

LABORATORY TEST REPORT

Submitted to:



April 30th, 2021

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RE: Laboratory Test Report for Water Resistant Flooring Test Services

1) INTRODUCTION:

Benchmark International, LLC (BMI) was commissioned by Jiangsu BBL Home Technology Co., Ltd., (hereinafter “Client”) to evaluate the water-resistant properties of laminate flooring.

2) TEST SAMPLES:

a. CUSTOMER-SUPPLIED PRODUCT AND SAMPLE DATA:

Samples were identified by Client as follows. Samples were assigned a laboratory number upon receipt at the BMI laboratory which was used to identify and trace the samples throughout the test specimen preparation, analysis, and reporting processes.

BMI-Assigned Lab Number:	2021-0496
Product Name/Description:	Water -Proof Laminate Flooring 7x48-10mm-AC4
Product Code/SKU:	Not Specified (N/S)
Manufacturer Name:	BBL Floor
Supplier Name (if different from manufacturer):	N/A
Lot/Batch Number:	N/S
Production Date:	N/S
Sample Collection Date:	March 31, 2021
Other Information:	N/A

b. SAMPLE SELECTION:

Samples were collected by the Client and submitted to Benchmark International, LLC for analysis. Samples were not independently collected and submitted by Benchmark International, LLC or its employees, Affiliates, or subcontractors.

Samples were received at the test laboratory on April 14, 2021. Samples were received in good condition.

3) EVALUATION AND TEST METHODS:

Testing was performed according to the following sample preparation and/or test methods:

- International Organization for Standardization (ISO) 24336:2005(E): *Laminate Floor Coverings – Determination of thickness swelling after partial immersion in water* (also published as European Standard (EN) 13329) **SEE NOTE 1**



- *30-Hour Standing Water Test*, WI-027 version 1 [SEE NOTE 2](#)
- *24-Hour and 30-Hour T-Seam Swell and Seepage Test*, WI-028 version 1 [SEE NOTE 2 AND NOTE 3](#)

Test specimens were prepared for analysis by the BMI laboratory as specified in the referenced test methods.

NOTE 1: The ISO Thickness Swell test stipulates that joint profiles will be removed prior to cutting test specimens. At Client request, the specimens were prepared to include the full width of the plank, resulting in a continuous joint profile along all three edges to be submerged.

NOTE 2: The 30-Hour Standing Water test and the 24/30-Hour T-Seam Swell and Seepage test are client-specified test methods. A summary of each test method is provided below. It should be noted that as a non-standard test method based on visual observations, rigorous estimation of repeatability and reproducibility is not possible. Factors which can influence measures of repeatability and reproducibility may include, but are not limited to: flooring product design and assembly (to include the design, machinability, and production quality of tongue/groove profiles); the types of raw materials used to produce the flooring product; surface topography of the flooring product (e.g. flat, handscrape, or other surface textures); environmental factors including temperature and relative humidity of the test environment; variations in the assembly of test specimens; inherent calibration measurement uncertainty, resolution, and tolerance of test equipment such as scales, calipers, and depth gauges; and other factors. Test results may only be compared to other test data generated using the identical test methods, parameters, and test conditions. Client is responsible for evaluating test results and drawing relevant conclusions such as conformity to published product specifications, where applicable.

NOTE 3: Per WI-028 version 1, the 24/30-Hour T-Seam Swell and Seepage test involves constructing two test assemblies, one to be tested over 24 hours and the other to be tested over 30 hours. At Client request, the second assembly was tested over 48 hours, rather than 30. Observation intervals were the same as the 30-Hour procedure detailed in WI-028 up through the 24-hour mark. Subsequent observations were made at 32 hours and 48 hours. Final swell and seepage measurements were made at the 48-hour mark. At Client request, a third assembly was constructed to be tested over 80 hours. Observation/measurement intervals were the same as for the 30-Hour procedure detailed in WI-028 up through the 24-hour mark. Subsequent observations were made at 32, 48, 56, 72 and 80 hours. Final swell and seepage measurements were made at the 80-hour mark. The test procedure overview presented on pp 5-6 of this report has been modified to reflect these deviations.

Overview of 30-hour Standing Water Test Procedure:

1. Blotting papers manufactured for scientific use were pre-conditioned in a test environment maintained at 23 +/- 3 degrees Celsius and 50% +/- 10% relative humidity (R.H.) for 48 hours. In addition, the flooring materials to be tested were pre-conditioned in the same environment for at least 48 hours prior to assembly and test.
2. At the end of the pre-conditioning period, the blotting papers were weighed to determine initial mass. The blotting papers were then assembled in a single layer on a table consisting of a flat, level clear acrylic test surface, the underside of which is marked with an 8-inch x 8-inch square grid.
3. The pre-conditioned flooring planks were then assembled into a panel on top of the layer of blotting papers. Plank assembly was completed according to the flooring manufacturer's assembly instructions. Flooring planks were used in sufficient quantity to achieve a final test panel measuring approximately 3 feet wide x 6 feet long. A combination of plank lengths (e.g., full-length and half-length) were used to ensure the end-seams of planks in adjacent rows were offset by at least 12 inches. Actual panel dimensions and the number of end seams were recorded.
4. A border of caulk was applied along the outer perimeter of the flooring panel top surface to form a dam to prevent water run-off from the sides or ends of the panel. The caulk was allowed to cure for at least 24 hours before starting the test.

5. One liter (1 L) of deionized water was allowed to reach a constant temperature of 23 +/- 3 deg. C. The deionized water was then colored using a dark blue dye and poured onto the flooring panel, taking reasonable care to distribute the water evenly across the panel surface.
6. Visual observations to include the approximate amount of water remaining on the panel surface and evidence of visible damage or other appearance changes to the flooring surface were made at the beginning of the test and again at various predetermined time intervals during the course of the test. In addition, the underside of the clear acrylic test surface was inspected for visible signs of water leakage through the flooring panel. The number of 8-inch x 8-inch squares that exhibited water leakage was recorded and photographs taken as needed to document the test observations.
7. At the end of the 30-hour test period, the top surface of the flooring panel was inspected and photographed. The underside of the clear acrylic test surface was also inspected for visible signs of water leakage through the flooring panel. The final number of 8-inch x 8-inch squares that exhibited water leakage was recorded. Photographs were taken as needed to document the final test observations.
8. A sufficient quantity of pre-conditioned blotting papers was placed in a container and weighed. The papers were then used to absorb all the water remaining on the top surface of the flooring panel, replaced in the container, and re-weighed. The difference in mass was determined to be the mass of the water remaining on the flooring panel at test end. Corresponding volume was calculated assuming a specific gravity of 1.00 for the water. Any deformations, blemishes, or other notable observations on the panel surface were recorded.
9. The flooring panel was dis-assembled. The blotting papers from beneath the flooring panel were then collected and re-weighed to determine the mass of water that had seeped through the plank seams to the underside of the flooring panel. The corresponding volume was calculated assuming a specific gravity of 1.00 for the water.
10. Water lost to absorption into the product or evaporation to the test environment was determined by subtracting the volume of water remaining on the panel surface and the volume of water underneath the flooring panel at test end from the original volume of water (1 Liter or 1,000 mL) applied to the panel surface at the start of the test.

Overview of 24/48/80* hour T-Seam Swell and Seepage Test (*per Client request, test conducted in 24-, 48- & 80-hour versions. See Note 3, Page 3 for details):

1. Blotting papers manufactured for scientific use were pre-conditioned in a test environment maintained at 23 +/- 3 degrees Celsius and 50% +/- 10% relative humidity (R.H.) for 48 hours. In addition, the flooring materials to be tested were pre-conditioned in the same environment for at least 48 hours prior to assembly and test.
2. Three flooring panels were assembled on a table comprised of a flat, level clear acrylic test surface. Each flooring panel measured at least 18 inches wide x 24 inches long and was constructed to contain two T-Seams positioned at least 12 inches apart. Four pre-weighed blotting papers were placed underneath each of the six T-Seams.
3. A PVC ring with an inner diameter of 3 inches was placed over the center of each of the T-Seams and sealed to the panel with caulk. The caulk was allowed to cure at least 24 hours prior to the start of test.
4. The initial height of each T-Seam was measured using a digital dial indicator affixed to a tripod. The locations of the tripod's feet were marked.
5. A sufficient volume of deionized water was allowed to reach a constant temperature of 23 +/- 3 deg. C. Four 50-mL aliquots were then measured and colored using a dark blue dye. Each of the 50 mL aliquots of dyed water was then poured into each of the sealed rings.

6. Visual observations to include the approximate amount of water remaining in each ring was made at the beginning of the test and again at various predetermined time intervals during the course of the test. Photographs were taken as needed to document the test observations.
7. In addition, the underside of the clear acrylic test surface was inspected for visible signs of water leakage through the flooring panel. In addition, any water observed to have traveled along a plank seam to re-emerge on the panel surface was removed using pre-weighed blotting papers. The saturated blotting papers were then re-weighed to determine the mass of leaked water. Corresponding volume was then calculated, assuming a specific gravity of 1.00.
8. At the end of 24 hours, a sufficient quantity of pre-conditioned blotting papers was placed in a container and weighed. The papers were then used to absorb all the water remaining in one of the T-seam rings, replaced in the container, and re-weighed. The difference in mass was determined to be the mass of the water remaining in the T-seam ring at test end. Corresponding volume was calculated assuming a specific gravity of 1.00 for the water. This procedure was repeated for the second T-seam ring on the panel.
9. T-Seam height was re-measured using the dial indicator. T-Seam swell was calculated as the difference between final and initial T-Seam heights.
10. The flooring panel was dis-assembled. The blotting papers located underneath each T-seam were re-weighed to determine the mass of water that had seeped through the T-seams to the underside of the assembly during the test period. Corresponding volume was then calculated, assuming a specific gravity of 1.00.
11. Steps 6 through 10 were repeated for the second and third flooring panels at the end of the 48-hour and 80-hour test periods, respectively.
12. Water lost to absorption into the product or evaporation to the test environment was determined for each T-seam tested by subtracting the volume of water remaining in the test ring and the volume of water underneath each T-seam at test end from the original volume of water (50 mL) poured into each ring at the start of the test.

Test specimen preparation and testing commenced on April 16, 2021 and was completed on April 29, 2021. All testing was completed by Benchmark International, LLC at its Eugene, Oregon test laboratory.

4) **SAMPLE CONDITIONING AND TEST ENVIRONMENT:**

30-Hour Standing Water Test and 24/48/80-Hour T-Seam Swell and Seepage Test: All flooring materials to be tested, and blotter papers and water to be used during testing were pre-conditioned to $23 \pm 3^{\circ}\text{C}$ and $50 \pm 10\%$ relative humidity for a period of at least 48 hours prior to assembly and test. All testing was conducted in an environment maintained at the same conditions.

ISO 24336 Laminate Flooring Thickness Swell Test: All materials to be tested were pre-conditioned to constant weight in an environment maintained at $23 \pm 3^{\circ}\text{C}$ and $50 \pm 10\%$ relative humidity.

5) TEST RESULTS:

a. ISO Thickness Swell Results:

Thickness Swell	
Specimen #	Thickness Swell (%)
1	2.6
2	2.2
3	3.3
4	1.9
Average	2.5

b. 24-Hour, 48-Hour and 80-Hour T-Seam Swell and Seepage Test Results:

Values

24 Hour Test Results						
"T-seam" No.	T-seam Swell (in)	Initial Water Mass (g)	Estimated Volume of Water Remaining in T-seam Ring After Test (mL)	Estimated Volume of Water Underneath Assembly After Test (mL)	Estimated Total Volume of Water Observed on Surface During Test (mL)	Estimated Total Volume of Water Absorbed or Lost During Test (mL)
1	0.005	50.00	34.68	0.00	0.00	15.32
2	0.002	50.00	33.57	0.00	0.00	16.43
Average	0.004	50.00	34.13	0.00	0.00	15.88

48 Hour Test Results						
"T-seam" No.	T-seam Swell (in)	Initial Water Mass (g)	Estimated Volume of Water Remaining in T-seam Ring After Test (mL)	Estimated Volume of Water Underneath Assembly After Test (mL)	Estimated Total Volume of Water Observed on Surface During Test (mL)	Estimated Total Volume of Water Absorbed or Lost During Test (mL)
1	0.003	50.00	15.22	0.00	0.00	34.78
2	0.004	50.00	13.19	0.00	0.00	36.81
Average	0.004	50.00	14.21	0.00	0.00	35.80

80 Hour Test Results						
"T-seam" No.	T-seam Swell (in)	Initial Water Mass (g)	Estimated Volume of Water Remaining in T-seam Ring After Test (mL)	Estimated Volume of Water Underneath Assembly After Test (mL)	Estimated Total Volume of Water Observed on Surface During Test (mL)	Estimated Total Volume of Water Absorbed or Lost During Test (mL)
1	0.007	50.01	0.00	0.00	0.00	50.01
2	0.001	50.01	0.00	0.00	0.00	50.01
Average	0.004	50.01	0.00	0.00	0.00	50.01



Time Specific Observations

24-Hour Assembly, T-seam 1					24-Hour Assembly, T-seam 2				
Observation Interval	Water Remaining in Ring	Estimated Vol. of Water Leaked onto Assembly Surface (mL)	Temp. (°C)	Relative Humidity (%)	Observation Interval	Water Remaining in Ring	Estimated Vol. of Water Leaked onto Assembly Surface (mL)	Temp. (°C)	Relative Humidity (%)
0h	More Than 50% of Original	N/A	22.9	51.6	0h	More Than 50% of Original	N/A	22.9	51.6
30m	More Than 50% of Original	0.00	22.1	53.6	30m	More Than 50% of Original	0.00	22.1	53.6
1h	More Than 50% of Original	0.00	22.0	54.6	1h	More Than 50% of Original	0.00	22.0	54.6
2h	More Than 50% of Original	0.00	22.6	54.6	2h	More Than 50% of Original	0.00	22.6	54.6
4h	More Than 50% of Original	0.00	22.2	55.6	4h	More Than 50% of Original	0.00	22.2	55.6
6h	More Than 50% of Original	0.00	22.8	47.6	6h	More Than 50% of Original	0.00	22.8	47.6
8h	More Than 50% of Original	0.00	22.9	47.6	8h	More Than 50% of Original	0.00	22.9	47.6
24h	More Than 50% of Original	0.00	22.6	48.6	24h	More Than 50% of Original	0.00	22.6	48.6

48-Hour Assembly, T-seam 1					48-Hour Assembly, T-seam 2				
Observation Interval	Water Remaining in Ring	Estimated Vol. of Water Leaked onto Assembly Surface (mL)	Temp. (°C)	Relative Humidity (%)	Observation Interval	Water Remaining in Ring	Estimated Vol. of Water Leaked onto Assembly Surface (mL)	Temp. (°C)	Relative Humidity (%)
0h	More Than 50% of Original	N/A	22.9	51.6	0h	More Than 50% of Original	N/A	22.9	51.6
30m	More Than 50% of Original	0.00	22.1	53.6	30m	More Than 50% of Original	0.00	22.1	53.6
1h	More Than 50% of Original	0.00	22.0	54.6	1h	More Than 50% of Original	0.00	22.0	54.6
2h	More Than 50% of Original	0.00	22.6	54.6	2h	More Than 50% of Original	0.00	22.6	54.6
4h	More Than 50% of Original	0.00	22.2	55.6	4h	More Than 50% of Original	0.00	22.2	55.6
6h	More Than 50% of Original	0.00	22.8	47.6	6h	More Than 50% of Original	0.00	22.8	47.6
8h	More Than 50% of Original	0.00	22.9	47.6	8h	More Than 50% of Original	0.00	22.9	47.6
24h	More Than 50% of Original	0.00	22.6	48.6	24h	More Than 50% of Original	0.00	22.6	48.6
32h	Less Than 50% of Original	0.00	22.5	47.6	32h	Less Than 50% of Original	0.00	22.5	47.6
48h	Less Than 50% of Original	0.00	22.6	47.6	48h	Less Than 50% of Original	0.00	22.8	47.6

80-Hour Assembly, T-seam 1					80-Hour Assembly, T-seam 2				
Observation Interval	Water Remaining in Ring	Estimated Vol. of Water Leaked onto Assembly Surface (mL)	Temp. (°C)	Relative Humidity (%)	Observation Interval	Water Remaining in Ring	Estimated Vol. of Water Leaked onto Assembly Surface (mL)	Temp. (°C)	Relative Humidity (%)
0h	More Than 50% of Original	N/A	22.9	51.6	0h	More Than 50% of Original	N/A	22.9	51.6
30m	More Than 50% of Original	0.00	22.1	53.6	30m	More Than 50% of Original	0.00	22.1	53.6
1h	More Than 50% of Original	0.00	22.0	54.6	1h	More Than 50% of Original	0.00	22.0	54.6
2h	More Than 50% of Original	0.00	22.6	54.6	2h	More Than 50% of Original	0.00	22.6	54.6
4h	More Than 50% of Original	0.00	22.2	55.6	4h	More Than 50% of Original	0.00	22.2	55.6
6h	More Than 50% of Original	0.00	22.8	47.6	6h	More Than 50% of Original	0.00	22.8	47.6
8h	More Than 50% of Original	0.00	22.9	47.6	8h	More Than 50% of Original	0.00	22.9	47.6
24h	More Than 50% of Original	0.00	22.6	48.6	24h	More Than 50% of Original	0.00	22.6	48.6
32h	Less Than 50% of Original	0.00	22.5	47.6	32h	Less Than 50% of Original	0.00	22.5	47.6
48h	Less Than 50% of Original	0.00	22.6	47.6	48h	Less Than 50% of Original	0.00	22.6	47.6
56h	Less Than 50% of Original	0.00	22.3	49.6	56h	Less Than 50% of Original	0.00	22.3	49.6
72h	Less Than 50% of Original	0.00	22.3	47.6	72h	Less Than 50% of Original	0.00	22.3	47.6
80h	0% of Original	0.00	22.8	47.6	80h	0% of Original	0.00	22.8	47.6

c. 30-Hour Standing Water Test Results:

Values

Approximate Assembly Dimensions (in)	Number of End Seams in Assembly	Initial Water Mass (g)	30-hour Residual Surface Water (mL)	30-hour Panel Seepage (mL)	30-hour Volume of Water Absorbed/Lost (mL)
72 x 35	5	996.80	0.78	0.00	996.02

Time Specific Observations

Time	Temp. (°C)	Relative Humidity (%)	Remaining Water	Number of Grids Showing Seepage	Comments
0h	22.9	51.6	More than 50% of original	0	(see photos)
0.5h	22.1	53.6	More than 50% of original	0	(see photos)
1h	22.0	54.6	More than 50% of original	0	(see photos)
2h	22.6	54.6	More than 50% of original	0	(see photos)
4h	22.2	55.6	More than 50% of original	0	(see photos)
6h	22.8	47.6	More than 50% of original	0	(see photos)
8h	22.9	47.6	More than 50% of original	0	(see photos)
24h	22.6	48.6	Less than 50% of original	0	(see photos)
30h	22.3	48.6	Less than 50% of original	0	(see photos)

6) PHOTOGRAPHS:



Figure 1: 30-Hour Standing Water Test Assembly prior to addition of water



Figure 2: 30-Hour Standing Water Test Assembly at commencement of test period



Figure 3: 30-Hour Standing Water Test Assembly at the 30-minute mark



Figure 4: 30-Hour Standing Water Test Assembly at the one-hour mark



Figure 5: 30-Hour Standing Water Test Assembly at the two-hour mark



Figure 6: 30-Hour Standing Water Test Assembly at the four-hour mark



Figure 7: 30-Hour Standing Water Test Assembly at the six-hour mark



Figure 8: 30-Hour Standing Water Test Assembly at the eight-hour mark



Figure 9: 30-Hour Standing Water Test Assembly at the 24-hour mark



Figure 10: 30-Hour Standing Water Assembly at the 30-hour mark

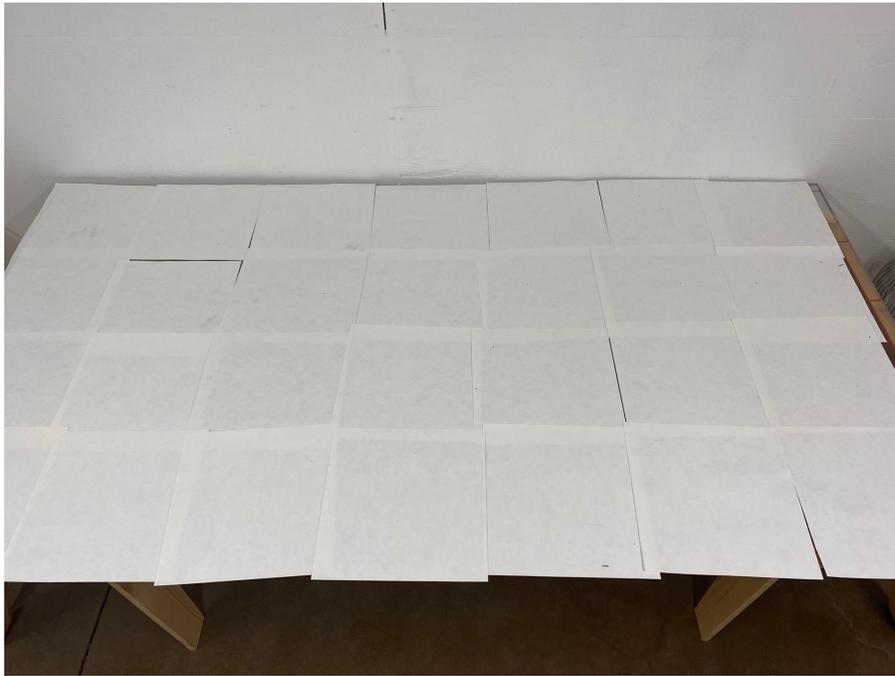


Figure 11: 30-Hour Standing Water Test blotter papers at endpoint



Figure 12: 24-Hour T-Seam at commencement of test



Figure 13: 24-Hour T-Seam at 30-minute mark





Figure 14: 24-Hour T-Seam at one-hour mark



Figure 15: 24-Hour T-Seam at two-hour mark



Figure 16: 24-Hour T-Seam at four-hour mark



Figure 17: 24-Hour T-Seam at six-hour mark



Figure 18: 24-Hour T-Seam at eight-hour mark



Figure 19: 24-Hour T-Seam at 24-hour mark



Figure 20: Blotter papers, 24-Hour T-Seam, at endpoint



Figure 21: 48-Hour T-Seam at commencement of test



Figure 22: 48-Hour T-Seam at 30-minute mark



Figure 23: 48-Hour T-Seam at one-hour mark



Figure 24: 48-Hour T-Seam at two-hour mark



Figure 25: 48-Hour T-Seam at four-hour mark



Figure 26: 48-Hour T-Seam at six-hour mark



Figure 27: 48-Hour T-Seam at eight-hour mark



Figure 28: 48-Hour T-Seam at 24-hour mark

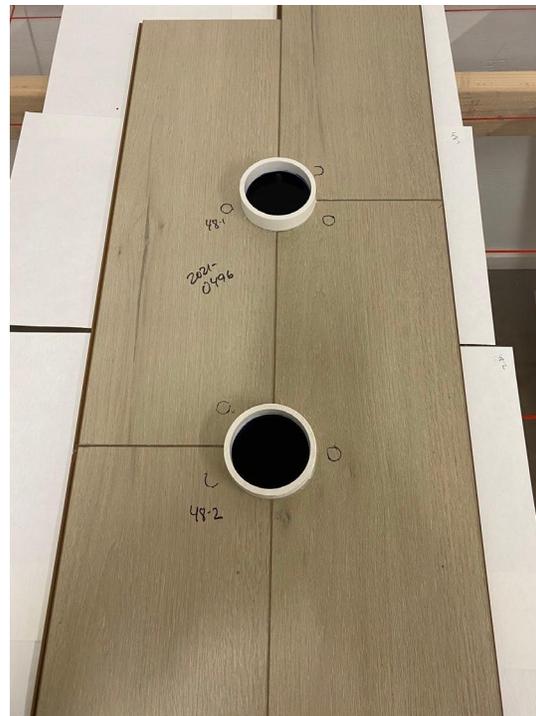


Figure 29: 48-Hour T-Seam at 48-hour mark

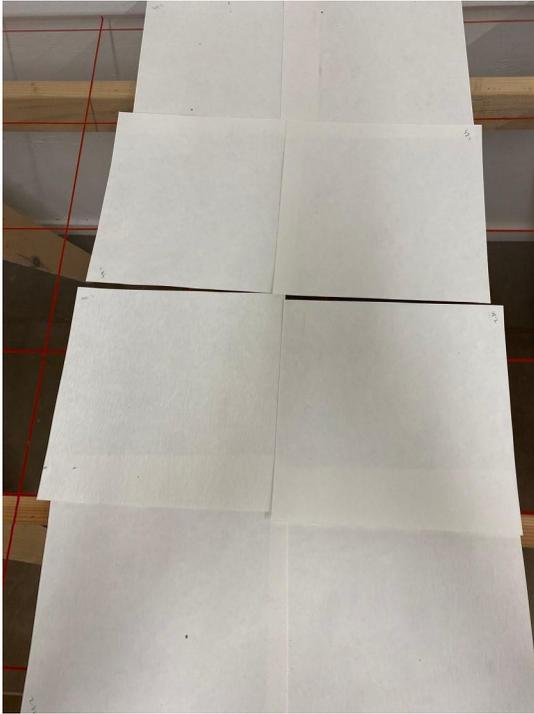


Figure 30: Blotter papers, 48-Hour T-Seam, at endpoint



Figure 31: 80-Hour T-Seam at commencement of test



Figure 32: 80-Hour T-Seam at 30-minute mark



Figure 33: 80-Hour T-Seam at one-hour mark



Figure 34: 80-Hour T-Seam at two-hour mark



Figure 35: 80-Hour T-Seam at four-hour mark



Figure 36: 80-Hour T-Seam at six-hour mark



Figure 37: 80-Hour T-Seam at eight-hour mark



Figure 38: 80-Hour T-Seam at 24-hour mark



Figure 39: 80-Hour T-Seam at 48-hour mark



Figure 40: 80-Hour T-Seam at 72-hour mark

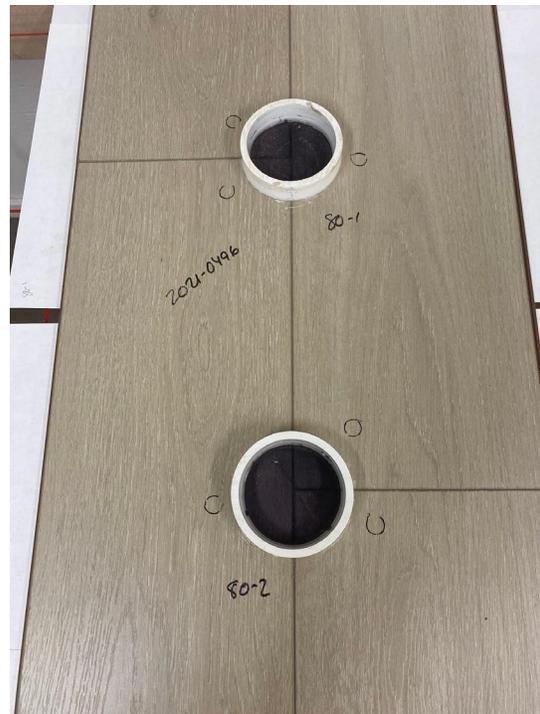


Figure 41: 80-Hour T-Seam at 80-hour mark

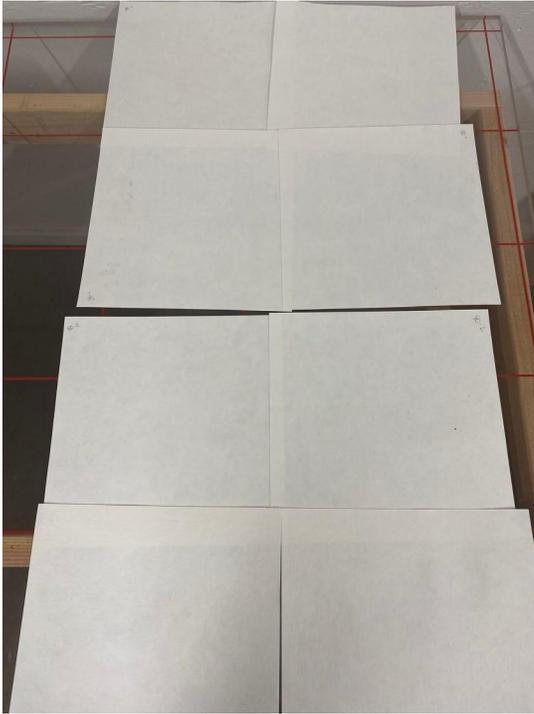


Figure 42: Blotter papers, 80-Hour T-Seam, at endpoint

7) SUMMARY:

T-seam swelling averaged 0.004 in. (~0.01mm), with individual measurements ranging from 0.002 in. (~0.03mm) up to 0.007 in. (~0.18mm). No water leaked out of any T-seam ring and onto the flooring assembly surface, and no water leaked through the T-seams to the underside. The 24h and 48h T-seams held water for the entirety of the test periods. The water in the 80h T-seams had evaporated or been absorbed by the 80h mark.

For the 30-Hour Standing Water test, more than 50% of the original quantity of water remained on the panel surface through the 8-hour mark, while a small amount (<1mL) of water remained on the surface at the 30-hour mark (the conclusion of the test). No water was observed to have leaked.

Thickness swell test specimens had an average of 2.5% thickness swell.

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Test results, to include professional opinions, interpretations, or judgments made if any, apply only to the specific product(s) and the lot(s)/batch(es) evaluated and identified in this test report. Report users must not represent test results in a manner so as to state or imply the test results may be applied to other product(s) or lot(s)/batch(es) that were not specifically included in the test evaluation.

Services performed for this project have been conducted with a level of care and skill ordinarily exercised by members of the profession currently practicing in this area under similar conditions and constraints. No warranty, expressed or implied, is made.

Respectfully Submitted,



Aaron Malsch
Laboratory Manager
Benchmark International, LLC (BMI)

TEST REPORT VERSION HISTORY

Version:	Change Summary:	Reviewed/Approved by:	Date Approved:
0	Initial Release	Aaron Malsch	May 31, 2021

END OF REPORT