ASTM G155 Xenon Arc Weathering
What's Changed and What You Need to Know
ASTM G155 氙灯老化试验
标准修订部分及注意事项

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Topics

- ASTM G155 background 背景
- Title and scope changes 名称及范围改动
- Daylight optical filter clarification
- 日光过滤片说明
- Test cycle updates 测试周期更新
- Other revisions 其它修订

ASTM G155

- ASTM G155 is ASTM's ***Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials***
- ASTM G155 非金属材料曝晒用氙灯设备操作规范
- **Performance-based** standard that establishes principles and procedures for operating a xenon-arc accelerated laboratory weathering apparatus
- 以性能为基础的标准，建立操作氙灯加速老化设备的原则和程序
  - Information about xenon arc lamp apparatus 有关氙灯设备的信息
  - Spectral irradiance 光谱辐照度
  - Temperature and water delivery 温度和供水
- Closely related to ASTM G151 (general laboratory weathering exposures) and ASTM G154 (UV fluorescent lab exposures)
- 与ASTM G151 (实验室老化曝晒总则)和ASTM G154 (紫外加速老化)密切相关

ASTM G155

- ASTM G155 is **widely-used and referenced**, along with related standards like ISO 4892-2
- 与相关标准（如ISO 4892-2）一样，ASTM G155被广泛使用及引用
- The standard had not been revised since 2013 该标准最后一次修订是2013年
- ASTM G03 (Weathering Committee) undertook a major revision, resulting in the recent publication of ASTM G155-21
- ASTM G03 (老化分委会)进行了重大修订，最近出版了ASTM G155-21
  - **Project leader:** Brad Reis from Q-Lab 项目负责人：Q-Lab公司Brad Reis
  - Instrument manufacturers (Q-Lab, Atlas, Suga) 设备制造商 (Q-Lab, Atlas, Suga)
  - Users (3M, independent scientists) 用户 (3M, 独立科学家)
- *Today we'll review the important changes made to ASTM G155*
- *今天我们将概述对ASTM G155所做的重要修订*

Title and Scope 标准名称和范围

Designation: G155 – 13

2013 version

Standard Practice for
Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials[1]

Designation: G155 – 21

2021 version

New title indicates broader use beyond non-metallic materials
新名称删除“非金属”，用途更广泛

Standard Practice for
Operating Xenon Arc Lamp Apparatus for Exposure of Materials[1]

Title and Scope 标准名称和范围

2021 version

1. Scope

1.1 This practice is limited to the basic principles and procedures for operating a xenon arc lamp and water apparatus; on its own, it does not deliver a specific result.

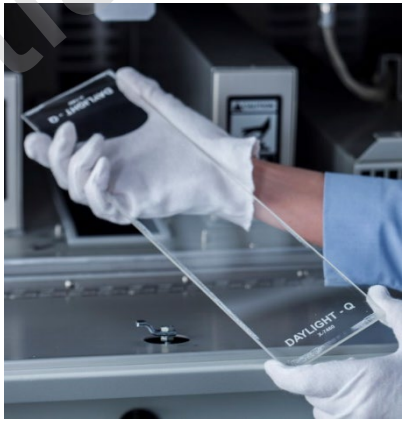
1.2 It is intended to be used in conjunction with a practice or method that defines specific exposure conditions for an application along with a means to evaluate changes in material properties. This practice is intended to reproduce the weathering effects that occur when materials are exposed to sunlight (either direct or through window glass) and moisture as humidity, rain, or dew in actual use. This practice is limited to the procedures for obtaining, measuring, and controlling conditions of exposure.

Clarifies that this is simply for the operation of a xenon test, not duration or interpretation of results

阐明这只是关于氙灯测试的操作，而不是试验时间或结果的解释

Optical Filter Definitions 光过滤片定义

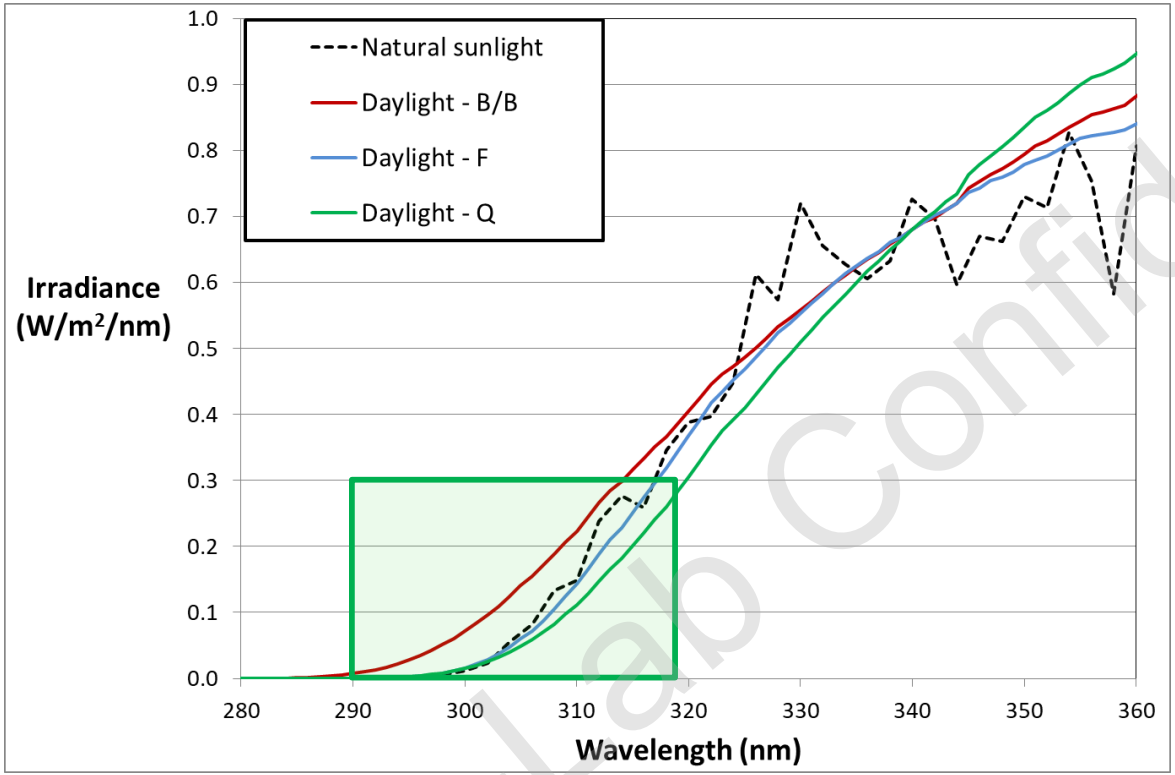
- ASTM G155 defines three types of Optical Filters:
- ASTM G155定义了三种类型的光过滤片
  - Daylight 日光过滤片
  - Window 窗玻璃过滤片
  - Extended UV 紫外延展过滤片



- The 2021 revision clarifies the Spectral Irradiance for Daylight filters, complementing work being done in **ISO 4892-2** (xenon testing of plastics) and **ISO 16474-2** (xenon testing of paint)

- 2021修订版进一步阐明了日光过滤片的光谱辐照度，补充了ISO 4892-2 (塑料的氙灯测试)和ISO 16474-2 (涂料的氙灯测试)中所做的工作

Daylight Filters 日光过滤片



- Each of these filters meets the ASTM G155 definition of **Daylight**
- 每种类型过滤片都符合ASTM G155定义
- Solar cut-on is significantly different for borosilicate (B/B) filters
- Daylight-B/B的截止点明显不同
- Different Daylight filters can give different test results!
- 不同过滤片可能给出不同的测试结果！
- No guidance given in 2013 version of ASTM G155
- 2013版ASTM G155中未给出指导

Daylight Optical Filter Definitions 日光过滤片定义

Spectral Bandpass Wavelength λ in nm	Minimum Percent[C]	Benchmark Solar Radiation Percent[D,E,F]	Maximum Percent[C]
λ < 290			0.15
290 ≤ λ ≤ 320	2.6	5.8	7.9
320 < λ ≤ 360	28.3	40.0	40.0
360 < λ ≤ 400	54.2	54.2	67.5

2013 version

Daylight filters described loosely

2013版对于日光过滤片的描述不够精确

2021 version – preserves “General” and adds **Type I** and **Type II** classifications

Type I and Type II are mutually exclusive, and both fall within General

Spectral Bandpass Wavelength λ in nm	General[B]		Type I[C]		Type II[D]		Benchmark Solar Radiation Percent[F,G,H]
	Min. %[E]	Max %[E]	Min. %[E]	Max %[E]	Min. %[E]	Max %[E]	
λ < 300[I]	2.6	8.1	0	0.2	0.2	1.1	5.8
300 ≤ λ ≤ 320			2.6	6	3.5	7.0	
320 < λ ≤ 340	28.3	40.0	10.0	17.0	10.0	17.0	40.0
340 < λ ≤ 360			18.3	23.2	18.3	23.2	
360 < λ ≤ 380	54.2	67.5	25.0	30.5	25.0	30.5	54.2
380 < λ ≤ 400			29.2	37.0	29.2	37.0	

Daylight Optical Filter Definitions 日光过滤片定义

Spectral Bandpass Wavelength λ in nm	General[B]		Type I[C]		Type II[D]		Benchmark Solar Radiation Percent[F,G,H]
	Min. %[E]	Max %[E]	Min. %[E]	Max %[E]	Min. %[E]	Max %[E]	
λ < 300[I]	2.6	8.1	0	0.2	0.2	1.1	5.8
300 ≤ λ ≤ 320			2.6	6	3.5	7.0	
320 < λ ≤ 340	28.3	40.0	10.0	17.0	10.0	17.0	40.0
340 < λ ≤ 360			18.3	23.2	18.3	23.2	
360 < λ ≤ 380	54.2	67.5	25.0	30.5	25.0	30.5	54.2
380 < λ ≤ 400			29.2	37.0	29.2	37.0	

- **Type I**
  - Close match to natural sunlight – **generally recommended** 接近自然太阳光 – **通常推荐**
  - Includes Daylight-Q and Daylight-F (**ASTM D7869** type) 包括Daylight-Q和Daylight-F (**ASTM D7869**)
- **Type II**
  - Match to historical borosilicate filters – **recommended only to match historical data**
  - 与过往用硼硅酸盐过滤片匹配 – **为了匹配历史数据时才推荐**
  - More shortwave UV than natural sunlight 短波紫外线比自然太阳光多

Test Cycles in ASTM G155 ASTM G155中的测试周期

- 12 test cycles are included in ASTM G155 ASTM G155中有12个测试周期
- The cycle parameters are ***not mandatory!*** 测试参数***不是强制性的！***
  - They appear in an **Appendix**, which is always non-mandatory (informational) in an ASTM document (an **Annex** is mandatory).
  - 它们列在非强制性（资料性）的附录中，而不是规范性附录中
- The language clearly states: *Any exposure conditions may be used, as long as the exact conditions are detailed in the report. Following are some representative exposure conditions. These are not necessarily preferred and no recommendation is implied. These conditions are provided for reference only*
- 文中明确规定：只要试验报告中详细说明了确切的条件，就可以使用任何一种曝晒条件。以下是一些有代表性的曝晒条件。这些不一定是首选，也没暗示任何建议。这些条件仅供参考。
  - *In reality, though … everyone treats them as being mandatory*
  - *但事实上，每个人都把它们视为强制性的*

Test Cycles: 2013 Revision 2013版中的测试周期

TABLE X3.1 Common Exposure Conditions

Cycle	Filter	Irradiance	Wavelength	Exposure Cycle
1	Daylight	0.35 W/(m^2· nm)	340 nm	102 min light at 63°C black panel temperature 18 min light and water spray (air temp. not controlled)
2	Daylight	0.35 W/(m^2· nm)	340 nm	102 min light at 63°C black panel temperature 18 min light and water spray (air temp. not controlled) repeated nine times for a total of 18h; followed by 6 h dark at 95 (±4.0) % RH, at 24°C black panel temperature
3	Daylight	0.35 W/(m^2· nm)	340 nm	1.5 h light, 70 % RH, at 77°C black panel temperature 0.5 h light and water spray (air temp. not controlled)
4	Window Glass	0.30 W/(m^2· nm)	340 nm	100 % light, 55 % RH, at 55°C black panel temperature
5	Window Glass	1.10 W/(m^2· nm)	420 nm	102 min light, 35 % RH, at 63°C black panel temperature 18 min light and water spray (air temp. not controlled)
6	Window Glass	1.10 W/(m^2· nm)	420 nm	3.8 h light, 35 % RH, at 63 °C black panel temperature 1 h dark, 90 % RH, at 43 ° C black panel temperature
7	Extended UV	0.55 W/(m^2·nm)	340 nm	40 min light, 50 % RH, at 70 (±2) °C black panel temperature and 47 (±2) °C chamber air temperature 20 min light and water spray on specimen face 60 min light, 50 % RH, at 70 (±2) °C black panel temperature; and 47 (±2) °C chamber air temperature 60 min dark and water spray on specimen front and back, 95 % RH, 38 (±2) °C black panel temperature and 38 (±2) °C chamber air temperature
7A	Daylight	0.55 W/(m^2·nm)	340 nm	40 min light, 50 (±5.0) % RH, at 70 (±2) °C black panel temperature and 47 (±2) °C chamber air temperature 20 min light and water spray on specimen face; 60 min light, 50 % RH, at 70 (±2) °C black panel temperature; and 47 (±2) °C chamber air temperature 60 min dark and water spray on specimen front and back, 95 % RH, 38 (±2) °C black panel temperature and 38 (±2) °C chamber air temperature
8	Extended UV	0.55 W/m^2·nm	340 nm	3.8 h light, 50 % RH, at 89 (±3) °C black panel temperature and 62 (±2) °C chamber air temperature 1.0 h dark, 95 % RH, at 38 (±2) °C black panel temperature and 38 (±2) °C chamber air temperature
9	Daylight	180 W/m^2	300–400 nm	102 min light at 63°C black panel temperature 18 min light and water spray (temperature not controlled)
10	Window Glass	162 W/m^2	300–400 nm	100 % light, 50 % RH, at 89°C black panel temperature
11	Window Glass	1.5 W/(m^2· nm)	420 nm	Continuous light at 63°C black panel temperature, 30 % RH
12	Daylight	0.35 W/(m^2· nm)	340 nm	18 h consisting of continuous light at 63°C black panel temperature 30 % RH 6 h dark at 90 % RH, at 35°C chamber air temperature

- Black Panel Temp, Relative Humidity, and Step Type are not always clear
- 黑板温度，相对湿度，步骤类型都不清晰
- Chamber air temperatures not included
- 没规定箱体空气温度

Test Cycles: 2021 Revision 2021版中的测试周期

TABLE X3.1 Some Historical Exposure Conditions

Cycle	Filter	Irradiance and Wavelength	Exposure Cycle	Black Panel Temperature (BPT) (°C)	Relative Humidity (RH) (%)	Chamber Air Temperature (CAT) (°C)
1	Daylight	0.35 W/(m²· nm) @ 340 nm	102 min light	63	50[A]	44[A]
			18 min light and water spray[B]	Uncontrolled		44[A]
2	Daylight	0.35 W/(m²· nm) @ 340 nm	102 min light[C]	63	50 [A]	44[A]
			18 min light and water spray[B,C]	Uncontrolled		44[A]
			6 h dark[D]	24[E]	95	24[A]
3	Daylight	0.35 W/(m²· nm) @ 340 nm	90 min light	77	70	63[A]
			30 min light and water spray[B]	Uncontrolled		63[A]
4	Window Glass	0.30 W/(m²· nm) @ 340 nm	Continuous light	55	55	45[A]
5	Window Glass	1.10 W/(m²· nm) @ 420 nm	102 min light	63	35	47[A]
			18 min light and water spray[B]	Uncontrolled		47[A]
6	Window Glass	1.10 W/(m²· nm) @ 420 nm	228 min light	63	35	47[A]
			60 min dark[D]	43	90	43[A]
7	Extended UV	0.55 W/(m²·nm) @ 340 nm	40 min light	70	50	47
			20 min light and water spray (front)[B]	Uncontrolled		47
			60 min light	70	50	47
			60 min dark and water spray (front and back)[D]	38	95	38
7A	Daylight (Type II)	0.55 W/(m²·nm) @ 340 nm	40 min light	70	50	47
			20 min light and water spray (front)[B]	Uncontrolled		47
			60 min light	70	50	47
			60 min dark and water spray (front and back)[D]	38	95	38
8	Extended UV	0.55 W/(m²·nm) @ 340 nm	228 min light	89	50	62
			60 min dark[D]	38	95	38
9	Daylight	180 W/m² @ 300 - 400 nm	102 min light	63	50	28[A]
			18 min light and water spray[B]	Uncontrolled		28[A]
10	Window Glass	162 W/m² @ 300 - 400 nm	Continuous Light	89	50	Uncontrolled
11	Window Glass	1.5 W/(m²· nm) @ 420 nm	Continuous Light	63	50	43[A]
12	Daylight	0.35 W/(m²· nm) @ 340 nm	18 hrs light	63	30	47[A]
			6 hrs dark[D]	35	90	35[A]
13	Daylight (Type I)	0.40 and 0.80 W/(m²· nm) @ 340 nm	See Note X3.4			

- Black Panel Temp, Relative Humidity, and Step Type now inline for readability
- 黑板温度，相对湿度，步骤类型分行列出，便于阅读
- Chamber air temperatures included (often optional)
- 列出了箱体空气温度（可选）
- ASTM D7869-type cycle included as Cycle 13
- 包含ASTM D7869型测试周期，如测试周期13

Sources of Spectral Irradiance Variation 光谱辐照度变化的来源

6.1.1 The following factors can affect the spectral power distribution of optically filtered xenon arc light sources used in these apparatus:

6.1.1.1 Differences in the composition and thickness of filters will have large effects on the UV radiation transmitted. Exposures conducted using different types or different combinations of optical filters can produce different results.

Filter type

6.1.1.2 Aging of optical filters from exposure can result in changes in spectral transmission, resulting in a significant reduction in the UV radiation emitted by the xenon arc lamp/optical filter system.

Filter aging

6.1.1.3 Accumulation of deposits, dirt, or other residue on the optical filters or xenon arc lamp can affect the UV radiation emitted by the xenon arc lamp/optical filter system.

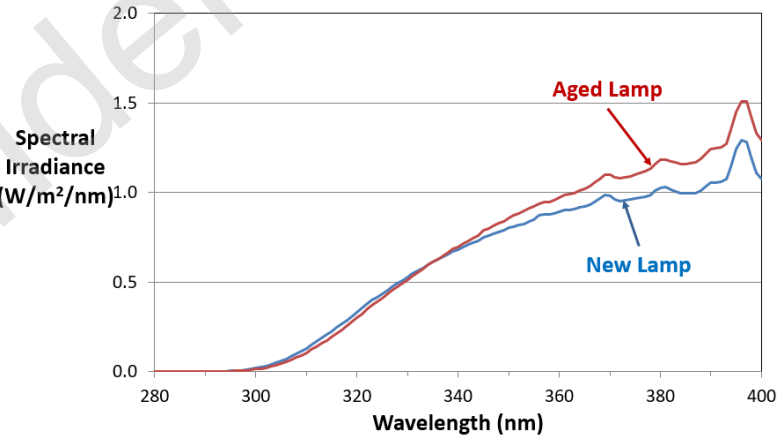
Contamination

6.1.1.4 Aging of the xenon arc lamp from use can result in changes in spectral output of the lamp.

Lamp aging

NOTE 5—More information on the effects of composition, aging, and deposits on a xenon arc lamp/optical filter system can be found in Refs (2-7).

6.1.2 As a result of the potential for significant changes in spectral irradiance due to effects described in 6.1.1.2, 6.1.1.3, and 6.1.1.4, users should follow the apparatus manufacturer's instructions for maintenance and replacement of xenon arc lamps and optical filters.



Contact Q-Lab for maintenance info!

Step Transitions 步骤间转换

6.5.3 Aspects of the apparatus' design, along with its heating, cooling, and control systems and ambient laboratory conditions, can have a significant impact on the amount of time it takes for the apparatus' thermometer to reach steady-state temperature during an exposure step. As a result, this affects how long specimens remain at the desired temperature, since exposure steps are typically fixed in total duration. The rate and magnitude of specimen degradation during exposure can be significantly impacted by these factors. Users are cautioned when comparing results from apparatus with different thermometer time-to-steady-state temperature characteristics.

8.2 Transition times between different thermometer temperature, chamber air temperature, and relative humidity conditions in an exposure cycle can affect test results. Variations in these transition times can adversely affect repeatability and reproducibility. The significance of this effect is dependent upon the exposure cycle used, the specimens under test, and how the specimens are mounted in the apparatus. Transition times are not specified in this standard. Apparatus where the specimen conditions reach and maintain steady state faster may produce different degradation results. Users are cautioned when comparing results from apparatus with different specimen-time-temperature characteristics.

- Transition times are not defined in weathering test standards 老化试验标准中未定义转换时间
- This revision acknowledges this and cautions that transitions may affect test result reproducibility
- 本版本承认这一点，并提醒转换时间可能会影响试验结果的再现性

Specimen Repositioning 试样轮换位置

9.5 *Specimen Repositioning*—Periodic repositioning of the test specimens during exposure is good laboratory practice, and may be employed to minimize the effect of variability in irradiance, temperature, and moisture exposure in the test chamber. Irradiance uniformity shall be determined in accordance with Practice G151 Annex A1 (Procedures for Measuring Irradiance Uniformity in Specimen Exposure Area). Recommendations for repositioning procedures, if used, are provided in Practice G151 Appendix X2 (Suggested Procedures for Reducing Variability By Periodic Random Positioning or Systematic Repositioning of Specimens).

- Specimen repositioning still not **required**, but **recommended** as good practice
- 仍然不是强制要求对试样轮换位置，但建议这样做
- Options for repositioning provided 提供了轮换位置的做法

Other Changes 其它变化

- ISO and ASTM references updated ISO和ASTM参考资料更新
- References added to good laboratory practice documents 添加了参考文献
- Clarification of moisture addition techniques (condensation, humidity, water spray)
- 对水分施加技术（冷凝，湿度，水喷淋）的更清晰描述
- Irradiance and temperature onboard sensor requirements and calibration recommendations updated
- 更新辐照度和温度传感器要求及校准建议
- Provision for specimen washing added 增加试样清洗的规定
- Clarification of front+back spray in SAE J2527 test SAE J2527中正面+背面喷淋的说明
- Caution added regarding “reciprocity” at high irradiance 增加了关于高辐照度下“互惠”的注意事项

Summary 总结

- ASTM G155 was revised in 2021, for the first time since 2013. This was a significant improvement driven by a multidisciplinary committee led by Q-Lab's Brad Reis.
- ASTM G155在2021年进行了修订，这是由Q-Lab公司的Brad Reis领导的多个技术委员会推动的重大改进
- **Daylight** optical filters definition clarified so users understand the true spectral irradiance
- 更精确定义**日光**过滤片，以便用户了解真实的光谱辐照度
- *Example* test cycle table updated and reformatted for easier reading; ASTM D7869 cycle incorporated
- 测试循环表已更新，以便于阅读；包含ASTM D7869测试循环
- Language improved throughout for ease of use and understanding of key factors (spectral irradiance, transitions) that can affect test results
- 全面改进文字描述，以便于使用和理解可能影响测试结果的关键因素（光谱辐照度，转换时间）

Questions?

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