

# How to run SAE J2412 and J2527

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# Overview

- Defining Expectations
- SAE Accelerated Exposure in Xenon-Arc Apparatus
- SAE J2412 & SAE J2527
  - Interpretation of test conditions
  - Setting up Q-SUN xenon-arc test chamber
  - Specimen preparation and mounting
  - Running the test
  - Evaluating and reporting

# What Kind of Test Should I Run?

Accelerated Test Type	Result	Test Time	Results compared to
Quality Control	Pass / fail	<ul style="list-style-type: none"> <li>• Defined</li> <li>• Short</li> </ul>	Material specification
Qualification / validation	Pass / fail	<ul style="list-style-type: none"> <li>• Defined</li> <li>• Medium-long</li> </ul>	Reference material or specification
Correlative	Rank-ordered data	<ul style="list-style-type: none"> <li>• Open-ended</li> <li>• Medium</li> </ul>	Natural exposure (Benchmark site)
Predictive	Service life Acceleration factor	<ul style="list-style-type: none"> <li>• Open-ended</li> <li>• Long</li> </ul>	Natural exposure (Service environment)

# What Kind of Test Should I Run?

Accelerated Test Type	Result	Test Time	Results compared to
Quality Control	Pass / fail	<ul style="list-style-type: none"> <li>• Defined</li> <li>• Short</li> </ul>	Material specification
Qualification / validation	Pass / fail	<ul style="list-style-type: none"> <li>• Defined</li> <li>• Medium-long</li> </ul>	Reference material or specification
Correlative	Rank-ordered data	<ul style="list-style-type: none"> <li>• Open-ended</li> <li>• Medium</li> </ul>	Natural exposure (Benchmark site)
Predictive	Service life Acceleration factor	<ul style="list-style-type: none"> <li>• Open-ended</li> <li>• Long</li> </ul>	Natural exposure (Service environment)

# Evolution of Standards

## 1<sup>st</sup> Generation Xenon Automotive Testing

- Introduced in the late 80's as SAE J1888 and SAE J1960.
- Initially were hardware-based, requiring water-cooled xenon lamps, but current revisions are performance-based which allow a multitude of chamber designs to satisfy the standards as long as conditions are met.
- When first introduced, these standards provided the best methods in screening and qualifying of materials
- SAE J1960 at the time
  - Correlated well to outdoor testing of coatings developed at the beginning of the clear-coat / base-coat era

# How to run laboratory test...

- Interpretation of test conditions
- Setting up Q-SUN xenon-arc test chamber
- Specimen preparation and mounting
- Running the test
- Evaluating and reporting

# Forces of Weathering

- Sunlight

- Light source
- Optical filter
- Irradiance Control point and setting



- Heat

- Black Panel or Insulated Black Panel
- Chamber Air Temperature



- Moisture

- Relative Humidity
- Spray







# SAE J2412

Accelerated Exposure of Automotive Interior  
Trim Components Using a Controlled Irradiance  
Xenon-Arc Apparatus

# Xenon-Arc Light Source

## SAE J2412

- Conveniently, the light source, xenon-arc, is mentioned directly in the title.
- In case there are any doubts, additional notes are included in the standard, giving users clear instruction:

*§ 5.2 The apparatus employed utilizes a xenon-arc lamp(s) as the source of radiation...*

*§ 5.2.1 A more complete description of the apparatus can be found in ASTM G151 and ASTM G155*

# Optical Filter Requirements

## SAE J2412

- SAE J2412 specifies an *Extended UV* optical filter, resulting in a relatively harsh spectrum.
- The device manufacturer has responsibility to ensure a particular filter satisfies the standard.

*§ 5.1 The equipment manufacturer is responsible for the approval of the equipment and for providing the proof of compliance of the critical test parameters, including the different spectral power distributions (SPD)...*

*§ 6.1.3 Fit the xenon-arc burner with an Extended UV Filter to provide a spectral power distribution (SPD) indicated in Appendix A, Table A1 and Figure A1.*

# Appendix A, Figure A1

## SAE J2412

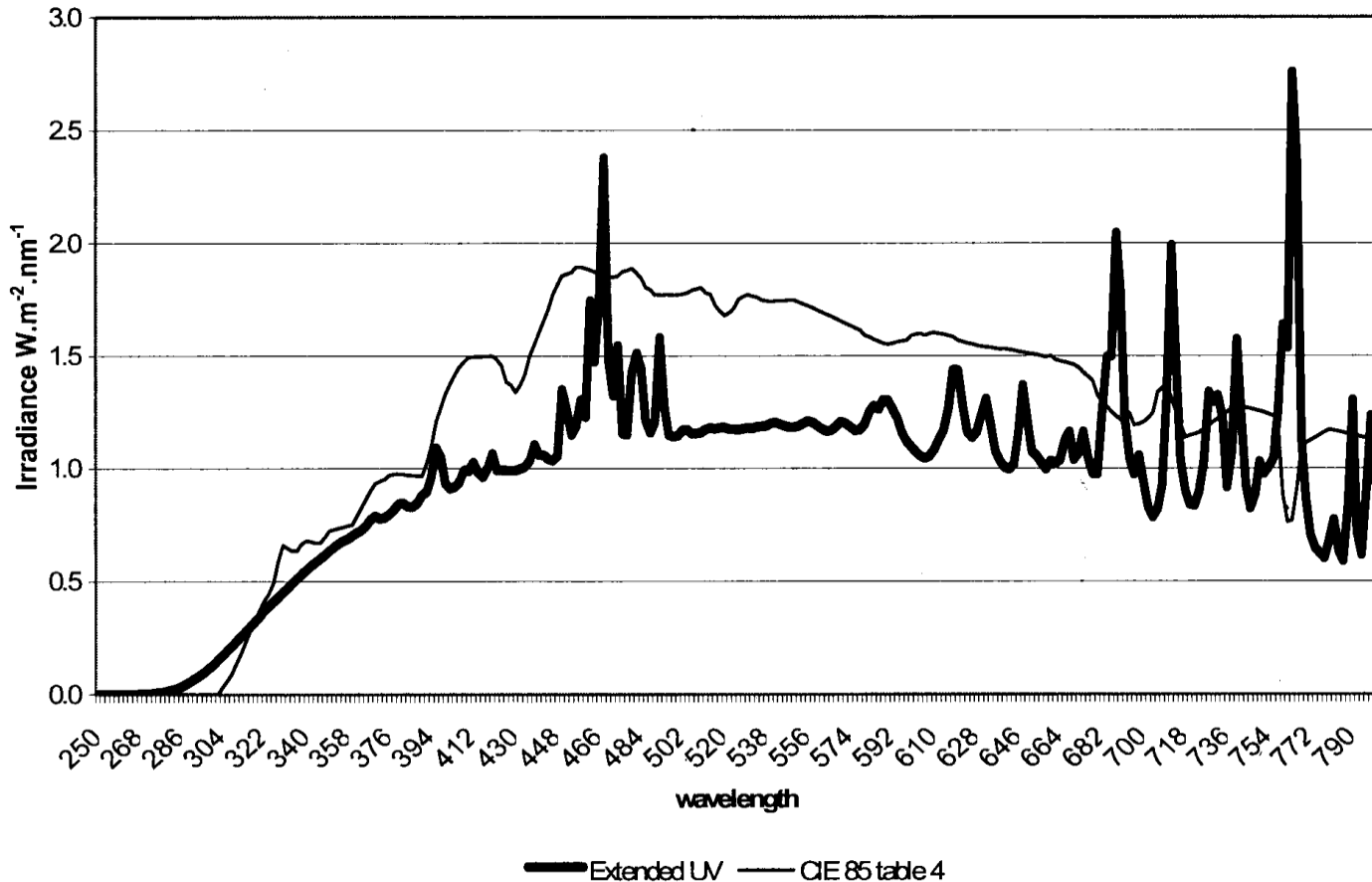
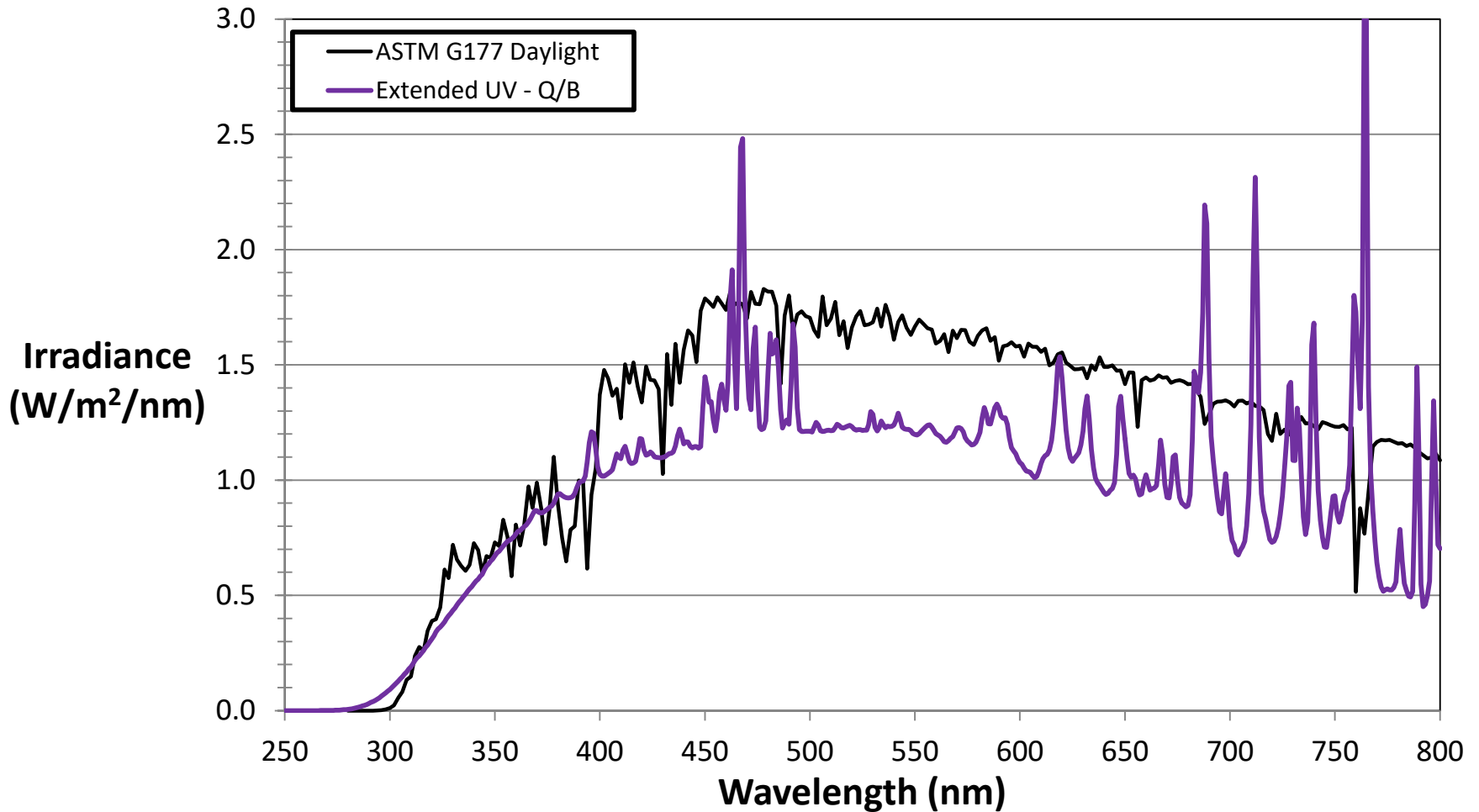


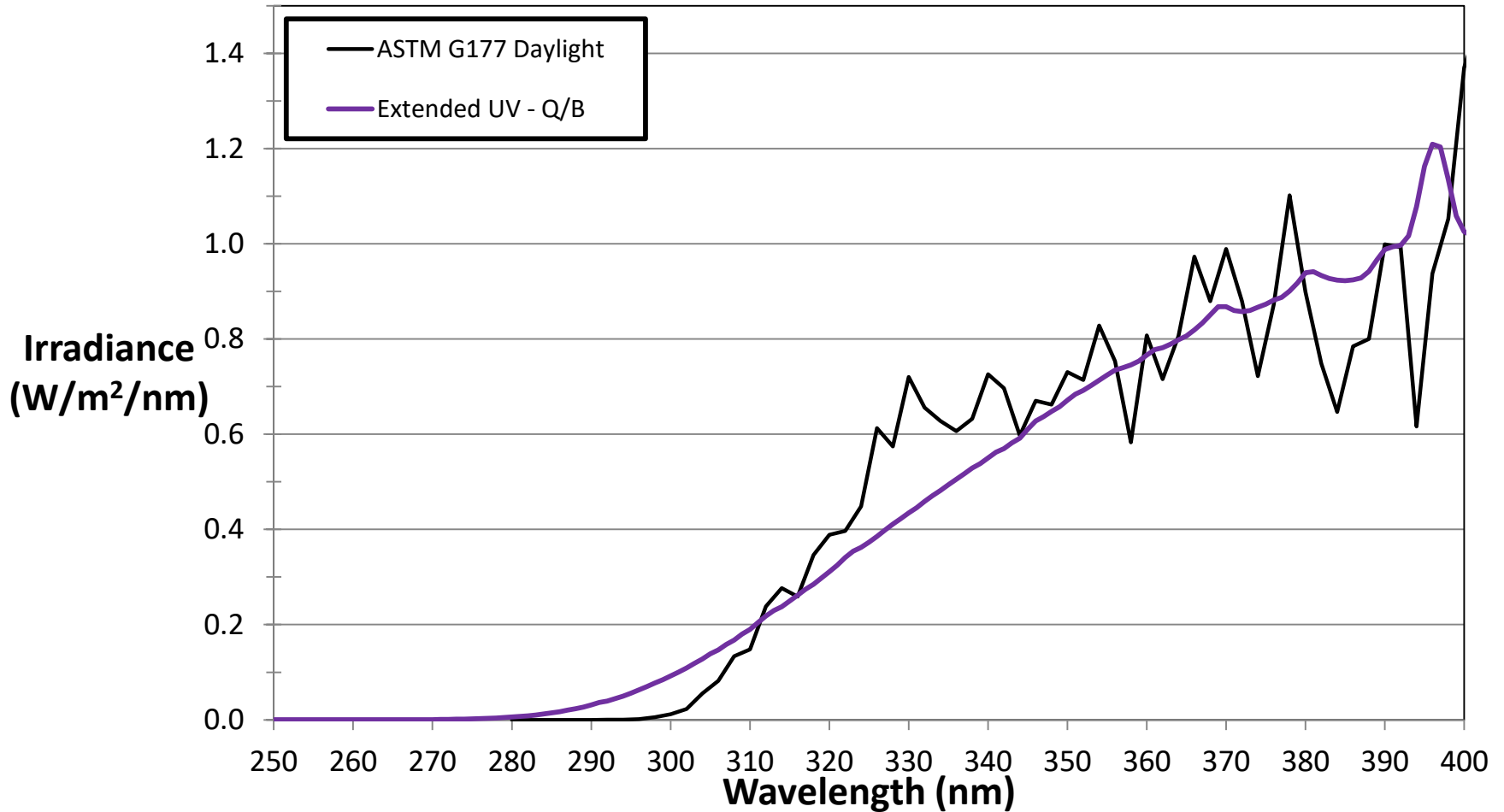
Figure A1 – Extended UV filter vs. sunlight spectral power distribution (SPD)

# Xenon Arc with Extended UV-Q/B

## UV and Visible Light

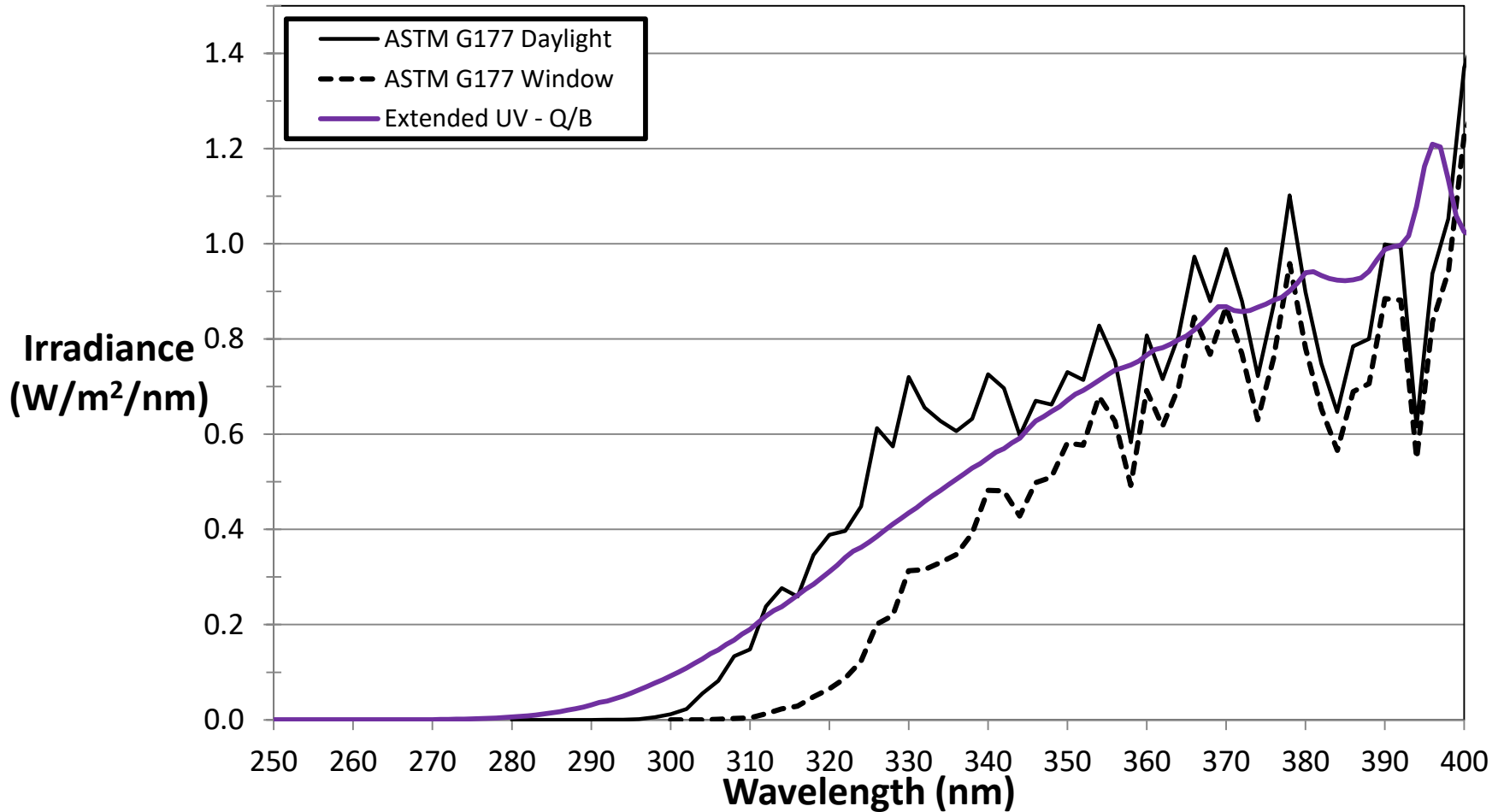


# Xenon Arc with Extended UV-Q/B UV Light



# Xenon Arc with Extended UV-Q/B

## UV Light



# Spectral Requirements Table

## SAE J2412

*Table A1 (Part 1) - Irradiance in W/m<sup>2</sup> based on 81 SPD's for Xenon-Arcs with extended UV filters normalized to exactly 0.55 W.m<sup>-2</sup> at 340 nm*

The spectral charts shown are a great visual representation of the optical filter intent, but the real requirement is given in *Table A1*.

bandpass	average	standard deviation	min	max
250-260	0.00	0.00	0.00	0.02
261-270	0.00	0.00	0.00	0.03
271-280	0.04	0.02	0.01	0.10
281-290	0.22	0.08	0.09	0.42
291-300	0.73	0.16	0.36	1.16
301-310	1.60	0.20	1.04	2.19
311-320	2.72	0.19	2.13	3.26
321-330	3.91	0.14	3.48	4.29
331-340	5.06	0.04	4.95	5.18
341-350	6.10	0.10	5.91	6.33
351-360	7.06	0.22	6.48	7.67
361-370	7.97	0.33	7.19	8.83
371-380	8.65	0.48	7.55	9.77
381-390	9.17	0.59	7.99	10.57
391-400	10.67	0.70	9.17	13.29
300-400	63.10	1.97	58.30	68.17



# Irradiance, Panel Temperature, Chamber Air Temperature & RH

- All four parameters are to be controlled automatically in SAE J2412

*§ 5.2 The instrument shall have the means to automatically control irradiance, Black Panel temperature, chamber temperature and relative humidity.*

# Narrowband 340 nm Irradiance

## SAE J2412

*Note 1:  $0.55 \text{ Wm}^{-2}\text{nm}^{-1}$  at 340 nm is the historic preferred irradiance for this test.. Equipment monitoring a broad band rather than the narrow band will have different target values than those listed in Table 1*

**Table 1 - Target values at control panel sensor**

Controls	Dark Cycle		Light Cycle	
	Target	Tolerance	Target	Tolerance
Automatic Irradiance	None		Contractual Agreement (See Note 1)	$\pm 0.02 \text{ Wm}^2 \text{ nm}^{-1}$
Black Panel Temperature	38 °C	$\pm 2.5 \text{ °C}$	89 °C	$\pm 2.5 \text{ °C}$
Dry Bulb Temperature	38 °C	$\pm 3 \text{ °C}$	62 °C	$\pm 2 \text{ °C}$
Relative Humidity	95%	$\pm 10\%$	50%	$\pm 10\%$
Radiant Exposure	Not applicable		Contractual Agreement	
Cycle Duration	1 hour (See Note 2)	$\pm 6 \text{ minutes}$	3.8 hours (See Note 2)	$\pm 6 \text{ minutes}$

# Black Panel Temperature Sensor

## SAE J2412

§ 5.3 The apparatus shall have an uninsulated black panel thermometer as described in ASTM G151

**Table 1 - Target values at control panel sensor**

Controls	Dark Cycle		Light Cycle	
	Target	Tolerance	Target	Tolerance
Automatic Irradiance	None		Contractual Agreement (See Note 1)	$\pm 0.02 \text{ Wm}^2 \text{ nm}^{-1}$
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Relative Humidity	95%	$\pm 10\%$	50%	$\pm 10\%$
Radiant Exposure	Not applicable		Contractual Agreement	
Cycle Duration	1 hour (See Note 2)	$\pm 6 \text{ minutes}$	3.8 hours (See Note 2)	$\pm 6 \text{ minutes}$

# Air Temperature and Relative Humidity

## SAE J2412

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Dry Bulb Temperature	38 °C	$\pm 3 \text{ °C}$	62 °C	$\pm 2 \text{ °C}$
Relative Humidity	95%	$\pm 10\%$	50%	$\pm 10\%$
Radiant Exposure	Not applicable		Contractual Agreement	
Cycle Duration	1 hour (See Note 2)	$\pm 6 \text{ minutes}$	3.8 hours (See Note 2)	$\pm 6 \text{ minutes}$

# Cycle Duration

## SAE J2412

*Note 2: Other cycle times may be used upon contractual agreement, if, for example, an irradiance different than the specified default value is specified*

**Table 1 - Target values at control panel sensor**

Controls	Dark Cycle		Light Cycle	
	Target	Tolerance	Target	Tolerance
Automatic Irradiance	None		Contractual Agreement (See Note 1)	$\pm 0.02 \text{ Wm}^2 \text{ nm}^{-1}$
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Relative Humidity	95%	$\pm 10\%$	50%	$\pm 10\%$
Radiant Exposure	Not applicable		Contractual Agreement	
Cycle Duration	1 hour (See Note 2)	$\pm 6 \text{ minutes}$	3.8 hours (See Note 2)	$\pm 6 \text{ minutes}$



# SAE J2527

Performance Based Standard for Accelerated Exposure of Automotive Exterior Materials Using a Controlled Irradiance Xenon-Arc Apparatus

# Xenon-Arc Light Source

## SAE J2527

- As with SAE J2412, the title of J2527 includes the light source directly in the title
- Additional criteria give users instruction:
  - § 5.2 The apparatus utilizes a xenon-arc lamp(s) as the source of radiation.*
  - § 5.2.1 A more detailed description of the apparatus can be found in ASTM G151 and ASTM G155*

# Optical Filter Requirements

## SAE J2527

- SAE J2527 allows for either Extended-UV optical filters or Daylight filters to be used for exposure.

*§ 6.3 Fit the xenon-arc lamp with the appropriate optical filters to meet the intended spectral power distribution (SPD). The filters shall provide an SPD that falls within the respective ranges shown in Tables C1 or C2 in Appendix C. Refer to Figure C1 or C2 in Appendix C for representative spectral power distributions.*



# Appendix C, Figure C2

## SAE J2527

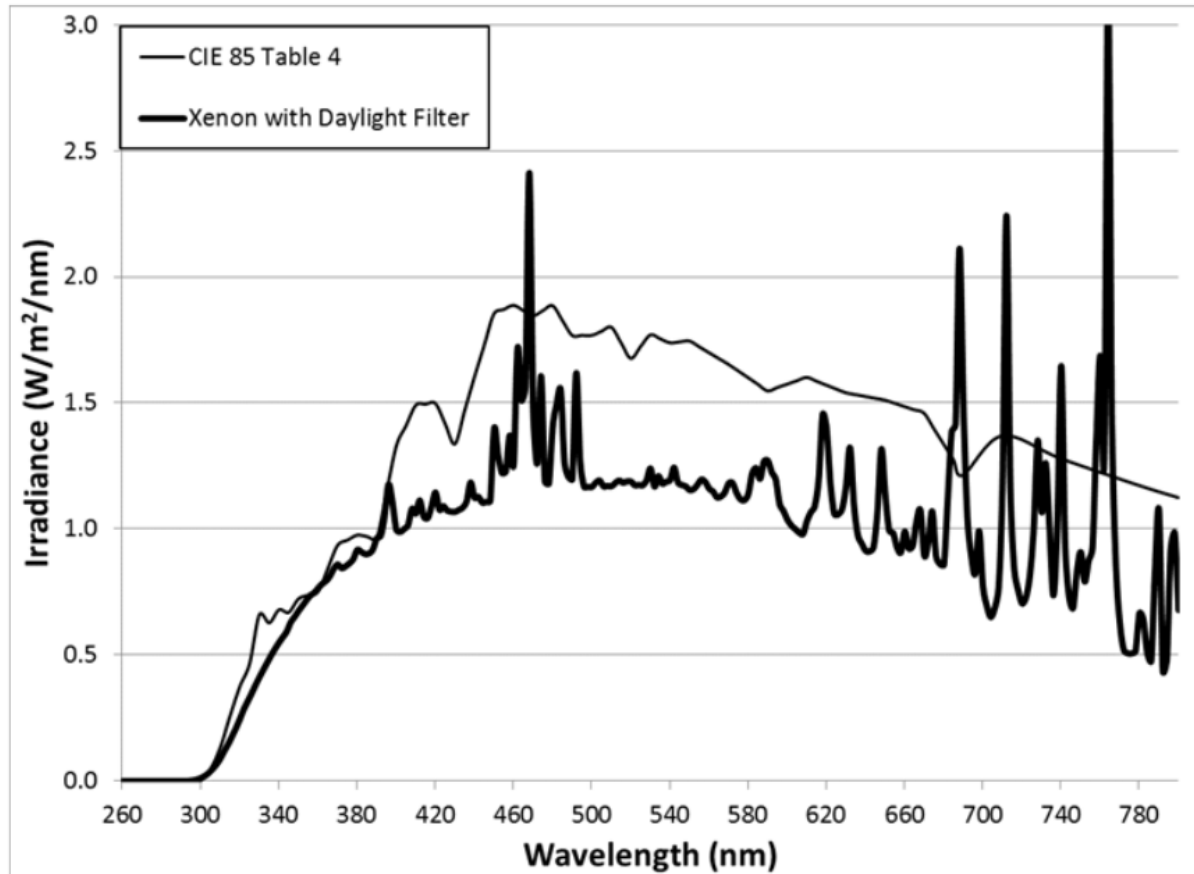
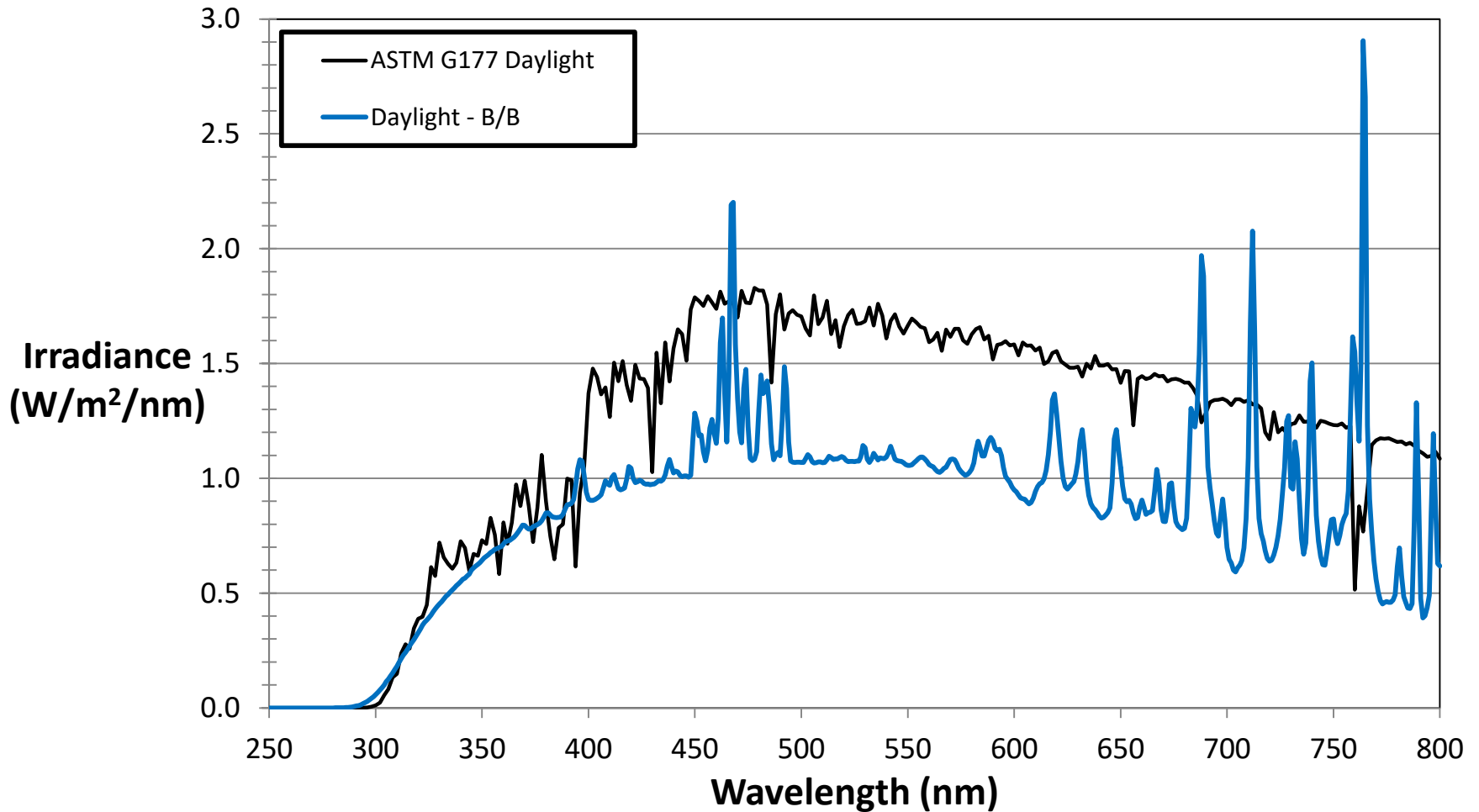


Figure C2 – Example of daylight filter vs. sunlight spectral power distribution

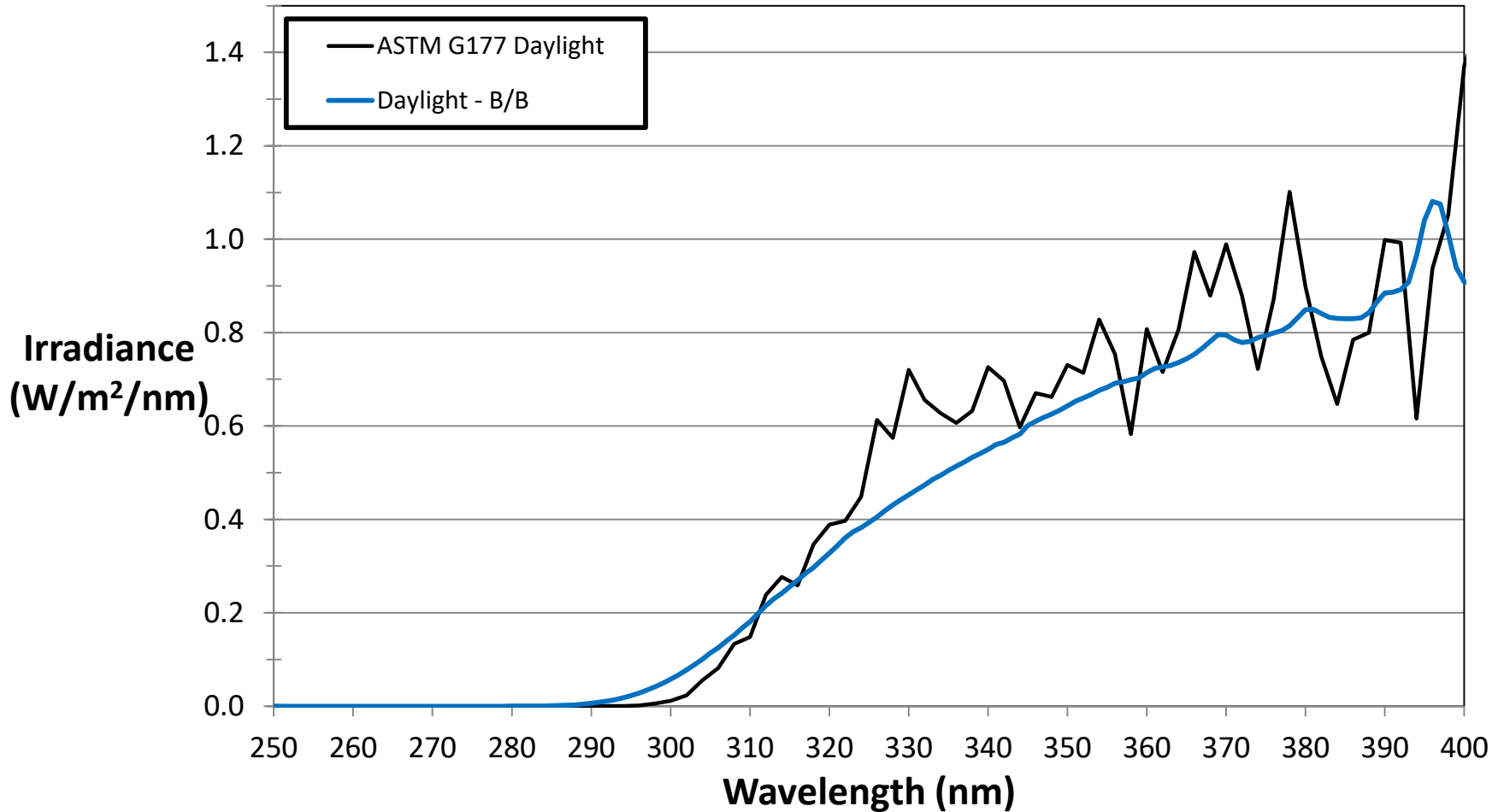
# Xenon Arc with Daylight-B/B Filters

## UV and Visible Light

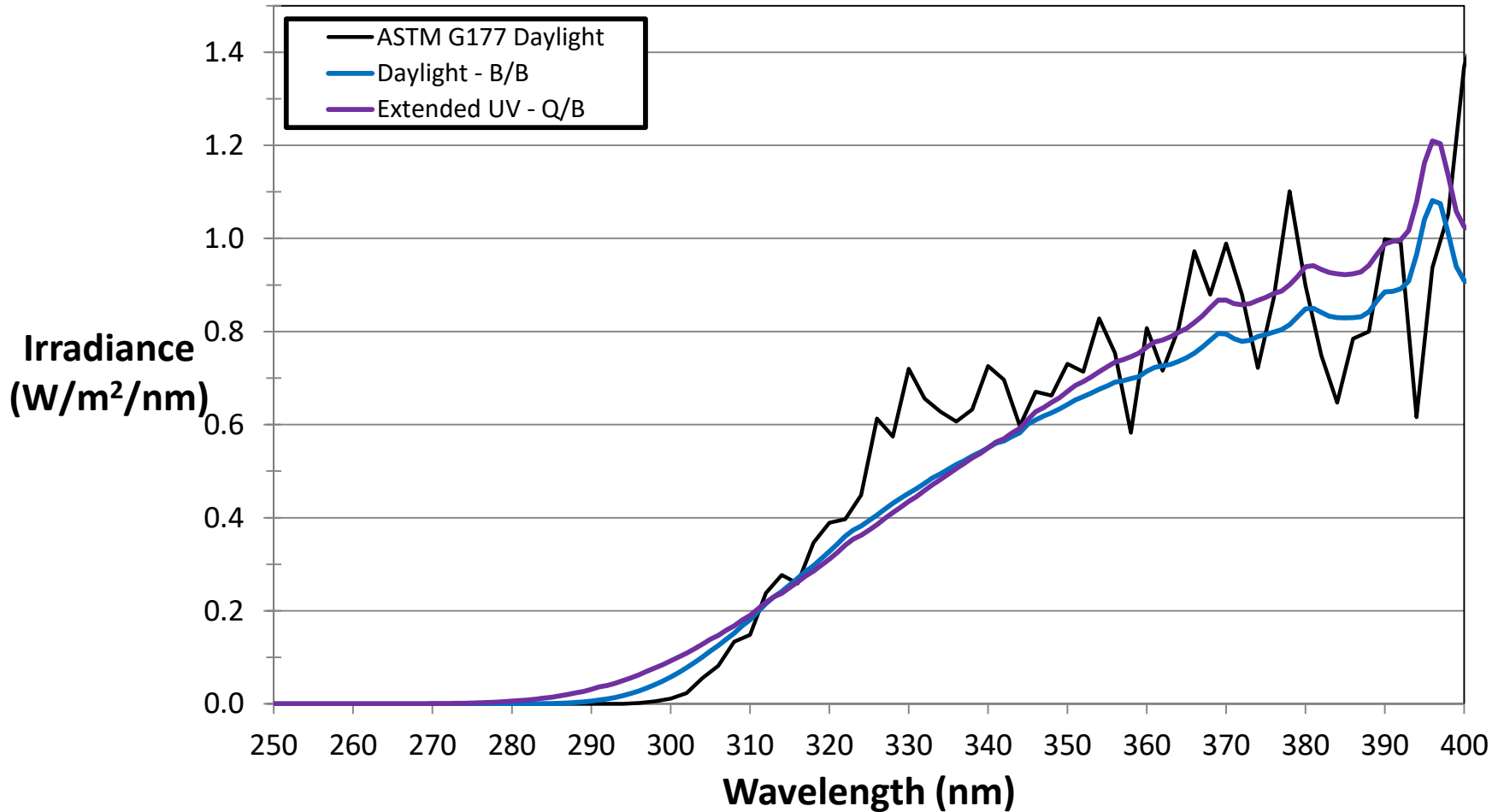


# Xenon Arc with Daylight-B/B Filters

## UV Light



# Xenon Arc Extended UV-Q/B, Daylight-B/B Filters



# Spectral Requirements Table

## SAE J2527

Table C2 - Daylight filters

*Irradiance in W/m<sup>2</sup> based on 111 SPD'S for Xenon-Arcs with Daylight Filters Normalized to Exactly 0.55 Wm<sup>-2</sup>nm<sup>-1</sup>" at 340 NM*

Bandpass	Mean	Std. Dev	Min	Max	Lower 95%	Upper 95%
250-260	0.00	0.00	0.00	0.00	0.00	0.00
261-270	0.00	0.00	0.00	0.00	0.00	0.00
271-280	0.00	0.00	0.00	0.01	0.00	0.00
281-290	0.02	0.02	0.00	0.11	0.00	0.06
291-300	0.19	0.10	0.03	0.55	0.00	0.38
301-310	0.77	0.21	0.32	1.46	0.35	1.18
311-320	1.91	0.21	1.31	2.68	1.49	2.33
321-330	3.39	0.13	2.96	3.97	3.12	3.65
331-340	4.92	0.06	4.68	5.11	4.80	5.03
341-350	6.24	0.09	5.80	6.40	6.06	6.43
351-360	7.40	0.22	6.66	7.82	6.97	7.84
361-370	8.58	0.41	7.56	9.82	7.76	9.39
371-380	9.25	0.60	8.09	11.36	8.04	10.45
381-390	9.92	0.89	8.39	13.71	8.15	11.69
391-400	11.88	1.44	9.64	18.57	8.99	14.76
300-400	64.31	3.57	57.79	78.96	57.16	71.45

The spectral requirements for SAE J2527 are given in Appendix C.

- **Table C1** details Extended UV Filters – for historical matching
- **Table C2** details Daylight Filters – recommended for more realistic test.

# Irradiance, Panel Temperature, Chamber Air Temperature & RH

- All four parameters are to be controlled automatically in SAE J2527

*§ 5.2 The apparatus shall have the means to simultaneously and automatically control irradiance, black panel temperature, relative humidity, and chamber temperature.*

# Narrowband 340 nm Irradiance

## SAE J2527

*\* 0.55 W·m<sup>-2</sup>·nm<sup>-1</sup> at 340 nm is the historic preferred irradiance for this test. An apparatus that monitors irradiance using a broadband rather than a narrowband will have a different value*

**Table 2 - Target values at control panel sensor**

Controls	Dark+Spray Step 1		Light Step 2,3,4	
	Target	Operational Fluctuation	Target	Operational Fluctuation
Automatic irradiance	None		0.55 Wm <sup>-2</sup> nm <sup>-1</sup> at 340 nm *	
Black panel temp.	None		70 °C	± 3 °C
Chamber air temp. (Dry bulb)	38 °C	Not Applicable	47 °C	± 3 °C
Relative humidity	95%	Not Applicable	50%	± 10%
Radiant exposure	None		See applicable specification	

# Black Panel Temperature Sensor

## SAE J2527

§ 5.3 The apparatus shall have an un-insulated black panel thermometer as described in ASTM G151 unless otherwise agreed upon by contractual parties.

**Table 2 - Target values at control panel sensor**

Controls	Dark+Spray Step 1		Light Step 2,3,4	
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Automatic irradiance	None		0.55 Wm <sup>-2</sup> nm <sup>-1</sup> at 340 nm *	
Black panel temp.	None		70 °C	± 3 °C
Chamber air temp. (Dry bulb)	38 °C	Not Applicable	47 °C	± 3 °C
Relative humidity	95%	Not Applicable	50%	± 10%
Radiant exposure	None		See applicable specification	



# Air Temperature and Relative Humidity

## SAE J2527

§ 5.2 *The apparatus shall have the means to simultaneously and automatically control irradiance, black panel temperature, relative humidity, and chamber temperature.*

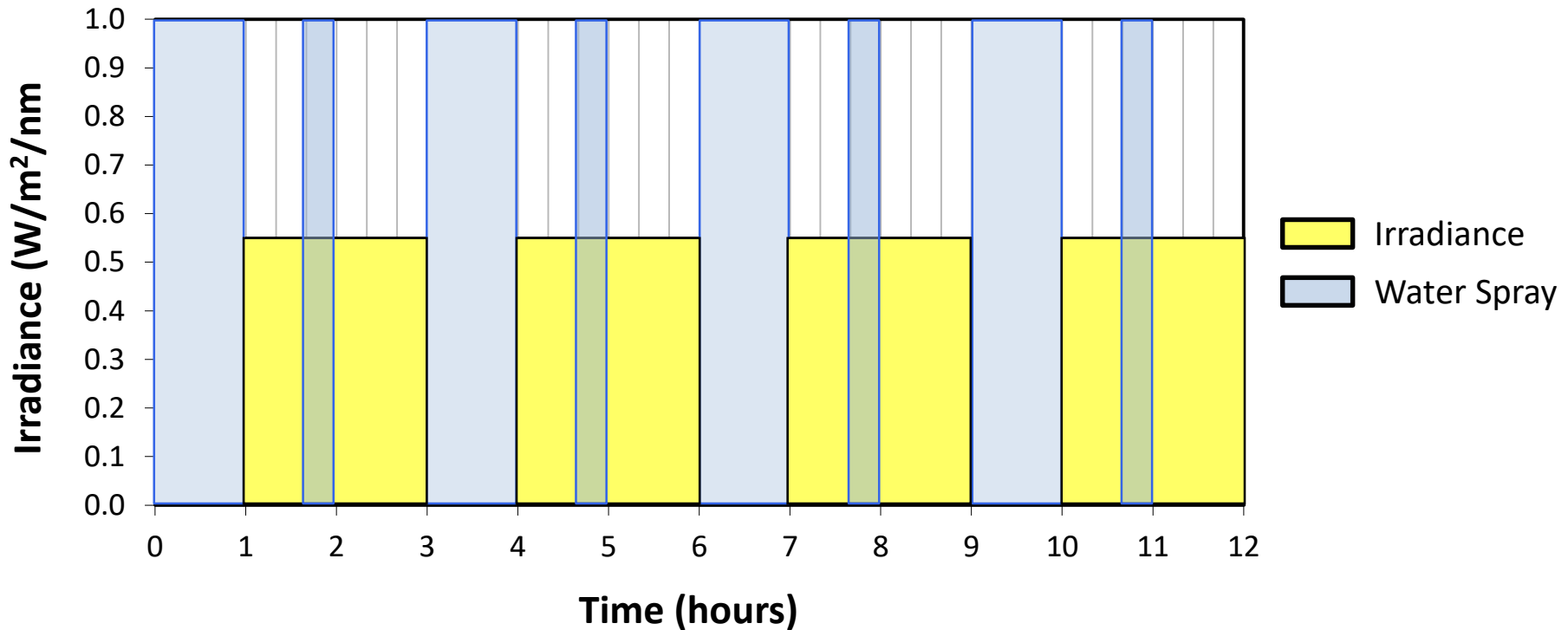
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Black panel temp.	None		70 °C	± 3 °C
Chamber air temp. (Dry bulb)	38 °C	Not Applicable	47 °C	± 3 °C
Relative humidity	95%	Not Applicable	50%	± 10%
Radiant exposure	None		See applicable specification	

# Cycle Duration

## SAE J2527

§ 6.4 Choose the program cycle which provides 120 minutes of light and 60 minutes of dark in the following cycle: 60 minutes of dark with both back and front spray, 40 minutes of light followed by 20 minutes of light and front specimen spray, followed by 60 minutes of light, and repeating. The test sequence shall follow the condition set up in Table 1



# Additional Requirements

## SAE J2412 & SAE J2527

- Specimen Repositioning
  - SAE J2412 & SAE J2527 § 5.4.1
- DI Water Supply (< 1 ppm solids and < 0.2 ppm silica)
  - SAE J2412 § 6.1.1
  - SAE J2527 § 6.2
- Test duration to be reported by total radiant exposure (kJ/m<sup>2</sup>/nm)
  - SAE J2412 & SAE J2527 § 9.2.6

# How to run laboratory test...

- Interpretation of test conditions
- **Setting up Q-SUN xenon-arc test chamber**
- Specimen preparation and mounting
- Running the test
- Evaluating and reporting

# How to Program SAE J2412 in Q-SUN?

- Q-SUN Xe-2 or Xe-3
- Extended UV-Q/B Filter
- Narrowband 340 nm Sensor
- Uninsulated Black Panel

Step	Function	Relative Humidity	Irradiance	Black Panel Temp	Chamber Air Temp	Step Time (hh:mm)
1	Light	50 %	0.55 W/m <sup>2</sup> /nm	89 °C	62 °C	3:48
2	Dark	95 %			38 °C	1:00

# How to Program SAE J2527 in Q-SUN?

- Q-SUN Xe-2HBS or Xe-3HBS (or any other –BS configuration)
- Extended UV-Q/B Filter -or- Daylight-BB Filter
- Narrowband 340 nm Sensor
- Uninsulated Black Panel

Step	Function	Relative Humidity	Irradiance	Black Panel Temp	Chamber Air Temp	Step Time (hh:mm)
1	Dark + Spray Front + Back	95 %			38 °C	1:00
2	Light	50 %	0.55 W/m <sup>2</sup> /nm	70 °C	47 °C	0:40
3	Light + Spray	50 %	0.55 W/m <sup>2</sup> /nm	70 °C	47 °C	0:20
4	Light	50 %	0.55 W/m <sup>2</sup> /nm	70 °C	47 °C	1:00

# Chamber Sensor Calibration

Sensor	Device
Irradiance	CR20/340QB CR20/340BB (SAE J2527 only) UC20/340
Panel	CT202/BP UC202/BP
Chamber Air Temperature Relative Humidity	Chamber Air Temperature / Relative Humidity Sensor



*UC20/340 Smart Sensor*



*UC202/BP Smart Sensor*

# How to run laboratory test...

- Interpretation of test conditions
- Setting up Q-SUN xenon-arc test chamber
- **Specimen preparation and mounting**
- Running the test
- Evaluating and reporting



# Mesh Tray in Q-SUN Xe-3

- In order for water delivery during SAE J2527's back spray, a mesh tray is required in an Xe-3HBS.
- The mesh tray may be used for SAE J2412 in order to meet the non-mandatory polystyrene tolerance.
- The mesh tray is not applicable to the Xe-2; open back specimen holders should be used.



*Xe-3 Mesh Tray*

# Specimen Preparation

- SAE J2412 & SAE J2527 Specimen Preparation and Conditioning

§ 7.1 Prepare the specimens to be exposed to fit the specimen holder being used. Refer to ASTM G 147 for conditioning and handling of specimens.
- SAE J2412 Back textiles with cardboard

§ 7.3 Interiors textiles (body cloth, carpet, vinyl coated fabrics, etc.) shall always be backed with white cardboard. In all cases the white cardboard shall be the size of the specimen holder to eliminate any gaps.
- SAE J2412 Fill unused slots and gaps with cardboard

§ 7.4 Fill all unused slots with an inert non-reflective material (e.g., white cardboard panels) to maintain desired air flow.



Textile Specimens  
on cardstock in Xe-2 holder

# How to run laboratory test...

- Interpretation of test conditions
- Setting up Q-SUN xenon-arc test chamber
- Specimen preparation and mounting
- **Running the test**
- Evaluating and reporting

# Specimen Repositioning

- Ensures best repeatability and reproducibility
- Perform at least 4 times per test



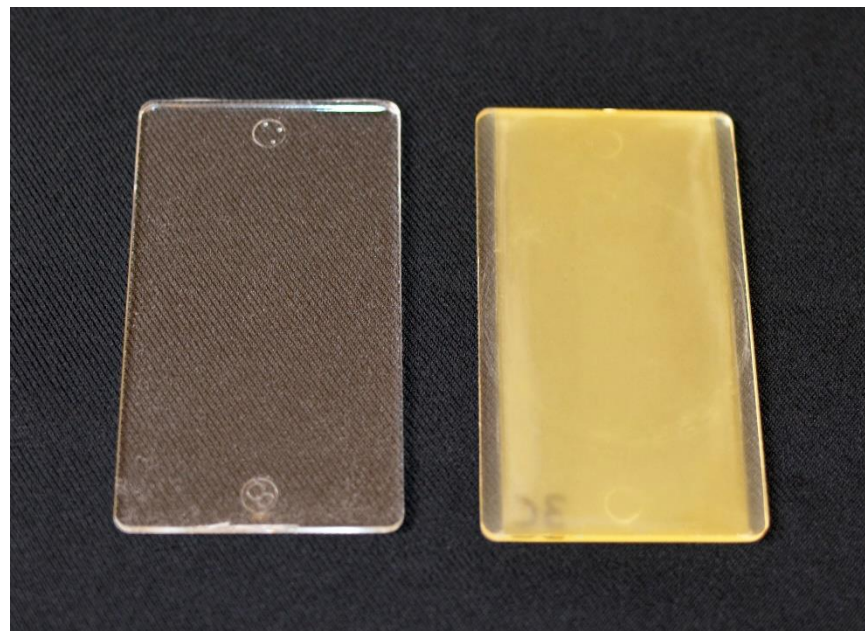
# Matching Polystyrene Tolerance

- Instrumental Color Measurement
  - CIELAB, D65 illuminant, 10° observer
- Back with white calibration tile
  - Do not back with paper as may include optical brighteners
- Mount polystyrene in specimen holder
- Mesh Tray
- Place chip close or directly next to the black panel

# Polystyrene Exposure



*Polystyrene Chip Location*



*Polystyrene Before and After Exposure*

# Polystyrene Lot 9 Specification (non-mandatory)

Radiant Dosage (kJ/m <sup>2</sup> ·nm @ 340 nm)	95% Tolerance Interval for Reflectance $\Delta b^*$ , SAE J1885 and J2412 Extended UV Filter		
	Low	Target	High
37.6			
75.2	1.30	2.40	3.50
112.8	1.78	3.03	4.29
150.4	2.26	3.66	5.07
188.0	2.74	4.30	5.86
225.6	3.21	4.93	6.64
263.2	3.69	5.56	7.43
300.8	4.17	6.19	8.21
338.4	4.65	6.83	9.00
376.0	5.13	7.46	9.79
413.6	5.61	8.09	10.57
451.2	6.09	8.72	11.36
488.8	6.56	9.35	12.14
526.4	7.04	9.99	12.93
564.0	7.52	10.62	13.71
601.6	8.00	11.25	14.50

***Automotive Materials Association Round Robin Study on PS Lot 9 SAE J2412 Exposure***

# Polystyrene Lot 9 Specification (non-mandatory)

SAE J2527 - Polystyrene Lot 9 Reference Material Specifications (Sept 2017)

Radiant Dosage (kJ/m <sup>2</sup> ·nm @340 nm)	95% Tolerance Interval for Reflectance $\Delta b^*$ , SAE J1960 and J2527 Table C1 Spectra Extended UV Filter			95% Tolerance Interval for Reflectance $\Delta b^*$ , SAE J2527 Table C2 Spectra Daylight Filter		
	Low	Target	High	Low	Target	High
	31.6					
63.2	0.40	1.20	2.00	0.50	1.00	1.50
94.8	0.69	1.57	2.45	0.71	1.29	1.86
126.4	0.99	1.94	2.89	0.93	1.57	2.21
158.0	1.28	2.31	3.34	1.14	1.86	2.57
189.6	1.57	2.68	3.79	1.36	2.14	2.93
221.2	1.86	3.05	4.23	1.57	2.43	3.29
252.8	2.16	3.42	4.68	1.79	2.71	3.64
284.4	2.45	3.79	5.13	2.00	3.00	4.00
316.0	2.74	4.16	5.57	2.21	3.29	4.36
347.6	3.04	4.53	6.02	2.43	3.57	4.71
379.2	3.33	4.90	6.46	2.64	3.86	5.07
410.8	3.62	5.27	6.91	2.86	4.14	5.43
442.4	3.91	5.64	7.36	3.07	4.43	5.79
474.0	4.21	6.01	7.80	3.29	4.71	6.14
505.6	4.50	6.38	8.25	3.50	5.00	6.50

***Automotive Materials Association Round Robin Study on PS Lot 9 SAE J2527 Exposure***



# Periodic Calibration and Lamp Replacement

- Irradiance Calibration
  - 500 hrs
- Temperature Calibration
  - 6 months
- Lamp replacement
  - 1500 hrs
  - Or 3000 hrs with new *E* model configuration

# How to run laboratory test...

- Interpretation of test conditions
- Setting up Q-SUN xenon-arc test chamber
- Specimen preparation and mounting
- Running the test
- Evaluating and reporting

# Evaluating and Reporting

- Visual Assessment
- Grey Scale Fade
- Instrumental Color Assessment
- Gloss retention
- Blistering
- Adhesion
- Duration to be reported as radiant exposure ( $\text{kJ}/\text{m}^2/\text{nm}$ )

# Conclusion

- These two standards have been instrumental in the development of material reliability and performance. The majority of the performance of these standards is for Qualification and Validation.
- Though new standards have better correlation to service environment or more accurate representation of light exposure, the standards are still very popular, with many manufacturers and automotive suppliers still performing.
- The Q-SUN Xe-2 and Xe-3 are both qualified to run either standard with the proper configuration and setup.

# Thank you for Listening!



## Questions?

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