ASTM G154 vs. ASTM G155: Understanding Accelerated Weathering Standards in Single-ply Roofing Membranes

A Technical Comparison for Roof Consultants, Architects, and Building Envelope Engineers

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Keywords

ASTM G154, ASTM G155, ASTM weathering standards, accelerated weathering, UV exposure testing, xenon arc testing, fluorescent UV testing, UV degradation, polymer stability, roofing membranes, roof coatings, single-ply roofing, PVC roofing, TPO roofing, bituminous membranes, modified bitumen, membrane durability, building envelope performance, thermal aging, ultraviolet resistance, color stability, long-term roof performance, architectural specifications, roof consultant resources, roof design guide, material testing, Siplast roofing systems, Siplast membranes, Siplast durability, building envelope science, sustainable roofing materials, roof performance testing, roofing innovation, laboratory weathering, weathering correlation, UV resistance testing, building material testing, roofing product evaluation

Executive Summary

Accelerated weathering is one of the most widely used laboratory techniques to estimate and compare the long-term performance of roofing materials. Among the most referenced standards are ASTM G154 and ASTM G155 for single ply membranes. Both prescribe how to expose materials to cycles of ultraviolet light, moisture, and heat to simulate environmental aging.

While similar in purpose, the two standards differ significantly in their light sources, spectral energy distribution, temperature control, and correlation to outdoor exposure. For roofing professionals, understanding these distinctions is essential when interpreting data in technical submittals or comparing performance claims.

This paper explains each standard, compares their core principles, and outlines how test results might translate into real-world performance of roofing membranes and assemblies. It concludes with practical guidance for specifiers and consultants seeking meaningful comparisons between products and systems.

Introduction

Single-ply membranes endure years of exposure to sunlight, rain, humidity, and temperature variations. Laboratory accelerated weathering tests simulate these conditions to evaluate how materials retain flexibility, tensile strength, color stability, and integrity over time.

ASTM G154, *Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials*, and ASTM G155, *Standard Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Nonmetallic Materials*, are the standardized practices that prescribe how these exposures are conducted. Neither is a "pass/fail" test method. Each guides laboratories in performing controlled, repeatable tests that reveal trends in material degradation.

For architects, consultants, and specifiers, these standards can provide a benchmark for evaluating the comparative durability of membranes, coatings, and other exposed materials. The key is understanding what each test actually tests and how to interpret the results within the context of real-world roofing environments.

Understanding ASTM G154

ASTM G154 uses fluorescent UV lamps to reproduce the short-wave ultraviolet portion of sunlight. These lamps, such as UVA-340 or UVB-313, emit energy between roughly 290 nm and 400 nm — the wavelengths most responsible for polymer degradation.

A typical G154 cycle alternates between UV light exposure and wetting. During the UV light phase, specimens are subjected to controlled ultraviolet light at a specific irradiance and temperature. In the dark phase, heated water vapor condenses on the specimen surface, replicating dew formation.

This practice isolates the UV component of sunlight and moisture without the influence of visible or infrared radiation. It provides a repeatable method for studying UV-driven reactions, such as polymer chain scission, oxidation, and surface embrittlement.

Because of its focused wavelength range and relatively simple apparatus, G154 is cost-effective, easy to operate, and well suited for screening formulations, comparing stabilizer packages, or performing quality-control tests.

Understanding ASTM G155

ASTM G155 uses a xenon-arc lamp that simulates the full solar spectrum — from ultraviolet through visible and infrared. Filters are used to tailor the spectrum to specific end-use environments, such as direct sunlight or sunlight through window glass.

G155 is more comprehensive; G155 includes black-panel temperature, chamber air temperature, relative humidity, and programmed water-spray cycles. In other words, the xenon-arc lamp reproduces not only UV-induced degradation but also the photothermal and color-fading effects that occur in outdoor exposure.

While G154 isolates the ultraviolet component of sunlight for focused screening, ASTM G155 expands the evaluation by using a xenon-arc lamp that replicates the full spectrum of sunlight exposure–UV, visible, and infrared radiation. G155 enables full-spectrum weathering assessments, including pigment fading, polymer plasticizer migration, and thermally driven changes in material properties. As such, G155 is commonly used for final validation of product durability and correlation to field performance of exposed roofing assemblies.

Comparing ASTM G154 and ASTM G155

Although both are accelerated weathering practices, their technical differences affect the type of data they generate.

Light Source and Spectrum:

G154 uses fluorescent UV lamps that deliver concentrated ultraviolet energy but exclude visible and infrared light. G155's xenon-arc lamp replicates the complete solar spectrum, providing a more realistic simulation of outdoor conditions. Consequently, G154 isolates UV-related degradation, while G155 captures the combined effects of UV, visible, and IR radiation.

Temperature and Moisture Control:

In G154, the specimen temperature is governed primarily by chamber air and black-panel heating–typically near 60°C–during the light phase with condensation at 50°C during the dark phase. G155 employs controlled black-panel temperatures that are higher (often 63°C – 83°C) and incorporates humidity or water-spray cycles to simulate rainfall and drying. This broader range of conditions better represents thermal and moisture stresses on roofing systems.

Cycle Complexity and Reproducibility:
G154 cycles are generally shorter and easier to replicate. G155 cycles, while more representative, require careful calibration of irradiance, filter performance, and humidity controls. Differences between xenon-arc test chambers can yield variations in results if not standardized.

Interpretation of Results:
Both standards simulate accelerated weathering. Results from either G154 or G155 are used to compare products' abilities to perform in such tests. Comparison to real-world results is difficult and generally not recommended. However, meaningful hours-to-years conversions are sometimes possible when based on validated correlations for a defined material, exposure cycle (e.g., lamp/filter, irradiance, temperature, moisture), and reference climate (e.g., South Florida, Arizona, temperate zones). When those inputs are controlled and supported by outdoor benchmark data, chamber hours can be translated to an estimated service duration with documented limits and confidence. Absent such validation for the specific product and cycle, results from accelerated weathering tests should be interpreted comparatively rather than converted to years.

Translating Laboratory Aging to Rooftop Reality

The goal of accelerated weathering is to determine if a material has the ability to perform to a minimum expectation and to be able to compare products based on a standardized test method. Correlation to real-world exposure is not intended. Real-world exposure includes ultraviolet light, visible light, heat, moisture, pollutants, biological growth, and mechanical stress - variables no single test can fully replicate.

G154 is valuable for identifying materials susceptible to ultraviolet embrittlement, surface chalking, or loss of flexibility. G155 adds the dimension of heat and visible light, revealing additional degradation modes such as pigment fading, surface erosion, and plasticizer migration.

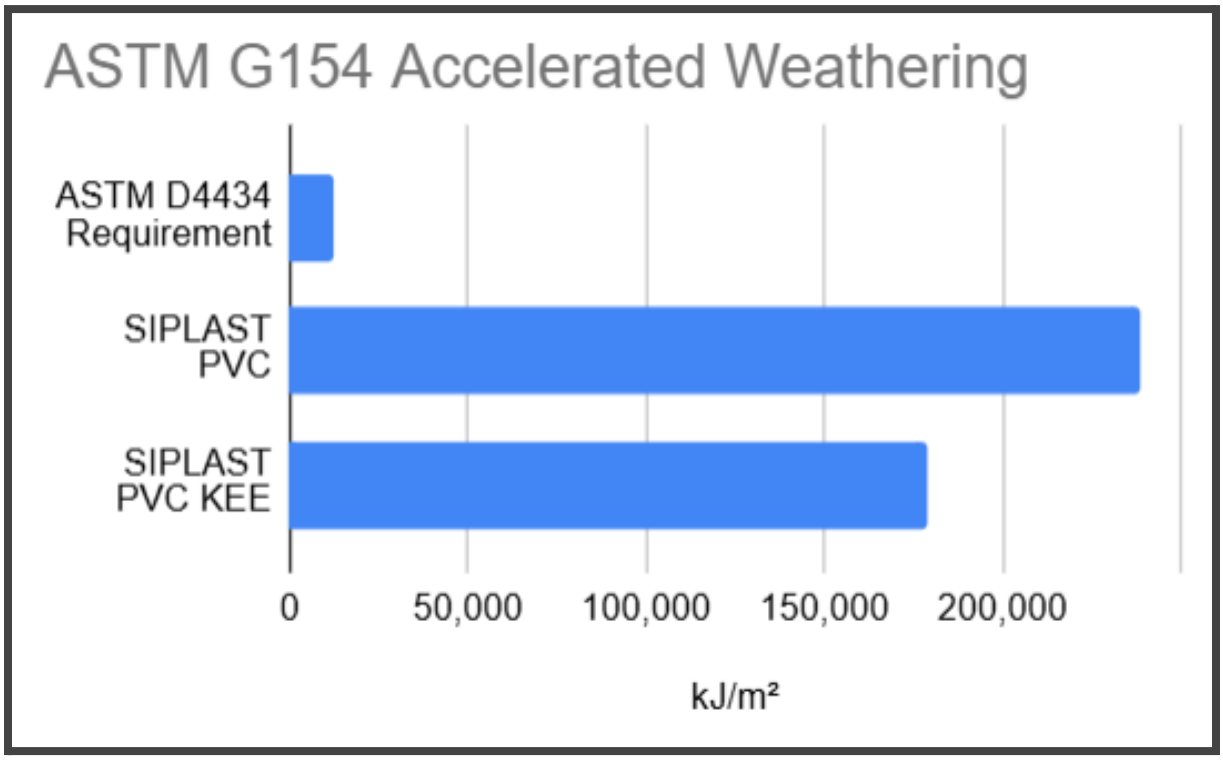
For roofing membranes, a key indicator of durability is how long essential properties are retained during accelerated weathering tests. ASTM G154 and G155 results are expressed in exposure hours, with failure or property-change thresholds defined by the project or manufacturer. Membranes that preserve tensile strength, elongation, and surface integrity over comparatively longer test hours show a greater resistance to cumulative UV, heat, and moisture exposure. For consultants, these hour-based comparisons provide a quantifiable framework for judging one system's expected service life against another's.

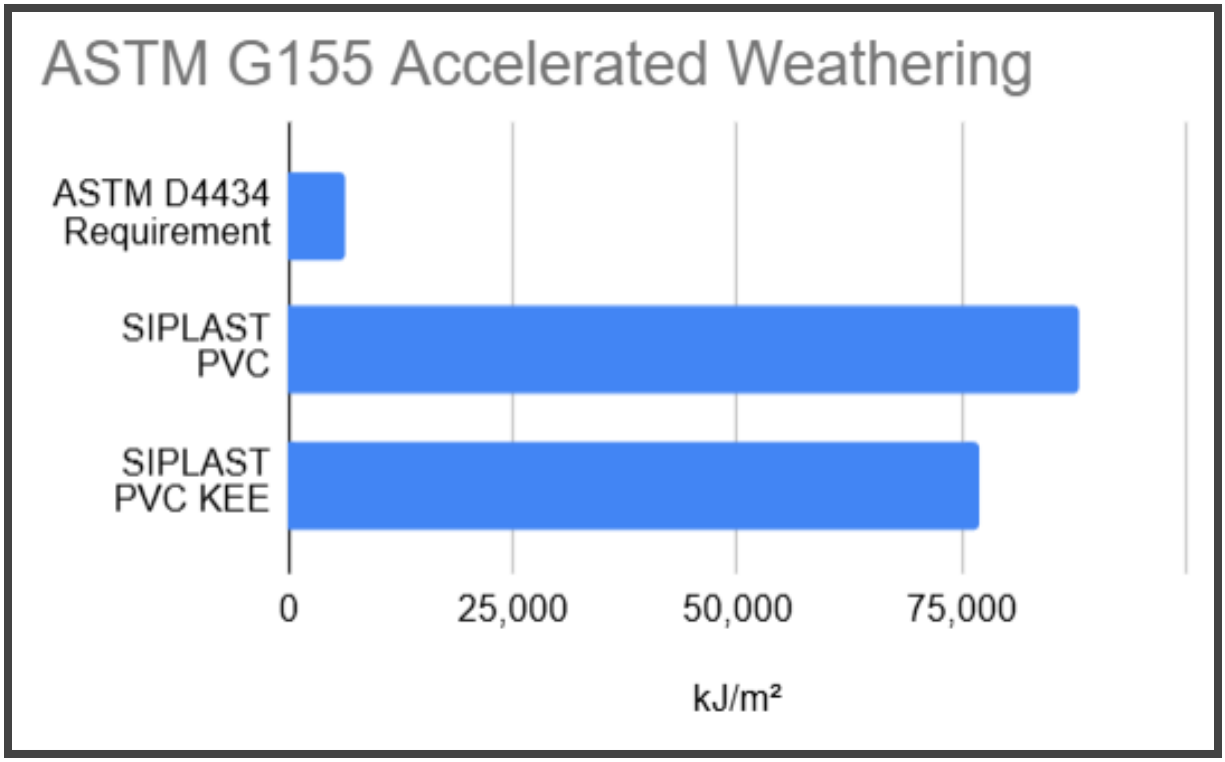
Siplast PVC Formulations Excel in Accelerated Weathering

Siplast develops roofing membranes with specific stabilization packages to address real-world UV-driven and photothermal aging mechanisms. These aging mechanisms can be captured by ASTM G154 (fluorescent UV) and ASTM G155 (xenon-arc). These practices provide controlled light, temperature, and moisture exposures to reveal trends in material durability; they are not pass/fail qualifications. Minimum requirements are found in the specific ASTM material standard.

The charts below* show results from accelerated weathering testing. Siplast PVC and PVC KEE sheets withstand significantly more irradiance during G154 and G155 testing than is required by the material standard for PVC roofing membranes.

More information about Siplast PVC and PVC KEE is available in our Parasolo® PVC brochure and Parasolo® PVC KEE brochure.





*Values stated are approximate and subject to normal manufacturing variation. These values are not guaranteed and are provided solely as a guide.

In addition, minimum requirements for tensile strength, breaking strength, and elongation are established after heat aging. It's important to recognize that heat aging is different from accelerated weathering. Other performance decisions—such as adhesion/peel, surface condition, or color stability—are established separately using relevant tests and specific criteria. These approaches let designers and consultants compare materials and evaluate the properties that matter for the roof assembly and project conditions.

Guidance for Roof Consultants and Specifiers

When evaluating product data or approving submittals:

1. **Identify the test standard.** A "UV exposure" result means little without knowing whether it followed G154 or G155.
2. **Understand the spectrum tested.** G154 represents specific high-energy UV stress with wetting; G155 represents the full spectrum of sunlight with heat and moisture.
3. **Compare like with like.** Results between the two different test methods should not be directly compared unless the same exposure parameters are used, which is often not the case.

4. **Specify test practices that are appropriate for the expected exposure.** For exposed membranes or coatings, xenon-arc (G155) testing may better predict performance. For underlayments or UV-shielded materials, G154 may be sufficient.

By incorporating this understanding into specifications, consultants, architects, and specifiers can help ensure that laboratory data are interpreted correctly and that product selection reflects anticipated service conditions.

Conclusion

ASTM G154 and ASTM G155 represent complementary approaches to accelerated weathering testing. G154 isolates ultraviolet degradation in a controlled, repeatable environment; G155 provides a comprehensive simulation of sunlight, temperature, and moisture.

For roofing professionals, recognizing the distinction allows for more meaningful interpretation and comparison of test results and better alignment between laboratory data and field performance expectations.

Siplast's continued commitment to material science, quality control, and chemistry ensures that our roofing systems are developed and validated appropriately. This emphasis supports long-term reliability, helping designers and owners specify and construct building enclosures that withstand the test of time — not just in the lab, but on the rooftop.

Disclaimer

ASTM G154 and ASTM G155 are laboratory exposure practices designed to simulate aspects of natural weathering. Results represent relative performance under controlled conditions and should be interpreted in conjunction with field data, material specifications, and project-specific requirements. No direct time equivalence to outdoor exposure is implied unless validated correlation data are available for the specific material and test cycle.

References

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