



2013 - 2014 BROAD SAMPLING

TPO TEST PROGRAM

EXECUTIVE SUMMARY

Purpose of Testing

Determine heat aging and UV resistance levels of white 060 TPO in production from four major manufacturers in 2013 - 2014 to include Carlisle, Firestone, GAF and Johns Manville. In addition, testing of lamination strength between cap and base is to be checked as well as total thickness and thickness over scrim variation across roll width; typically 10 foot rolls were procured.

Test Method

Generally the ASTM D6878 – 11a guidelines were followed for heat aging, lamination strength, accelerated weathering and thickness over scrim. Specific detail of each test sequence used is as follows:

1. Heat Aging - used ASTM D573 with test run at 275°F (135°C); weight change was monitored to 0.001 gram accuracy during heat aging of 2" x 6" samples. Cracks were checked by mandrel bend over a 3 inch diameter solid round section. Days to cracking was monitored concurrent with weight loss; cracks were checked for using 7x magnification.
2. Lamination strength was checked using ASTM D 1876 (T-Peel).
3. Thickness of sheet overall was checked using ASTM D751.
4. Thickness of coating over scrim followed the ASTM D7635 method.
5. Accelerated Weathering – samples were exposed to fluorescent UV light (QUV) per ASTM G154, using UVA 340 lamps with a 700 minute light cycle followed by 20 minute water spray. Exposure was 30,240 kJ/(m²·nm).
6. Samples were also weighed and heat aged after QUV testing per Item 1 above.

Sampling Method

Five (5) rolls of white 060 TPO per plant were to be procured by SRI from the market or distribution. The date of manufacture was to be different for each roll procured. The total number of plants included 2 each for Carlisle, Firestone and GAF; Johns Manville has one plant.

In addition to standard white 060 TPO, the test sampling included rolls of GAF Extreme White 050 and 060 rolls, each with a different date of manufacture. The TPO membrane procured for this test totaled 45 rolls broken out as follows:

10 Rolls Carlisle White 060 TPO
10 Rolls Firestone White 060 TPO
10 Rolls GAF Standard White 060 TPO
5 Rolls GAF Extreme 50
5 Rolls GAF Extreme 60
5 Rolls Johns Manville White 060 TPO

Additional rolls of some TPO materials were received as a broad approach was used to procure individual product. However, the testing protocol used was that the first five rolls of any specific TPO product received were to be used in the comparative testing reported herein.

Summary of Heat Aging and QUV Exposure

Heat aging oven time ran from February 25, 2014 to January 28, 2015. The QUV exposure to the 30,240 kJ level ran from February 11, 2014 to October 28, 2014 followed by up to 84 days of heat aging for some of the samples.

Sampling of Results

The geographical locations of white 050 and 060 TPO roll samples procured, date of manufacture, tables, charts and graphs containing test results are given below. The roll thickness profile shown is a sampling of the data.

Page 3 – TPO roll sample geographic source areas and date of manufacture summary

Page 4 - Sample of roll thickness profiles

Page 5– Thickness over scrim and T peel laminate strength summary

Page 6 – Heat aging/weight loss curves for Products # 1 and # 2

Page 7 – Heat aging/weight loss curves for Products # 3 and # 4

Page 8 – Heat aging/weight loss curves for Products # 5 and # 6

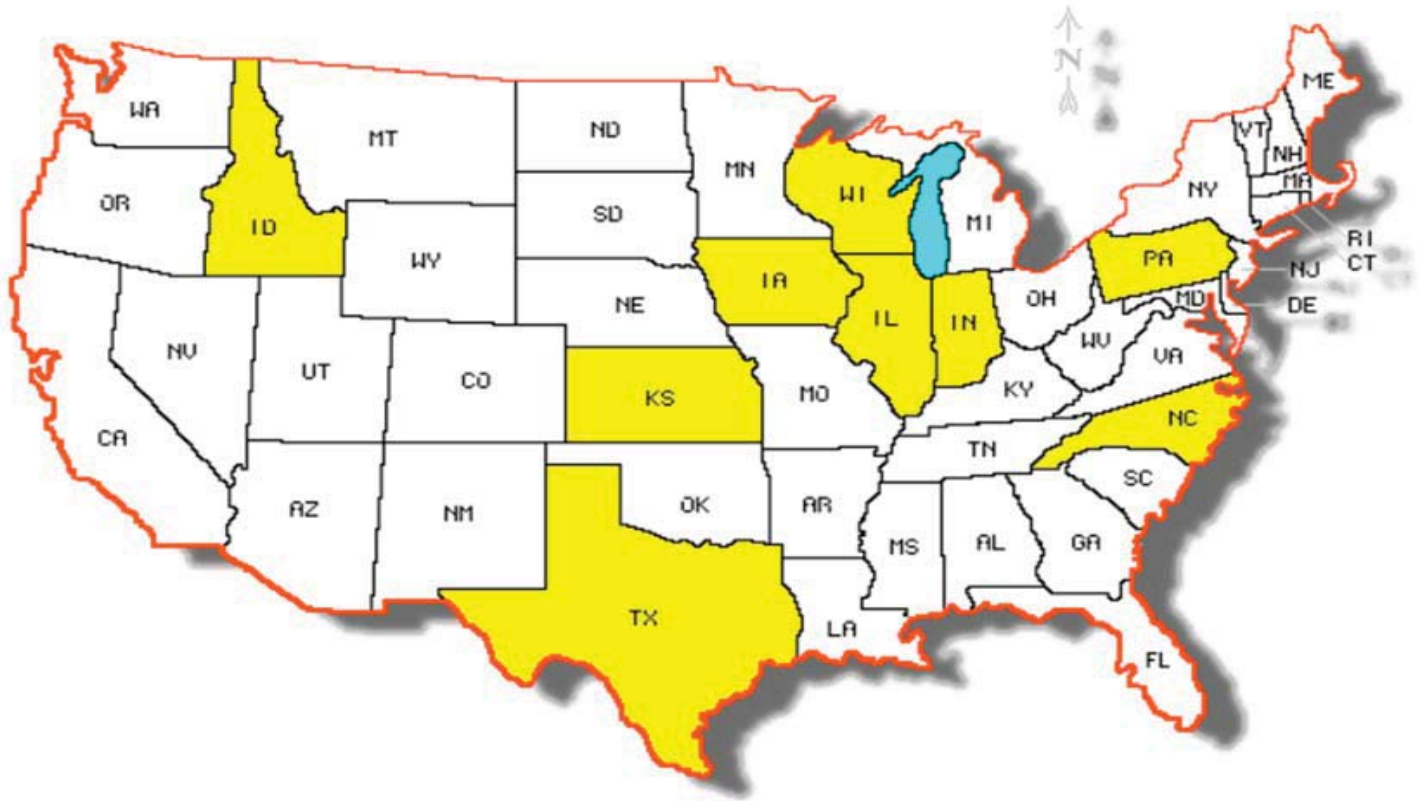
Page 9 – Heat aging days to first crack and heat aging days to first crack or greater than 1.5 % weight loss charts

Page 10 – QUV results plus heat aging QUV sample chart showing average days to cracking after QUV with average weight loss

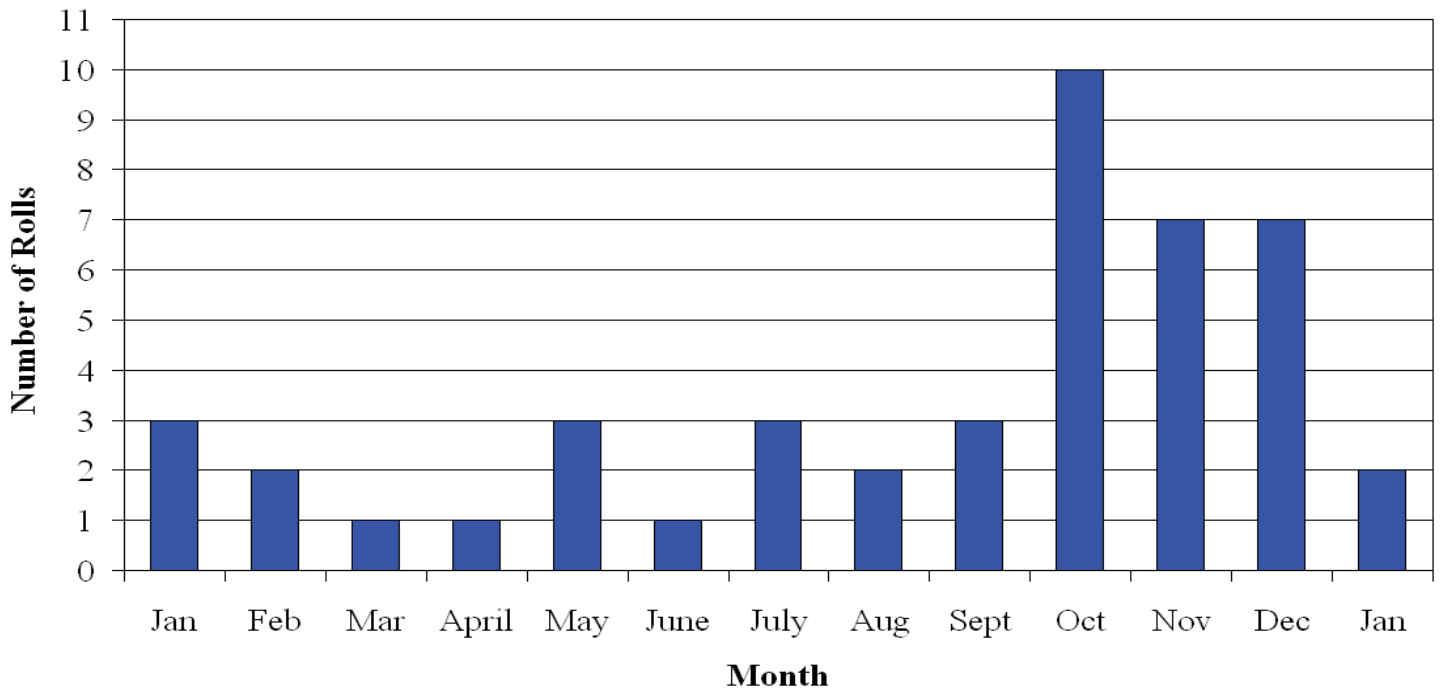
Page 11 – Reporting key



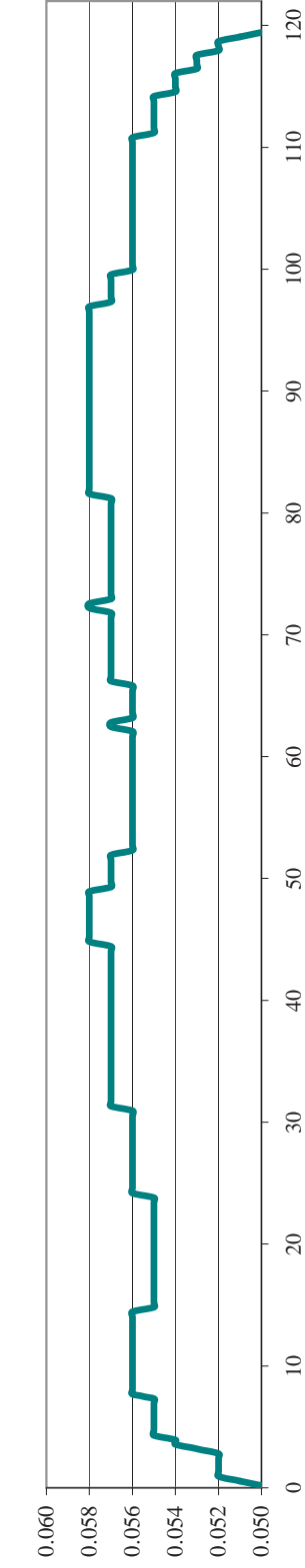
TPO Roll Sample Source Areas



Month TPO Roll Manufactured Jan 2013 to Jan 2014



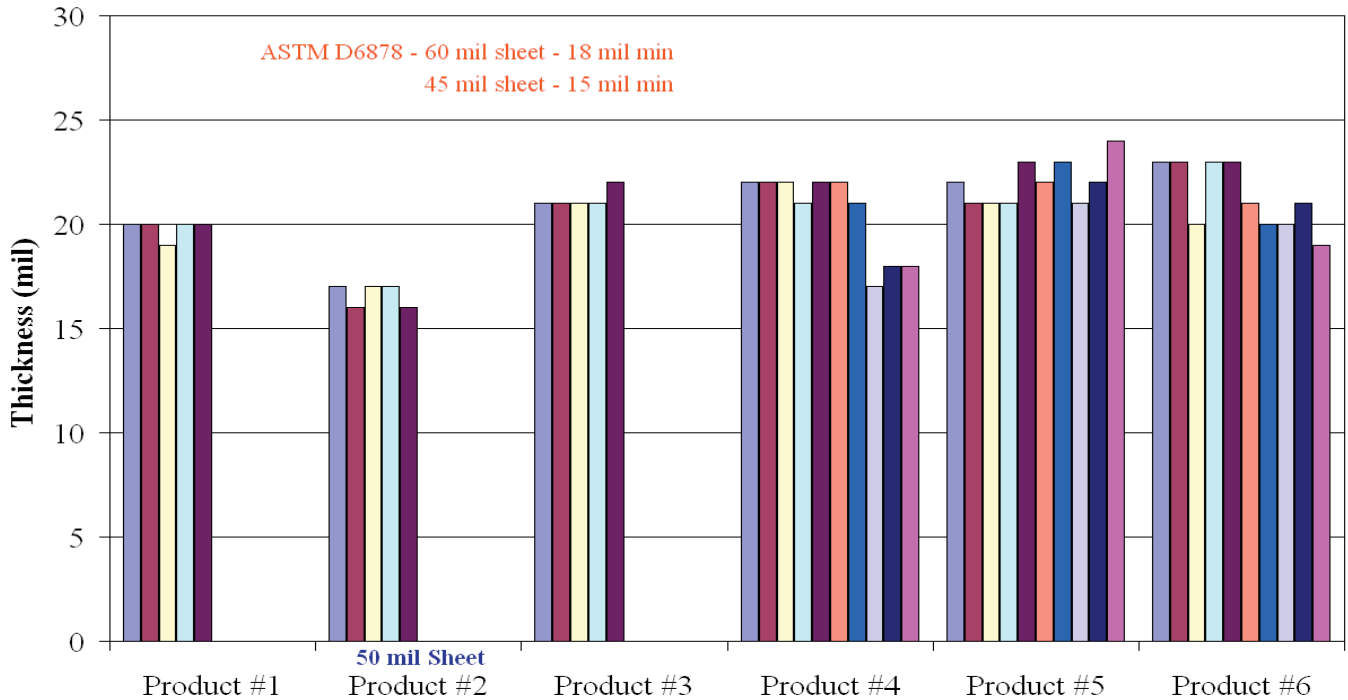
Example of Roll Thickness Profile (Cross-Machine Direction), inches



TPO Product Number 4
 Average value, in 0.056
 Minimum reading, in 0.050
 Maximum reading, in 0.058
 Number of Readings 319
 Gauge deadweight, oz 6
 Gauge pressure foot \emptyset , in 0.375



Thickness over Scrim



ASTM D1876 - 08
Standard Test Method for
Peel Resistance of Adhesives (T-Peel Test)

Test Speed: 10 inches/minute (Rate of Separation: 5 inches/minute)

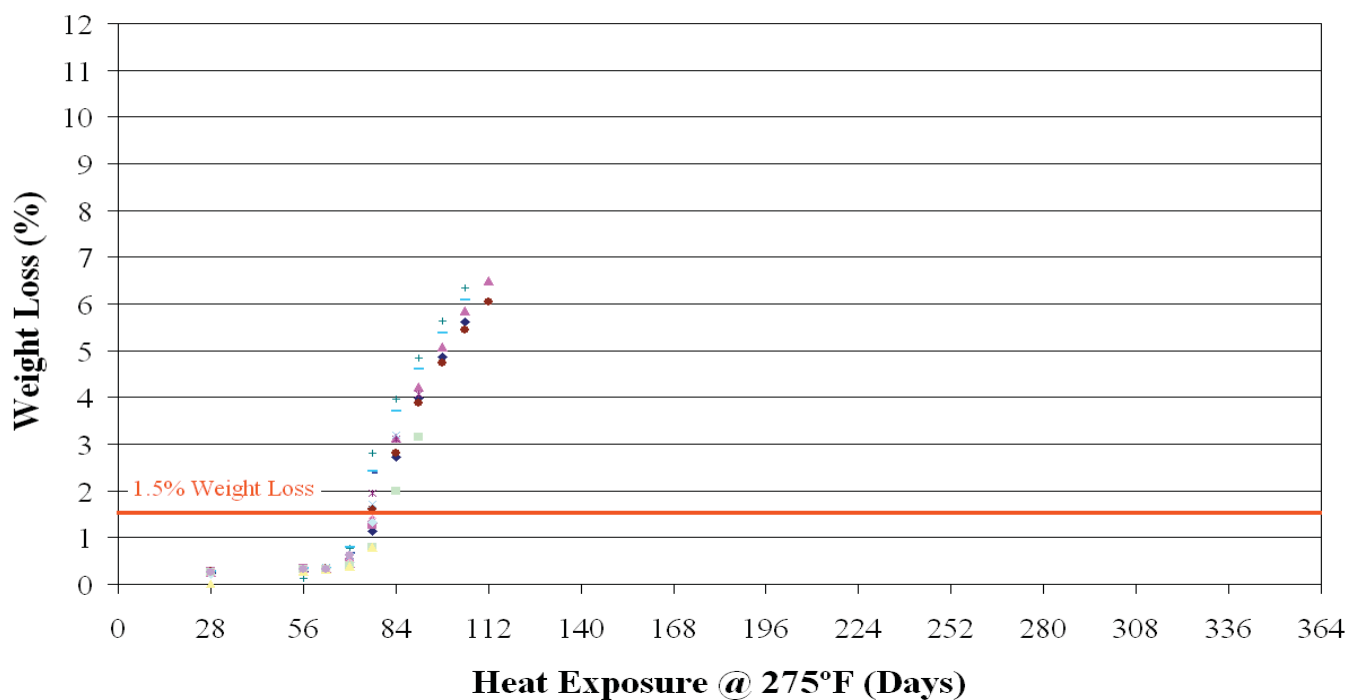
Conditioned and Tested @ 73.4 ± 3.6°F & 50 ± 5% RH

Strike-Through Peel Strength

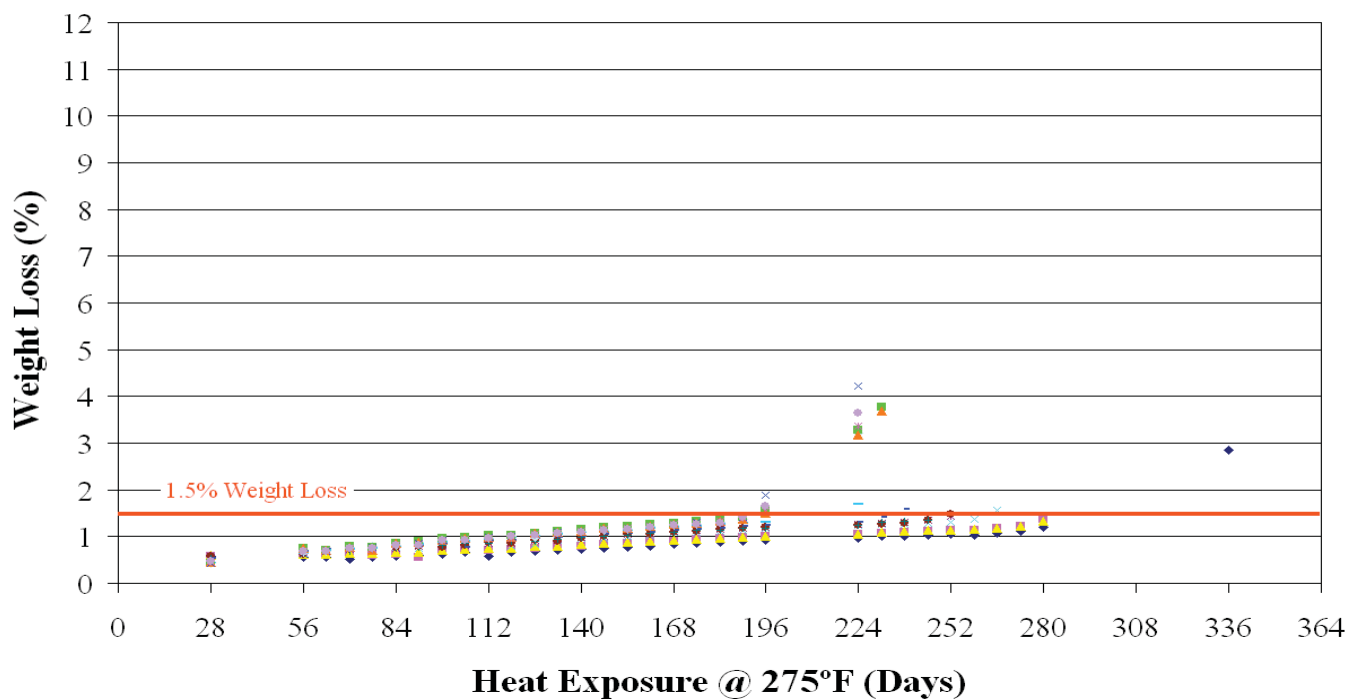
Product Number	Weld Location	Strength (lbf/in)
1	Exposed Edge	39.9
2	Exposed Edge	43.0
3	Exposed Edge	38.0
4A	Exposed Edge	38.8
4B	Exposed Edge	33.1
5A	Exposed Edge	45.9
5B	Exposed Edge	51.3
6A	Exposed Edge	29.3
6B	Exposed Edge	40.4



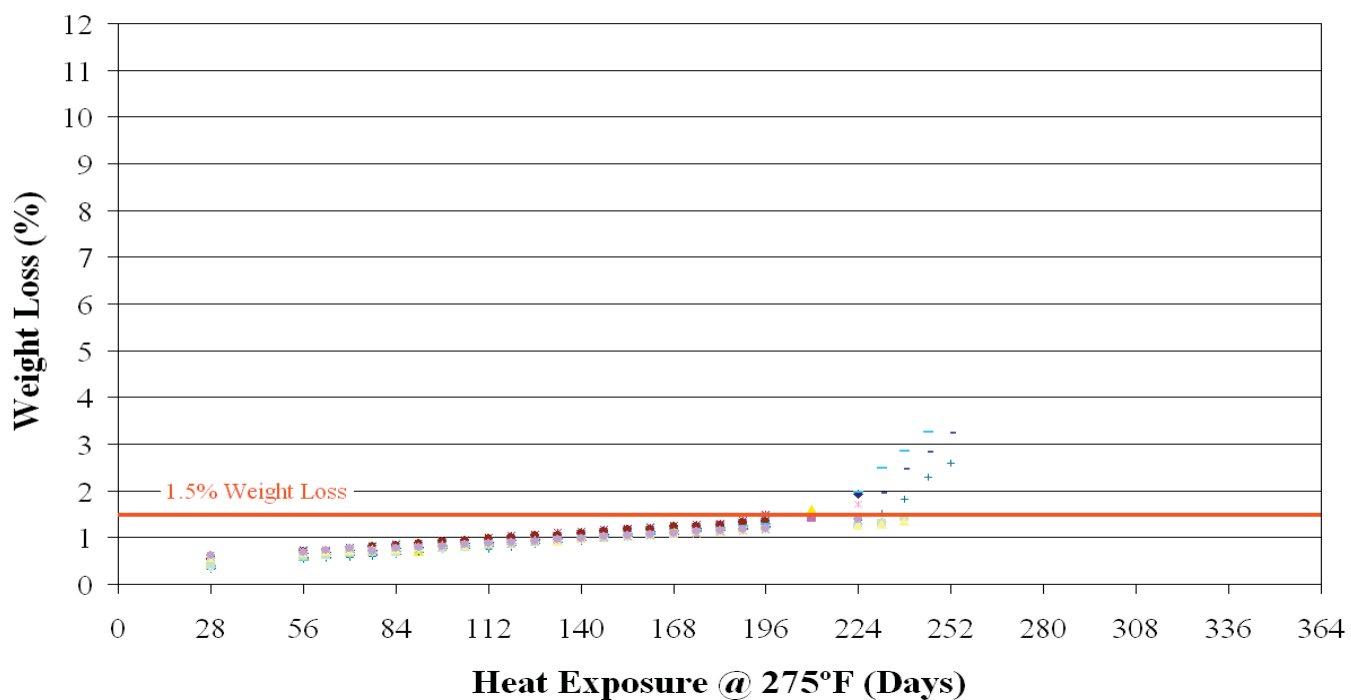
Product #1



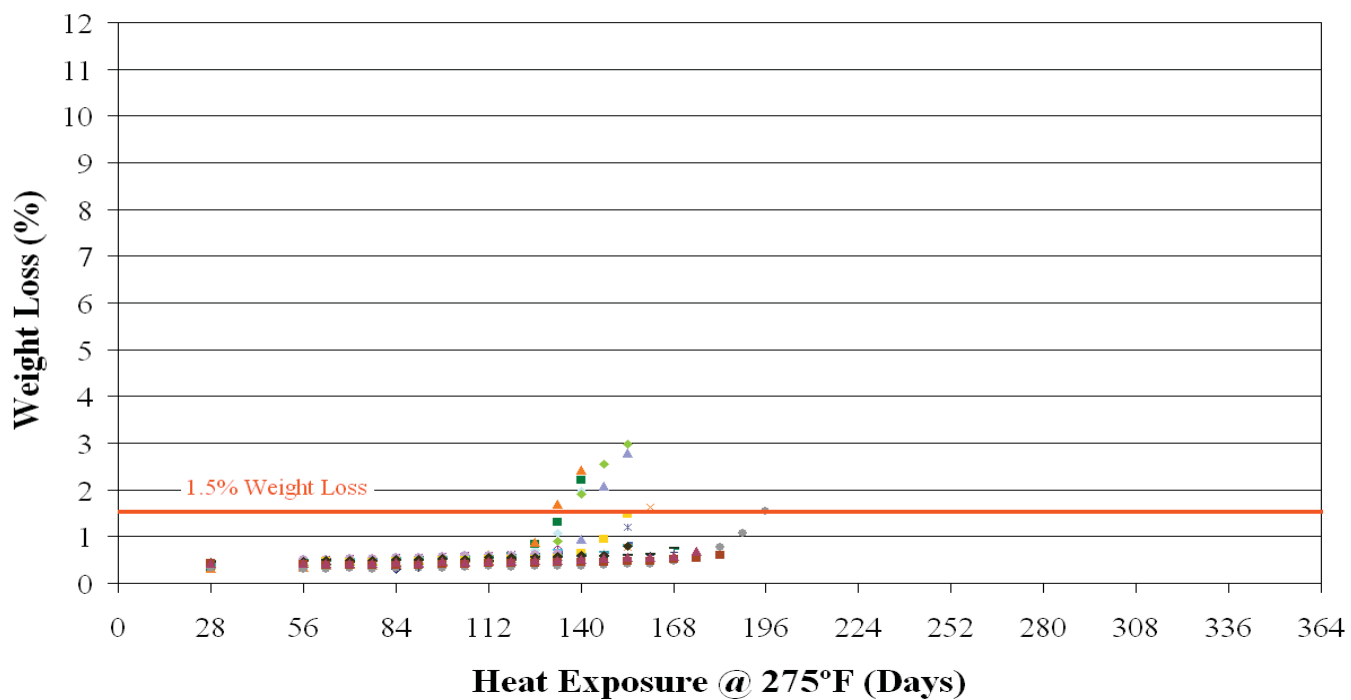
Product #2



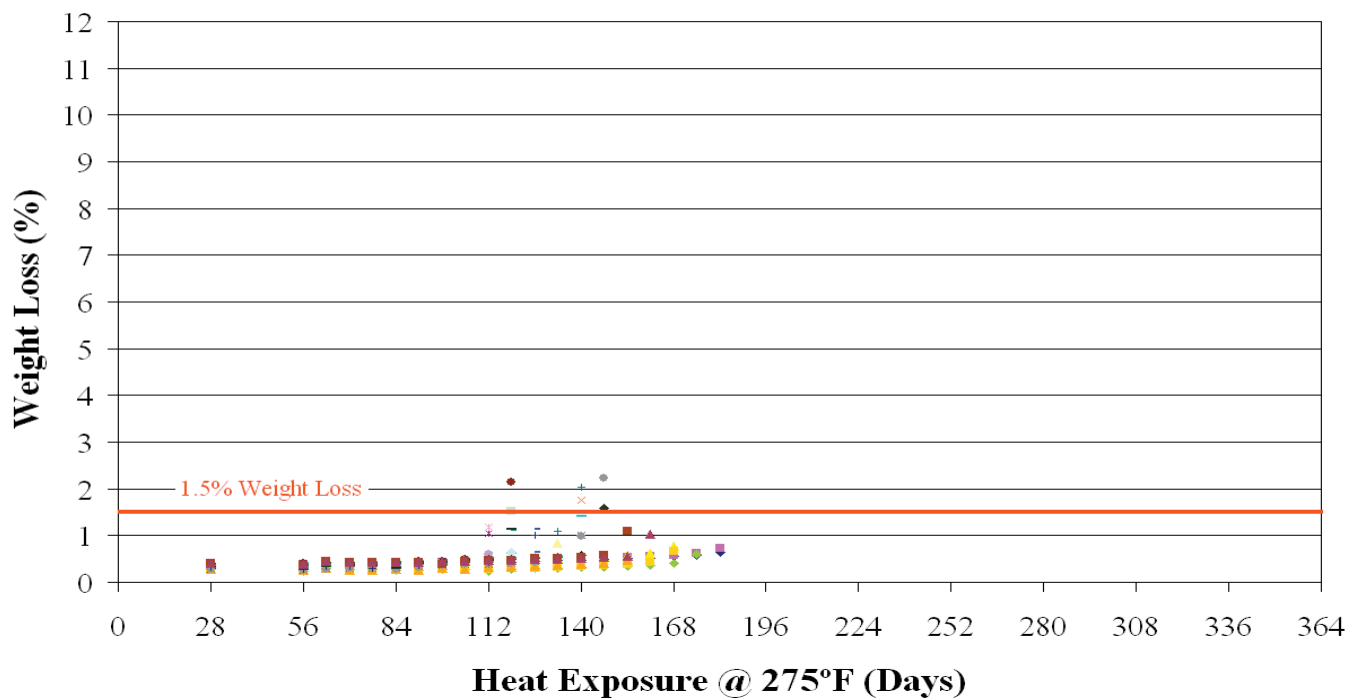
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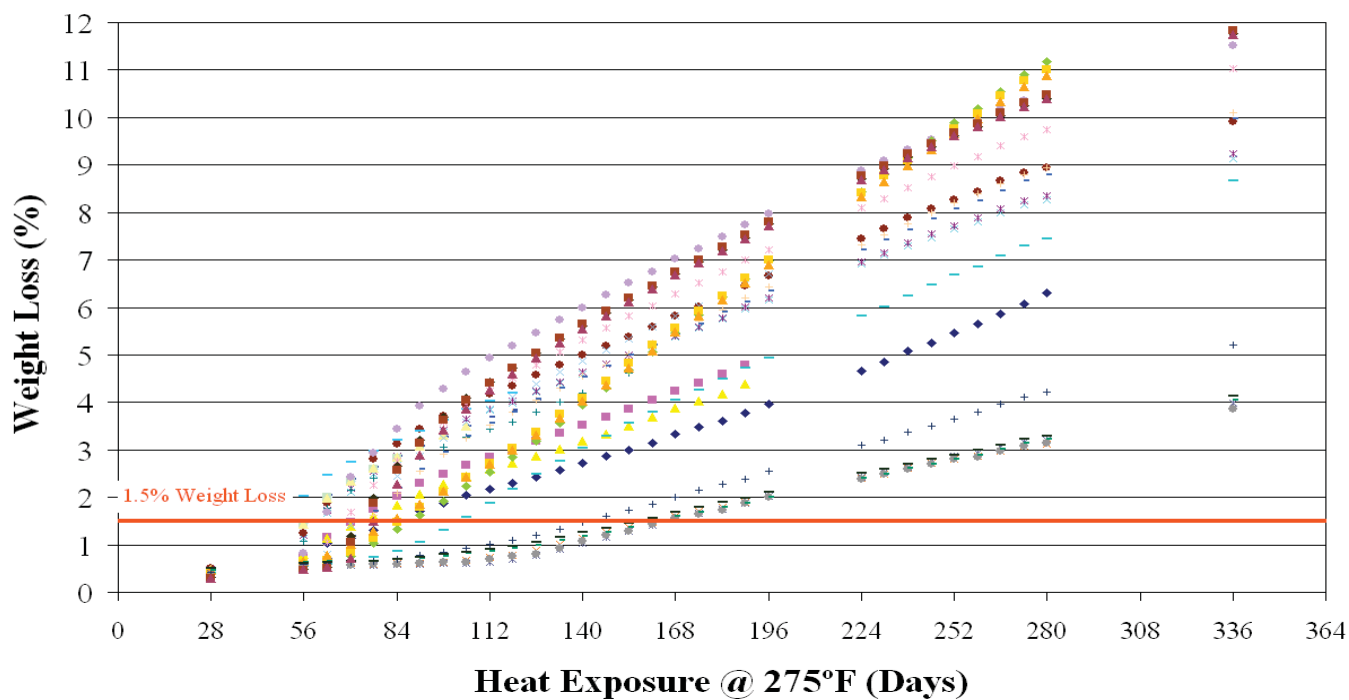
Product #4



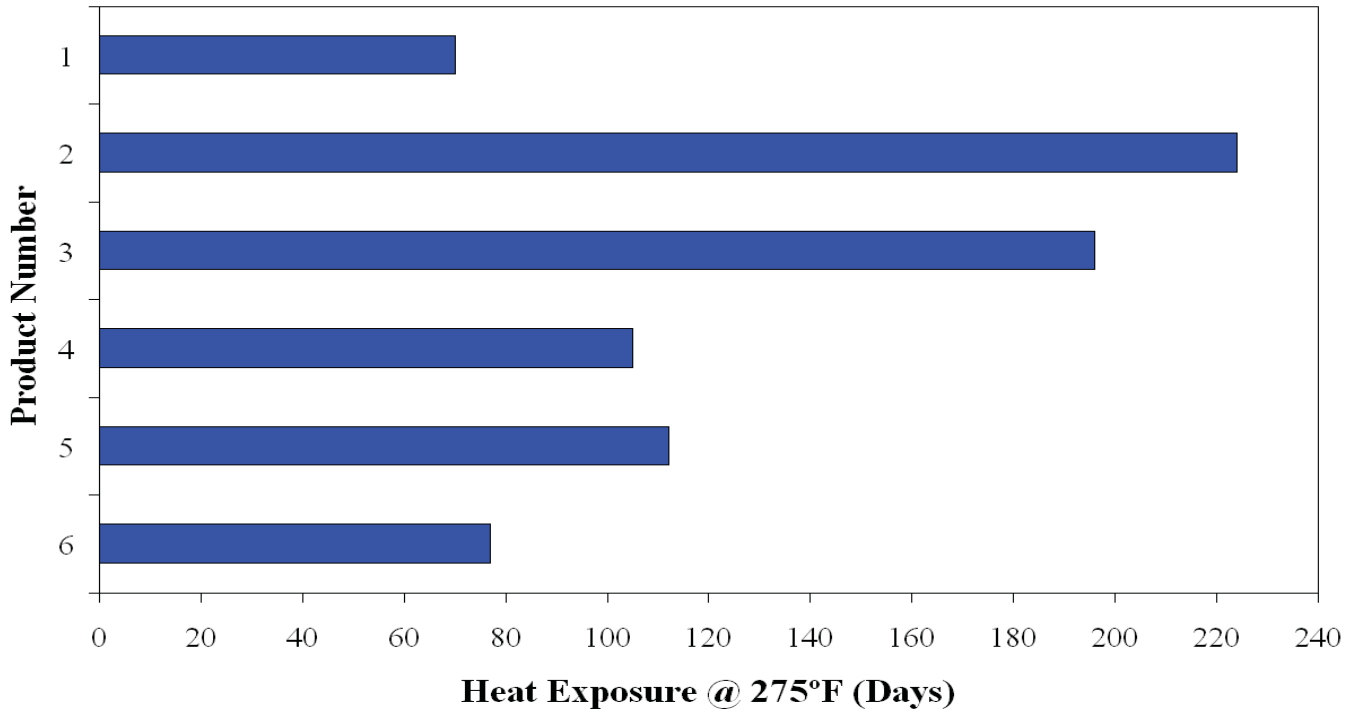
Product #5



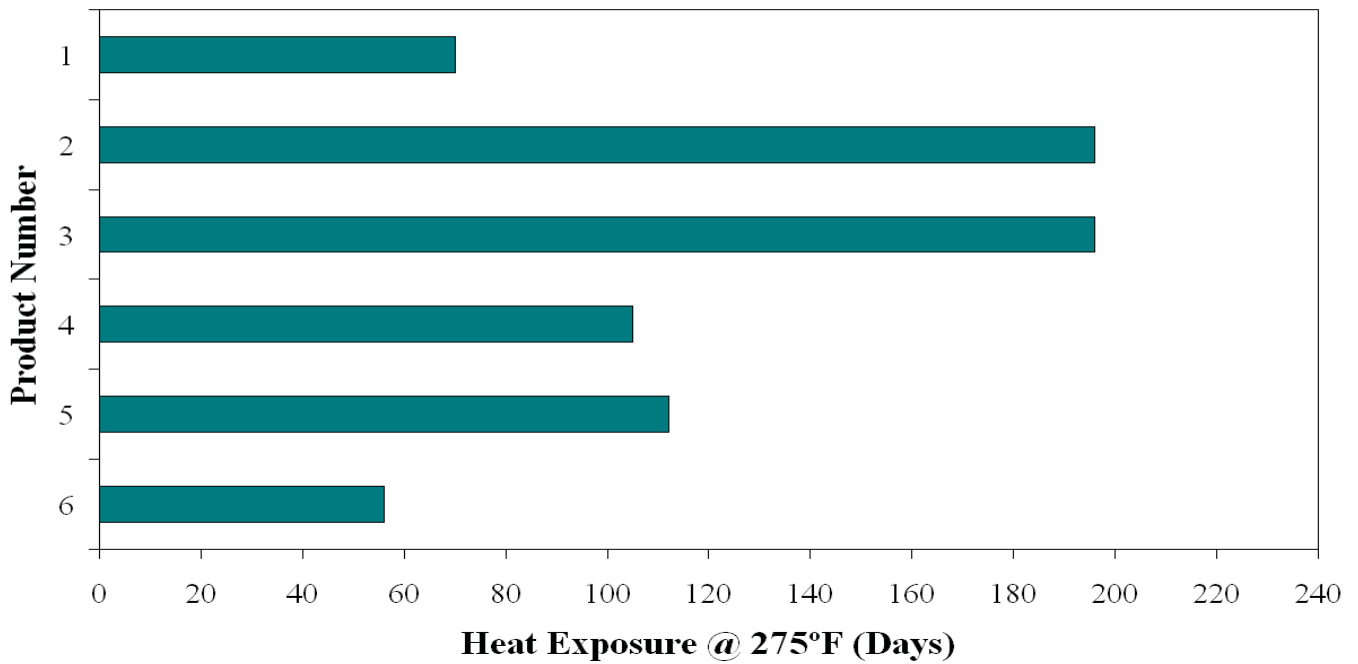
Product #6



Heat Aging - Days to First Crack

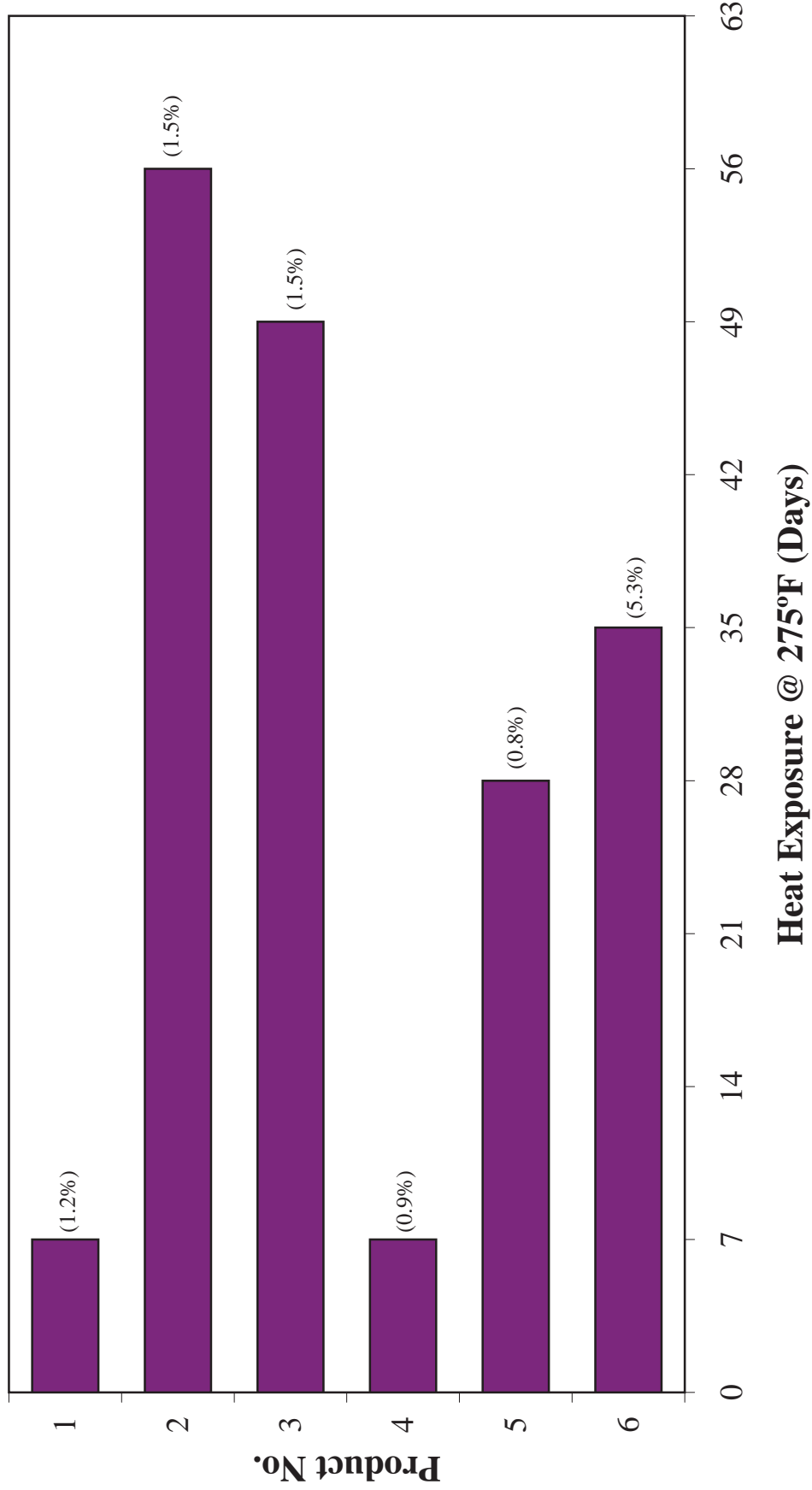


Heat Aging - Days to Either First Crack or Greater than 1.5% Weight Loss



QUV Exposure of 30240 kJ/m² followed by Oven Heat Aging
(No Failures After QUV Exposure Only)

Average Days to Crack (Average Percent Weight Loss)



2013 - 2014 TPO Test Program

SRI Reporting Key

Product Number	Manufacturer
1	Johns Manville TPO 60 mil
2	GAF EverGuard Extreme 50 mil TPO
3	GAF EverGuard Extreme 60 mil TPO
4	Firestone UltraPly TPO 60 mil
5	GAF EverGuard TPO 60 mil
6	Carlisle Sure-Weld TPO 60 mil

