
ALL THINGS LIGHTING® ASSOCIATION

***Illuminating the Complicated***

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# ATLA S001-A

## AMENDMENT TO STANDARD FORMAT FOR THE ELECTRONIC TRANSFER OF LUMINAIRE OPTICAL DATA, INCLUDING JSON SPECIFICATION

## REVISION 1.02

| **Errata** | |
|---|---|
| 22/01/20 | Changed “NumberTop” to “NumberC270” and “TopArea” to “C270Area” in “C270Face” element of JSON schema. |
| 22/05/17 | Changed “candela per square meter” to “lux” in Section 4.5.19.4.3.<br>Deleted Note 2 in Section 4.5.19.4.3. |
| 22/05/18 | Revision 1.00 release. |
| 22/06/17 | Added root element name to Section 4.0.<br>Added Note to Section 4.5.17.1.4, Normalized Element.<br>Added Note 2 to Section 4.5.17.1.7, Quantum Element.<br>Added “FileType” element to Section 4.8.2, JSON Schema and Appendix A.2. |
| 22/07/01 | Added interchangeable version statement to Section 4.8.<br>Added Notes 1 and 2 to Symmetry element in Tables 22, 25, 28, 32 and 34. |
| 22/07/05 | Added Multiplier element clarification to Clauses 4.5.14.1.7, 4.5.15.3.7, 4.5.16.3.7, 4.5.17.1.6, 4.5.17.1.7, 4.5.17.2.8, 4.5.18.7, 4.5.19.4.3, 4.5.20.6.3, 4.5.21.6.3, and 4.5.22.4.4. |




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# 1.0 Introduction and Scope

## 1.1 Introduction

The architectural and roadway lighting communities have long relied on standardized data formats for the electronic transfer of far-field photometric data and related information. These data formats include IES LM-63-02, CIBSE TM14, and EULUMDAT. Apart from a few minor revisions, these data formats have remained essentially unchanged for the past several decades.

With the introduction of solid-state lighting with color-changing capabilities, there is a need to include spectral power distributions in these data representations. There is also a need to represent radiant and photosynthetically active radiation (PAR) intensity distributions for horticultural, aquacultural, and animal husbandry lighting applications.

Unfortunately, it is difficult to impossible to incorporate such information in existing photometric data standards. It is also unreasonable to develop new standards specifically for specialized applications, such as horticultural lighting. This document therefore presents a standardized data format for use with all lighting applications.

The represented data may be obtained when testing or simulating the optical characteristics of a luminaire, which may then be used with lighting design and analysis software, architectural visualization software, or optical design software.

The data is formatted in accordance with W3C Extensible Markup Language (XML) 1.1 Recommendation and the W3C XML Schema Definition Language (XSD). This allows end users to utilize and view the data directly without the need for proprietary software.

In the event of any ambiguity or discrepancy with respect to the textual specification and the XML Schema in this document, the XML Schema shall take precedence.

In the event of any ambiguity or discrepancy with respect to the description of XML or XML Schema in this document, the W3C Recommendations shall take precedence.

## 1.2 Scope

This document specifies an electronic (XML-based) data format for the transfer of luminaire optical data useful for lighting design and analysis.

Details about the XML document format, XML schema, XSLT transforms and more can be found at the W3C's website, the authority for the XML document format. This document is intended as a description of a specific implementation of an XML document, and is not a tutorial on the XML document format itself.

# 2.0 Normative References

ANSI C78.377-2017. American National Standard for Electric Lamps – Specifications for the Chromaticity of Solid-State Lighting Products. Rosslynn, Virginia: National Electrical Manufacturers Association.

ANSI/ASABE [S640]. Quantities and Units of Electromagnetic Radiation for Plants (Photosynthetic Organisms). St. Joseph, MI: American Society of Agricultural and Biological Engineers.

ANSI/IES LS-1-21, Nomenclature and Definitions for Illuminating Engineering. New York: Illuminating Engineering Society of North America.

CIE 13.3-1995. Method of Measuring and Specifying Colour Rendering Properties of Light Sources. Commission Internationale de l'Eclairage, Vienna, Austria.




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CIE 15:2018, Fourth Edition. Colorimetry. Commission Internationale de l'Eclairage, Vienna, Austria.

CIE 63-1984. The Spectroradiometric Measurement of Light Sources. Commission Internationale de l'Eclairage, Vienna, Austria.

CIE 117-1995. Discomfort Glare in Interior Lighting. Commission Internationale de l'Eclairage, Vienna, Austria.

CIE 121-1996. The Photometry and Goniophotometry of Luminaires. Commission Internationale de l'Eclairage, Vienna, Austria.

CIE 224-2017. CIE 2017 Colour Fidelity Index for Accurate Scientific Use. Commission Internationale de l'Eclairage, Vienna, Austria.

ECMA-404. The JSON Data Interchange Syntax, Second Edition. (http://www.ecma-international.org/publications/files/ECMA-ST/ECMA-404.pdf)

IES LM-63-19. Standard File Format for Electronic Transfer of Photometric Data. New York: Illuminating Engineering Society of North America.

IES LM-75-19. Goniophotometer Types and Photometric Coordinates. New York: Illuminating Engineering Society of North America.

IES TM-27-20. IES Standard Format for the Electronic Transfer of Spectral Data. New York: Illuminating Engineering Society of North America.

IES TM-30-20. IES Method for Evaluating Light Source Color Rendition. New York: Illuminating Engineering Society of North America.

IES TM-33-18. IES Standard Format for the Electronic Transfer of Luminaire Optical Data. New York: Illuminating Engineering Society of North America.

RFC 4122. P. Leach, M. Mealling, and R. A. Salz. Universally Unique Identifier (UUID) URN Namespace, Internet Engineering Task Force; July 2015.

W3C Extensible Markup Language (XML) 1.1, Second Edition (http://www.w3.org/TR/xml11).

W3C XML Schema Definition Language (XSD) 1.1 Part 1: Structures (http://www.w3.org/TR/xmlschema11-1).

W3C XML Schema Definition Language (XSD) 1.1 Part 2: Datatypes (http://www.w3.org/TR/xmlschema11-2).

# 3.0 Definitions

## 3.1 Bandpass Correction

The correction of measured spectral data to account for the bandpass width of the detector element and the scanning interval. There are several methods of bandpass correction, and this correction is usually performed either in the measurement equipment itself or by the data processing software.

## 3.2 Channel Multiplier

A number between 0 and 1 that represents the contribution of a single channel emitter to the measured or simulated spatial intensity distribution and flux of a multichannel luminaire. For example, if a three-channel theatrical luminaire with independently-dimmable red, green, and blue light-emitting




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diode emitters generates 1,000 lumens of white light with a correlated color temperature (CCT) of 6500 K, the corresponding channel multipliers might be 0.63, 0.74, and 1.00 respectively.

## 3.3 Dimensions

For the purposes of this document, a luminaire shall be represented as a rectangular or cylindrical object with dimensions of length, width, and (optionally) height, as shown in FIG. 1:

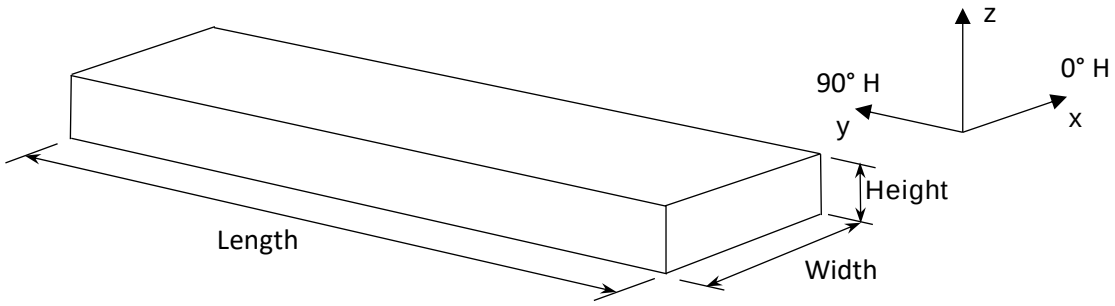


Figure 1 – Luminaire dimensions

where the width dimension is parallel to the 0 – 180 degrees axis of the intensity distribution, and the length dimension is parallel to the 90 – 270 degrees axis of the intensity distribution. (This convention conforms with CIE 121.)

NOTE 1: The purpose of this geometric object is to represent planar surfaces for the emission areas (see Clause 3.7). It is not intended to represent the physical geometry of the luminaire housing.

NOTE 2: The 0-degree axis corresponds with the 90-degree horizontal angle of IES LM-75-19.

The x-y-z coordinate system consists of the x-axis aligned with 0 degrees horizontal, the y-axis aligned with 90 degrees horizontal, and the z-axis aligned with zenith (+90 degrees vertical). The origin is coincident with the geometric center of the rectangular or cylindrical object (which may be different from the emitter center used for measurement purposes).

The four side faces of the enclosing box shall be identified as:

- C0 Perpendicular to 0-degree (+x) axis
- C90 Perpendicular to 90-degree (+y) axis
- C180 Perpendicular to 180-degree (-x) axis
- C270 Perpendicular to 270-degree (-y) axis

All dimensions shall be expressed in meters.

## 3.4 Document

Instead of using “file” as the description for this data storage mechanism, the term “document” will be used. The term “document” is more appropriate when the information may not actually exist as a physical file but may instead be generated dynamically and electronically transmitted.

## 3.5 Emitter

Any device that emits electromagnetic (“optical”) radiation within the wavelength range of 100 nm to 1000 µm.

NOTE: A device that emits optical radiation within the wavelength range of 380 nm to 780 nm (that is, visible light) may also be referred to as a “light source.”




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### 3.6 Emitter Center

The point that represents the origin for intensity distribution measurements. It may be offset from the geometric center of the rectangular or cylindrical luminaire representation. Also referred to as the “photometric center” for goniophotometric applications, it is the point in a luminaire or emitter from which the inverse square law operates most closely in the direction of maximum intensity.

### 3.7 Emission Areas

The areas of a specified face from which optical radiation is emitted. Multiple emission areas per face are allowed, including rectangular and elliptical shapes. They are intended primarily for use in CIE Unified Glare Rating (UGR) and similar visual glare calculations.

### 3.8 Far-field versus Near-field

Far-field intensity measurements assume a point emitter. In practice, the distance from the emitter to the sensor should be at least five times the largest diagonal dimension of the emission area (i.e., the “five-times” rule for goniophotometry).

Near-field illuminance, irradiance, photon flux density, and spectral irradiance measurements are typically made on a regular grid on a plane. No assumptions are made about the dimensions or geometry of the emitter(s).

### 3.9 Geometric Center

The center of the rectangular or cylindrical object defining the luminaire dimensions.

### 3.10 Gonioradiometer

For the purpose of this document, an instrument for measuring the directional radiant intensity, spectral radiant intensity, or spectrally-weighted radiant intensity distribution of an emitter. This definition encompasses goniophotometers, gonioradiometers, and goniospectroradiometers.

### 3.11 Luminous

For the purpose of this document, the term “luminous” is synonymous with “photometric.”

### 3.12 Photon Flux

The rate of flow of photons. It is analogous to radiant flux, except that it is measured in micromoles of photons per second (µmol/s) rather than joules of energy per second (watts). See Annex B, Photon Flux, for further information. Also known as “quantum flux.”

### 3.13 Photon Intensity

The photon flux emitted by an emitter in a given direction. It is measured in micromoles of photons per second per steradian (µmol/s·sr). Analogous to radiant intensity.

### 3.14 Photon Flux Density

The areal density of photon flux incident upon a real or imaginary surface. It is measured in micromoles of photons per second per square meter (µmol/s·$m^2$). Analogous to irradiance.

## 4.0 XML Schema for Luminaire Optical Data

The luminaire optical data document follows the W3C XML Schema presented in Section 4.7.

The XML root element shall be `<ATLA_S001_A>`.




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The XML document is separated into six elements:

1. The required `Version` element, which identifies the XML schema version.

2. The required `Header` element, which contains all generic information about the luminaire;

3. The optional `Luminaire` element, which contains information about the luminaire dimensions, shape, and number of emitters;

4. The optional `Equipment` element, which contains information about the measurement equipment used to perform the optical measurements;

5. The required `Emitter` element, which contains information about the emitter(s), including generic information, intensity distribution data, and spectral power distribution data; and

6. The optional `CustomData` element, which contains information specific to a particular application; for example, government-mandated environmental criteria.

## 4.1 Version Element

The required `Version` element identifies the XML schema version. It shall be “1.0”.

## 4.2 Header Element

The required `Header` element is the parent of the document header section. This section contains information that is not specific to the luminaire data. Header elements are listed in Table 1.

**Table 1. Header Element Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Manufacturer | `Manufacturer` | xs:string | Optional | 4.2.1 |
| Catalog Number | `CatalogNumber` | xs:string | Optional | 4.2.2 |
| GTIN Number | `GTIN` | xs:integer | Optional | 4.2.3 |
| Description | `Description` | xs:string | Yes | 4.2.4 |
| Laboratory | `Laboratory` | xs:string | Yes | 4.2.5 |
| Report Number | `ReportNumber` | xs:string | Yes | 4.2.6 |
| Report Date | `ReportDate` | xs:date | Yes | 4.2.7 |
| Document Creator | `DocumentCreator` | xs:string | Optional | 4.2.8 |
| Document Creation Date | `DocumentCreationDate` | xs:date | Optional | 4.2.9 |
| Unique Identifier | `UniqueIdentifier` | xs:string | Optional | 4.2.10 |
| Comment | `Comment` | xs:string | Optional | 4.2.11 |
| Reference | `Reference` | xs:string | Optional | 4.2.12 |
| More Information URI | `MoreInfoURI` | xs:anyURI | Optional | 4.2.13 |

### 4.2.1 Manufacturer Element

The optional `Manufacturer` element identifies the manufacturer of the luminaire or emitter.

### 4.2.2 Catalog Number Element

The optional `CatalogNumber` element identifies the manufacturer’s product catalog number.




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#### 4.2.3 GTIN Number Element

The optional `GTIN` element identifies the Global Trade Item Number (GTIN) of the luminaire or emitter.

#### 4.2.4 Description Element

The required `Description` element contains a text description of the luminaire or emitter.

#### 4.2.5 Laboratory Element

The required `Laboratory` element identifies the testing laboratory name that performed the data measurements. If the data was generated from a computer simulation and not tested at a laboratory, this field shall contain the name of the company that generated the data.

#### 4.2.6 Report Number Element

The required `ReportNumber` element identifies the testing laboratory report number.

#### 4.2.7 Report Date Element

The required `ReportDate` element identifies the testing laboratory report date using the XSD Date data type, YYYY-MM-DD.

#### 4.2.8 Document Creator Element

The optional `DocumentCreator` element identifies the creator of the document, which may be a test lab, a research group, a standard body, a company or an individual.

#### 4.2.9 Document Creation Date Element

The optional `DocumentCreationDate` element identifies the document creation date using the XSD Date data type, YYYY-MM-DD.

#### 4.2.10 Unique Identifier Element

The optional `UniqueIdentifier` element contains a Universally Unique Identifier (UUID) as defined by RFC 4122. Most scientific programming language libraries include functions that will automatically generate UUIDs.

A UUID is a unique 128-bit value expressed as a string with 32 hexadecimal digits in the format xxxxxxxx-xxxx-xxxx-xxxx-xxxxxxxxxxxx. For example:

21EC2020-3AEA-4069-A2DD-08002B30309D

The intent of the UUID is to uniquely identify the document's measurement data. The document creator shall generate a new UUID whenever the document's measurement data is modified.

The document creator shall also generate a new UUID whenever an existing photometric data file is converted to this standard.

#### 4.2.11 Comment Element

The optional `Comment` element provides arbitrary additional information relating to the tested and reported data.

Multiple `Comment` elements are allowed.



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#### 4.2.12 Reference Element

The optional `Reference` element identifies one or more regulatory standards or other documents with which the luminaire or emitter complies, or the regulatory standards or other documents to which the laboratory measurements conform. This may, for example, be a document name or a web address.

Multiple `Reference` elements are allowed.

#### 4.2.13 More Information URI Element

The optional `MoreInfoURI` element provides a Uniform Resource Identifier (URI) address for further luminaire information.

### 4.3 Luminaire Element

The optional `Luminaire` element is the parent of the luminaire data. Elements are detailed in Table 2.

**Table 2. Luminaire Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Dimensions | `Dimensions` | XML Element | Yes | 4.3.1 |
| Shape | `Shape` | xs:string | Optional | 4.3.2 |
| Number of Emitters | `NumEmitter` | xs:int | Yes | 4.3.3 |

#### 4.3.1 Dimensions Element

The required `Dimensions` element is the parent of the luminaire dimensions data. Elements are detailed in Table 3.

**Table 3. Dimensions Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Length | `Length` | xs:decimal | Yes | 4.3.1.1 |
| Width | `Width` | xs:decimal | Yes | 4.3.1.2 |
| Height | `Height` | xs:decimal | Yes | 4.3.1.3 |

##### 4.3.1.1 Length Element

The required `Length` element specifies the length of the luminaire housing in meters.

##### 4.3.1.2 Width Element

The required `Width` element specifies the width of the luminaire housing in meters.

##### 4.3.1.3 Height Element

The required `Height` element specifies the height of the luminaire housing in meters. (To support legacy photometric data file formats, the value of this element may be zero.)

#### 4.3.2 Shape Element

The luminaire may optionally be represented as an axis-aligned cylindrical object.




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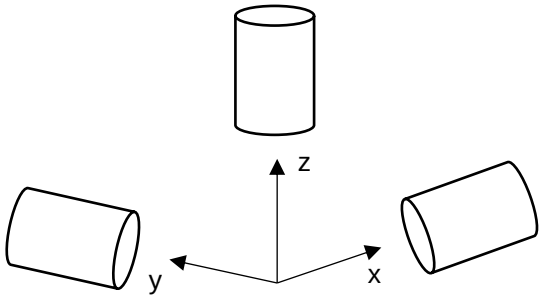


Figure 2 – Axis-aligned cylindrical luminaire orientations

The optional `Shape` element identifies the aligned axis. Valid values are listed in Table 4.

**Table 4. Shape Types**

| Type | Description |
|---|---|
| `Align_X` | Luminaire is circular or elliptical in the y-z plane |
| `Align_Y` | Luminaire is circular or elliptical in the x-z plane |
| `Align_Z` | Luminaire is circular or elliptical in the x-y plane |

### 4.3.3 Number of Emitters Element

The required `NumEmitter` element specifies the number of `Emitter` elements. (See Section 4.5 for details.)

## 4.4 Equipment Element

The optional `Equipment` element is the parent of measurement equipment data. Elements are detailed in Table 5.

**Table 5. Equipment Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Gonioradiometer | `Gonioradiometer` | XML Element | Optional | 4.4.1 |
| Integrating Sphere | `IntegratingSphere` | XML Element | Optional | 4.4.2 |
| Spectroradiometer | `Spectroradiometer` | XML Element | Optional | 4.4.3 |

### 4.4.1 Gonioradiometer Element

The optional `Gonioradiometer` element is the parent of gonioradiometric data. This element contains information that is specific to the gonioradiometer data. Elements are detailed in Table 6.

**Table 6. Gonioradiometer Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Type | `Type` | xs:string | Yes | 4.4.1.1 |
| Measurement Equipment | `MeasurementEquipment` | xs:string | Optional | 4.4.1.2 |




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#### 4.4.1.1 Type Element

The required `Type` element identifies the gonioradiometer type. Valid values are listed in Table 7.

**Table 7. Gonioradiometer Types**

| Type | Reference |
|---|---|
| `CIE_A` | CIE 121-1996 |
| `CIE_B` | CIE 121-1996 |
| `CIE_C` | CIE 121-1996 |
| `IES_A` | IES LM-75-19 |
| `IES_B` | IES LM-75-19 |
| `IES_C` | IES LM-75-19 |
| `CUSTOM` | Not applicable |

#### 4.4.1.2 Measurement Equipment Element

The optional `MeasurementEquipment` element contains a description of the equipment used to measure the gonioradiometric data.

Multiple `MeasurementEquipment` elements are allowed.

### 4.4.2 Integrating Sphere Element

The optional `IntegratingSphere` element is the parent of integrating sphere data. Elements are detailed in Table 8.

**Table 8. Integrating Sphere Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Measurement Equipment | `MeasurementEquipment` | xs:string | Yes | 4.4.2.1 |

#### 4.4.2.1 Measurement Equipment Element

The required `MeasurementEquipment` element contains a description of the equipment used to measure the integrating sphere data.

Multiple `MeasurementEquipment` elements are allowed.

### 4.4.3 Spectroradiometer Element

The optional `Spectroradiometer` element is the parent of spectroradiometer data. Elements are detailed in Table 9.

**Table 9. Spectroradiometer Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Measurement Equipment | `MeasurementEquipment` | xs:string | Yes | 4.4.3.1 |
| Bandwidth FWHM | `BandwidthFWHM` | xs:decimal | Optional | 4.4.3.2 |
| Bandwidth Corrected | `BandwidthCorrected` | xs:boolean | Optional | 4.4.3.3 |
| Bandwidth Method | `BandwidthMethod` | xs:string | Optional | 4.4.3.4 |




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#### 4.4.3.1 Measurement Equipment Element

The required `MeasurementEquipment` element contains a description of the equipment used to measure the spectral data.

#### 4.4.3.2 Bandwidth FWHM Element

The optional `BandwidthFWHM` attribute specifies the spectroradiometer full-width half-maximum bandwidth in nanometers.

#### 4.4.3.3 Bandwidth Corrected Element

The optional `BandwidthCorrected` attribute specifies that bandwidth correction has been applied to the measured data.

#### 4.4.3.4 Bandwidth Method Element

The optional `BandwidthMethod` attribute documents the bandwidth correction method.

## 4.5 Emitter Element

The required `Emitter` element is the parent of emitter data. Elements are detailed in Table 10.

Multiple `Emitter` elements are allowed as per `NumEmitter` element (Section 4.3.3).

**Table 10: Emitter Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Quantity | `Quantity` | xs:int | Yes | 4.5.1 |
| Description | `Description` | xs:string | Yes | 4.5.2 |
| Catalog Number | `CatalogNumber` | xs:string | Optional | 4.5.3 |
| Rated Lumens | `RatedLumens` | xs:decimal | Optional | 4.5.4 |
| Input Wattage | `InputWattage` | xs:decimal | Yes | 4.5.5 |
| Power Factor | `PowerFactor` | xs:decimal | Optional | 4.5.6 |
| Ballast Factor | `BallastFactor` | xs:decimal | Optional | 4.5.7 |
| Tilt Angles | `TiltAngles` | XML Element | Optional | 4.5.8 |
| Correlated Color Temperature (CCT) | `ColorTemperature` | XML Element | Optional | 4.5.9 |
| Color Rendering | `ColorRendering` | XML Element | Optional | 4.5.10 |
| Duv | `Duv` | xs:decimal | Optional | 4.5.11 |
| S/P Ratio | `SPRatio` | xs:decimal | Optional | 4.5.12 |
| Data Generation | `DataGeneration` | XML Element | Optional | 4.5.13 |
| Luminous Data | `LuminousData` | XML Element | Optional | 4.5.14 |
| Radiant Data | `RadiantData` | XML Element | Optional | 4.5.15 |
| Photon Data | `PhotonData` | XML Element | Optional | 4.5.16 |
| Spectral Data | `SpectralData` | XML Element | Optional | 4.5.17 |
| Angular Color Data | `AngularColor` | XML Element | Optional | 4.5.18 |




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| | | | | |
|---|---|---|---|---|
| Illuminance Data | IllumData | XML Element | Optional | 4.5.19 |
| Irradiance Data | IrradData | XML Element | Optional | 4.5.20 |
| Photon Flux Density Data | PFDData | XML Element | Optional | 4.5.21 |
| Spectral Irradiance Data | SpecIrradData | XML Element | Optional | 4.5.22 |
| Channels | Channels | XML Element | Optional | 4.5.23 |
| Emission Areas | EmissionAreas | XML Element | Optional | 4.5.24 |
| Emitter Center | EmitterCenter | XML Element | Optional | 4.5.25 |
| Regulatory | Regulatory | XML Element | Optional | 4.5.26 |

NOTE: The Emitter element shall include at least one of the following elements: LuminousData, RadiantData, PhotonData, SpectralData, AngularColor, IllumData, IrradData, PFDData, and SpecIrradData.

#### 4.5.1 Quantity Element

The required Quantity element specifies the number of emitters.

#### 4.5.2 Description Element

The required Description element describes the emitter type.

#### 4.5.3 Catalog Number Element

The optional CatalogNumber element specifies the emitter manufacturer's catalog number.

#### 4.5.4 Rated Emitter Lumens Element

The optional RatedLumens element specifies the manufacturer's rated emitter lumens. For variable-CCT emitters, this value shall be the maximum rated emitter lumens.

#### 4.5.5 Input Wattage Element

The required InputWattage element specifies the input wattage.

#### 4.5.6 Power Factor Element

The optional PowerFactor element specifies the power factor.

#### 4.5.7 Ballast Factor Element

The optional BallastFactor element specifies the ratio of the flux emitted by the emitter when operated with a commercial ballast to the flux emitted by the same emitter when operated with a standard (reference) ballast used for rating lamp lumens. For application purposes, the ballast factor is used to adjust the emitter performance data from laboratory test conditions to actual field conditions.

#### 4.5.8 Tilt Angles Element

The optional TiltAngles element is the parent of the emitter tilt angle data. Elements are detailed in Table 11.



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**Table 11. Tilt Angle Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Number of Angles | NumberAngles | xs:int | Yes | 4.5.8.1 |
| Tilt | Tilt | XML Element | Yes | 4.5.8.2 |

#### 4.5.8.1 Number of Angles Element

The required NumberAngles element specifies the number of tilt angles.

#### 4.5.8.2 Tilt Element

The required Tilt element specifies the emitter intensity multiplier for the specified tilt angle (in degrees). For example:

```
<Tilt angle="30.0">0.87</Tilt>
```

### 4.5.9 Correlated Color Temperature Element

The optional ColorTemperature element is the parent of the correlated color temperature (CCT) range data. Elements are detailed in Table 12.

**Table 12. Correlated Color Temperature Range Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Fixed CCT | FixedCCT | xs:int | Optional | 4.5.9.1 |
| Minimum CCT | MinCCT | xs:int | Optional | 4.5.9.2 |
| Maximum CCT | MaxCCT | xs:int | Optional | 4.5.9.3 |

#### 4.5.9.1 Fixed CCT Element

The optional FixedCCT element specifies the correlated color temperature of a fixed-CCT emitter.

#### 4.5.9.2 Minimum CCT Element

The optional MinCCT element specifies the minimum correlated color temperature of a variable-CCT emitter.

#### 4.5.9.3 Maximum CCT Element

The optional MaxCCT element specifies the maximum correlated color temperature of a variable-CCT emitter.

### 4.5.10 Color Rendering Element

The optional ColorRendering element is the parent of color rendering metrics data. Elements are detailed in Table 13.

**Table 13. Color Rendering Metrics Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| CIE CRI | CIE_CRI | XML Element | Optional | 4.5.10.1 |
| IES TM-30 | IES_TM30 | XML Element | Optional | 4.5.10.2 |

#### 4.5.10.1 CIE CRI Element

The optional CIE_CRI element is the parent of CIE Colour Rendering Indices data. Elements are detailed in Table 14.




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**Table 14. CIE CRI Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Ra | Ra | xs:int | Yes | 4.5.10.1.1 |
| R9 | R9 | xs:int | Optional | 4.5.10.1.2 |

#### 4.5.10.1.1 Ra Element

The required Ra element specifies the CIE General Colour Rendering Index Ra.

#### 4.5.10.1.2 R9 Element

The optional R9 element specifies the CIE Special Colour Rendering Index R9.

### 4.5.10.2 IES TM30 Element

The optional IES_TM30 element is the parent of IES TM-30 color rendering metrics data. Elements are detailed in Table 15.

**Table 15. IES TM30 Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| $R_f$ | Rf | xs:int | Yes | 4.5.10.2.1 |
| $R_g$ | Rg | xs:int | Yes | 4.5.10.2.2 |
| $R_{fh01}$ | Rfh01 | xs:int | Optional | 4.5.10.2.3 |
| $R_{fh02}$ | Rfh02 | xs:int | Optional | 4.5.10.2.3 |
| $R_{fh03}$ | Rfh03 | xs:int | Optional | 4.5.10.2.3 |
| $R_{fh04}$ | Rfh04 | xs:int | Optional | 4.5.10.2.3 |
| $R_{fh05}$ | Rfh05 | xs:int | Optional | 4.5.10.2.3 |
| $R_{fh06}$ | Rfh06 | xs:int | Optional | 4.5.10.2.3 |
| $R_{fh07}$ | Rfh07 | xs:int | Optional | 4.5.10.2.3 |
| $R_{fh08}$ | Rfh08 | xs:int | Optional | 4.5.10.2.3 |
| $R_{fh09}$ | Rfh09 | xs:int | Optional | 4.5.10.2.3 |
| $R_{fh10}$ | Rfh10 | xs:int | Optional | 4.5.10.2.3 |
| $R_{fh11}$ | Rfh11 | xs:int | Optional | 4.5.10.2.3 |
| $R_{fh12}$ | Rfh12 | xs:int | Optional | 4.5.10.2.3 |
| $R_{fh13}$ | Rfh13 | xs:int | Optional | 4.5.10.2.3 |
| $R_{fh14}$ | Rfh14 | xs:int | Optional | 4.5.10.2.3 |
| $R_{fh15}$ | Rfh15 | xs:int | Optional | 4.5.10.2.3 |
| $R_{fh16}$ | Rfh16 | xs:int | Optional | 4.5.10.2.3 |
| $R_{csh01}$ | Rcsh01 | xs:int | Optional | 4.5.10.2.4 |
| $R_{csh02}$ | Rcsh02 | xs:int | Optional | 4.5.10.2.4 |
| $R_{csh03}$ | Rcsh03 | xs:int | Optional | 4.5.10.2.4 |
| $R_{csh04}$ | Rcsh04 | xs:int | Optional | 4.5.10.2.4 |
| $R_{csh05}$ | Rcsh05 | xs:int | Optional | 4.5.10.2.4 |
| $R_{csh06}$ | Rcsh06 | xs:int | Optional | 4.5.10.2.4 |
| $R_{csh07}$ | Rcsh07 | xs:int | Optional | 4.5.10.2.4 |
| $R_{csh08}$ | Rcsh08 | xs:int | Optional | 4.5.10.2.4 |
| $R_{csh09}$ | Rcsh09 | xs:int | Optional | 4.5.10.2.4 |
| $R_{csh10}$ | Rcsh10 | xs:int | Optional | 4.5.10.2.4 |
| $R_{csh11}$ | Rcsh11 | xs:int | Optional | 4.5.10.2.4 |
| $R_{csh12}$ | Rcsh12 | xs:int | Optional | 4.5.10.2.4 |
| $R_{csh13}$ | Rcsh13 | xs:int | Optional | 4.5.10.2.4 |
| $R_{csh14}$ | Rcsh14 | xs:int | Optional | 4.5.10.2.4 |
| $R_{csh15}$ | Rcsh15 | xs:int | Optional | 4.5.10.2.4 |
| $R_{csh16}$ | Rcsh16 | xs:int | Optional | 4.5.10.2.4 |




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#### 4.5.10.2.1 $R_f$ Element

The required `Rf` element specifies the IES TM-30 fidelity index Rf.

#### 4.5.10.2.2 $R_g$ Element

The required `Rg` element specifies the IES TM-30 gamut index Rg.

#### 4.5.10.3 $R_{fh*}$ Elements

The optional `Rfh*` elements specify the sixteen local fidelity values within each hue-angle range.

#### 4.5.10.2.4 $R_{csh*}$ Elements

The optional `Rcsh*` elements specify the sixteen local chroma shift values within each hue-angle range.

### 4.5.11 Duv Element

The optional `Duv` element specifies the closest distance of the emitter chromaticity to the Planckian locus as defined in ANSI C78.377-2017.

### 4.5.12 S/P Ratio Element

The optional `SPRatio` element specifies the emitter scotopic-to-photopic lumens ratio.

### 4.5.13 Data Generation Element

The optional `DataGeneration` element is the parent of data generation information. Elements are detailed in Table 16.

**Table 16. Data Generation Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Simulation | `Simulation` | xs:boolean | Optional | 4.5.13.1 |
| Laboratory | `Laboratory` | XML Element | Optional | 4.5.13.2 |
| Intensity Scaling | `IntensityScaling` | xs:boolean | Optional | 4.5.13.3 |
| Angle Interpolation | `AngleInterpolation` | xs:boolean | Optional | 4.5.13.4 |

#### 4.5.13.1 Simulation Element

The optional `Simulation` element, if true, indicates that the intensity data was generated by means of a computer simulation rather than measured.

#### 4.5.13.2 Laboratory Element

The optional `Laboratory` element is the parent of the Laboratory Certification data. Elements are detailed in Table 17.

**Table 17. Laboratory Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Certification Type | `Certification` | xs:string | Yes | 4.5.13.2.1 |




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| | | | | |
|---|---|---|---|---|
| Approval Body | ApprovalBody | xs:string | Yes | 4.5.13.2.2 |
| Approval Scope | ApprovalScope | xs:string | Yes | 4.5.13.2.3 |
| Measurement Uncertainty | MeasUncertainty | XML Element | Yes | 4.5.13.2.4 |

#### 4.5.13.2.1 Certification Type Element

The required Certification element identifies the certification type. Valid values are listed in Table 18.

**Table 18. Certification Types**

| Type | Element Description |
|---|---|
| Accredited | Accredited test laboratory |
| Associated | Associated test laboratory |
| Customer | Customer test facilities |
| None | – |

#### 4.5.13.2.2 Approval Body Element

The required ApprovalBody element identifies the approval body. For example, “NVLAP”.

#### 4.5.13.2.3 Approval Scope Element

The required ApprovalScope element identifies the scope of the approval. For example, “IES LM-79 [Sections 9, 10, 12]”.

#### 4.5.13.2.4 Measurement Uncertainty Element

The required MeasUncertainty element is the parent of the Measurement Uncertainty data. Elements are detailed in Table 19.

Multiple MeasUncertainty elements are allowed.

**Table 19. Measurement Uncertainty Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Measurement Type | MeasurementType | xs:string | Yes | 4.5.13.2.4.1 |
| Uncertainty | Uncertainty | xs:decimal | Yes | 4.5.13.2.4.2 |

##### 4.5.13.2.4.1 Measurement Type Element

The required MeasurementType element identifies the measurement type.

##### 4.5.13.2.4.2 Uncertainty Element

The required Uncertainty element specifies the measurement uncertainty.

### 4.5.13.3 Intensity Scaling Element

The optional IntensityScaling element, if true, indicates that the reported intensity data has been uniformly scaled with respect to the laboratory measurements.

### 4.5.13.4 Angle Interpolation Element

The optional AngleInterpolation element, if true, indicates that the reported intensity data at the reported horizontal and/or vertical angles have been interpolated with respect to the laboratory measurements.



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### 4.5.14 Luminous Data Element

The optional `LuminousData` element is the parent of luminous data. This element contains information that is specific to the luminous data. Elements are detailed in Table 20.

**Table 20: Luminous Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Luminous Intensity | `LuminousIntensity` | XML Element | Yes | 4.5.14.1 |
| Luminous Flux | `LuminousFlux` | xs:decimal | Optional | 4.5.14.2 |

#### 4.5.14.1 Luminous Intensity Element

The required `LuminousIntensity` element is the parent of the luminous intensity data. Elements are detailed in Table 21.

**Table 21. Luminous Intensity Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Absolute Photometry | `AbsolutePhotometry` | xs:boolean | Yes | 4.5.14.1.1 |
| Symmetry | `Symm` | xs:string | Optional | 4.5.14.1.2 |
| Multiplier | `Multiplier` | xs:decimal | Optional | 4.5.14.1.3 |
| Number Measured | `NumberMeasured` | xs:int | Yes | 4.5.14.1.4 |
| Number Horz | `NumberHorz` | xs:int | Yes | 4.5.14.1.5 |
| Number Vert | `NumberVert` | xs:int | Yes | 4.5.14.1.6 |
| Intensity Data | `IntData` | XML Element | Yes | 4.5.14.1.7 |

##### 4.5.14.1.1 Absolute Photometry Element

The required `AbsolutePhotometry` element, if true, indicates that the luminous intensity measurements were performed using absolute photometry.

##### 4.5.14.1.2 Symmetry Element

The optional `Symm` element identifies the horizontal symmetry type. Valid values for `CIE_C` and `IES_C` gonioradiometer types only are shown in Table 22.

**Table 22. Symmetry Types**

| Type | Description |
|---|---|
| `Symm_None` | No horizontal symmetry |
| `Symm_Bi_0` | Symmetric about the 0-180 degree plane |
| `Symm_Bi_90` | Symmetric about the 90-270 degree plane |
| `Symm_Quad` | Symmetric in each quadrant |
| `Symm_Full` | Symmetric in all vertical planes |
| `Symm_Arbitrary` | No horizontal or vertical symmetry |

If the `Symm` element is not present, the default value is `Symm_None`.

NOTE 1*:* `Symm_Arbitrary` indicates that the intensity data represent measurements at arbitrary horizontal and vertical angles, such as for example an imaginary geodesic sphere.



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NOTE 2*:* If the `Symm` element is `Symm_Arbitrary`, the values of the `NumberHorz` and `NumberVert` elements shall be zero.

#### 4.5.14.1.3 Multiplier Element

The optional `Multiplier` element, if present, indicates a floating-point multiplier that shall be applied to the luminous intensity measurements.

If the `Multiplier` element is not present, the default value is 1.0.

#### 4.5.14.1.4 Number Measured Element

The required `NumberMeasured` element specifies the number of luminous intensity measurements.

#### 4.5.14.1.5 Number Horz Element

The required `NumberHorz` element specifies the number of horizontal angles. The value shall be zero if the measurement coordinate system does not consist of a set of planes.

#### 4.5.14.1.6 Number Vert Element

The required `NumberVert` element specifies the number of vertical angles. The value shall be zero if the measurement coordinate system does not consist of a set of planes.

#### 4.5.14.1.7 Intensity Data Element

The required `IntData` element, when multiplied by the `Multiplier` element, specifies the luminous intensity data (in candela) for the specified horizontal and vertical angles (in degrees). The element contains the value to be reported and there are attributes for the horizontal and vertical angles at which this value occurs. For example:

```
<IntData h="0.0" v="65.0">44</IntData>
```

NOTE 1: Scientific notation (e.g., 1.23E-2) is allowed for the luminous intensity value.

NOTE 2: The `Multiplier` element enables luminous intensity values to be reported in candelas per kilolumen.

Multiple `IntData` elements are allowed.

### 4.5.14.2 Luminous Flux Element

The optional `LuminousFlux` element specifies the luminous flux in lumens.

### 4.5.15 Radiant Data Element

The optional `RadiantData` element is the parent of radiant data. Elements are detailed in Table 23.

**Table 23. Radiant Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Minimum Wavelength | `MinWavelength` | xs:decimal | Yes | 4.5.15.1 |
| Maximum Wavelength | `MaxWavelength` | xs:decimal | Yes | 4.5.15.2 |



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| | | | | |
|---|---|---|---|---|
| Radiant Intensity | RadiantIntensity | XML Element | Yes | 4.5.15.3 |
| Radiant Flux | RadiantFlux | xs:decimal | Optional | 4.5.15.4 |

#### 4.5.15.1 Minimum Wavelength Element

The required MinWavelength element specifies the minimum wavelength of the radiant intensity measurements in nanometers.

#### 4.5.15.2 Maximum Wavelength Element

The required MaxWavelength element specifies the maximum wavelength of the radiant intensity measurements in nanometers.

#### 4.5.15.3 Radiant Intensity Element

The required RadiantIntensity element is the parent of the radiant intensity data. Elements are detailed in Table 24.

**Table 24. Radiant Intensity Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Absolute | Absolute | xs:boolean | Optional | 4.5.15.3.1 |
| Symmetry | Symm | xs:string | Optional | 4.5.15.3.2 |
| Multiplier | Multiplier | xs:decimal | Optional | 4.5.15.3.3 |
| Number Measured | NumberMeasured | xs:int | Yes | 4.5.15.3.4 |
| Number Horz | NumberHorz | xs:int | Yes | 4.5.15.3.5 |
| Number Vert | NumberVert | xs:int | Yes | 4.5.15.3.6 |
| Intensity Data | IntData | XML Element | Yes | 4.5.15.3.7 |

##### 4.5.15.3.1 Absolute Element

The optional Absolute element, if true, indicates that the radiant intensity measurements were performed using absolute radiometry.

If the Absolute element is not present, the default value is true.

##### 4.5.15.3.2 Symmetry Element

The optional Symm element identifies the horizontal symmetry type. Valid values for CIE_C and IES_C gonioradiometer types only are shown in Table 25.

**Table 25. Symmetry Types**

| Type | Description |
|---|---|
| Symm_None | No horizontal symmetry |
| Symm_Bi_0 | Symmetric about the 0-180 degree plane |
| Symm_Bi_90 | Symmetric about the 90-270 degree plane |
| Symm_Quad | Symmetric in each quadrant |
| Symm_Full | Symmetric in all vertical planes |
| Symm_Arbitrary | No horizontal or vertical symmetry |

If the Symm element is not present, the default value is Symm_None.

NOTE 1: Symm_Arbitrary indicates that the intensity data represent measurements at arbitrary horizontal and vertical angles, such as for example an imaginary geodesic sphere.



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NOTE 2*:* If the `Symm` element is `Symm_Arbitrary`, the values of the `NumberHorz` and `NumberVert` elements shall be zero.

#### 4.5.15.3.3 Multiplier Element

The optional `Multiplier` element, if present, indicates a floating-point multiplier that shall be applied to the radiant intensity measurements.

If the `Multiplier` element is not present, the default value is 1.0.

#### 4.5.15.3.4 Number Measured Element

The required `NumberMeasured` element specifies the number of radiant intensity measurements.

#### 4.5.15.3.5 Number Horz Element

The required `NumberHorz` element specifies the number of horizontal angles. The value shall be zero if the measurement coordinate system does not consist of a set of planes.

#### 4.5.15.3.6 Number Vert Element

The required `NumberVert` element specifies the number of vertical angles. The value shall be zero if the measurement coordinate system does not consist of a set of planes.

#### 4.5.15.3.7 Intensity Data Element

The required `IntData` element, when multiplied by the `Multiplier` element, specifies the radiant intensity data (in watts per steradian) for the specified horizontal and vertical angles (in degrees). The element contains the value to be reported, and there are attributes for the horizontal and vertical angles at which this value occurs. For example:

```
<IntData h="0.0" v="65.0">44</IntData>
```

NOTE 1: Scientific notation (e.g., 1.23E-2) is allowed for the radiant intensity value.

NOTE 2: The `Multiplier` element enables radiant intensity values to be reported in microwatts per steradian or milliwatts per steradian.

Multiple `IntData` elements are allowed.

### 4.5.15.4 Radiant Flux Element

The optional `RadiantFlux` element specifies the radiant flux in watts.

### 4.5.16 Photon Data Element

The optional `PhotonData` element is the parent of photon data. Elements are detailed in Table 26.

**Table 26. Photon Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Minimum Wavelength | `MinWavelength` | xs:decimal | Yes | 4.5.16.1 |
| Maximum Wavelength | `MaxWavelength` | xs:decimal | Yes | 4.5.16.2 |



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| | | | | |
|---|---|---|---|---|
| Photon Intensity | PhotonIntensity | XML Element | Yes | 4.5.16.3 |
| Photon Flux | PhotonFlux | xs:decimal | Optional | 4.5.16.4 |

#### 4.5.16.1 Minimum Wavelength Element

The required MinWavelength element specifies the minimum wavelength of the photon measurements in nanometers.

#### 4.5.16.2 Maximum Wavelength Element

The required MaxWavelength element specifies the maximum wavelength of the photon measurements in nanometers.

#### 4.5.16.3 Photon Intensity Element

The required PhotonIntensity element is the parent of the photon intensity data. Elements are detailed in Table 27.

**Table 27. Photon Intensity Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Absolute | Absolute | xs:boolean | Optional | 4.5.16.3.1 |
| Symmetry | Symm | xs:string | Optional | 4.5.16.3.2 |
| Multiplier | Multiplier | xs:decimal | Optional | 4.5.16.3.3 |
| Number Measured | NumberMeasured | xs:int | Yes | 4.5.16.3.4 |
| Number Horz | NumberHorz | xs:int | Yes | 4.5.16.3.5 |
| Number Vert | NumberVert | xs:int | Yes | 4.5.16.3.6 |
| Intensity Data | IntData | XML Element | Yes | 4.5.16.3.7 |

##### 4.5.16.3.1 Absolute Element

The optional Absolute element, if true, indicates that the photon intensity measurements were performed using absolute radiometry.

If the Absolute element is not present, the default value is true.

##### 4.5.16.3.2 Symmetry Element

The optional Symm element identifies the horizontal symmetry type. Valid values for CIE_C and IES_C gonioradiometer types only are shown in Table 28.

**Table 28. Symmetry Types**

| Type | Description |
|---|---|
| Symm_None | No horizontal symmetry |
| Symm_Bi_0 | Symmetric about the 0-180 degree plane |
| Symm_Bi_90 | Symmetric about the 90-270 degree plane |
| Symm_Quad | Symmetric in each quadrant |
| Symm_Full | Symmetric in all vertical planes |
| Symm_Arbitrary | No horizontal or vertical symmetry |

If the Symm element is not present, the default value is Symm_None.

NOTE 1: Symm_Arbitrary indicates that the intensity data represent measurements at arbitrary horizontal and vertical angles, such as for example an imaginary geodesic sphere.



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NOTE 2*:* If the `Symm` element is `Symm_Arbitrary`, the values of the `NumberHorz` and `NumberVert` elements shall be zero.

#### 4.5.16.3.3 Multiplier Element

The optional `Multiplier` element, if present, indicates a floating-point multiplier that shall be applied to the photon intensity measurements.

If the `Multiplier` element is not present, the default value is 1.0.

#### 4.5.16.3.4 Number Measured Element

The required `NumberMeasured` element specifies the number of photon intensity measurements.

#### 4.5.16.3.5 Number Horz Element

The required `NumberHorz` element specifies the number of horizontal angles. The value shall be zero if the measurement coordinate system does not consist of a set of planes.

#### 4.5.16.3.6 Number Vert Element

The required `NumberVert` element specifies the number of vertical angles. The value shall be zero if the measurement coordinate system does not consist of a set of planes.

#### 4.5.16.3.7 Intensity Data Element

The required `IntData` element, when multiplied by the `Multiplier` element, specifies the photon intensity data (in micromoles per steradian per second) for the specified horizontal and vertical angles (in degrees). The element contains the value to be reported and there are attributes for the horizontal and vertical angles at which this value occurs. For example:

```
<IntData h="0.0" v="65.0">44</IntData>
```

NOTE: Scientific notation (e.g., 1.23E-2) is allowed for the photon intensity value.

Multiple `IntData` elements are allowed.

### 4.5.16.4 Photon Flux Element

The optional `PhotonFlux` element specifies the photon flux in micromoles per second (µmol/s).

### 4.5.17 Spectral Data Element

The optional `SpectralData` element is the parent of spectroradiometric data. Elements are detailed in Table 29.

**Table 29. Spectral Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Spectral Intensity | `EmitterSpectral` | XML Element | Optional | 4.5.17.1 |
| Angular Spectral | `AngularSpectral` | XML Element | Optional | 4.5.17.2 |



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#### 4.5.17.1 Emitter Spectral Element

The optional `EmitterSpectral` element is the parent of emitter spectral data. Elements are detailed in Table 30.

Multiple `EmitterSpectral` elements are allowed.

**Table 30: Emitter Spectral Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Emitter Name | `EmitterName` | xs:string | Optional | 4.5.17.1.1 |
| Number of Wavelength | `NumberWavelength` | xs:int | Yes | 4.5.17.1.2 |
| Multiplier | `Multiplier` | xs:decimal | Optional | 4.5.17.1.3 |
| Normalized | `Normalized` | xs:boolean | Optional | 4.5.17.1.4 |
| Timestamp | `Timestamp` | xs:int | Optional | 4.5.17.1.5 |
| Power Data | `PwrData` | XML Element | Yes | 4.5.17.1.6 |
| Quantum | `Quantum` | xs:boolean | Optional | 4.5.17.1.7 |

##### 4.5.17.1.1 Emitter Name Element

The optional `EmitterName` element specifies the emitter name. For example, a multichannel theatrical luminaire may have separate color channels identified as “red,” “green,” “blue,” and “amber.”

##### 4.5.17.1.2 Number of Wavelength Element

The required `NumberWavelength` element specifies the number of wavelengths for which data are reported.

##### 4.5.17.1.3 Multiplier Element

The optional `Multiplier` element, if present, indicates a floating-point multiplier that shall be applied to the spectral power measurements.

If the `Multiplier` element is not present, the default value is 1.0.

##### 4.5.17.1.4 Normalized Element

The optional `Normalized` element, if true, indicates that the spectral power data values have been normalized such that the maximum value is 1.0.

NOTE: If the `Normalized` element is not present, the default value is false.

##### 4.5.17.1.5 Timestamp Element

The optional `Timestamp` element is intended for luminous flux and color maintenance tests. The value represents the number of hours of operation from when the test procedure commenced.

##### 4.5.17.1.6 Power Data Element

The required `PwrData` element, when multiplied by the `Multiplier` element, specifies the emitter spectral data in watts per nanometer if the optional `Quantum` element is absent or “false”. The element contains the value to be reported, and there is an attribute for the wavelength this value occurs at (in nanometers). For example:




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```
<PwrData w="555.0">0.053</PwrData>
```

NOTE 1: Scientific notation (e.g., 1.23E-2) is allowed for the spectral power value.

NOTE 2: The `Multiplier` element enables spectral power values to be reported in microwatts per nanometers or milliwatts per nanometer.

NOTE 3: If `Normalized` is true and `Multiplier` is not present, the spectral power data value is unitless.

Multiple `PwrData` elements are allowed.

#### 4.5.17.1.7 Quantum Element

The optional `Quantum` element, if true, indicates that the spectral power data values, when multiplied by the `Multiplier` element, are reported in micromoles per second per nanometer (µmol/s·nm) rather than watts per nanometer. The emitter spectral data then represents a spectral quantum distribution (SQD) rather than a spectral power distribution (SPD).

NOTE 1: A normalized SPD can be converted to a normalized SQD by multiplying each spectral power data value by $\lambda/\lambda_{max}$, where $\lambda$ is the value wavelength and $\lambda_{max}$ is the peak value wavelength, and renormalizing as required.

NOTE 2: If the `Quantum` element is not present, the default value is false.

### 4.5.17.2 Angular Spectral Element

The optional `AngularSpectral` element is the parent of angular spectral radiant intensity data. Elements are detailed in Table 31.

**Table 31. Angular Spectral Intensity Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Absolute | `Absolute` | xs:boolean | Optional | 4.5.17.2.1 |
| Symmetry | `Symm` | xs:string | Optional | 4.5.17.2.2 |
| Multiplier | `Multiplier` | xs:decimal | Optional | 4.5.17.2.3 |
| Number Measured | `NumberMeasured` | xs:int | Yes | 4.5.17.2.4 |
| Number Horz | `NumberHorz` | xs:int | Yes | 4.5.17.2.5 |
| Number Vert | `NumberVert` | xs:int | Yes | 4.5.17.2.6 |
| Number of Wavelengths | `NumberWavelength` | xs:int | Yes | 4.5.17.2.7 |
| Intensity Data | `IntData` | XML Element | Yes | 4.5.17.2.8 |

#### 4.5.17.2.1 Absolute Element

The optional `Absolute` element, if true, indicates that the angular spectral intensity measurements were performed using absolute radiometry.

If the `Absolute` element is not present, the default value is true.

#### 4.5.17.2.2 Symmetry Element

The optional `Symm` element identifies the horizontal symmetry type. Valid values for `CIE_C` and `IES_C` gonioradiometer types only are shown in Table 32.




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**Table 32. Symmetry Types**

| Type | Description |
|---|---|
| Symm_None | No horizontal symmetry |
| Symm_Bi_0 | Symmetric about the 0-180 degree plane |
| Symm_Bi_90 | Symmetric about the 90-270 degree plane |
| Symm_Quad | Symmetric in each quadrant |
| Symm_Full | Symmetric in all vertical planes |
| Symm_Arbitrary | No horizontal or vertical symmetry |

If the Symm element is not present, the default value is Symm_None.

NOTE 1*:* Symm_Arbitrary indicates that the intensity data represent measurements at arbitrary horizontal and vertical angles, such as for example an imaginary geodesic sphere.

NOTE 2*:* If the Symm element is Symm_Arbitrary, the values of the NumberHorz and NumberVert elements shall be zero.

#### 4.5.17.2.3 Multiplier Element

The optional Multiplier element, if present, indicates a floating-point multiplier that shall be applied to the angular spectral intensity measurements.

If the Multiplier element is not present, the default value is 1.0.

#### 4.5.17.2.4 Number Measured Element

The required NumberMeasured element specifies the number of angular spectral intensity measurements.

#### 4.5.17.2.5 Number Horz Element

The required NumberHorz element specifies the number of horizontal angles. The value shall be zero if the measurement coordinate system does not consist of a set of planes.

#### 4.5.17.2.6 Number Vert Element

The required NumberVert element specifies the number of vertical angles. The value shall be zero if the measurement coordinate system does not consist of a set of planes.

#### 4.5.17.2.7 Number of Wavelengths Element

The required NumberWavelength element specifies the number of wavelengths.

#### 4.5.17.2.8 Intensity Data Element

The required IntData element, when multiplied by the Multiplier element, specifies the spectral radiant intensity data (in watts per steradian per nanometer) for the specified horizontal and vertical angles (in degrees). The element contains the value to be reported and there are attributes for the horizontal and vertical angles and wavelength (in nanometers) at which this value occurs. For example:

```
<IntData h="0.0" v="65.0" w="555.0">0.023</IntData>
```

NOTE 1: Scientific notation (e.g., 1.23E-2) is allowed for the angular spectral intensity value.

NOTE 2: The Multiplier element enables angular spectral intensity values to be reported in microwatts per nanometer or milliwatts per steradian per nanometer.




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Multiple IntData elements are allowed.

### 4.5.18 Angular Color Element

The optional AngularColor element is the parent of angular color data. Elements are detailed in Table 33.

**Table 33. Angular Color Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Absolute | Absolute | xs:boolean | Optional | 4.5.18.1 |
| Symmetry | Symm | xs:string | Optional | 4.5.18.2 |
| Multiplier | Multiplier | xs:decimal | Optional | 4.5.18.3 |
| Number Measured | NumberMeasured | xs:int | Yes | 4.5.18.4 |
| Number Horz | NumberHorz | xs:int | Yes | 4.5.18.5 |
| Number Vert | NumberVert | xs:int | Yes | 4.5.18.6 |
| Color Data | ColorData | XML Element | Yes | 4.5.18.7 |

#### 4.5.18.1 Absolute Element

The optional Absolute element, if true, indicates that the angular color measurements were performed using absolute photometry.

If the Absolute element is not present, the default value is true.

#### 4.5.18.2 Symmetry Element

The optional Symm element identifies the horizontal symmetry type. Valid values for CIE_C and IES_C gonioradiometer types only are shown in Table 34.

**Table 34. Symmetry Types**

| Type | Description |
|---|---|
| Symm_None | No horizontal symmetry |
| Symm_Bi_0 | Symmetric about the 0-180 degree plane |
| Symm_Bi_90 | Symmetric about the 90-270 degree plane |
| Symm_Quad | Symmetric in each quadrant |
| Symm_Full | Symmetric in all vertical planes |
| Symm_Arbitrary | No horizontal or vertical symmetry |

If the Symm element is not present, the default value is Symm_None.

NOTE 1*:* Symm_Arbitrary indicates that the color data represent measurements at arbitrary horizontal and vertical angles, such as for example an imaginary geodesic sphere.

NOTE 2*:* If the Symm element is Symm_Arbitrary, the values of the NumberHorz and NumberVert elements shall be zero.

#### 4.5.18.3 Multiplier Element

The optional Multiplier element, if present, indicates a floating-point multiplier that shall be applied to the luminous intensity (CIE Y) measurements.

If the Multiplier element is not present, the default value is 1.0.




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#### 4.5.18.4 Number Measured Element

The required `NumberMeasured` element specifies the number of angular color measurements.

#### 4.5.18.5 Number Horz Element

The required `NumberHorz` element specifies the number of horizontal angles. The value shall be zero if the measurement coordinate system does not consist of a set of planes.

#### 4.5.18.6 Number Vert Element

The required `NumberVert` element specifies the number of vertical angles. The value shall be zero if the measurement coordinate system does not consist of a set of planes.

#### 4.5.18.7 Color Data Element

The required `ColorData` element specifies the CIE *xy* chromaticity coordinates and, when multiplied by the `Multiplier` element, the luminous intensity data (CIE Y, stated in candelas) for the specified horizontal and vertical angles (in degrees). The element contains the value to be reported, and there are attributes for the horizontal and vertical angles, and CIE *xy* chromaticity coordinates at which this value occurs. For example:

```
<ColorData h="0.0" v="65.0" x="0.435" y="0.401">65.0</ColorData>
```

NOTE 1: Scientific notation (e.g., 1.23E-2) is allowed for the angular luminous intensity value.

NOTE 2: The `Multiplier` element enables luminous intensity values to be reported in candela per kilolumen.

Multiple `ColorData` elements are allowed.

### 4.5.19 Illuminance Data Element

The optional `IllumData` element is the parent of illuminance data. This element contains information that is specific to illuminance data. Elements are detailed in Table 35.

**Table 35. Illuminance Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Absolute | `Absolute` | xs:boolean | Optional | 4.5.19.1 |
| Multiplier | `Multiplier` | xs:decimal | Optional | 4.5.19.2 |
| Number of Planes | `NumberPlanes` | xs:int | Yes | 4.5.19.3 |
| Plane Data | `PlaneData` | XML Element | Yes | 4.5.19.4 |

#### 4.5.19.1 Absolute Element

The optional `Absolute` element, if true, indicates that the illuminance measurements were performed using absolute photometry.

If the `Absolute` element is not present, the default value is true.

#### 4.5.19.2 Multiplier Element

The optional `Multiplier` element, if present, indicates a floating-point multiplier that shall be applied to the illuminance measurements.

If the `Multiplier` element is not present, the default value is 1.0.




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#### 4.5.19.3 Number of Planes Element

The required `NumberPlanes` element specifies the number of measurement planes.

#### 4.5.19.4 Plane Data Element

The required `PlaneData` element specifies the illuminance data for the specified measurement plane. Elements are detailed in Table 36.

Multiple `PlaneData` elements are allowed.

**Table 36. Plane Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Plane Normal | `PlaneNormal` | XML Element | Optional | 4.5.19.4.1 |
| Number Measured | `NumberMeasured` | xs:int | Yes | 4.5.19.4.2 |
| Illuminance | `Illum` | XML Element | Yes | 4.5.19.4.3 |

##### 4.5.19.4.1 Plane Normal Element

The optional `PlaneNormal` element specifies coordinates of the unit plane normal with respect to the luminaire dimensions coordinate system. For example:

```
<PlaneNormal x="-1.0" y="0.0" z="0.0"/>
```

NOTE: The plane can be oriented arbitrarily with respect to the emitter.

If absent, the unit plane normal coordinates are assumed to be aligned with zenith:

```
<PlaneNormal x="0.0" y="0.0" z="1.0"/>
```

##### 4.5.19.4.2 Number Measured Element

The required `NumberMeasured` element specifies the number of illuminance measurements for the specified plane.

##### 4.5.19.4.3 Illuminance Element

The required `Illum` element, when multiplied by the `Multiplier` element, specifies illuminance data (in lux) for the specified position. The element contains the value to be reported, and there are attributes for the plane position (in meters) at which this value occurs. For example:

```
<Illum x="0.0" y="1.5" z="1.2">55</Illum>
```

NOTE 1: Scientific notation (e.g., 1.23E-2) is allowed for the illuminance value.

Multiple `Illum` elements are allowed.

### 4.5.20 Irradiance Data Element

The optional `IrradData` element is the parent of irradiance data. This element contains information that is specific to the irradiance data. Elements are detailed in Table 37.

**Table 37. Irradiance Data Fields**




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| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Absolute | `Absolute` | xs:boolean | Optional | 4.5.20.1 |
| Multiplier | `Multiplier` | xs:decimal | Optional | 4.5.20.2 |
| Minimum Wavelength | `MinWavelength` | xs:decimal | Yes | 4.5.20.3 |
| Maximum Wavelength | `MaxWavelength` | xs:decimal | Yes | 4.5.20.4 |
| Number of Planes | `NumberPlanes` | xs:int | Yes | 4.5.20.5 |
| Plane Data | `PlaneData` | XML Element | Yes | 4.5.20.6 |

#### 4.5.20.1 Absolute Element

The optional `Absolute` element, if true, indicates that the irradiance measurements were performed using absolute photometry.

If the `Absolute` element is not present, the default value is true.

#### 4.5.20.2 Multiplier Element

The optional `Multiplier` element, if present, indicates a floating-point multiplier that shall be applied to the irradiance measurements.

If the `Multiplier` element is not present, the default value is 1.0.

#### 4.5.20.3 Minimum Wavelength Element

The required `MinWavelength` element specifies the minimum wavelength of the irradiance measurements in nanometers.

#### 4.5.20.4 Maximum Wavelength Element

The required `MaxWavelength` element specifies the maximum wavelength of the irradiance measurements in nanometers.

#### 4.5.20.5 Number of Planes Element

The required `NumberPlanes` element specifies the number of measurement planes.

#### 4.5.20.6 Plane Data Element

The required `PlaneData` element specifies the irradiance data for the specified measurement plane. Elements are detailed in Table 38.

Multiple `PlaneData` elements are allowed.

**Table 38. Plane Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Plane Normal | `PlaneNormal` | XML Element | Optional | 4.5.20.6.1 |
| Number Measured | `NumberMeasured` | xs:int | Yes | 4.5.20.6.2 |
| Irradiance | `Irrad` | XML Element | Yes | 4.5.20.6.3 |




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#### 4.5.20.6.1 Plane Normal Element

The optional `PlaneNormal` element specifies coordinates of the unit plane normal with respect to the luminaire dimensions coordinate system. For example:

```
<PlaneNormal x="-1.0" y="0.0" z="0.0"/>
```

NOTE: The plane can be oriented arbitrarily with respect to the emitter.

If absent, the unit plane normal coordinates are assumed to be aligned with zenith:

```
<PlaneNormal x="0.0" y="0.0" z="1.0"/>
```

#### 4.5.20.6.2 Number Measured Element

The required `NumberMeasured` element specifies the number of irradiance measurements for the specified plane.

#### 4.5.20.6.3 Irradiance Element

The required `Irrad` element, when multiplied by the `Multiplier` element, specifies irradiance data (in watts per square meter) for the specified position. The element contains the value to be reported, and there are attributes for the plane position (in meters) at which this value occurs. For example:

```
<Irrad x="0.0" y="1.5" z="1.2">55</Irrad>
```

NOTE 1: Scientific notation (e.g., 1.23E-2) is allowed for the irradiance value.

NOTE 2: The `Multiplier` element enables irradiance values to be reported in microwatts per square meter or milliwatts per square meter.

Multiple `Irrad` elements are allowed.

### 4.5.21 Photon Flux Density Data Element

The optional `PFDData` element is the parent of photon flux density data. This element contains information that is specific to the photon flux density data. Elements are detailed in Table 39.

**Table 39. Photon Flux Density Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Absolute | `Absolute` | xs:boolean | Optional | 4.5.21.1 |
| Multiplier | `Multiplier` | xs:decimal | Optional | 4.5.21.2 |
| Minimum Wavelength | `MinWavelength` | xs:decimal | Yes | 4.5.21.3 |
| Maximum Wavelength | `MaxWavelength` | xs:decimal | Yes | 4.5.21.4 |
| Number of Planes | `NumberPlanes` | xs:int | Yes | 4.5.21.5 |
| Plane Data | `PlaneData` | XML Element | Yes | 4.5.21.6 |

#### 4.5.21.1 Absolute Element

The optional `Absolute` element, if true, indicates that the irradiance measurements were performed using absolute photometry.

If the `Absolute` element is not present, the default value is true.




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#### 4.5.21.2 Multiplier Element

The optional `Multiplier` element, if present, indicates a floating-point multiplier that shall be applied to the photon flux density measurements.

If the `Multiplier` element is not present, the default value is 1.0.

#### 4.5.21.3 Minimum Wavelength Element

The required `MinWavelength` element specifies the minimum wavelength of the photon flux density measurements in nanometers.

#### 4.5.21.4 Maximum Wavelength Element

The required `MaxWavelength` element specifies the maximum wavelength of the photon flux density measurements in nanometers.

#### 4.5.21.5 Number of Planes Element

The required `NumberPlanes` element specifies the number of measurement planes.

#### 4.5.21.6 Plane Data Element

The required `PlaneData` element specifies the photon flux density data for the specified measurement plane. Elements are detailed in Table 40.

Multiple `PlaneData` elements are allowed.

**Table 40: Plane Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Plane Normal | `PlaneNormal` | XML Element | Optional | 4.5.21.6.1 |
| Number Measured | `NumberMeasured` | xs:int | Yes | 4.5.21.6.2 |
| Photon Flux Density | `PFD` | XML Element | Yes | 4.5.21.6.3 |

##### 4.5.21.6.1 Plane Normal Element

The optional `PlaneNormal` element specifies coordinates of the unit plane normal with respect to the luminaire dimensions coordinate system. For example:

```
<PlaneNormal x="-1.0" y="0.0" z="0.0"/>
```

NOTE: The plane can be oriented arbitrarily with respect to the emitter.

If absent, the unit plane normal coordinates are assumed to be aligned with zenith:

```
<PlaneNormal x="0.0" y="0.0" z="1.0"/>
```

##### 4.5.21.6.2 Number Measured Element

The required `NumberMeasured` element specifies the number of photon flux density measurements for the specified plane.

##### 4.5.21.6.3 Photon Flux Density Element

The required `PFD` element, when multiplied by the `Multiplier` element, specifies photon flux density data (in micromoles per second per square meter) for the specified position. The




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element contains the value to be reported, and there are attributes for the plane position (in meters) at which this value occurs. For example:

```
<PFD x="0.0" y="1.5" z="1.2">55</PFD>
```

NOTE: Scientific notation (e.g., 1.23E-2) is allowed for the photon flux density value.

Multiple `PFD` elements are allowed.

### 4.5.22 Spectral Irradiance Data Element

The optional `SpecIrradData` element is the parent of spectral irradiance data. This element contains information that is specific to the spectral irradiance data. Elements are detailed in Table 41.

**Table 41. Spectral Irradiance Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Absolute | `Absolute` | xs:boolean | Optional | 4.5.22.1 |
| Multiplier | `Multiplier` | xs:decimal | Optional | 4.5.22.2 |
| Number of Planes | `NumberPlanes` | xs:int | Yes | 4.5.22.3 |
| Plane Data | `PlaneData` | XML Element | Yes | 4.5.22.4 |

#### 4.5.22.1 Absolute Element

The optional `Absolute` element, if true, indicates that the spectral irradiance measurements were performed using absolute photometry.

If the `Absolute` element is not present, the default value is true.

#### 4.5.22.2 Multiplier Element

The optional `Multiplier` element, if present, indicates a floating-point multiplier that shall be applied to the spectral irradiance measurements.

If the `Multiplier` element is not present, the default value is 1.0.

#### 4.5.22.3 Number of Planes Element

The required `NumberPlanes` element specifies the number of measurement planes.

#### 4.5.22.4 Plane Data Element

The required `PlaneData` element specifies the spectral irradiance data for the specified measurement plane. Elements are detailed in Table 42.

Multiple `PlaneData` elements are allowed.

**Table 42. Plane Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Plane Normal | `PlaneNormal` | XML Element | Optional | 4.5.22.4.1 |
| Number Measured | `NumberMeasured` | xs:int | Yes | 4.5.22.4.2 |
| Number of Wavelengths | `NumberWavelength` | xs:int | Yes | 4.5.22.4.3 |
| Spectral Irradiance | `SIrrad` | XML Element | Yes | 4.5.22.4.4 |




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#### 4.5.22.4.1 Plane Normal Element

The optional `PlaneNormal` element specifies coordinates of the unit plane normal with respect to the luminaire dimensions coordinate system. For example:

```
<PlaneNormal x="-1.0" y="0.0" z="0.0"/>
```

NOTE: The plane can be oriented arbitrarily with respect to the emitter.

If absent, the unit plane normal coordinates are assumed to be aligned with zenith:

```
<PlaneNormal x="0.0" y="0.0" z="1.0"/>
```

#### 4.5.22.4.2 Number Measured Element

The required `NumberMeasured` element specifies the number of spectral irradiance measurements for the specified plane.

#### 4.5.22.4.3 Number of Wavelengths Element

The required `NumberWavelength` element specifies the number of wavelengths.

#### 4.5.22.4.4 Spectral Irradiance Element

The required `SIrrad` element, when multiplied by the `Multiplier` element, specifies spectral irradiance data (in watts per square meter per nanometer) for the specified position. The element contains the value to be reported, and there are attributes for the plane position (in meters) and wavelength (in nanometers) at which this value occurs. For example:

```
<SIrrad x="0.0" y="1.5" z="1.2" w="555.0">55</SIrrad>
```

NOTE 1: Scientific notation (e.g., 1.23E-2) is allowed for the spectral irradiance value.

NOTE 2: The `Multiplier` element enables spectral irradiance values to be reported in microwatts per square meter per nanometer or milliwatts per square meter per nanometer.

Multiple `SIrrad` elements are allowed.

### 4.5.23 Channels Element

A luminaire may have multiple emitters with different spectral power distributions, such as a theatrical luminaire with red, green, blue, and amber light-emitting diodes. If the intensity of each emitter can be independently controlled (that is, dimmed) without significantly changing the spatial intensity distribution, a “channel multiplier” can be applied to the measured or simulated intensity distribution to represent the intensity distribution when the channel is tested at a specific correlated color temperature.

The optional `Channels` element is the parent of emitter channels data. Elements are detailed in Table 43.

**Table 43. Channels Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Number of Channels | `NumberChannels` | xs:int | Yes | 4.5.23.1 |
| Channel Multiplier | `ChannelMult` | XML Element | Yes | 4.5.23.2 |




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#### 4.5.23.1 Number of Channels Element

The required `NumberChannels` element specifies the number of independent emitter channels.

#### 4.5.23.2 Channel Multiplier Element

The required `ChannelMult` element specifies an independent emitter channel multiplier that is applied to the emitter intensity values or flux value. For example:

```
<ChannelMult name="red">0.63</ChannelMult>
```

where the channel names should be the same as emitter spectral names (Section 4.5.17.1.1) if multiple `EmitterSpectral` elements are present.

Multiple `ChannelMult` elements are allowed.

### 4.5.24 Emission Areas Element

The optional `EmissionAreas` element is the parent of emission areas data. Elements are detailed in Table 44.

NOTE: For cylindrical shapes, the planar emission faces are orthographically projected onto the cylindrical face.

**Table 44. Emission Face Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Top Face | `TopFace` | XML Element | Optional | 4.5.24.1 |
| Bottom Face | `BottomFace` | XML Element | Optional | 4.5.24.2 |
| C0 Face | `C0Face` | XML Element | Optional | 4.5.24.3 |
| C90 Face | `C90Face` | XML Element | Optional | 4.5.24.4 |
| C180 Face | `C180Face` | XML Element | Optional | 4.5.24.5 |
| C270 Face | `C270Face` | XML Element | Optional | 4.5.24.6 |

#### 4.5.24.1 Top Face Element

The optional `TopFace` element is the parent of top face emission areas data. Elements are detailed in Table 45.

**Table 45. Top Face Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Number Top | `NumberTop` | xs:int | Yes | 4.5.24.1.1 |
| Top Area | `TopArea` | XML Element | Yes | 4.5.24.1.2 |

#### 4.5.24.1.1 Number Top Element

The required `NumberTop` element specifies the number of top face emission areas.

#### 4.5.24.1.2 Top Area Element

The required `TopArea` element is the parent of top face emission area data. Elements are detailed in Table 46.

Multiple `TopArea` elements are allowed.

**Table 46. Top Face Emission Area Fields**




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| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Length | Length | xs:decimal | Yes | 4.5.24.1.2.1 |
| Width | Width | xs:decimal | Yes | 4.5.24.1.2.2 |
| Length Offset | LengthOffset | xs:decimal | Yes | 4.5.24.1.2.3 |
| Width Offset | WidthOffset | xs:decimal | Yes | 4.5.24.1.2.4 |
| Circular | Circular | xs:boolean | Optional | 4.5.24.1.2.5 |

#### 4.5.24.1.2.1 Length Element

The required Length element specifies the length of the top face emission area in meters.

#### 4.5.24.1.2.2 Width Element

The required Width element specifies the width of the top face emission area in meters.

#### 4.5.24.1.2.3 Length Offset Element

The required LengthOffset element specifies the offset of the top face emission area from the geometric center of the luminaire along the length (y) axis in meters.

#### 4.5.24.1.2.4 Width Offset Element

The required WidthOffset element specifies the offset of the top face emission area from the geometric center of the luminaire along the width (x) axis in meters.

#### 4.5.24.1.2.5 Circular Element

The optional Boolean Circular element, if true, indicates that the top face emission area is circular rather than rectangular. (If the length and width element values are not equal, the area is considered to be elliptical.)

### 4.5.24.2 Bottom Face Element

The optional BottomFace element is the parent of bottom face emission areas data. Elements are detailed in Table 47.

**Table 47. Bottom Face Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Number Bottom | NumberBottom | xs:int | Yes | 4.5.24.2.1 |
| Bottom Area | BottomArea | XML Element | Yes | 4.5.24.2.2 |

#### 4.5.24.2.1 Number Bottom Element

The required NumberBottom element specifies the number of bottom face emission areas.

#### 4.5.24.2.2 Bottom Area Element

The required BottomArea element is the parent of the bottom face emission area data. Elements are detailed in Table 48.

Multiple BottomArea elements are allowed.

**Table 48. Bottom Face Emission Area Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Length | Length | xs:decimal | Yes | 4.5.24.2.2.1 |
| Width | Width | xs:decimal | Yes | 4.5.24.2.2.2 |




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| | | | | |
|---|---|---|---|---|
| Length Offset | LengthOffset | xs:decimal | Yes | 4.5.24.2.2.3 |
| Width Offset | WidthOffset | xs:decimal | Yes | 4.5.24.2.2.4 |
| Circular | Circular | xs:boolean | Optional | 4.5.24.2.2.5 |

#### 4.5.24.2.2.1 Length Element

The required Length element specifies the length of the bottom face emission area in meters.

#### 4.5.24.2.2.2 Width Element

The required Width element specifies the width of the bottom face emission area in meters.

#### 4.5.24.2.2.3 Length Offset Element

The required LengthOffset element specifies the offset of the bottom face emission area from the geometric center of the luminaire along the length (y) axis in meters.

#### 4.5.24.2.2.4 Width Offset Element

The required WidthOffset element specifies the offset of the bottom face emission area from the geometric center of the luminaire along the width (x) axis in meters.

#### 4.5.24.2.2.5 Circular Element

The optional Boolean Circular element, if true, indicates that the bottom face emission area is circular rather than rectangular. (If the length and width element values are not equal, the area is considered to be elliptical.)

### 4.5.24.3 C0 Face Element

The optional C0Face element is the parent of C0 face emission areas data. Elements are detailed in Table 49.

**Table 49. C0 Face Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Number C0 | NumberC0 | xs:int | Yes | 4.5.24.3.1 |
| C0 Area | C0Area | XML Element | Yes | 4.5.24.3.2 |

#### 4.5.24.3.1 Number C0 Element

The required NumberC0 element specifies the number of C0 face emission areas.

#### 4.5.24.3.2 C0 Area Element

The required C0Area element is the parent of C0 face emission area data. Elements are detailed in Table 50.

Multiple C0Area elements are allowed.

**Table 50: C0 Face Emission Area Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Length | Length | xs:decimal | Yes | 4.5.24.3.2.1 |
| Height | Height | xs:decimal | Yes | 4.5.24.3.2.2 |
| Length Offset | LengthOffset | xs:decimal | Yes | 4.5.24.3.2.3 |
| Height Offset | HeightOffset | xs:decimal | Yes | 4.5.24.3.2.4 |
| Circular | Circular | xs:boolean | Optional | 4.5.24.3.2.5 |



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#### 4.5.24.3.2.1 Length Element

The required `Length` element specifies the length of the C0 face emission area in meters.

#### 4.5.24.3.2.2 Height Element

The required `Height` element specifies the height of the C0 face emission area in meters.

#### 4.5.24.3.2.3 Length Offset Element

The required `LengthOffset` element specifies the offset of the C0 face emission area from the geometric center of the luminaire along the length (y) axis in meters.

#### 4.5.24.3.2.4 Height Offset Element

The required `HeightOffset` element specifies the offset of the C0 face emission area from the geometric center of the luminaire along the height (z) axis in meters.

#### 4.5.24.3.2.5 Circular Element

The optional Boolean `Circular` element, if true, indicates that the C0 face emission area is circular rather than rectangular. (If the length and width element values are not equal, the area is considered to be elliptical.)

### 4.5.24.4 C90 Face Element

The optional `C90Face` element is the parent of C90 face emission areas data. Elements are detailed in Table 51.

**Table 51. C90 Face Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Number C90 | `NumberC90` | xs:int | Yes | 4.5.24.4.1 |
| C90 Area | `C90Area` | XML Element | Yes | 4.5.24.4.2 |

#### 4.5.24.4.1 Number C90 Element

The required `NumberC90` element specifies the number of C90 face emission areas.

#### 4.5.24.4.2 C90 Area Element

The required `C90Area` element is the parent of C90 face emission area data. Elements are detailed in Table 52.

Multiple `C90Area` elements are allowed.

**Table 52. C90 Face Emission Area Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Width | `Width` | xs:decimal | Yes | 4.5.24.4.2.1 |
| Height | `Height` | xs:decimal | Yes | 4.5.24.4.2.3 |
| Width Offset | `WidthOffset` | xs:decimal | Yes | 4.5.24.4.2.3 |
| Height Offset | `HeightOffset` | xs:decimal | Yes | 4.5.24.4.2.4 |
| Circular | `Circular` | xs:boolean | Optional | 4.5.24.4.2.5 |

#### 4.5.24.4.2.1 Width Element

The required `Width` element specifies the width of the C90 face emission area in meters.




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#### 4.5.24.4.2.2 Height Element

The required `Height` element specifies the height of the C90 face emission area in meters.

#### 4.5.24.4.2.3 Width Offset Element

The required `WidthOffset` element specifies the offset of the C90 face emission area from the geometric center of the luminaire along the width (x) axis in meters.

#### 4.5.24.4.2.4 Height Offset Element

The required `HeightOffset` element specifies the offset of the C90 face emission area from the geometric center of the luminaire along the height (z) axis in meters.

#### 4.5.24.4.2.5 Circular Element

The optional Boolean `Circular` element, if true, indicates that the C90 face emission area is circular rather than rectangular. (If the length and width element values are not equal, the area is considered to be elliptical.)

### 4.5.24.5 C180 Face Element

The optional `C180Face` element is the parent of C180 face emission areas data. Elements are detailed in Table 53.

**Table 53. C180 Face Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Number C180 | `NumberC180` | xs:int | Yes | 4.5.24.5.1 |
| C180 Area | `C180Area` | XML Element | Yes | 4.5.24.5.2 |

#### 4.5.24.5.1 Number C180 Element

The required `NumberC180` element specifies the number of C180 face emission areas.

#### 4.5.24.5.2 C180 Area Element

The required `C180Area` element is the parent of C180 face emission area data. Elements are detailed in Table 54.

Multiple `C180Area` elements are allowed.

**Table 54. C180 Face Emission Area Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Length | `Length` | xs:decimal | Yes | 4.5.24.5.2.1 |
| Height | `Height` | xs:decimal | Yes | 4.5.24.5.2.2 |
| Length Offset | `LengthOffset` | xs:decimal | Yes | 4.5.24.5.2.3 |
| Height Offset | `HeightOffset` | xs:decimal | Yes | 4.5.24.5.2.4 |
| Circular | `Circular` | xs:boolean | Optional | 4.5.24.5.2.5 |

#### 4.5.24.5.2.1 Length Element

The required `Length` element specifies the length of the C180 face emission area in meters.

#### 4.5.24.5.2.2 Height Element

The required `Height` element specifies the height of the C180 face emission area in meters.




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#### 4.5.24.5.2.3 Length Offset Element

The required `LengthOffset` element specifies the offset of the C180 face emission area from the geometric center of the luminaire along the length (y) axis in meters.

#### 4.5.24.5.2.4 Height Offset Element

The required `HeightOffset` element specifies the offset of the C180 face emission area from the geometric center of the luminaire along the height (z) axis in meters.

#### 4.5.24.5.2.5 Circular Element

The optional Boolean `Circular` element, if true, indicates that the C180 face emission area is circular rather than rectangular. (If the length and width element values are not equal, the area is considered to be elliptical.)

### 4.5.24.6 C270 Face Element

The optional `C270Face` element is the parent of C270 face emission areas data. Elements are detailed in Table 55.

**Table 55. C270 Face Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Number C0 | `NumberC270` | xs:int | Yes | 4.5.24.6.1 |
| C270 Area | `C270Area` | XML Element | Yes | 4.5.24.6.2 |

#### 4.5.24.6.1 Number C270 Element

The required `NumberC270` element specifies the number of C270 face emission areas.

#### 4.5.24.6.2 C270 Area Element

The required `C270Area` element is the parent of C270 face emission area data. Elements are detailed in Table 56.

Multiple `C270Area` elements are allowed.

**Table 56. C270 Face Emission Area Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Width | `Width` | xs:decimal | Yes | 4.5.24.6.2.1 |
| Height | `Height` | xs:decimal | Yes | 4.5.24.6.2.2 |
| Width Offset | `WidthOffset` | xs:decimal | Yes | 4.5.24.6.2.3 |
| Height Offset | `HeightOffset` | xs:decimal | Yes | 4.5.24.6.2.4 |
| Circular | `Circular` | xs:boolean | Optional | 4.5.24.6.2.5 |

#### 4.5.24.6.2.1 Width Element

The required `Width` element specifies the width of the C270 face emission area in meters.

#### 4.5.24.6.2.2 Height Element

The required `Height` element specifies the height of the C270 face emission area in meters.

#### 4.5.24.6.2.3 Width Offset Element

The required `WidthOffset` element specifies the offset of the C270 face emission area from the geometric center of the luminaire along the width (x) axis in meters.




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#### 4.5.24.6.2.4 Height Offset Element

The required `HeightOffset` element specifies the offset of the C270 face emission area from the geometric center of the luminaire along the height (z) axis in meters.

#### 4.5.24.6.2.5 Circular Element

The optional Boolean `Circular` element, if true, indicates that the C270 face emission area is circular rather than rectangular. (If the length and width element values are not equal, the area is considered to be elliptical.)

### 4.5.25 Emitter Center Element

The optional `EmitterCenter` element is the parent of emitter center data. Elements are detailed in Table 57.

If the `EmitterCenter` element is absent, the emitter center is assumed to be coincident with the geometric center.

**Table 57. Emitter Center Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Length Offset | `LengthOffset` | xs:decimal | Yes | 4.5.25.1 |
| Width Offset | `WidthOffset` | xs:decimal | Yes | 4.5.25.2 |
| Height Offset | `HeightOffset` | xs:decimal | Yes | 4.5.25.3 |

#### 4.5.25.1 Length Offset Element

The required `LengthOffset` element specifies the offset of the emitter center from the geometric center of the luminaire along the length (y) axis in meters.

#### 4.5.25.2 Width Offset Element

The required `WidthOffset` element specifies the offset of the emitter center from the geometric center of the luminaire along the width (x) axis in meters.

#### 4.5.25.3 Height Offset Element

The required `HeightOffset` element specifies the offset of the emitter center from the geometric center of the luminaire along the height (z) axis in meters.

### 4.5.26 Regulatory Element

The optional `Regulatory` element is the parent of regulatory data. Elements are detailed in Table 58.

**Table 58. Regulatory Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Input Wattage | `InputWattage` | xs:string | Optional | 4.5.5 |
| Power Factor | `PowerFactor` | xs:string | Optional | 4.5.6 |
| Ballast Factor | `BallastFactor` | xs:string | Optional | 4.5.7 |
| Correlated Color Temperature (CCT) | `ColorTemperature` | xs:string | Optional | 4.5.9 |
| CIE CRI | `CIE_CRI` | xs:string | Optional | 4.5.10.1 |
| IES TM-30 | `IES_TM30` | xs:string | Optional | 4.5.10.2 |
| Duv | `Duv` | xs:string | Optional | 4.5.11 |
| S/P Ratio | `SPRatio` | xs:string | Optional | 4.5.12 |




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| | | | | |
|---|---|---|---|---|
| Luminous Intensity | LuminousIntensity | xs:string | Optional | 4.5.14.1.6 |
| Luminous Flux | LuminousFlux | xs:string | Optional | 4.5.14.2 |
| Radiant Intensity | RadiantIntensity | xs:string | Optional | 4.5.15.3.5 |
| Radiant Flux | RadiantFlux | xs:string | Optional | 4.5.15.4 |
| Photon Intensity | PhotonIntensity | xs:string | Optional | 4.5.16.3.5 |
| Photon Flux | PhotonFlux | xs:string | Optional | 4.5.16.4 |
| Spectral Power | SpectralPower | xs:string | Optional | 4.5.17.1.5 |
| Spectral Intensity | SpectralIntensity | xs:string | Optional | 4.5.17.2.7 |
| Angular Color | AngularColor | xs:string | Optional | 4.5.18.5 |
| Illuminance | Illuminance | xs:string | Optional | 4.5.19.2.4 |
| Irradiance | Irradiance | xs:string | Optional | 4.5.20.4.4 |
| Photon Flux Density | PhotonFluxDensity | xs:string | Optional | 4.5.21.4.4 |
| Spectral Irradiance | SpectralIrradiance | xs:string | Optional | 4.5.22.2.5 |

Each optional Regulatory element shall be identified as having measured, nominal, or rated values, as listed in Table 59.

**Table 59. Regulatory Value Types**

| Type | Description |
|---|---|
| Measured | Measured value(s) |
| Nominal | Nominal value(s) |
| Rated | Rated value(s) |

A “rated” value is the value of a quantity used for specification purposes, established for a specified set of operating conditions of the product.

A “nominal” value is an approximate quantity value used to designate or identify a product.

If a Regulatory element is absent, its values are assumed to be measured or calculated from measured data.

### 4.6 Custom Data Element

The optional CustomData element is the parent of custom data. Elements are detailed in Table 60.

The intent of the CustomData element is to provide a means of including custom data within the luminaire optical data document. For example, a company or government agency may require additional information that cannot be represented within the base XML schema (Section 4.7).

Multiple CustomData elements are allowed.

**Table 60: Custom Data Fields**

| Element Description | Element Name | Data Type | Required | Document Section |
|---|---|---|---|---|
| Name | Name | xs:string | Yes | 4.6.1 |
| Unique Identifier | UniqueIdentifier | xs:string | Yes | 4.6.2 |
| Any Data | [Not applicable] | XML Element | Optional | 4.6.3 |

#### 4.6.1 Name Element

The required Name element specifies the name describing the custom data, for example “Italian CAM”.




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### 4.6.2 Unique Identifier Element

The required `UniqueIdentifier` element contains a Universally Unique Identifier (UUID) as defined by RFC 4122. Most scientific programming language libraries include functions that will automatically generate UUIDs.

A UUID is a unique 128-bit value expressed as a string with 32 hexadecimal digits in the format xxxxxxxx-xxxx-xxxx-xxxx-xxxxxxxxxxxx. For example:

E1EC2128-3AEB-1069-A24E-98712B54306F

The purpose of this UUID is to prevent name collisions between different instances of the `Name` element.

### 4.6.3 AnyData Element

The base XML schema (Section 4.7) allows an arbitrary sequence of XML elements within the `CustomData` element using an `<any>` declaration with an `##any` namespace attribute to instruct a validating parser to ignore the element sequence for validation purposes.

## 4.7 XML Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">

  <!-- Common attribute definitions -->
  <xs:attribute name="angle" type="xs:decimal"/>
  <xs:attribute name="h" type="xs:decimal"/>
  <xs:attribute name="v" type="xs:decimal"/>
  <xs:attribute name="w" type="xs:decimal"/>
  <xs:attribute name="x" type="xs:decimal"/>
  <xs:attribute name="y" type="xs:decimal"/>
  <xs:attribute name="z" type="xs:decimal"/>

  <!-- Common simple element definitions -->
  <xs:element name="Circular" type="xs:boolean"/>
  <xs:element name="Height" type="xs:decimal"/>
  <xs:element name="HeightOffset" type="xs:decimal"/>
  <xs:element name="Length" type="xs:decimal"/>
  <xs:element name="LengthOffset" type="xs:decimal"/>
  <xs:element name="MaxWavelength" type="xs:decimal"/>
  <xs:element name="MeasurementEquipment" type="xs:string"/>
  <xs:element name="MinWavelength" type="xs:decimal"/>
  <xs:element name="Multiplier" type="xs:float"/>
  <xs:element name="NumberHorz" type="xs:int"/>
  <xs:element name="NumberMeasured" type="xs:int"/>
  <xs:element name="NumberPlanes" type="xs:int"/>
  <xs:element name="NumberVert" type="xs:int"/>
  <xs:element name="NumberWavelength" type="xs:int"/>
  <xs:element name="Width" type="xs:decimal"/>
  <xs:element name="WidthOffset" type="xs:decimal"/>

  <!-- Common element definitions -->
  <xs:complexType name="IntDataType2">
    <xs:simpleContent>
      <xs:extension base="xs:float">
        <xs:attribute ref="h"/>
        <xs:attribute ref="v"/>
```



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```
    </xs:extension>
  </xs:simpleContent>
</xs:complexType>
<xs:complexType name="IntDataType3">
  <xs:simpleContent>
    <xs:extension base="xs:float">
      <xs:attribute ref="h"/>
      <xs:attribute ref="v"/>
      <xs:attribute ref="w"/>
    </xs:extension>
  </xs:simpleContent>
</xs:complexType>
<xs:complexType name="IntDataType4">
  <xs:simpleContent>
    <xs:extension base="xs:float">
      <xs:attribute ref="x"/>
      <xs:attribute ref="y"/>
    </xs:extension>
  </xs:simpleContent>
</xs:complexType>
<xs:complexType name="PlaneNormalType">
  <xs:simpleContent>
    <xs:extension base="xs:decimal">
      <xs:attribute ref="x"/>
      <xs:attribute ref="y"/>
      <xs:attribute ref="z"/>
    </xs:extension>
  </xs:simpleContent>
</xs:complexType>
<xs:complexType name="PwrDataType">
  <xs:simpleContent>
    <xs:extension base="xs:float">
      <xs:attribute ref="w"/>
    </xs:extension>
  </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="RegulatoryValue">
  <xs:restriction base="xs:string">
    <xs:enumeration value="Measured"/>
    <xs:enumeration value="Nominal"/>
    <xs:enumeration value="Rated"/>
  </xs:restriction>
</xs:simpleType>
<xs:simpleType name="SymmType">
  <xs:restriction base="xs:string">
    <xs:enumeration value="Symm_None"/>
    <xs:enumeration value="Symm_Bi_0"/>
    <xs:enumeration value="Symm_Bi_90"/>
    <xs:enumeration value="Symm_Quad"/>
    <xs:enumeration value="Symm_Full"/>
    <xs:enumeration value="Symm_Arbitrary"/>
  </xs:restriction>
</xs:simpleType>

<xs:element name="ATLA_S001_A">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="Version" type="xs:string" fixed="1.1"/>
```





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```
<xs:element name="Header">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="Manufacturer" type="xs:string"
          minOccurs="0"/>
      <xs:element name="CatalogNumber" type="xs:string"
          minOccurs="0"/>
      <xs:element name="GTIN" type="xs:integer"
          minOccurs="0"/>
      <xs:element name="Description" type="xs:string"/>
      <xs:element name="Laboratory" type="xs:string"/>
      <xs:element name="ReportNumber" type="xs:string"/>
      <xs:element name="ReportDate" type="xs:date"/>
      <xs:element name="DocumentCreator" type="xs:string"
          minOccurs="0"/>
      <xs:element name="DocumentCreationDate" type="xs:date"
          minOccurs="0"/>
      <xs:element name="UniqueIdentifier" type="xs:string"
          minOccurs="0"/>
      <xs:element name="Comment" type="xs:string"
          minOccurs="0" maxOccurs="unbounded"/>
      <xs:element name="Reference" type="xs:string"
          minOccurs="0" maxOccurs="unbounded"/>
      <xs:element name="MoreInfoURI" type="xs:anyURI"
          minOccurs="0"/>
   </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="Luminaire" minOccurs="0">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="Dimensions">
        <xs:complexType>
          <xs:sequence>
            <xs:element ref="Length"/>
            <xs:element ref="Width"/>
            <xs:element ref="Height"/>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
      <xs:element name="Shape" minOccurs="0">
        <xs:simpleType>
          <xs:restriction base="xs:string">
            <xs:enumeration value="Align_X"/>
            <xs:enumeration value="Align_Y"/>
            <xs:enumeration value="Align_Z"/>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
      <xs:element name="NumEmitter" type="xs:int"/>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="Equipment" minOccurs="0">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="Gonioradiometer" minOccurs="0">
        <xs:complexType>
```





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```
            <xs:sequence>
              <xs:element name="Type">
                <xs:simpleType>
                  <xs:restriction base="xs:string">
                    <xs:enumeration value="CIE_A"/>
                    <xs:enumeration value="CIE_B"/>
                    <xs:enumeration value="CIE_C"/>
                    <xs:enumeration value="IES_A"/>
                    <xs:enumeration value="IES_B"/>
                    <xs:enumeration value="IES_C"/>
                    <xs:enumeration value="CUSTOM"/>
                  </xs:restriction>
                </xs:simpleType>
              </xs:element>
              <xs:element ref="MeasurementEquipment"
                  minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
        <xs:element name="IntegratingSphere" minOccurs="0">
          <xs:complexType>
            <xs:sequence>
              <xs:element ref="MeasurementEquipment"
                  minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
        <xs:element name="Spectroradiometer" minOccurs="0">
          <xs:complexType>
            <xs:sequence>
              <xs:element ref="MeasurementEquipment"
                  maxOccurs="unbounded"/>
              <xs:element name="BandwidthFWHM" type="xs:decimal"
                  minOccurs="0"/>
              <xs:element name="BandwidthCorrected"
                  type="xs:boolean" minOccurs="0"/>
              <xs:element name="BandwidthMethod"
                  type="xs:string" minOccurs="0"/>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="Emitter" maxOccurs="unbounded">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="Quantity" type="xs:int"/>
        <xs:element name="Description" type="xs:string"/>
        <xs:element name="CatalogNumber" type="xs:string"
            minOccurs="0"/>
        <xs:element name="RatedLumens" type="xs:decimal"
            minOccurs="0"/>
        <xs:element name="InputWattage" type="xs:decimal"/>
        <xs:element name="PowerFactor" type="xs:decimal"
            minOccurs="0"/>
        <xs:element name="BallastFactor" type="xs:decimal"
            minOccurs="0"/>
```





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```
<xs:element name="TiltAngles" minOccurs="0">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="NumberAngles" type="xs:int"/>
      <xs:element name="Tilt">
        <xs:complexType>
          <xs:simpleContent>
            <xs:extension base="xs:decimal">
              <xs:attribute ref="angle"/>
            </xs:extension>
          </xs:simpleContent>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="ColorTemperature" minOccurs="0">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="FixedCCT" type="xs:int"
          minOccurs="0"/>
      <xs:element name="MinCCT" type="xs:int"
          minOccurs="0"/>
      <xs:element name="MaxCCT" type="xs:int"
          minOccurs="0"/>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="ColorRendering" minOccurs="0">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="CIE_CRI" minOccurs="0">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="Ra" type="xs:int"/>
            <xs:element name="R9" type="xs:int"
                minOccurs="0"/>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
      <xs:element name="IES_TM30" minOccurs="0">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="Rf" type="xs:int"/>
            <xs:element name="Rg" type="xs:int"/>
            <xs:element name="Rfh01" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rfh02" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rfh03" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rfh04" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rfh05" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rfh06" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rfh07" type="xs:int"
```



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```
                minOccurs="0"/>
            <xs:element name="Rfh08" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rfh09" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rfh10" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rfh11" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rfh12" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rfh13" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rfh14" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rfh15" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rfh16" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rcsh01" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rcsh02" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rcsh03" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rcsh04" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rcsh05" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rcsh06" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rcsh07" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rcsh08" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rcsh09" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rcsh10" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rcsh11" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rcsh12" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rcsh13" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rcsh14" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rcsh15" type="xs:int"
                minOccurs="0"/>
            <xs:element name="Rcsh16" type="xs:int"
                minOccurs="0"/>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="Duv" type="xs:decimal" minOccurs="0"/>
```





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```
<xs:element name="SPRatio" type="xs:decimal"
    minOccurs="0"/>
<xs:element name="DataGeneration" minOccurs="0">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="Simulation" type="xs:boolean"
          minOccurs="0"/>
      <xs:element name="Laboratory" minOccurs="0">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="Certification"
                type="xs:string"/>
            <xs:element name="ApprovalBody"
                type="xs:string"/>
            <xs:element name="ApprovalScope"
                type="xs:string"/>
            <xs:element name="MeasUncertainty">
              <xs:complexType>
                <xs:sequence>
                  <xs:element name="MeasurementType"
                      type="xs:string"/>
                  <xs:element name="Uncertainty"
                      type="xs:decimal"/>
                </xs:sequence>
              </xs:complexType>
            </xs:element>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
      <xs:element name="IntensityScaling"
          type="xs:boolean" minOccurs="0"/>
      <xs:element name="AngleInterpolation"
          type="xs:boolean" minOccurs="0"/>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="LuminousData" minOccurs="0">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="LuminousIntensity">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="AbsolutePhotometry"
                type="xs:boolean" minOccurs="0"/>
            <xs:element name="Symm"
                type="SymmType" minOccurs="0"/>
            <xs:element name="Multiplier"
                type="xs:float" minOccurs="0"/>
            <xs:element ref="NumberMeasured"/>
            <xs:element ref="NumberHorz"/>
            <xs:element ref="NumberVert"/>
            <xs:element name="IntData"
                type="IntDataType2"
                maxOccurs="unbounded"/>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
      <xs:element name="LuminousFlux" type="xs:decimal"
```



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```
            minOccurs="0"/>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="RadiantData" minOccurs="0">
    <xs:complexType>
      <xs:sequence>
        <xs:element ref="MinWavelength"/>
        <xs:element ref="MaxWavelength"/>
        <xs:element name="RadiantIntensity">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="Absolute"
                  type="xs:boolean" minOccurs="0"/>
              <xs:element name="Symm"
                  type="SymmType" minOccurs="0"/>
              <xs:element name="Multiplier"
                  type="xs:float" minOccurs="0"/>
              <xs:element ref="NumberMeasured"/>
              <xs:element ref="NumberHorz"/>
              <xs:element ref="NumberVert"/>
              <xs:element name="IntData"
                  type="IntDataType2"
                  maxOccurs="unbounded"/>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
        <xs:element name="RadiantFlux" type="xs:decimal"
            minOccurs="0"/>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="PhotonData" minOccurs="0">
    <xs:complexType>
      <xs:sequence>
        <xs:element ref="MinWavelength"/>
        <xs:element ref="MaxWavelength"/>
        <xs:element name="PhotonIntensity">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="Absolute"
                  type="xs:boolean" minOccurs="0"/>
              <xs:element name="Symm"
                  type="SymmType" minOccurs="0"/>
              <xs:element name="Multiplier"
                  type="xs:float" minOccurs="0"/>
              <xs:element ref="NumberMeasured"/>
              <xs:element ref="NumberHorz"/>
              <xs:element ref="NumberVert"/>
              <xs:element name="IntData"
                  type="IntDataType2"
                  maxOccurs="unbounded"/>
             </xs:sequence>
          </xs:complexType>
        </xs:element>
        <xs:element name="PhotonFlux" type="xs:decimal"
            minOccurs="0"/>
      </xs:sequence>
```





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```
  </xs:complexType>
</xs:element>
<xs:element name="SpectralData" minOccurs="0">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="EmitterSpectral" minOccurs="0"
          maxOccurs="unbounded">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="EmitterName"
                minOccurs="0"/>
            <xs:element ref="NumberWavelength"/>
            <xs:element name="Multiplier"
                type="xs:float" minOccurs="0"/>
            <xs:element name="Normalized"
                type="xs:boolean" minOccurs="0"/>
            <xs:element name="Timestamp"
                type="xs:int" minOccurs="0"/>
            <xs:element name="PwrData"
                type="PwrDataType"
                maxOccurs="unbounded"/>
            <xs:element name="Quantum"
                type="xs:int" minOccurs="0"/>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
      <xs:element name="AngularSpectral" minOccurs="0">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="Absolute"
                type="xs:boolean" minOccurs="0"/>
            <xs:element name="Symm"
                type="SymmType" minOccurs="0"/>
            <xs:element name="Multiplier"
                type="xs:float" minOccurs="0"/>
            <xs:element ref="NumberMeasured"/>
            <xs:element ref="NumberHorz"/>
            <xs:element ref="NumberVert"/>
            <xs:element ref="NumberWavelength"/>
            <xs:element name="IntData"
                type="IntDataType3"
                maxOccurs="unbounded"/>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="AngularColor" minOccurs="0">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="Symm"
          type="SymmType" minOccurs="0"/>
      <xs:element name="Multiplier"
          type="xs:float" minOccurs="0"/>
      <xs:element ref="NumberMeasured"/>
      <xs:element ref="NumberHorz"/>
      <xs:element ref="NumberVert"/>
```





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```
      <xs:element name="IntData"
          type="IntDataType4"
          maxOccurs="unbounded"/>
     </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="IllumData" minOccurs="0">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="Absolute"
          type="xs:boolean" minOccurs="0"/>
      <xs:element name="Multiplier"
          type="xs:float" minOccurs="0"/>
      <xs:element ref="NumberPlanes"/>
      <xs:element name="PlaneData">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="PlaneNormal"
                type="PlaneNormalType" minOccurs="0"/>
            <xs:element ref="NumberMeasured"/>
              <xs:element name="Illum"
                  maxOccurs="unbounded">
              <xs:complexType >
                <xs:simpleContent>
                  <xs:extension base="xs:float">
                    <xs:attribute ref="x"/>
                    <xs:attribute ref="y"/>
                    <xs:attribute ref="z"/>
                  </xs:extension>
                </xs:simpleContent>
              </xs:complexType>
            </xs:element>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="IrradData" minOccurs="0">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="Absolute"
          type="xs:boolean" minOccurs="0"/>
      <xs:element name="Multiplier"
          type="xs:float" minOccurs="0"/>
      <xs:element ref="MinWavelength"/>
      <xs:element ref="MaxWavelength"/>
      <xs:element ref="NumberPlanes"/>
      <xs:element name="PlaneData">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="PlaneNormal"
                type="PlaneNormalType" minOccurs="0"/>
            <xs:element ref="NumberMeasured"/>
              <xs:element name="Irrad"
                  maxOccurs="unbounded">
              <xs:complexType>
                <xs:simpleContent>
```





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```
                    <xs:extension base="xs:float">
                      <xs:attribute ref="x"/>
                      <xs:attribute ref="y"/>
                      <xs:attribute ref="z"/>
                    </xs:extension>
                  </xs:simpleContent>
                </xs:complexType>
              </xs:element>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="PFDData" minOccurs="0">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="Absolute"
            type="xs:boolean" minOccurs="0"/>
        <xs:element name="Multiplier"
            type="xs:float" minOccurs="0"/>
        <xs:element ref="MinWavelength"/>
        <xs:element ref="MaxWavelength"/>
        <xs:element ref="NumberPlanes"/>
        <xs:element name="PlaneData">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="PlaneNormal"
                  type="PlaneNormalType" minOccurs="0"/>
              <xs:element ref="NumberMeasured"/>
              <xs:element name="PFD"
                  maxOccurs="unbounded">
                <xs:complexType>
                  <xs:simpleContent>
                    <xs:extension base="xs:float">
                      <xs:attribute ref="x"/>
                      <xs:attribute ref="y"/>
                      <xs:attribute ref="z"/>
                    </xs:extension>
                  </xs:simpleContent>
                </xs:complexType>
              </xs:element>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="SpecIrradData" minOccurs="0">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="Absolute"
            type="xs:boolean" minOccurs="0"/>
        <xs:element name="Multiplier"
            type="xs:float" minOccurs="0"/>
        <xs:element ref="NumberPlanes"/>
        <xs:element name="PlaneData">
          <xs:complexType>
```



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```
            <xs:sequence>
              <xs:element name="PlaneNormal"
                  type="PlaneNormalType" minOccurs="0"/>
              <xs:element ref="NumberMeasured"/>
              <xs:element ref="NumberWavelength"/>
              <xs:element name="SIrrad"
                  maxOccurs="unbounded">
                <xs:complexType>
                  <xs:simpleContent>
                    <xs:extension base="xs:float">
                      <xs:attribute ref="x"/>
                      <xs:attribute ref="y"/>
                      <xs:attribute ref="z"/>
                      <xs:attribute ref="w"/>
                    </xs:extension>
                  </xs:simpleContent>
                </xs:complexType>
              </xs:element>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="Channels" minOccurs="0">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="NumChannels" type="xs:int"/>
        <xs:element name="ChannelMult"
            maxOccurs="unbounded">
          <xs:complexType>
            <xs:simpleContent>
              <xs:extension base="xs:decimal">
                <xs:attribute name="name"
                    type="xs:string"/>
              </xs:extension>
            </xs:simpleContent>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="EmissionAreas" minOccurs="0">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="TopFace" minOccurs="0">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="NumberTop" type="xs:int"/>
              <xs:element name="TopArea"
                  maxOccurs="unbounded">
                <xs:complexType>
                  <xs:sequence>
                    <xs:element ref="Length"/>
                    <xs:element ref="Width"/>
                    <xs:element ref="LengthOffset"/>
                    <xs:element ref="WidthOffset"/>
                    <xs:element ref="Circular"
```



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```
                minOccurs="0"/>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="BottomFace" minOccurs="0">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="NumberBottom"
            type="xs:int"/>
        <xs:element name="BottomArea"
            maxOccurs="unbounded">
          <xs:complexType>
            <xs:sequence>
              <xs:element ref="Length"/>
              <xs:element ref="Width"/>
              <xs:element ref="LengthOffset"/>
              <xs:element ref="WidthOffset"/>
              <xs:element ref="Circular"
                  minOccurs="0"/>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="C0Face" minOccurs="0">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="NumberC0" type="xs:int"/>
        <xs:element name="C0Area"
            maxOccurs="unbounded">
          <xs:complexType>
           <xs:sequence>
              <xs:element ref="Length"/>
              <xs:element ref="Height"/>
              <xs:element ref="LengthOffset"/>
              <xs:element ref="HeightOffset"/>
             <xs:element ref="Circular"
                 minOccurs="0"/>
           </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="C90Face" minOccurs="0">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="NumberC90" type="xs:int"/>
        <xs:element name="C90Area"
            maxOccurs="unbounded">
          <xs:complexType>
            <xs:sequence>
              <xs:element ref="Width"/>
              <xs:element ref="Height"/>
```





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```
                    <xs:element ref="WidthOffset"/>
                    <xs:element ref="HeightOffset"/>
                    <xs:element ref="Circular"
                        minOccurs="0"/>
                  </xs:sequence>
                </xs:complexType>
              </xs:element>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
        <xs:element name="C180Face" minOccurs="0">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="NumberC180"
                  type="xs:int"/>
              <xs:element name="C180Area"
                  maxOccurs="unbounded">
                <xs:complexType>
                  <xs:sequence>
                    <xs:element ref="Length"/>
                    <xs:element ref="Height"/>
                    <xs:element ref="LengthOffset"/>
                    <xs:element ref="HeightOffset"/>
                    <xs:element ref="Circular"
                        minOccurs="0"/>
                  </xs:sequence>
                </xs:complexType>
              </xs:element>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
        <xs:element name="C270Face" minOccurs="0">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="NumberC270"
                  type="xs:int"/>
              <xs:element name="C270Area"
                  maxOccurs="unbounded">
                <xs:complexType>
                  <xs:sequence>
                    <xs:element ref="Width"/>
                    <xs:element ref="Height"/>
                    <xs:element ref="WidthOffset"/>
                    <xs:element ref="HeightOffset"/>
                    <xs:element ref="Circular"
                        minOccurs="0"/>
                  </xs:sequence>
                </xs:complexType>
              </xs:element>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="EmitterCenter" minOccurs="0">
    <xs:complexType>
      <xs:sequence>
```





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```
            <xs:element ref="LengthOffset"/>
            <xs:element ref="WidthOffset"/>
            <xs:element ref="HeightOffset"/>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
      <xs:element name="Regulatory" minOccurs="0">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="InputWattage"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="PowerFactor"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="BallastFactor"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="ColorTemperature"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="CIE_CRI"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="IES_TM30"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="Duv"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="SPRatio"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="LuminousIntensity"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="LuminousFlux"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="RadiantIntensity"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="RadiantFlux"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="PhotonIntensity"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="PhotonFlux"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="SpectralPower"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="SpectralIntensity"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="AngularColor"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="Illuminance"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="Irradiance"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="PhotonFluxDensity"
                type="RegulatoryValue" minOccurs="0"/>
            <xs:element name="SpectralIrradiance"
                type="RegulatoryValue" minOccurs="0"/>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="CustomData" minOccurs="0"
```





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```
            maxOccurs="unbounded">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="Name" type="xs:string"/>
              <xs:element name="UniqueIdentifier" type="xs:string"/>
              <xs:any namespace="##any" processContents="skip"
                  minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</xs:schema>
```





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### 4.8 JSON Document Format

JavaScript Object Notation (JSON) is a minimalist data-interchange format that is widely used for Internet client-server communications. Unlike the rich semantics of XML with its many data types, JSON allows only name-value pairs and ordered lists.

The advantage of the XML document format in representing luminaire optical data is that the documents can be validated using the associated schema (Section 4.7); the advantage of the JSON document format is that its ordered lists can be used to compactly represent data arrays, such as luminous intensity and photon flux density. In particular, JSON documents tend to be an order of magnitude smaller than their equivalent XML documents.

XML- and JSON-formatted versions of this standard shall be interchangeable, such that one version can be converted into the other version and back again without any loss of information.

#### 4.8.1 XML to JSON Mapping

Mapping XML elements to JSON name-value pairs is straightforward. For example, the XML complex element:

```
<Equipment>
  <Gonioradiometer>
    <Type>CIE_C</Type>
  </Gonioradiometer>
</Equipment>
```

becomes this in JSON:

```
"Equipment": {
  "Gonioradiometer": {
    "Type": "CIE_C"
  }
}
```

Where multiple XML elements are allowed, these can be represented in JSON as arrays. For example, this:

```
<Comment>This is a comment</Comment>
<Comment>This is another comment</Comment>
```

becomes this:

```
"Comments": {
  "This is a comment",
  "This is another comment"
}
```

##### 4.8.1.1 Multiple XML Elements without Attributes

Multiple XML elements without attributes that can be represented as JSON arrays are shown in Table 61:

**Table 61. Multiple XML Elements without Attributes**

| Section | Element Name |
|---|---|
| 4.2.11 | Comment |
| 4.2.12 | Reference |
| 4.4.1.2 | MeasurementEquipment |




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| | |
|---|---|
| 4.4.2.1 | MeasurementEquipment |
| 4.4.3.1 | MeasurementEquipment |
| 4.5 | Emitter |
| 4.5.12.2.4 | MeasUncertainty |
| 4.5.17.1 | EmitterSpectral |
| 4.5.18.2 | PlaneData |
| 4.5.19.4 | PlaneData |
| 4.5.20.4 | PlaneData |
| 4.5.23.1.2 | TopArea |
| 4.5.23.2.2 | BottomArea |
| 4.5.23.3.2 | C0Area |
| 4.5.23.4.2 | C90Area |
| 4.5.23.5.2 | C180Area |
| 4.5.23.6.2 | C270Area |
| 4.5.25 | Regulatory |
| 4.6 | CustomData |

#### 4.8.1.2 Multiple XML Elements with Attributes

Multiple XML elements with attributes that can be represented as JSON arrays are shown in Table 62:

**Table 62. Multiple XML Elements with Attributes**

| Section | Element Names |
|---|---|
| 4.5.8 | Tilt |
| 4.5.14.1 | Intensity Data |
| 4.5.15.3 | Intensity Data |
| 4.5.16.3 | Intensity Data |
| 4.5.17.2.8 | Intensity Data |
| 4.5.17.1 | Power Data |
| 4.5.17.2 | Angular Spectral Intensity |
| 4.5.18 | Angular Color |
| 4.5.19.4.1 | Plane Normal |
| 4.5.20.6.1 | Plane Normal |
| 4.5.21.6.1 | Plane Normal |
| 4.5.22.4.1 | Plane Normal |
| 4.5.19 | Illuminance Data |
| 4.5.20 | Irradiance Data |
| 4.5.21 | Photon Flux Density Data |
| 4.5.22 | Spectral Irradiance Data |
| 4.5.23 | Channels |

##### 4.8.1.2.1 Tilt Element

A typical Tilt Angles XML element (see Section 4.5.8) is:

```
<TiltAngles>
  <NumberAngles>3</NumberAngles>
  <Tilt angle="0.0">1.00</Tilt>
  <Tilt angle="10.0">0.90</Tilt>
  <Tilt angle="20.0">0.80</Tilt>
</TiltAngles>
```

The equivalent JSON elements are:

```
"TiltAngles": {
```



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```
  "NumberAngles": 3,
  "TiltArray": {
    "Angle": [0.0, 10.0, 20.0],
    "Mult": [1.00, 0.90, 0.80]
  }
}
```

#### 4.8.1.2.2 Intensity Data Element

A typical Luminous Intensity Data XML element (see Section 4.5.14.1) is:

```
<LuminousIntensity>
  <AbsolutePhotometry>true</AbsolutePhotometry>
  <Symm>Symm_Full</Symm>
  <NumberMeasured>95</NumberMeasured>
  <NumberHorz>5</NumberHorz>
  <NumberVert>19</NumberVert>
  …
  <IntData h="0.0" v="60.0">53</IntData>
  <IntData h="0.0" v="65.0">44</IntData>
  …
</LuminousIntensity>
```

If the `Symm` type is `Symm_Arbitrary` and `NumberHorz` is zero and `NumberVert` is zero (that is, the measurement coordinate system does not consist of a set of planes), the equivalent JSON elements are:

```
"LuminousIntensity": {
  "AbsolutePhotometry": true,
  "Symm": "Symm_Arbitrary",
  "NumberMeasured": 95,
  "NumberHorz": 0,
  "NumberVert": 0,
  "IntDataNoSymm": [
    …
    [0.0, 60.0, 53],
    [5.0, 65.0, 44],
    …
  ]
}
```

Otherwise, horizontal symmetry allows the intensity data to be expressed more compactly as:

```
"LuminousIntensity": {
  "AbsolutePhotometry": true,
  "Symm": "Symm_Full",
  "NumberMeasured": 95,
  "NumberHorz": 5,
  "NumberVert": 19,
  "IntDataSymm": {
    "h": [0.0],
    "v": [ …, 60.0, 65.0, … ],
    "IntData": [
       [ …, 53, 44, … ],
      …
       [ …, 50, 43, … ]
    ]
  }
```




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```
}
```

where "IntData" is a two-dimensional array with "NumberHorz" rows and "NumberVert" columns. That is, it is ordered by "NumberHorz" and "NumberVert".

Radiant intensity and photon intensity data elements (see Sections 4.5.15.3, and 4.5.16.3) can be similarly expressed.

#### 4.8.1.2.3 Power Data Element

A typical Emitter Spectral XML element (see Section 4.5.17.1) is:

```
<EmitterSpectral>
  <NumberWavelength>61</NumberWavelength>
  …
  <PwrData w="555.0">0.053</PwrData>
  …
</EmitterSpectral>
```

The equivalent JSON elements are:

```
"EmitterSpectral": {
  "NumberWavelength": 61,
  "PwrDataArray": {
    "w": […, 555.0, …],
    "PwrData": […, 0.053, …]
  }
}
```

#### 4.8.1.2.4 Angular Spectral Intensity Data Element

A typical Angular Spectral Intensity Data XML element (see Section 4.5.17.2) is:

```
<AngularSpectral>
  <Symm>Symm_Full</Symm>
  <NumberMeasured>19</NumberMeasured>
  <NumberHorz>1</NumberHorz>
  <NumberVert>19</NumberVert>
  <NumberWavelength>81</NumberWavelength>
  …
  <IntData h="0.0" v="60.0" w="555.0">0.023</IntData>
  <IntData h="0.0" v="60.0" w="560.0">0.031</IntData>
  …
</AngularSpectral>
```

If the Symm type is Symm_Arbitrary and NumberHorz is zero and NumberVert is zero (that is, the measurement coordinate system does not consist of a set of planes), the equivalent JSON elements are:

```
"AngularSpectral": {
  "Symm": "Symm_Arbitrary",
  "NumberMeasured": 19,
  "NumberHorz": 0,
  "NumberVert": 0,
  "NumberWavelength": 81,
  "IntDataNoSymm": [
    …
    [0.0, 60.0, 555.0, 0.023],
```




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```
    [0.0, 60.0, 555.0, 0.031],
    …
  ]
}
```

Otherwise, horizontal symmetry allows the intensity data to be expressed more compactly as:

```
"AngularSpectral": {
  "Symm": "Symm_Full",
  "NumberMeasured": 19,
  "NumberHorz": 1,
  "NumberVert": 19,
  "NumberWavelength": 81,
  "IntDataSymm": {
    "h": [0.0],
    "v": […, 60.0, …],
    "w": […, 555.0, 560.0, …],
    "IntData": [
      [
        …
        [ …, 0.023, 0.031, … ],
        …
      ]
    ]
  }
}
```

where "`IntData`" is a three-dimensional array ordered by "`NumberHorz`", "`NumberVert`", and "`NumberWavelength`".

#### 4.8.1.2.5 Angular Color Data Element

A typical Angular Color Data XML element (see Section 4.5.18) is:

```
<AngularColor>
  <Symm>Symm_Full</Symm>
  <NumberMeasured>19</NumberMeasured>
  <NumberHorz>1</NumberHorz>
  <NumberVert>19</NumberVert>
  …
  <ColorData h="0.0" v="60.0" x="0.3135" y="0.3293">55</ColorData>
  <ColorData h="0.0" v="65.0" y="0.3129" y="0.3290">52</ColorData>
  …
</AngularColor>
```

If the `Symm` type is `Symm_Arbitrary` and `NumberHorz` is zero and `NumberVert` is zero (that is, the measurement coordinate system does not consist of a set of planes), the equivalent JSON elements are:

```
"AngularColor": {
  "Symm": "Symm_Arbitrary",
  "NumberMeasured": 19,
  "NumberHorz": 0,
  "NumberVert": 0,
  "NumberWavelength": 81,
  "ColorDataNoSymm": [
    …
    [0.0, 60.0, 0.3135, 0.3293, 55],
```



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```
    [0.0, 65.0, 0.3129, 0.3290, 52],
    …
  ]
}
```

Otherwise, horizontal symmetry allows the color data to be expressed more compactly as:

```
"AngularColor": {
  "Symm": "Symm_Full",
  "NumberMeasured": 19,
  "NumberHorz": 1,
  "NumberVert": 19,
  "ColorDataSymm": {
    "h": [0.0],
    "v": […, 60.0, 65.0, …],
    "ColorData": [
      [
        …
        [0.3135, 0.3293, 55],
        [0.3129, 0.3290, 52],
        …
      ]
    ]
  }
}
```

where "`IntData`" is a two-dimensional array ordered by "`NumberHorz`" and "`NumberVert`".

#### 4.8.1.2.6 Plane Normal Element

A typical Plane Normal XML element (see Sections 4.5.19.4.1, 4.5.20.6.1, 4.5.21.6.1, and 4.5.22.4.1) is:

```
<PlaneNormal x="1.0" y="0.0" z="0.0"/>
```

The equivalent JSON element is:

```
"PlaneNormal": [1.0,0.0,0.0]
```

#### 4.8.1.2.7 Illuminance Data Element

A typical Illuminance Data element (see Section 4.5.19) is:

```
<IllumData>
  <NumberPlanes>1</NumberPlanes>
  <PlaneData>
    <NumberMeasured>128</NumberMeasured>
    …
    <Illum x="0.0" y="1.5" z="1.2">55</Illum>
    …
  </PlaneData>
</IllumData>
```

If the illuminance measurements are not on a rectangular grid, the equivalent JSON elements are:

```
"IllumData": {
  "NumberPlanes": 1,
```



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```
  "PlaneData": [
    "NumberMeasured": 128,
    "IllumNoSymm": [
      …
      [0.0,1.5,1.2,55],
      …
    ]
  ]
}
```

Otherwise, symmetry allows the illuminance data to be expressed more compactly as:

```
"IllumData": {
  "NumberPlanes": 1,
  "PlaneData": [
    "IllumSymm": {
      "x": […, 0.0, …],
      "y”: […, 1.5, …],
      "z": […, 1.2, …],
      "Illum": [
        [
          …
          […, 55, …]
          …
        ]
      ]
    }
  ]
}
```

where “`Illum`” is a three-dimensional array ordered by “`x`”, “`y`”, and “`z`”.

#### 4.8.1.2.8 Irradiance Data Element

A typical Irradiance Data element (see Section 4.5.20) is:

```
<IrradData>
  <NumberPlanes>1</NumberPlanes>
  <PlaneData>
    <NumberMeasured>128</NumberMeasured>
    …
    <Irrad x="0.0" y="1.5" z="1.2">55</Irrad>
    …
  </PlaneData>
</IrradData>
```

If the irradiance measurements are not on a rectangular grid, the equivalent JSON elements are:

```
"IrradData": {
  "NumberPlanes": 1,
  "PlaneData": [
    "NumberMeasured": 128,
    "IrradNoSymm": [
      …
      [0.0,1.5,1.2,55],
      …
    ]
```



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```
  ]
}
```

Otherwise, symmetry allows the irradiance data to be expressed more compactly as:

```
"IrradData": {
  "NumberPlanes": 1,
  "PlaneData": [
    "IrradSymm": {
      "x": […, 0.0, …],
      "y”: […, 1.5, …],
      "z": […, 1.2, …],
      "Irrad": [
        [
          …
          […, 55, …]
          …
        ]
      ]
    }
  ]
}
```

where “Irrad” is a three-dimensional array ordered by “x”, “y”, and “z”.

#### 4.8.1.2.9 Photon Flux Density Data Element

A typical Photon Flux Density Data element (see Section 4.5.21) is:

```
<PFDData>
  <NumberPlanes>1</NumberPlanes>
  <PlaneData>
    <NumberMeasured>128</NumberMeasured>
    …
    <PFD x="0.0" y="1.5" z="1.2">55</PFD>
    …
  </PlaneData>
</PFDData>
```

If the photon flux density measurements are not on a rectangular grid, the equivalent JSON elements are:

```
"PFDData": {
  "NumberPlanes": 1,
  "PlaneData": [
    "NumberMeasured": 128,
    "PFDNoSymm": [
      …
      [0.0,1.5,1.2,55],
      …
    ]
  ]
}
```

Otherwise, symmetry allows the photon flux density data to be expressed more compactly as:

```
"PFDData": {
  "NumberPlanes": 1,
```



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```
  "PlaneData": [
    "PFDSymm": {
      "x": […, 0.0, …],
      "y”: […, 1.5, …],
      "z": […, 1.2, …],
      "PFD": [
        [
          …
          […, 55, …]
          …
        ]
      ]
    }
  ]
}
```

where “PFD” is a three-dimensional array ordered by “x”, “y”, and “z”.

#### 4.8.1.2.10 Spectral Irradiance Data Element

A typical Spectral Irradiance Data element (see Section 4.5.22) is:

```
<SpecIrradData>
  <NumberPlanes>1</NumberPlanes>
  <PlaneData>
    <NumberMeasured>128</NumberMeasured>
    …
    <SIrrad x="0.0" y="1.5" z="1.2" w="555.0">55</SIrrad>
    …
  </PlaneData>
</SpecIrradData>
```

If the irradiance measurements are not on a rectangular grid, the equivalent JSON elements are:

```
"SpecIrradData": {
  "NumberPlanes": 1,
  "PlaneData": [
    "NumberMeasured": 128,
    "SpecIrradNoSymm": [
      …
      [0.0, 1.5, 1.2, 555.0, 55],
      …
    ]
  ]
}
```

Otherwise, symmetry allows the irradiance data to be expressed more compactly as:

```
"SpecIrradData": {
  "NumberPlanes": 1,
  "PlaneData”: [
    "SpecIrradSymm": {
      "x": […, 0.0, …],
      "y”: […, 1.5, …],
      "z": […, 1.2, …],
      "w": […, 555.0, …],
      "SIrrad": [
```



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```
          [
            [
              …
              […, 55, …]
              …
            ]
          ]
        ]
      }
    ]
}
```

where “SIrrad” is a four-dimensional array ordered by “x”, “y”, “z”, and “w”.

#### 4.8.1.2.11 Channels Element

A typical Channels element (see Section 4.5.23) is:

```
<Channels>
  <NumChannels>3</NumChannels>
  <ChannelMult name="red">0.21</ChannelMult>
  <ChannelMult name="green">0.72</ChannelMult>
  <ChannelMult name="blue">0.08</ChannelMult>
</Channels>
```

The equivalent JSON elements are:

```
"Channels": {
  "NumChannels": 3,
  "ChannelMult": [
    { "Name"="red", "ChannelMult"=0.21 },
    { "Name"="green", "ChannelMult"=0.72 },
    { "Name"="blue", "ChannelMult"=0.08 }
  ]
}
```

### 4.8.2 JSON Schema

The JSON schema follows:

```
{
  "$schema": "http://json-schema.org/draft/2019-09/schema#",
  "type": "object",
  "properties": {
    "FileType": {
      "type": "string"
    },
    "Version": {
      "type": "number"
    },
    "Header": {
      "type": "object",
      "properties": {
        "Manufacturer": {
          "type": "string"
        },
        "CatalogNumber": {
          "type": "string"
        },
```




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```
    "GTIN": {
      "type": "number"
    },
    "Description": {
      "type": "string"
    },
    "Laboratory": {
      "type": "string"
    },
    "ReportNumber": {
      "type": "string"
    },
    "ReportDate": {
      "type": "string",
      "pattern": "(^([0-9]{4}-[0-9]{2}-[0-9]{2})$|UNKNOWN)"
    },
    "DocumentCreator": {
      "type": "string"
    },
    "DocumentCreationDate": {
      "type": "string",
      "pattern": "^([0-9]{4}-[0-9]{2}-[0-9]{2})$"
    },
    "UniqueIdentifier": {
      "type": "string"
    },
    "Comments": {
      "type": "array",
      "items": {
        "type": "string"
      }
    },
    "Reference": {
      "type": "array",
      "items": {
        "type": "string"
      }
    },
    "MoreInfoURI": {
      "type": "string"
    }
  },
  "required": [
    "Description", "Laboratory", "ReportNumber", "ReportDate"
  ]
},
"Luminaire": {
  "type": "object",
  "properties": {
    "Dimensions": {
      "type": "object",
      "properties": {
        "Length": {
          "type": "number"
        },
        "Width": {
          "type": "number"
        },
        "Height": {
          "type": "number"
        }
```





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```
      },
      "required": ["Length", "Width", "Height"]
    },
    "Shape": {
      "type": "string",
      "enum": ["Align_X", "Align_Y", "Align_Z"]
    },
    "NumEmitter": {
      "type": "integer"
    }
  },
  "required": ["Dimensions", "NumEmitter"]
},
"Equipment": {
  "type": "object",
  "properties": {
    "Gonioradiometer": {
      "type": "array",
      "items": {
        "type": "object",
        "properties": {
          "Type": {
            "type": "string",
            "enum": [
              "CIE_A",
              "CIE_B",
              "CIE_C",
              "IES_A",
              "IES_B",
              "IES_C",
              "CUSTOM"
            ]
          },
          "MeasurementEquipment": {
            "type": "array",
            "items": {
              "type": "string"
            }
          }
        },
        "required": ["Type"]
      },
      "IntegratingSphere": {
        "type": "array",
        "items": {
          "MeasurementEquipment": {
            "type": "string"
          }
        },
        "required": ["MeasurementEquipment"]
      },
      "Spectroradiometer": {
        "type": "array",
        "items": {
          "type": "object",
          "properties": {
            "MeasurementEquipment": {
              "type": "string"
            },
            "BandwidthFWHM": {
              "type": "number"
```





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```
            },
            "BandwidthCorrected": {
              "type": "boolean"
            },
            "BandwidthMethod": {
              "type": "string"
            },
            "required": ["MeasurementEquipment"]
          }
        },
        "required": ["MeasurementEquipment"]
      }
    }
  }
},
"Emitter": {
  "type": "array",
  "items": {
    "type": "object",
    "properties": {
      "Quantity": {
        "type": "integer"
      },
      "Description": {
        "type": "string"
      },
      "CatalogNumber": {
        "type": "string"
      },
      "RatedLumens": {
        "type": "number"
      },
      "InputWattage": {
        "type": "number"
      },
      "PowerFactor": {
        "type": "number"
      },
      "BallastFactor": {
        "type": "number"
      },
      "TiltAngles": {
        "type": "object",
        "properties": {
          "NumberAngles": {
            "type": "integer"
          },
          "TiltArray": {
            "type": "object",
            "properties": {
              "Angle": {
                "type": "array",
                "items": {
                  "type": "number"
                }
              },
              "Mult": {
                "type": "array",
                "items": {
                  "type": "number"
                }
```





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```
        }
      },
      "required": ["Angle", "Mult"]
    }
  },
  "required": ["NumberAngles", "TiltArray"]
},
"ColorTemperature": {
  "type": "object",
  "properties": {
    "FixedCCT": {
      "type": "integer"
    },
    "MinCCT": {
      "type": "integer"
    },
    "MaxCCT": {
      "type": "integer"
    }
  }
},
"ColorRendering": {
  "type": "object",
  "properties": {
    "CIE_CRI": {
      "type": "object",
      "properties": {
        "Ra": {
          "type": "integer"
        },
        "R9": {
          "type": "integer"
        }
      },
      "required": ["Ra"]
    },
    "IES_TM30": {
      "type": "object",
      "properties": {
        "Rf": {
          "type": "integer"
        },
        "Rg": {
          "type": "integer"
        },
        "Rfh01": {
          "type": "integer"
        },
        "Rfh02": {
          "type": "integer"
        },
        "Rfh03": {
          "type": "integer"
        },
        "Rfh04": {
          "type": "integer"
        },
        "Rfh05": {
          "type": "integer"
        },
        "Rfh06": {
```



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```
    "type": "integer"
  },
  "Rfh07": {
    "type": "integer"
  },
  "Rfh08": {
    "type": "integer"
  },
  "Rfh09": {
    "type": "integer"
  },
  "Rfh10": {
    "type": "integer"
  },
  "Rfh11": {
    "type": "integer"
  },
  "Rfh12": {
    "type": "integer"
  },
  "Rfh13": {
    "type": "integer"
  },
  "Rfh14": {
    "type": "integer"
  },
  "Rfh15": {
    "type": "integer"
  },
  "Rfh16": {
    "type": "integer"
  },
  "Rcsh01": {
    "type": "integer"
  },
  "Rcsh02": {
    "type": "integer"
  },
  "Rcsh03": {
    "type": "integer"
  },
  "Rcsh04": {
    "type": "integer"
  },
  "Rcsh05": {
    "type": "integer"
  },
  "Rcsh06": {
    "type": "integer"
  },
  "Rcsh07": {
    "type": "integer"
  },
  "Rcsh08": {
    "type": "integer"
  },
  "Rcsh09": {
    "type": "integer"
  },
  "Rcsh10": {
    "type": "integer"
```





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```
        },
        "Rcsh11": {
          "type": "integer"
        },
        "Rcsh12": {
          "type": "integer"
        },
        "Rcsh13": {
          "type": "integer"
        },
        "Rcsh14": {
          "type": "integer"
        },
        "Rcsh15": {
          "type": "integer"
        },
        "Rcsh16": {
          "type": "integer"
        }
      },
      "required": ["Rf", "Rg"]
    }
  }
},
"Duv": {
  "type": "number"
},
"SPRatio": {
  "type": "number"
},
"DataGeneration": {
  "type": "object",
  "properties": {
    "Simulation": {
      "type": "boolean"
    },
    "Laboratory": {
      "type": "object",
      "properties": {
        "Certification": {
          "type": "string",
          "enum": [
            "Accredited", "Associated", "Customer", "None"
          ]
        },
        "ApprovalBody": {
          "type": "string"
        },
        "ApprovalScope": {
          "type": "string"
        },
        "MeasUncertainty": {
          "type": "array",
          "items": {
            "type": "object",
            "properties": {
              "MeasurementType": {
                "type": "string"
              },
              "Uncertainty": {
                "type": "number"
```





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```
              }
            }
          },
          "required": ["MeasurementType", "Uncertainty"]
        }
      },
      "required": [
        "Certification",
        "ApprovalBody",
        "ApprovalScope",
        "MeasUncertainty"
      ]
    },
    "IntensityScaling": {
      "type": "boolean"
    },
    "AngleInterpolation": {
      "type": "boolean"
    }
  }
},
"LuminousData": {
  "type": "object",
  "properties": {
    "LuminousIntensity": {
      "type": "object",
      "properties": {
        "AbsolutePhotometry": {
          "type": "boolean"
        },
        "Symm": {
          "type": "string",
          "enum": [
            "Symm_None",
            "Symm_Bi_0",
            "Symm_Bi_90",
            "Symm_Quad",
            "Symm_Full",
            "Symm_Arbitrary"
          ]
        },
        "Multiplier": {
          "type": "number"
        },
        "NumberMeasured": {
          "type": "integer"
        },
        "NumberHorz": {
          "type": "integer"
        },
        "NumberVert": {
          "type": "integer"
        },
        "IntDataSymm": {
          "type": "object",
          "properties": {
            "h": {
              "type": "array",
              "items": {
                "type": "number"
              }
```





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```
            },
            "v": {
              "type": "array",
              "items": {
                "type": "number"
              }
            },
            "IntData": {
              "type": "array",
              "items": {
                "type": "array",
                "items": {
                  "type": "number"
                }
              }
            }
          },
          "required": ["h", "v", "IntData"]
        },
        "IntDataNoSymm": {
          "type": "array",
          "items": {
            "type": "array",
            "items": {
              "type": "number",
              "minItems": 3,
              "maxItems": 3
            }
          }
        }
      },
      "oneOf": [
        {
          "required": [
            "NumberMeasured",
            "NumberHorz",
            "NumberVert",
            "IntDataSymm"
          ]
        },
        {
          "required": [
            "NumberMeasured",
            "NumberHorz",
            "NumberVert",
            "IntDataNoSymm"
          ]
        }
      ]
    },
    "LuminousFlux": {
      "type": "number"
    }
  },
  "required": ["LuminousIntensity"]
},
"RadiantData": {
  "type": "object",
  "properties": {
    "MinWavelength": {
      "type": "number"
```





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```
},
"MaxWavelength": {
  "type": "number"
},
"RadiantIntensity": {
  "type": "object",
  "properties": {
    "Absolute": {
      "type": "boolean"
    },
    "Symm": {
      "type": "string",
      "enum": [
        "Symm_None",
        "Symm_Bi_0",
        "Symm_Bi_90",
        "Symm_Quad",
        "Symm_Full",
        "Symm_Arbitrary"
      ]
    },
    "Multiplier": {
      "type": "number"
    },
    "NumberMeasured": {
      "type": "integer"
    },
    "NumberHorz": {
      "type": "integer"
    },
    "NumberVert": {
      "type": "integer"
    },
    "IntDataSymm": {
      "type": "object",
      "properties": {
        "h": {
          "type": "array",
          "items": {
            "type": "number"
          }
        },
        "v": {
          "type": "array",
          "items": {
            "type": "number"
          }
        },
        "IntData": {
          "type": "array",
          "items": {
            "type": "array",
            "items": {
              "type": "number"
            }
          }
        }
      },
      "required": ["h", "v", "IntData"]
    },
    "IntDataNoSymm": {
```





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```
            "type": "array",
            "items": {
              "type": "array",
              "items": {
                "type": "number",
                "minItems": 3,
                "maxItems": 3
              }
            }
          }
        },
        "oneOf": [
          {
            "required": [
              "NumberMeasured",
              "NumberHorz",
              "NumberVert",
              "IntDataSymm"
            ]
          },
          {
            "required": [
              "NumberMeasured",
              "NumberHorz",
              "NumberVert",
              "IntDataNoSymm"
            ]
          }
        ]
      },
      "RadiantFlux": {
        "type": "number"
      }
    },
    "required": [
      "MinWavelength", "MaxWavelength", "RadiantIntensity"
    ]
  },
  "PhotonData": {
    "type": "object",
    "properties": {
      "MinWavelength": {
        "type": "number"
      },
      "MaxWavelength": {
        "type": "number"
      },
      "PhotonIntensity": {
        "type": "object",
        "properties": {
          "Absolute": {
            "type": "boolean"
          },
          "Symm": {
            "type": "string",
            "enum": [
              "Symm_None",
              "Symm_Bi_0",
              "Symm_Bi_90",
              "Symm_Quad",
              "Symm_Full",
```





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```
        "Symm_Arbitrary"
      ]
    },
    "Multiplier": {
      "type": "number"
    },
    "NumberMeasured": {
      "type": "integer"
    },
    "NumberHorz": {
      "type": "integer"
    },
    "NumberVert": {
      "type": "integer"
    },
    "IntDataSymm": {
      "type": "object",
      "properties": {
        "h": {
          "type": "array",
          "items": {
            "type": "number"
          }
        },
        "v": {
          "type": "array",
          "items": {
            "type": "number"
          }
        },
        "IntData": {
          "type": "array",
          "items": {
            "type": "array",
            "items": {
              "type": "number"
            }
          }
        }
      },
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# Annex A Sample Luminous (Photometric) Documents

## A.1 Sample Luminous (Photometric) XML Document

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## A.2 Sample Luminous (Photometric) JSON Document


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          "R9": 85
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## Annex B Photon Flux (Informative)

Visible light is typically defined in terms of either lumens (luminous flux) or watts (radiant flux). Horticulturalists, however, measure electromagnetic radiation over the range of 280 nm to 800 nm in terms of photons per second.

Each photon is a “quantum” of electromagnetic energy, the magnitude of which is inversely proportional to its wavelength. Thus, the number of photons per second can be expressed in watts if the wavelength of each photon (or, more practically, of all the photons that have the same wavelength) is known.

Plant photosynthesis, however, depends on a chlorophyll molecule absorbing a single photon, regardless of its wavelength between, approximately 400 nm and 700 nm. Thus, horticulturalists are not concerned with the photon’s energy. They instead measure “photon flux” in terms of micromoles ($6.022 \times 10^{17}$) of photons per second (μmol/s). If the wavelength range is 400 nm to 700 nm, this is photosynthetically active radiation (PAR).

Plants also respond to ultraviolet radiation (280 nm to 400 nm) and “far-red” radiation (700 nm to 800 nm). Depending on the application, horticultural measurements may be reported in terms of radiant flux or photon flux.

A comprehensive list of horticultural lighting metrics is provided in ANSI/ASABE S640 JUL2017, Quantities and Units of Electromagnetic Radiation for Plants (Photosynthetic Organisms).




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