

TEST REPORT

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EVALUATION CENTER

INTERTEK TESTING SERVICES NA LTD.
1500 BRIGANTINE DRIVE
COQUITLAM, BC V3K 7C1

RENDERED TO

LINERLOCK INC.
1509 E. MCFADDEN AVENUE
SANTA ANA, CA
92705
USA

PRODUCT EVALUATED: LL 110 RU
EVALUATION PROPERTY: Physical Properties

Report of LL 110 RU Roofing Underlayment for compliance with the testing requirements of the following criteria: CAN/CSA A220.1 Series-06, Concrete Roof Tiles, revised May 2010

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2 Introduction

Intertek Testing Services NA Ltd. (Intertek) has conducted a testing evaluation for LinerLock Inc. on an engineered roofing underlayment product identified as LL 110 RU. The evaluation was carried out to determine if the material would comply with Section 4.4 of CAN/CSA A220.1 Series-06, *Concrete Roof Tiles*, revised May 2010, as a roll underlayment over solid sheathing. This evaluation was completed during the month(s) of November 2012 to January 2013.

3 Test Samples

3.1. SAMPLE SELECTION

Intertek representative, Fred Soto, randomly sampled rolls of roofing underlayment on November 2, 2012. The sample selection process was conducted at LinerLock, Inc., 1509 E. McFadden Avenue, Santa Ana, CA, 92705. The product was selected in accordance with recognized independent sampling procedures, and was received at the Evaluation Center on November 9, 2012.

3.2. SAMPLE AND ASSEMBLY DESCRIPTION

The sample was identified as the LL 110 RU, a 3-layer constructed synthetic roofing underlayment (Coquitlam ID# VAN1211090741-001). The product consists of a cross-woven polypropylene base scrim and is coated with an anti-slip coating on both sides. The weight is 2.2 lbs/100 ft² (3.3 oz/yd² or 105 g/m²) and standard roll size is 4 ft x 250 ft long (1.2 m x 76.2 m).

4 Testing and Evaluation Methods

4.1. CONDITIONING

All specimens were cut to the required dimensions using a straight edge and a sharp blade. Before testing, the test specimen materials were held in standard laboratory conditions for at least 24 hours at a temperature of 23 ± 2°C and relative humidity of 50 ± 5%.

4.2. WATER PERMEABILITY

The water permeability was conducted in accordance with Section 4.4.6.3 of CAN/CSA A220.1 Series-06, *Concrete Roof Tiles*. Five 100 mm × 130 mm specimens were cut and sealed onto the bottom of a plastic frame to give it a watertight seal. A 55 mm head of water was maintained on the specimen throughout the test. The sample was monitored every hour for the first 8 hours and after 24 hours for signs of water dripping. Specimens were tested in the “as received” condition, after ultraviolet exposure and after ultraviolet exposure followed by accelerated aging.

4.3. TENSILE STRENGTH

Tensile strength was conducted in accordance with Section 4.4.6.4 of CAN/CSA A220.1 Series-06, *Concrete Roof Tiles* and ASTM D828-97 (Reapproved 2002), *Standard Test Method for*

Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus. Five 25 mm x 230 mm specimens were cut in the roll direction and five in the cross roll direction. The testing was conducted using an Instron 3382 Universal Tester with an initial jaw separation of 180 mm and a crosshead speed of 25 mm per minute. Specimens were tested in the “as received” condition, after ultraviolet exposure and after ultraviolet exposure followed by accelerated aging.

4.4. PLIABILITY

Pliability was tested in accordance with Section 4.4.6.5 of CAN/CSA A220.1 Series-06, *Concrete Roof Tiles*. Five 25 mm x 200 mm specimens were cut in the machine direction. They were placed in an -18°C cold chamber for 24 hours prior to being bent over a 3 mm diameter steel mandrel through a 90° angle within 2 seconds. Each specimen was visually examined for signs of cracking or delamination. The samples were then put back in the cold chamber for 90 hours and bent over a 3 mm diameter steel mandrel through a 180° angle within two seconds and again each specimen was visually examined for signs of cracking or delamination. Specimens were tested in the “as received” condition, after ultraviolet exposure and after ultraviolet exposure followed by accelerated aging.

4.5. PUNCTURE RESISTANCE

The puncture resistance was sent to an external facility for evaluation. Three 250 mm x 250 mm specimens were cut with the orientation of the specimen being noted. The test was conducted in accordance with TAPPI Standard T803-06. A full report is included in Appendix B.

4.6. LONG-TERM SAG

The long-term sag was tested in accordance with Section 4.4.6.7 of CAN/CSA A220.1 Series-06, *Concrete Roof Tiles*. A 300 mm x 1200 mm specimen was cut from the middle of a 450 mm x 1200 mm sample. The specimen was placed over three 50 mm nominal width rafters spaced at 600 ± 5 mm on center with the ends of the specimen nailed to the outmost rafters at a temperature of 38 ± 3°C. A 450 ± 10 g sand bag was placed at the center of each span. The initial sag at the center of each span was recorded and after 48 ± 0.25 h, the sag at the same locations was recorded again.

4.7. LINEAR DIMENSIONAL CHANGES

Tests for linear dimensional stability were conducted in accordance with ASTM D1204-08, *Standard Test Method for Linear Dimensional Changes of Non-rigid Thermoplastic Sheeting or Film at Elevated Temperatures*. Two pieces of the underlayment measuring 250 mm x 250 mm were cut, one from either edge and the other from the center of the sheet. The specimens were dusted with talc, placed in between two pieces of paper, then stored in oven at 85°C ± 1°C for 24h. After the oven exposure period, the specimens were reconditioned as per Section 4.1. The linear dimensional change was derived by the difference between the opposite edges of the specimens. The linear dimensional change was calculated as follows:

$$\text{Linear change, \%} = [(D_f - D_o) / D_o] \times 100$$

where: D_f = final length (or width) of specimen after test, mm
 D_o = original length (or width) of specimen, mm

4.8. MOISTURE VAPOUR TRANSMISSION RATE

The water vapour transmission was determined as per ASTM E96-05, *Standard Test Methods for Water Vapour Transmission of Materials*, desiccant method. Four circular specimens of the material were prepared for testing. Three test dishes measuring 229 mm (9 in.) in diameter were filled with calcium chloride to within 6.4 mm (¼-in.) of the top. The circular specimens were then attached to the top of each dish by sealing the perimeter of the material to the dish with a molten wax blend. The specimens were prepared with the product exterior surface placed face up. An additional control specimen was prepared in an identical manner to the other three test specimens with the exception that no calcium chloride was placed in the dish. The four assemblies were placed in a controlled chamber operating at a temperature and relative humidity of 23°C and 50% respectively. The assemblies were then weighed periodically until 8 (eight) data points were obtained. The water-vapor transmission was calculated as follows:

$$WVT = G/tA$$

where: WVT = rate of water vapor transmission, g/m²s
G = weight change, g
t = time during which G occurred
A = test area, m²

4.9. ULTRAVIOLET EXPOSURE

Two 450 mm × 1200 mm specimens were prepared and exposed to ultraviolet sun lamps for 10 ± 0.2 hours a day for 21 days (210 ± 1 hour) as per Section 4.4.5.2 of CAN/CSA A220.1 Series-06, *Concrete Roof Tiles*. The lamps and enclosure were adjusted to maintain the specimens at a product temperature of between 55 and 60°C. Visual examination of the specimens was conducted after ultraviolet exposure for any evidence of surface or structural changes. One of the samples was then subjected to accelerated aging.

4.10. ACCELERATED AGING

Following UV exposure, one 450 mm × 1200 mm specimen was subjected to 25 cycles of accelerated aging in accordance with the procedure described in Section 4.4.5.3 of CAN/CSA A220.1 Series-06, *Concrete Roof Tiles*. During weekends and holidays, the accelerated aging process was suspended by holding the specimens in standard laboratory conditions. The cycling consists of oven drying for 3 hours, immersion in water for 3 hours, and then air-drying for a minimum of 18 hours. Visual examination of the specimen was made after accelerated aging for any evidence of surface or structural changes.

5 Testing and Evaluation Results

5.1. EXAMINATION OF RESULTS


The product test results, together with the applicable requirements of Table 1a, *Underlayment Performance Requirements (For Use Throughout Canada)* of CAN/CSA A220.1 Series-06, revised August 2008 are shown in Table 1 below (a full set of test data is included in Appendix A).

| Table 1. CAN/CSA A220.1-06 Physical Properties – LL 110 RU | | | |
|--|-------------|-------------|-----------|
| Property (Roll Underlayment) | Test Result | Requirement | Pass/Fail |
| Water Permeability | | | |
| • As Received | No dripping | No dripping | Pass |
| • After Ultraviolet Aging | No dripping | No dripping | Pass |
| • After Ultraviolet and Accelerated Aging | No dripping | No dripping | Pass |
| Tensile Strength, kN/m | | | |
| • As Received | | | |
| ○ Machine Direction | 13.4 | 3.5 min. | Pass |
| ○ Cross – Machine Direction | 6.8 | 3.5 min. | Pass |
| • After Ultraviolet Aging | | | |
| ○ Machine Direction | 13.0 | 3.5 min. | Pass |
| ○ Cross – Machine Direction | 12.9 | 3.5 min. | Pass |
| • After Ultraviolet and Accelerated Aging | | | |
| ○ Machine Direction | 11.8 | 3.5 min. | Pass |
| ○ Cross – Machine Direction | 10.2 | 3.5 min. | Pass |
| Pliability | | | |
| • As Received | No cracking | No cracking | Pass |
| • After Ultraviolet Aging | No cracking | No cracking | Pass |
| • After Ultraviolet and Accelerated Aging | No cracking | No cracking | Pass |
| Puncture Resistance, J | | | |
| • As Received | 8.9 | ≥ 0.34 | Pass |
| • After Ultraviolet Aging | 8.0 | ≥ 0.34 | Pass |
| • After Ultraviolet and Accelerated Aging | 8.5 | ≥ 0.34 | Pass |
| Long-term Sag, % | 1 | ≤ 5 | Pass |
| Linear Dimensional Change, % | | | |
| • Length | 2.6 | ≤ 3 | Pass |
| • Width | 2.9 | ≤ 3 | Pass |
| Moisture Vapour Transmission, g/m ² -24 h | 0.31 | < 70 | Pass |

6 Conclusion

The LL 110 RU Underlayment product identified and evaluated in this report has met the physical requirements of Section 4.4 of CAN/CSA A220.1 Series-06, *Concrete Roof Tiles*, revised August 2008 for use throughout Canada as presented in Section 5 of this report.

INTERTEK TESTING SERVICES NA LTD.

Tested/Reported by: 
Chris Chang, EIT
Engineer, Building Products

Reviewed by: 
Baldeep Sandhu, AScT
Technologist, Building Products

APPENDIX A: Test Data (12 pages)



| | | | |
|--------------|-------------------|----------------|--------------------------|
| Company | LinerLock Inc. | Technician(s) | Geru Nishio <i>GN</i> |
| Project No. | G100944599 | Reviewer | Baldeep Sandhu <i>BS</i> |
| Models | N/A | Start/End Date | Nov. 2012 - Jan.2012 |
| Product Name | LL 110 RU | Sample ID | VAN1211090741-001 |
| Standard | CAN/CSA A220.1-06 | | |

Test Data Package

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Test: **Water Permeability**
Date: 15-Nov-12
Client: LinerLock
Project: G100944599
Eng/Tech: G. Nishio *GN*
Reviewer: B. Sandhu *BSS*
Product: **LL 110 RU**
Test Method: CAN/CSA A220.1
Exposure: As Received, after Ultraviolet Light and after UV followed by Accelerated Aging
Ambient: 21°C, 50% RH, 07:59
Conditioning: Min 40 hrs @ 21±2°C and 50% RH
Equipment: Permeability test jigs with 60mm wall ht.
Sample size: 100mm x 130mm

| Test Pressure | As Received | | | | |
|---------------|-------------|---------|---------|---------|---------|
| (mm of water) | 1 | 2 | 3 | 4 | 5 |
| 55 | No Drip | No Drip | No Drip | No Drip | No Drip |

| Test Pressure | After Ultraviolet Light | | | | |
|---------------|-------------------------|---------|---------|---------|---------|
| (mm of water) | 1 | 2 | 3 | 4 | 5 |
| 55 | No Drip | No Drip | No Drip | No Drip | No Drip |

| Test Pressure | After UV followed by Accelerated Aging | | | | |
|---------------|--|---------|---------|---------|---------|
| (mm of water) | 1 | 2 | 3 | 4 | 5 |
| 55 | No Drip | No Drip | No Drip | No Drip | No Drip |



Test: **Tensile Testing**
 Date: 13-Nov-12
 Client: LinerLock
 Project: G100944599
 Eng/Tech: G. Nishio *GN*
 Reviewer: B. Sandhu *BS*
 Product: **LL 110 RU**
 Test Method(s): CAN/CSA A220.1
 Exposure: **As Received**
 Ambient: 12:26 PM/ 21.7°C/ 49 %RH
 Conditioning: 24 hours at a temperature of 23 ± 2°C and relative humidity of 50 ± 5%
 Equipment: Instron 3382 loading apparatus (Intertek ID# P60553, cal due July 2013)
 Mitutoyo Digital Calipers (Intertek ID# P52652, cal due May 2013)
 Sample size: 1"x10"
 Gauge Length: 180 mm
 Crosshead Speed: 25.4 mm/min

| <i>Machine direction</i> | | | | |
|--------------------------|-----------|--------------|---------------|----------------|
| Specimen | Width (m) | Max Load (N) | Max Load (kN) | Brk Str (kN/m) |
| 1 | 0.025 | 333.95 | 0.334 | 13.1 |
| 2 | 0.025 | 342.70 | 0.343 | 13.5 |
| 3 | 0.025 | 338.78 | 0.339 | 13.3 |
| 4 | 0.025 | 348.27 | 0.348 | 13.7 |
| 5 | 0.025 | 332.85 | 0.333 | 13.1 |
| Mean: | | 339.3 | 0.339 | 13.4 |
| StdDev: | | 6.4 | 0.0 | 0.3 |
| COV: | | 1.88% | 1.88% | 1.88% |

| <i>Cross-machine direction</i> | | | | |
|--------------------------------|-----------|--------------|---------------|----------------|
| Specimen | Width (m) | Max Load (N) | Max Load (kN) | Brk Str (kN/m) |
| 1 | 0.025 | 163.63 | 0.164 | 6.4 |
| 2 | 0.025 | 168.39 | 0.168 | 6.6 |
| 3 | 0.025 | 161.84 | 0.162 | 6.4 |
| 4 | 0.025 | 182.19 | 0.182 | 7.2 |
| 5 | 0.025 | 184.10 | 0.184 | 7.2 |
| Mean: | | 172.0 | 0.172 | 6.8 |
| StdDev: | | 10.4 | 0.0 | 0.4 |
| COV: | | 6.07% | 6.07% | 6.07% |



Test: **Tensile Testing**
 Date: 13-Dec-12
 Client: LinerLock
 Project: G100944599
 Eng/Tech: G. Nishio *GN*
 Reviewer: B. Sandhu *BSS*
 Product: **LL 110 RU**
 Test Method(s): CAN/CSA A220.1
 Exposure: **After 21d UV exposure**
 Ambient: 21.6°C, 48% RH, 2:41 PM
 Conditioning: 24 hours at a temperature of 23 ± 2°C and relative humidity of 50 ± 5%
 Equipment: Instron 3382 loading apparatus (Intertek ID# P60553, cal due July 2013)
 Mitutoyo Digital Calipers (Intertek ID# P52652, cal due May 2013)
 Sample size: 1"x10"
 Gauge Length: 180 mm
 Crosshead Speed: 25.4 mm/min
 Tested:

| <i>Machine direction</i> | | | | |
|--------------------------|-----------|--------------|---------------|----------------|
| Specimen | Width (m) | Max Load (N) | Max Load (kN) | Brk Str (kN/m) |
| 1 | 0.025 | 340.1 | 0.340 | 13.4 |
| 2 | 0.025 | 343.2 | 0.343 | 13.5 |
| 3 | 0.025 | 325.3 | 0.325 | 12.8 |
| 4 | 0.025 | 329.0 | 0.329 | 13.0 |
| 5 | 0.025 | 318.8 | 0.319 | 12.6 |
| Mean: | | 331.3 | 0.331 | 13.0 |
| StdDev: | | 10.2 | 0.0 | 0.4 |
| COV: | | 3.08% | 3.08% | 3.08% |

| <i>Cross-machine direction</i> | | | | |
|--------------------------------|-----------|--------------|---------------|----------------|
| Specimen | Width (m) | Max Load (N) | Max Load (kN) | Brk Str (kN/m) |
| 1 | 0.025 | 321.1 | 0.321 | 12.6 |
| 2 | 0.025 | 323.5 | 0.324 | 12.7 |
| 3 | 0.025 | 328.8 | 0.329 | 12.9 |
| 4 | 0.025 | 338.3 | 0.338 | 13.3 |
| 5 | 0.025 | 327.9 | 0.328 | 12.9 |
| Mean: | | 327.9 | 0.328 | 12.9 |
| StdDev: | | 6.6 | 0.0 | 0.3 |
| COV: | | 2.02% | 2.02% | 2.02% |



Test: **Tensile Testing**
 Date: 18-Jan-13
 Client: LinerLock
 Project: G100944599
 Eng/Tech: G. Nishio *GN*
 Reviewer: B. Sandhu *BS*
 Product: **LL 110 RU**
 Test Method(s): CAN/CSA A220.1
 Exposure: **After 21d UV exposure and 25 cycles of accelerated aging**
 Ambient: 22.1°, 48% RH, 12:37 PM
 Conditioning: 24 hours at a temperature of 23 ± 2°C and relative humidity of 50 ± 5%
 Equipment: Instron 3382 loading apparatus (Intertek ID# P60553, cal due July 2013)
 Mitutoyo Digital Calipers (Intertek ID# P52652, cal due May 2013)
 Sample size: 1"x10"
 Gauge Length: 180 mm
 Crosshead Speed: 25.4 mm/min
 Tested: 12:37PM/ 22.1°C/48.2%RH

| <i>As Received in machine direction</i> | | | | |
|---|-----------|--------------|---------------|----------------|
| Specimen | Width (m) | Max Load (N) | Max Load (kN) | Brk Str (kN/m) |
| 1 | 0.025 | 307.1 | 0.307 | 12.1 |
| 2 | 0.025 | 317.6 | 0.318 | 12.5 |
| 3 | 0.025 | 334.1 | 0.334 | 13.2 |
| 4 | 0.025 | 296.5 | 0.297 | 11.7 |
| 5 | 0.025 | 237.9 | 0.238 | 9.4 |
| Mean: | | 298.6 | 0.299 | 11.8 |
| StdDev: | | 36.7 | 0.0 | 1.4 |
| COV: | | 12.28% | 12.28% | 12.28% |

| <i>As Received in cross-machine direction</i> | | | | |
|---|-----------|--------------|---------------|----------------|
| Specimen | Width (m) | Max Load (N) | Max Load (kN) | Brk Str (kN/m) |
| 1 | 0.025 | 239.3 | 0.239 | 9.4 |
| 2 | 0.025 | 246.0 | 0.246 | 9.7 |
| 3 | 0.025 | 273.8 | 0.274 | 10.8 |
| 4 | 0.025 | 278.0 | 0.278 | 10.9 |
| 5 | 0.025 | 256.5 | 0.256 | 10.1 |
| Mean: | | 258.7 | 0.259 | 10.2 |
| StdDev: | | 16.9 | 0.0 | 0.7 |
| COV: | | 6.54% | 6.54% | 6.54% |



Test: **Pliability**
 Date: 15-Nov-12
 Client: LinerLock
 Project: G100944599
 Eng./Tech: G. Nishio *44*
 Reviewer: B. Sandhu *BS*
 Product: **LL 110 RU**
 Test method: CAN/CSA A220.1
 Exposure: 24 hrs @ -18 ± 2°C followed by 90 hrs @ -18 ± 2°C
 Ambient: 23.4°C, 47% RH, 08:15,
 Equipment: Cold Temperature Chamber
 Fluke Thermometer (Intertek ID# 51295, cal due Feb 8, 2013)
 3mm mandrel and test jig
 Samp size: 1 in. x 8 ins. (25mm x 200mm)
 Test Temp: 0°F (-18°C)
 Test Method: Samples conditioned at -18°C for 24 hours before testing
 Samples bent 90° around 1/8 inch mandrel in 2 s at -18°C
 Sample then maintained at -18°C for 90 hours
 Samples bent 180° around 1/8 inch mandrel in 2 s at -18°C

As Received

| Testing | Date: | Status |
|----------------------|---------|--------|
| After 24 hrs @ -18°C | Nov. 13 | Pass |
| After 90 hrs @ -18°C | Nov. 17 | Pass |

Sample Roll I - Machine Direction

| Specimen | Sample Orientation | Observations | |
|----------|--------------------|-----------------------------|------|
| 1 | Weathering side up | no cracking or delamination | Pass |
| 2 | Weathering side up | no cracking or delamination | Pass |
| 3 | Weathering side up | no cracking or delamination | Pass |
| 4 | Weathering side up | no cracking or delamination | Pass |
| 5 | Weathering side up | no cracking or delamination | Pass |

After UV Exposure

| Testing | Date: | Status |
|----------------------|---------|--------|
| After 24 hrs @ -18°C | Dec. 13 | Pass |
| After 90 hrs @ -18°C | Dec. 17 | Pass |

Sample Roll I - Machine Direction

| Specimen | Sample Orientation | Observations | |
|----------|--------------------|-----------------------------|------|
| 1 | Weathering side up | no cracking or delamination | Pass |
| 2 | Weathering side up | no cracking or delamination | Pass |
| 3 | Weathering side up | no cracking or delamination | Pass |
| 4 | Weathering side up | no cracking or delamination | Pass |
| 5 | Weathering side up | no cracking or delamination | Pass |

After UV Exp . Followed by Acc. Aging

| Testing | Date: | Status |
|----------------------|--------|--------|
| After 24 hrs @ -18°C | Jan.21 | Pass |
| After 90 hrs @ -18°C | Jan.25 | Pass |

Sample Roll I - Machine Direction

| Specimen | Sample Orientation | Observations | |
|----------|--------------------|-----------------------------|------|
| 1 | Weathering side up | no cracking or delamination | Pass |
| 2 | Weathering side up | no cracking or delamination | Pass |
| 3 | Weathering side up | no cracking or delamination | Pass |
| 4 | Weathering side up | no cracking or delamination | Pass |
| 5 | Weathering side up | no cracking or delamination | Pass |



Test: **Long - Term Sag**
Date: 14-Nov-12
Client: LinerLock
Project No: **G100944599**
Technician(s): G. Nishio *GN*
Reviewer: B. Sandhu *BS*
Product: **LL 110 RU**
Test Methods: CAN/CSA A220.1
Exposure: 48 hrs in enclosed chamber with 4 100W incandescent light bulbs
Ambient: 22.3°C, 48% RH, 10:05
Conditioning: 24 hours at a temperature of 23 ± 2°C and relative humidity of 50 ± 5%
Equipment: Mitutoyo Digital Calipers (Intertek ID# P52652, cal due May 2013)
Fluke Thermometer (Intertek ID# D2679, cal due May, 2013)

Sample size: 300mm x 1200mm

| Span | Initial Height (mm) | Height after 48 hours (mm) | Final Sag (%) |
|------|------------------------|----------------------------------|------------------|
| 1 | 317 | 315 | 0.6 |
| 2 | 314 | 311 | 1.0 |
| | | Mean: | 0.8 |
| | | StdDev: | 0.23 |
| | | COV: | 28.93% |



Test: **Dimensional change**
 Date: 14-Nov-12
 Client: LinerLock
 Project No: G100944599
 Technician(s): G. Nishio *GN*
 Reviewer: B. Sandhu *BSS*
 Product: **LL 110 RU**
 Method: CAN/CSA A220.1
 Exposure: **24 hour @ 85 ± 1°C, followed by a minimum of 1 hr at 23°C and 50% RH.**
 Ambient: 21.9°C, 48% RH, 10:30
 Conditioning: not less than 40 hours at a temperature of 23 ± 2°C and relative humidity of 50 ± 5%
 Equipment: Mitutoyo Digital Calipers (ID P53639, cal due November 2013)
 Temperature-controlled oven (ID 9-0477)
 Graphtec MIDI Logger (Intertek ID# P60555, cal due August 2013)
 Specimen Size: 250 x250 mm

| Initial Measurement | | |
|-------------------------|---------------|---------------|
| Specimen | Length (mm) | Width (mm) |
| 1 | 249.82 | 249.92 |
| 2 | 249.48 | 249.69 |
| After Exposure - 24 hrs | | |
| Specimen | Length (mm) | Width (mm) |
| 1 | 242.81 | 242.47 |
| 2 | 243.32 | 242.86 |
| Dimensional Stability | | |
| Specimen | Length (%) | Width (%) |
| | 24 hrs | 24 hrs |
| 1 | -2.81% | -2.98% |
| 2 | -2.47% | -2.74% |
| Mean: | -2.64% | -2.86% |
| StdDev: | 0.0 | 0.0 |

*Note: Negative value- shrinkage
 Postive value- expansion



Test: **Water Vapor Transmission**
 Date: 14-Nov-12
 Client: Linerlock
 Product: **LL 110 RU**
 Test Methods: ASTM E96/E96M-10, *Test Method for Water Vapour Transmission of Materials*
 Test Procedure: **Method A (Dessicant Method)**
 Conditioning: 24 hours at a temperature of 23 ± 2°C and relative humidity of 50 ± 2%
 Equipment: Setra Balance 2000g (Intertek ID# P52606, cal due February 2013)
 Test Chamber (Intertek ID# 9-0473)
 Digital Calipers (Intertek ID# P60005, cal due May 2013)
 Digital Anemometer (Intertek ID# P60000, cal due December 2012)
 T&D Thermorecorder TR72Ui (Intertek ID# P60554, cal due August 2013)

Project: G100944599
 Eng/Tech: Chris Chang
 Reviewer: Baldeep Sandhu

| Measurement | Specimen | | |
|--|----------|----------|----------|
| | 1 | 2 | 3 |
| Mean Barometric Pressure (kPa) | 101.53 | 101.53 | 101.53 |
| Mean Air Temperature (°C) | 21.3 | 21.3 | 21.3 |
| Mean Saturation Vapour Pressure ¹ (Pa) | 2575 | 2575 | 2575 |
| Mean Relative Humidity in chamber (%) | 52.3 | 52.3 | 52.3 |
| Relative Humidity in test dish (%) | 0 | 0 | 0 |
| Specimen Weight Change (g) | 0.151 | 0.211 | 0.202 |
| Moisture Gain of Dessicant (%) | 0 | 0 | 0 |
| Moisture Gain Control Limit (%) | 10 | 10 | 10 |
| Effective Test Dish Diameter (mm) | 230.0 | 230.0 | 230.0 |
| Effective Test Area (m ²) | 4.15E-02 | 4.15E-02 | 4.15E-02 |
| Gradient of weight/time graph (g/hour) | 4.31E-04 | 5.83E-04 | 5.87E-04 |
| Specimen Mean Thickness (mm) | 0.14 | 0.13 | 0.14 |
| Uncorrected Water Transmission (g/hour.m ²) | 1.04E-02 | 1.40E-02 | 1.41E-02 |
| Uncorrected Water Permeance (ng/Pa.s.m ²) | 2.14E+00 | 2.90E+00 | 2.92E+00 |
| Permeability of Still Air (ng/Pa.s.m) | 1.94E+02 | 1.94E+02 | 1.94E+02 |
| Permeance of Still Air (ng/Pa.s.m ²) | 3.03E+04 | 3.03E+04 | 3.03E+04 |
| Vapor Resistance of Still Air (m ² .s.Pa/kg) | 3.30E+07 | 3.30E+07 | 3.30E+07 |
| Surface Resistances (m ² .s.Pa./kg) | 4.00E+07 | 4.00E+07 | 4.00E+07 |
| Total Still Air and Specimen Surface (m ² .s.Pa/kg) | 7.30E+07 | 7.30E+07 | 7.30E+07 |
| Four Times Test Area Divided By Perimeter (m) | 2.30E-01 | 2.30E-01 | 2.30E-01 |
| Excess Water Transmission Due to Mask (%) | 0.05 | 0.05 | 0.05 |
| Excess Water Permeance Due to Mask (ng/Pa.s.m ²) | 1.15E-03 | 1.47E-03 | 1.54E-03 |
| Mask-corrected Water Permeance (ng/Pa.s.m ²) | 2.14E+00 | 2.90E+00 | 2.92E+00 |
| Water Vapour Transmission (g/hour.m ²) | 1.04E-02 | 1.40E-02 | 1.41E-02 |
| Water Vapour Permeance (ng/Pa.s.m ²) | 2.14E+00 | 2.90E+00 | 2.92E+00 |
| Water Vapour Permeability (ng/Pa.s.m) | 3.00E-04 | 3.84E-04 | 4.01E-04 |

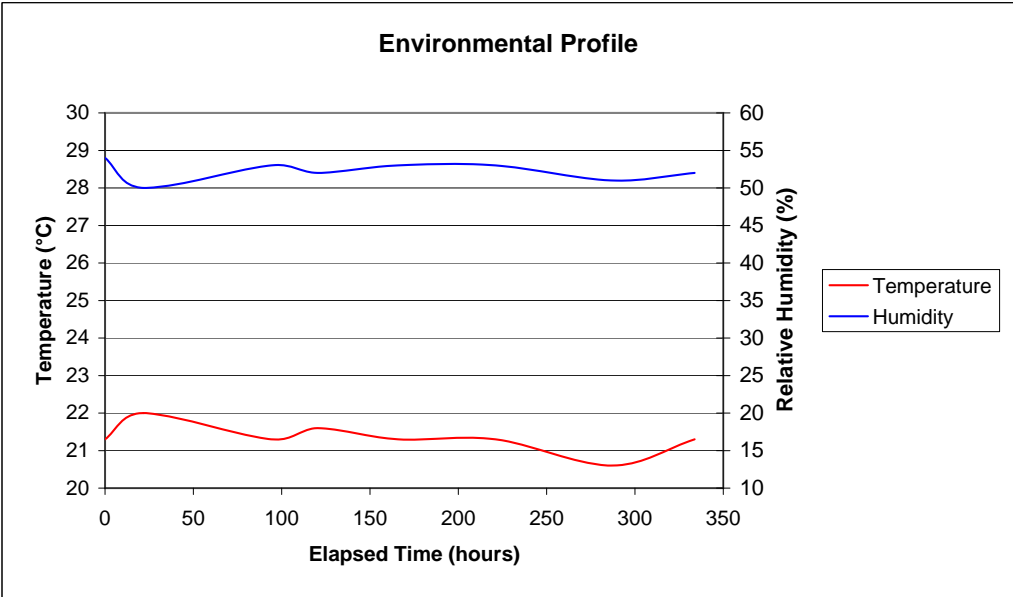
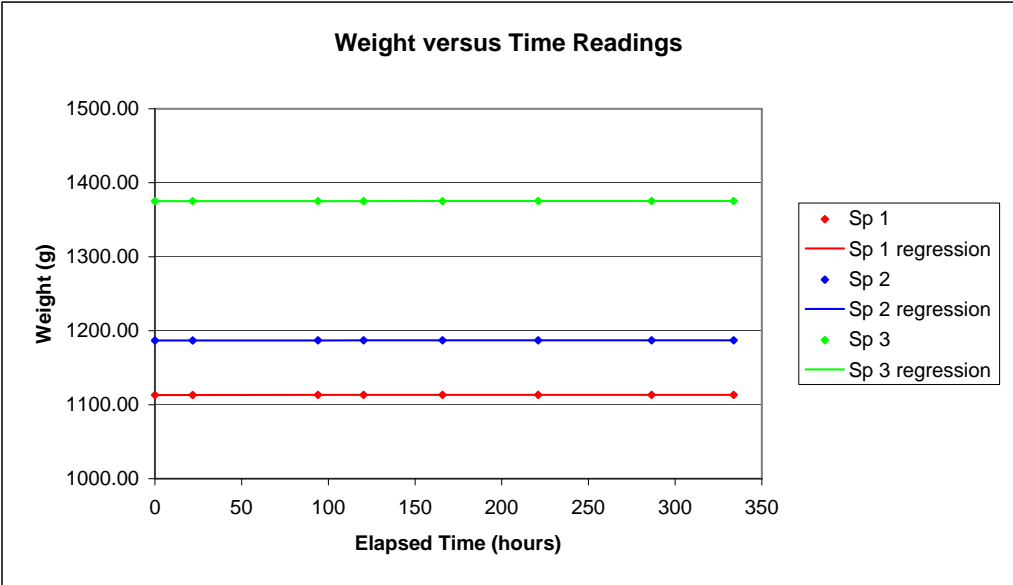
¹Estimated by the Clausius-Clapeyron equation

| Test Result Summary | Metric units | Imperial Units |
|--------------------------|---------------------------------|-----------------------------------|
| Water Vapor Transmission | 1.28E-02 g/hr.m ² | 1.84E-02 grns/hr.ft ² |
| | 3.08E-01 g/day.m ² | 4.41E-01 grns/day.ft ² |
| Water Vapor Permeance | 2.65E+00 ng/Pa.s.m ² | 4.64E-02 perms |
| Water Vapor Permeability | 3.62E-04 ng/Pa.s.m | 2.49E-04 Perm inch |



Test: **Water Vapor Transmission**
Date: 14-Nov-12
Client: Linerlock
Product: **LL 110 RU**
Test Methods: ASTM E96/E96M-10, *Test Method for Water Vapour Transmission of Materials*
Test Procedure: **Method A (Dessicant Method)**
Conditioning: 24 hours at a temperature of $23 \pm 2^\circ\text{C}$ and relative humidity of $50 \pm 2\%$
Equipment: Setra Balance 2000g (Intertek ID# P52606, cal due February 2013)
Test Chamber (Intertek ID# 9-0473)
Digital Calipers (Intertek ID# P60005, cal due May 2013)
Digital Anemometer (Intertek ID# P60000, cal due December 2012)
T&D Thermorecorder TR72Ui (Intertek ID# P60554, cal due August 2013)

Project: G100944599
Eng/Tech: Chris Chang
Reviewer: Baldeep Sandhu *BSS*





Test: **Ultraviolet Exposure-21d**
 Date: 19-Nov-12
 Client: LinerLock
 Project: G100944599
 Eng./Tech: G. Nishio *GN*
 Reviewr: B. Sandhu *BS*
 Product: **LL 110 RU**
 Test Method: CAN/CSA A220.1
 Exposure: Ultraviolet light produced by four Osram 300 watt Ultra Vitalux UV lamps, 10 hours per day for 21
 Specimen Temp: 131-140°F (55-60°C)
 Equipment: Ultraviolet light chamber
 Fluke Thermometer (Intertek ID# D2679, cal due May, 2013)

| Date | Day | UV lamps on | UV lamps off |
|-------------------|-----|-------------|--------------|
| November 19, 2012 | 1 | 8:00 AM | 6:00 PM |
| November 20, 2012 | 2 | 8:00 AM | 6:00 PM |
| November 21, 2012 | 3 | 8:00 AM | 6:00 PM |
| November 22, 2012 | 4 | 8:00 AM | 6:00 PM |
| November 23, 2012 | 5 | 8:00 AM | 6:00 PM |
| November 24, 2012 | 6 | 8:00 AM | 6:00 PM |
| November 25, 2012 | 7 | 8:00 AM | 6:00 PM |
| November 26, 2012 | 8 | 8:00 AM | 6:00 PM |
| November 27, 2012 | 9 | 8:00 AM | 6:00 PM |
| November 28, 2012 | 10 | 8:00 AM | 6:00 PM |
| November 29, 2012 | 11 | 8:00 AM | 6:00 PM |
| November 30, 2012 | 12 | 8:00 AM | 6:00 PM |
| December 1, 2012 | 13 | 8:00 AM | 6:00 PM |
| December 2, 2012 | 14 | 8:00 AM | 6:00 PM |
| December 3, 2012 | 15 | 8:00 AM | 6:00 PM |
| December 4, 2012 | 16 | 8:00 AM | 6:00 PM |
| December 5, 2012 | 17 | 8:00 AM | 6:00 PM |
| December 6, 2012 | 18 | 8:00 AM | 6:00 PM |
| December 7, 2012 | 19 | 8:00 AM | 6:00 PM |
| December 8, 2012 | 20 | 8:00 AM | 6:00 PM |
| December 9, 2012 | 21 | 8:00 AM | 6:00 PM |

Comments: No visible damage to the specimens after ultraviolet conditioning.



Test: **Accelerated Aging**
 Date: 11-Dec-12
 Client: LinerLock
 Project: G100944599
 Eng./Tech: Geri Nishio *GN*
 B. Sandhu *BS*
 Product: **LL 110 RU**
 Exposure: **After 21d UV**
 Test Standard(s): CAN/CSA A220.1
 Equipment: Temperature Controlled Oven (Intertek ID C-04585)
 Water bath
 Graphtec MIDI Logger (Intertek ID# P60555, cal due August 2013)
 Exposure cycle: Oven drying at a temperature of 50 ± 2°C for 3 hours
 Water immersion at a temperature of 23 ± 2°C for 3 hours
 Air drying at a temperature and RH of 23 ± 2°C and 50 ± 5% respectively for 12 hours min.

| Date | Cycle | Air Drying | Oven Drying | | Immersion in water | | Air Drying |
|-------------------|-------|------------|-------------|----------|--------------------|---------|------------|
| | | Out | In | Out | In | Out | In |
| December 11, 2012 | 1 | | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| December 12, 2012 | 2 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| December 13, 2012 | 3 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| December 14, 2012 | 4 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| December 15, 2012 | 5 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| December 17, 2012 | 6 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| December 18, 2012 | 7 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| December 19, 2012 | 8 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| December 20, 2012 | 9 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| December 21, 2012 | 10 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| January 2, 2013 | 11 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| January 3, 2013 | 12 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| January 4, 2013 | 13 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| January 5, 2013 | 14 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| January 6, 2013 | 15 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| January 7, 2013 | 16 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| January 8, 2013 | 17 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| January 9, 2013 | 18 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| January 10, 2013 | 19 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| January 11, 2013 | 20 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| January 14, 2013 | 21 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| January 15, 2013 | 22 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| January 16, 2013 | 23 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| January 17, 2013 | 24 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |
| January 18, 2013 | 25 | 7:30 AM | 7:30 AM | 10:30 AM | 10:30 AM | 1:30 PM | 1:30 PM |

Comments: No visible damage to the specimens after accelerated aging.

APPENDIX B: Beach Puncture Test Report (2 pages)



Intertek Testing Services NA Ltd

1500 Brigantine Drive
Coquitlam, British Columbia
Canada

Attn: Baldeep Sandhu

| | |
|------------------------------------|------------------------------|
| Test Report No: 3044807PP01 | Date: 23 January 2013 |
|------------------------------------|------------------------------|

SAMPLE(S) SUBMITTED

BY THE CLIENT AS: Three (3) lots of Roof Underlayment Material, three (3) samples each, identified as: As Received, After 21 d. UV, and After 21 d. UV + Acc. Aging.

DATE OF RECEIPT: 21 January 2013.

TEST PERIOD: 23 January 2013.

TEST(S) REQUESTED: The materials were tested in Cross-Machine Direction for Puncture Resistance in accordance with TAPPI T-803 (Beach Puncture).

Prior to actual testing, the samples were exposed to a controlled atmosphere maintained at 73° F - 50% RH for 24 hours.

TEST RESULTS: See Page 2.

PREPARED BY:

**DIMITAR DIMOV, PH. D.
SR. PROJECT ENGINEER**

dd

**SIGNED FOR AND ON BEHALF OF
SGS NORTH AMERICA INC.:**

**JASON SHERRIER, CPLP
LAB. MANAGER, PACKAGING&MATERIALS**

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TEST RESULTS

Test: **PUNCTURE RESISTANCE (BEACH PUNCTURE METHOD), TAPPI T-803**

| Material: | (Joules) | | |
|-------------|-------------|----------------|--------------------------------|
| | AS RECEIVED | AFTER 21 D. UV | AFTER 21 D. UV + ACC. AGING |
| | 9.27 | 7.18 | 7.03 |
| | 8.22 | 9.12 | 9.72 |
| | <u>9.27</u> | <u>7.62</u> | <u>8.67</u> |
| Avg. | 8.92 | 7.97 | 8.47 |

We trust the results and will prove useful and informative. Should you have any questions, please feel free to contact us.

END OF REPORT