CARLISLE SYNTEC SYSTEMS

Sure-Weld TPO
Reinforced Membrane

Extreme Testing For Severe Climates

ASTM Standard D6878 is the material specification for Thermoplastic Polyolefin-Based Sheet Roofing. It covers material property requirements for TPO roof sheeting and includes initial and aged properties after heat and xenon-arc exposure. As stated in the scope of the standard, "the tests and property limits used to characterize the sheet are values intended to ensure minimum quality for the intended purpose." Carlisle's goal is to produce TPO that ensures maximum performance for the intended purpose of roofing membranes. Maximum performance requires the membrane to far exceed the requirements of ASTM D6878. For severe climates like Miami, FL and Phoenix, AZ, EXTREME testing is required.

Heat Aging accelerates the oxidation rate that roughly doubles for each 10°C (18°F) increase in roof membrane temperature. Oxidation (reaction with oxygen) is one of the primary chemical degradation mechanisms of roofing materials.

Carlisle Extreme Testing – Heat Aging

	ASTM Requirement	Sure-Weld Requirement
ASTM TEST 240°F	32 weeks*	52 weeks
Carlisle Extreme Test 275°F	N/A	13 weeks

*Comparable to 1,024 weeks (20 years) at 185°F for 6 hours/day.

- Test specimen is 1" by 4" piece of 45-mil membrane unbacked, placed in circulating hot-air oven.
- Criterion – no visible cracks after bending aged test specimen around 0.25"-diameter mandrel.

Xenon-Arc exposes the membrane samples to the combined effect of ultraviolet, visible and infrared radiation as well as ozone, heat and water spray, to greatly accelerate the effects of outdoor weathering. The radiation dose is measured in kilojoules per square meter (kJ/m^2) at 340 nm machine UV wavelength. The irradiance power of the xenon-arc lamp is measured in Watts per square meter (W/m^2).

Carlisle Extreme Testing – Xenon-Arc

		Sure-Weld Results		
ASTM TEST	**ASTM D6878 Requirement**	**45-mil**	**60-mil**	**80-mil**
kJ/m^2 at 340 nm	10,080	17,640	20,160	27,720

- Test specimen is 2.75" by 5.5" piece of membrane, unbacked, weathering side facing arc lamp.
- Criterion – no visible cracks viewed under 10x magnification while wrapped around 3"-diameter mandrel.

Environmental Cycling subjects the membrane to repeated cycles of heat aging, hot-water immersion followed by xenon-arc exposure. The acid fog accelerates acid etching that may occur from acid rain if the roof membrane is not resistant to acidic conditions.

- ASTM requirement – none
- Carlisle EXTREME test*:
  - 10 days heat aging at 240°F (116°C) followed by
  - 5 days water immersion at 158°F (70°C) followed by
  - 5040 kJ/m^2 (2000 hours at 0.70 W/m^2 irradiance) xenon-arc exposure

*Test specimen is 2.75" by 5.5" piece of membrane with edges sealed.

*Criterion – after 3 complete cycles, test specimens shall remain flexible and not have any cracking under 10x magnification while wrapped around a 3"-diameter mandrel.

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Supplemental Approvals, Statements and Characteristics:

1. Sure-Weld TPO meets or exceeds the requirements of ASTM D6878 Standard Specification for Thermoplastic Polyolefin-Based Sheet Roofing.
2. **Radiative Properties** for ENERGY STAR, Cool Roof Rating Council (CRRC) and LEED.
3. Sure-Weld TPO membranes conform to requirements of the U.S.E.P.A. Toxic Leachate Test (40 CFR part 136) performed by an independent analytical laboratory.
4. Sure-Weld reinforced TPO was tested for dynamic puncture resistance per ASTM D5635-04 using the most recently modified impact head. 45-mil was watertight after an impact energy of 12.5 J (9.2 ft-lbf) and 60-mil was watertight after 22.5 J (16.6 ft-lbf). 80-mil EXTRA was watertight after an impact energy of 30.0 J (22.1 ft-lbf).

Radiative Properties for ENERGY STAR, Cool Roof Rating Council (CRRC) and LEED

	Test Method	White TPO	Tan TPO	Gray TPO
ENERGY STAR – initial solar reflectance	Solar Spectrum Reflectometer	0.79	0.71	N/A
ENERGY STAR –initial solar reflectance after 3 years	Solar Spectrum Reflectometer (uncleaned)	0.70	0.64	N/A
CRRC – initial solar reflectance	ASTM C1549	0.79	0.71	0.46
CRRC – solar reflectance after 3 years	ASTM C1549 (uncleaned)	0.70	0.64	0.43
CRRC – initial thermal emittance	ASTM C1371	0.90	0.86	0.89
CRRC – thermal emittance after 3 years	ASTM C1371 (uncleaned)	0.86	0.87	0.88
LEED – thermal emittance	PASS	0.90	0.86	0.86
*SRI (Solar Reflectance Index)		99	86	53

*Solar Reflectance Index (SRI) is calculated per ASTM E1980. The SRI is a measure of the roof's ability to reject solar heat, as shown by a small temperature rise. It is defined so that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100. Materials with the highest SRI values are the coolest choices for roofing. Due to the way SRI is defined, particularly hot materials can even take slightly negative values and particularly cool materials can even exceed 100.

LEED Information

Pre-consumer Recycled Content	10%
Post-consumer Recycled Content	0%
Manufacturing Location	Senatobia, MS Tooele, UT
Solar Reflectance Index	99 (white) 86 (tan)

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