of that material as a component of an air retarder system	✓	Sheathing exceeded IECC requirements by 50% for code requirements of 0.004 cfm/ft2 at 75 Pa with below code air infiltration rates of 0.002 cfm/ft2 at 75 Pa
Mold Resistance			
ASTM D3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber	Determines the resistance of interior coatings to mold growth; useful in estimating the performance of coatings designed for use in interior environments that promote mold growth	✓	Highest Score of 10

Canada Testing

ADDITIONAL AIR BARRIER SYSTEM AND COMPONENT TESTING FOR CANADIAN CODE COMPLIANCE

TEST	DESCRIPTION	MEETS OR EXCEEDS	RESULTS
ASTM E2178 with additional **CAN/ULC S741** test requirements Specimens installed per ASTM E2178, with incremental negative and positive test pressures followed by decremental pressures. Upon completion, the specimens were tested for Ultra-Violet/Condensation exposure followed by Heat Exposure for 772 hours.	CAN/ULC S741 requirement; Where the air leakage characteristic determined for unconditioned specimens is less than 0.01 (L/s.m2) at 75 Pa pressure difference, the air leakage characteristic of the conditioned specimens shall not increase by more than 0.001 (L/s.m2) at 75 Pa pressure difference	✓	DensElement™ Sheathing meets the prior to UV exposure (unconditioned) requirement <.02L/s.m2 @ 75 Pa and the post UV exposure (conditioned) requirements of not increasing by more than 0.001(L/s.m2)@ 75 Pa
ASTM E2357 with additional **CAN/ULC S742** test requirements ASTM E2357 plus the required Wind Pressure Loading/Deflection Testing/Air Leakage Rate Testing at cold temperature of -20 degree C in the test chamber	Wind pressure loading of 650 Pa for Sustained wind load, 950 Pa for Cyclic wind load, and 1410 Pa for Gust wind load	✓	DensElement™ Barrier System is classified as A1 (air leakage not exceeding 0.05 L/(s.m2) @75 Pa) when subjected to sustained hourly wind load of 650 Pa and the cyclic and gust loads that are equivalent to a building height of 12 meters
ASTM D1623 with additional **CAN/ULC 716 .1** Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics	Measures bond strength of the EIFS adhesive to the DensElement™ sheathing under three different conditions	✓	The bond strength exceeds the test requirements under all three required test conditions
CAN/ULC 716.1 Annex B/ISO 15148 Water absorption co-efficient as measured by g/m2.s1/2	Measures water absorption under the method defined in this standard. Samples must absorb less than 4 g/m2.s1/2	✓	The water absorbed 0.0021 g/m2.s1/2, far less than the required minimum absorption of 4 g/m2.s1/2.
CAN/ULC 716.1 Annex C Joint durability test as defined in standard	Treated joints were subjected to 15 cycles of 65 degree C for 15 hours and minus 10 degrees C for 5 hours	✓	No apparent deterioration or perforation after the 15 cycles

AAMA – *The American Architectural Manufacturers Association* A material-neutral organization, the AAMA proactively and effectively influences codes, construction and specification issues

EIMA – *EIFS Industry Members Association* A not-for-profit trade organization committed to advancement and growth of demand for EIFS.

ASTM – *ASTM International* A globally recognized leader in the development and delivery of voluntary consensus standards used around the world to improve product quality, enhance health and safety, strengthen market access and trade, and build consumer confidence.

ICC – *International Code Council* An association dedicated to developing model codes and standards used in the design, build and compliance process to construct safe, sustainable, affordable and resilient structures.

NFPA – *National Fire Protection Agency* A global, nonprofit organization, established in 1896, that delivers information and knowledge through more than 300 consensus codes and standards, research, training, education, outreach and advocacy.

IECC – *International Energy Code* The IECC is a model code that regulates minimum energy conservation requirements for new buildings

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