
**Textiles — Standard data format for
colorimetric communication — Textiles
and related measurements**

*Textiles — Format de données standard pour la communication
colorimétrique — Textiles et mesurages associés*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10617 was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 1, *Test for coloured textiles and colorants*.

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Introduction

Spectrophotometers are now well established in the process and quality-control processes within the colour-using industries, as a tool for the measurement of colour, and subsequent computation of colour difference, that is required for colour approval. Colorimetric data has increasingly become the choice as a “standard” for use in the specification of a colour, in preference to a physical sample, due to the accuracy, stability and mobility of data compared to physical samples.

Textile production and sourcing, in particular, now have a truly global nature where manufacturing and retailing are literally continents apart. Product management and design have remained in the fashion centres (for example New York, Paris, London) whereas manufacturing goes where the economics of production dictate. In addition, retail sales are global. An essential element for speed of response to market needs and for cost reduction of colour development and production is the effective communication of colorimetric data between different measurement systems. This enables the remote operation of processes such as colour approval, trim and range of colour coordination, etc.

Currently, there are many suppliers of colour measuring instruments and software systems to support the computations associated with colour measurement. These include quality-control systems and recipe prediction systems, as well as on screen colour systems. Colorimetric information generated by such systems is not readily consumed by other systems, as it is in a format known only to the system maker. Some systems can decode the data formats of other systems and allow transformation into a compatible format.

New and existing systems are continually being developed and new data formats introduced. These new data formats will not be readily understood or useable in other colour systems.

In order that dissimilar systems can be used effectively in communicating colour, a common Data Standard is required. This would allow the colorimetric data output from any system to be readily consumed by any other system, whether it is a colour system or business system. Data would be readily viewable by standard browser software and other simple data tools.

XML is a meta-mark-up language developed for use with the Internet (WC3 endorsed standard) to allow the exchange of data between dissimilar systems. XML provides data about the data (meta-data), as well as the data itself, thereby allowing dissimilar systems to understand the contents of a standard XML document. It provides a standard format for data in a document form.

There are many utilities available to developers and users to enable the handling of data in this format and, since the underlying code is text-based, a simple editor can ‘see’ the data included.

The primary data communicated is usually the spectral data. Other data relating to illuminants and observers is a calculation based on the spectral data. The software receiving the spectral data must be more than capable of doing these well-defined calculations, according to internationally agreed ISO/CIE standards.

Where only colorimetric data is being exchanged, there is provision for the observer and illuminant data to be included (see 6.2.5).

Quality-control data, such as standard and batch association, profiling data, specific illuminant to be used, etc. is arbitrary and subject to agreement between the manufacturer and customer. This is outside the scope of this International Standard. The header of the data being exchanged, as described in 6.1, includes a section entitled “Comments”, where quality-control data could possibly be communicated.

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Textiles — Standard data format for colorimetric communication — Textiles and related measurements

1 Scope

This International Standard is primarily concerned with the exchange of the spectral data, which is the fundamental data behind the colour being communicated.

This International Standard provides a standard format for the interchange of data between a colorimetric measurement instrument and software used to make calculations based on those measured data.

A key application is in the measurement and associated recipe formulation of dyes used in the textile industry. The application can, however, be to any industry where there is a need to communicate colorimetric data, e.g. pigment formulation in plastics and paints, colour management in the graphic arts and other colour reproduction industries.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CIE¹⁾ Publication 15:2004, *Colorimetry*

CIE Publication 17.4:1987, *International Lighting Vocabulary*, 4th ed. (Joint publication IEC/CIE)

3 Abbreviations

For the purposes of this document, the following abbreviation applies.

cdf: colorimetric data exchange format

4 Principle

This International Standard describes the terms used in the colorimetric data exchange format (cdf). It shows the order of the fields and how the format is laid out. None of the fields in the format are mandatory; the requisite field for the term can be left blank, in which case a default value is assumed. It should, however, be noted that the more information that is provided with the measurements, the greater the confidence that the recipient can have in the data.

The format described is concerned solely with the data to be communicated. It is not concerned with how the data is created, read or processed by measurement software, data processing software, spreadsheets, etc. All data is communicated as an XML document.

1) Commission Internationale de l'Éclairage, CIE Central Bureau, Kegelgasse 27, A-1030 Vienna, Austria, www.cie.co.at

While this International Standard has been developed with the support of the textile industry, it can be applied in any industry that uses colour-measurement instrumentation. Care should be exercised to ensure that there are no other standards specific to the application area or industry that could be applied.

5 Terminology

The terms used to describe a valid measurement record form two sections. The first section, A, is the sample-identification section and is common to all measurements. It has descriptive information concerning the sample to be measured. The second section is made up of one or more data blocks, B to G, each representing a specific set of measurement data. Multiple measurement data blocks are useful when, for example, a sample has either been measured separately for two or more geometries, or simultaneously using two or more geometries (e.g. in the case of a multi-angle measuring instrument). Generally, the multiple data blocks will be of the same type. Examples of valid data records are ABB or ACCCCC or ABBC.

In each section, the headings of each parameter used for communication are given and then explained in the table below it. Since each parameter is optional, if omitted, they will either take on the default value (as indicated in the following descriptions) or, where no default is specified, should be regarded as *undefined* or *not applicable*.

6 Structure

A file containing measurement data would normally be structured as shown in Figure 1. This structure allows multiple data blocks within a single exchange file as described in Clause 5.

Sample identification
Measurement data block 1
Measurement data block 2
"
"
Measurement data block N

Figure 1 — Structure of a data measurement file

If more than one sample is to be measured then a complete data file shall be assembled for each sample.

Figure 2 shows the hierarchy between the various components of the colorimetric data exchange file. This allows for a description of the sample, spectral measurements and colorimetric measurements. The lower part of Figure 2 shows the relationship between the various parameters that can be associated with each measurement.

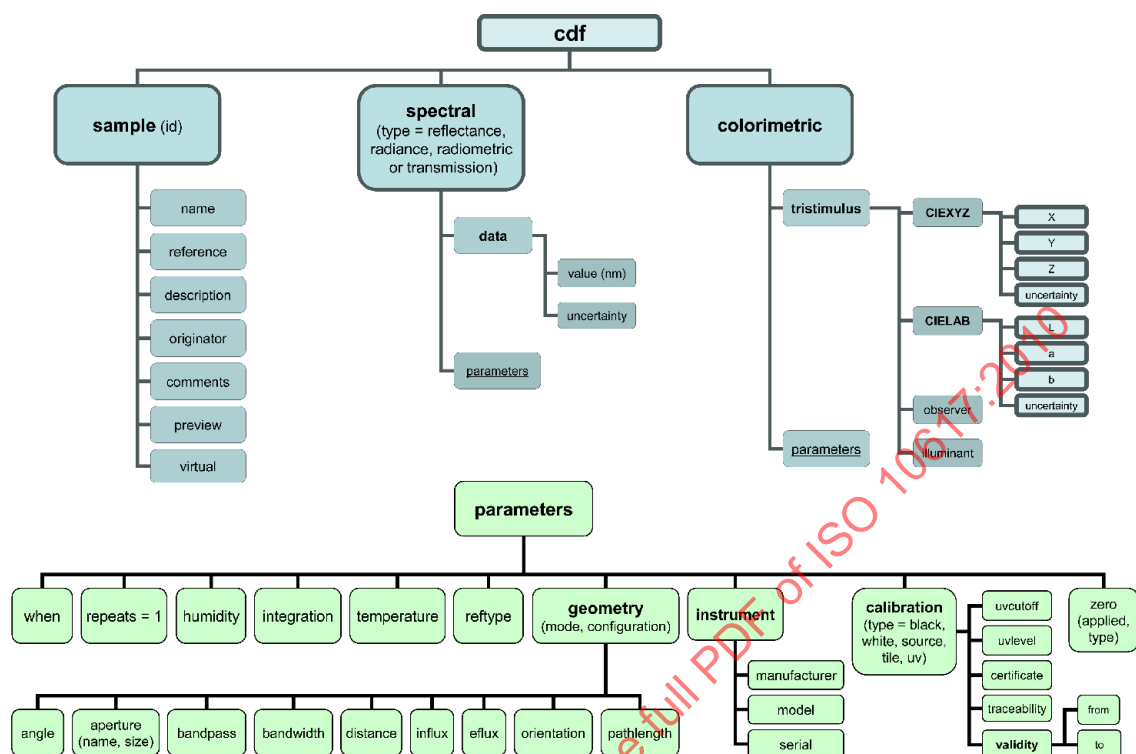


Figure 2 — Parameters that can be associated with each measurement block

6.1 Sample identification (A)

- Name
- Reference
- Description
- Backing
- Originator
- Unique identifier
- Comments
- Colour preview

This section is composed of text identifying and describing the sample being measured. It is the first section to be communicated and is followed by one or more measurement data blocks. See Table 1.

Table 1 — Sample identification (A)

Parameter	Type	Description
Name	Text	Name of sample being measured.
Reference	Text	User's identification of sample.
Description	Text	Details and attributes of sample.
Backing	Text	Details of material used behind the sample during measurement.
Originator	Text	Person making the measurement.
Unique identifier	Text	Identifier generated by measurement software. Ideally, this would be created from instrument serial number and a date/time stamp.
Comment	Text	Area for the user to add any other information that he/she may wish to transmit.
Colour preview	Numeric hexadecimal	The colour preview contains an approximate representation of the colour specified using the sRGB colour space and written as six hexadecimal digits: e.g. #FF0000 (red). There may be multiple previews if, for example, the record contains multi-angle or both specular included and excluded data. The colour preview is only meant to provide a visual approximation for sample identification and should not be used to transmit actual data.

6.2 Measurement data block

There are six possible measurement data blocks that can be associated with a sample. At least one of these must follow the sample block. When a sample has, for example, either been measured separately using two or more geometries or simultaneously for two or more geometries, then there follows a measurement data block for each geometry.

6.2.1 Spectral reflectance measurement (B)

The measurement, as a function of wavelength, of the ratio of the reflected radiant or luminous flux to the incident flux in the given conditions.

- a) Wavelength (nm)
- b) Value (%)
- c) Uncertainty ($\pm$ %)
- d) **Measurement parameters**
 - Date and time of measurement
 - Number of measurements averaged
 - Relative humidity (%)
 - Temperature ($^{\circ}$ C)
- e) **Geometry**
 - Aperture diameter (mm) and description
 - Bandpass corrected ("yes" or "no")
 - Bandwidth (nm)

- Configuration (specular “included” or “excluded”)
 - Influx (degrees, “d” or “t”) (see Table 2)
 - Efflux (degrees, “d” or “t”) (see Table 2)
 - Orientation/Surround of sample (descriptive)
- f) **Instrument identification**
- Manufacturer
 - Model
 - Serial number
- g) **Source parameters**
- Source (descriptive)
 - Filter (descriptive)
 - Polarization (descriptive)
- h) **Reference standard (black)**
- Certificate serial number
 - To whom it is traceable
 - Validity
- i) **Reference standard (white)**
- Certificate serial number
 - To whom it is traceable
 - Validity
- j) **UV component**
- Cut-off wavelength (nm)
 - Level set
- k) **Reference standard (UV)**
- Certificate serial number
 - To whom it is traceable
 - Validity

This covers measurements of reflectance where spectral data is output from an instrument with an integrating sphere. Two possible geometries are allowed, as defined by the CIE: specular included and specular excluded. See Table 2.

Table 2 — Spectral reflectance measurement (B)

Parameter	Type	Description
Wavelength (nm)	Numeric	Wavelength, in nanometres, at which the reflectance was measured. It has associated value and uncertainty parameters (see below). NOTE This is repeated along with the value and uncertainty (see below) for the number of spectral data points measured. A minimum of 16 wavelength, value and uncertainty data sets, consistent with the calculation of colorimetric data, shall be entered for meaningful colorimetric results (i.e. 400 nm to 700 nm at 20 nm intervals). Wavelength steps shall be at equal intervals and without "holes".
Value (%)	Numeric	Reflectance expressed as a percentage. It has associated wavelength and uncertainty parameters. (See also the Note to wavelength.)
Uncertainty ($\pm$ %)	Numeric	Uncertainty in reflectance value expressed as $\pm$ %. It has associated wavelength and value parameters. (See also the Note to wavelength.)
Measurement parameters		
Date and time of measurement	Date: time	Expressed as year, month and day; and hours, minutes and seconds (CCYY-MM-DD-hh:mm:ss).
Number of measurements averaged	Integer [default = 1]	Some instruments may average over a number of measurements to create the final reported measurement result.
Relative humidity (%)	Numeric	The percentage relative humidity of the sample being measured.
Temperature ($^{\circ}$ C)	Numeric	The temperature, in degrees Celsius, of the sample being measured.
Geometry		
Aperture diameter (mm) and description	Numeric + text	The size, in millimetres, of the sample port aperture and a qualitative description, e.g. "large".
Bandpass corrected ("yes" or "no")	Text "yes" or "no"	Has the instrument result been corrected for the bandpass function not being triangular?
Bandwidth (nm)	Numeric	The bandwidth of the measurement, in nanometres.
Configuration	Text	Two options relating to the specular component; either "included" or "excluded".
Influx (degrees, "d" or "t")	Numeric, if degrees Text, if "d" or "t"	For directional illumination, the illuminating direction, in degrees, with respect to the normal to the sample plane (typically 8°). For integrating-sphere illumination, either "d" for diffuse illumination with specular component excluded, or "t" for diffuse illumination with specular component included.
Efflux (degrees, "d" or "t")	Numeric, if degrees Text, if "d" or "t"	For directional detection, the detecting/measuring direction, in degrees, with respect to the normal to the sample plane (typically 8°). For integrating-sphere detection, either "d" for diffuse detection with the specular component excluded, or "t" for diffuse detection with specular component included.
Orientation/Surround of sample (descriptive)	Text	Description of the placement of the sample with respect to the illumination, e.g. up, down, parallel to weave.
Instrument identification		
Manufacturer	Text	Name of the instrument manufacturer.
Model	Text	Instrument model number.
Serial number	Text	Instrument serial number.
Source parameters		
Source	Text	Source used during measurement. This provides a guide when measuring fluorescent samples. Examples could be "xenon flash" or "tungsten".

Table 2 (continued)

Parameter	Type	Description
Filter	Text	Identifies the use of a physical filter during measurement. Examples could be "D65", "UV" or "none".
Polarization	Text: "yes" or "no"	Indicates the use of a physical polarization filter during measurement.
Reference standard (black)		Standard used to calibrate instrument dark or black measurements.
Certificate serial number	Text	Certificate serial number or reference.
To whom it is traceable	Text	National standard laboratory, calibration laboratory or other organization to which the certified values are traceable.
Validity	From (date) to (date)	Certified dates (CCYY-MM-DD) between which measurements are valid.
Reference standard (white)		Standard used to calibrate instrument's 100 % level or white measurements.
Certificate serial number	Text	Certificate serial number or reference.
To whom it is traceable	Text	National standard laboratory, calibration laboratory or other organization to which the certified values are traceable.
Validity	From (date) to (date)	Certified dates (CCYY-MM-DD) between which measurements are valid.
UV component		Some instruments allow the UV component of the illumination light to be excluded.
Cut-off wavelength	Numeric	Wavelength, in nanometres, of the cut-off for an adjustable UV filter, if present.
Level set	Numeric	UV level set, if adjustable.
Reference standard (UV)		Standard used to set the UV cut-off wavelength or UV level.
Certificate serial number	Text	Certificate serial number or reference.
To whom it is traceable	Text	National standard laboratory, calibration laboratory or other organization to which the certified values are traceable.
Validity	From (date) to (date)	Certified dates (CCYY-MM-DD) between which measurements are valid.

6.2.2 Spectral radiance factor measurement (C)

The measurement, as a function of wavelength, of the ratio of the radiance of the surface element in the given direction to that of the perfect reflecting or transmitting diffuser identically irradiated and viewed.

- a) Wavelength (nm)
- b) Value (%)
- c) Uncertainty ($\pm$ %)
- d) **Measurement parameters**
 - Date and time of measurement
 - Number of measurements averaged
 - Relative humidity (%)
 - Temperature ($^{\circ}$ C)

e) Geometry

- Aperture diameter (mm) and description
- Bandpass corrected
- Bandwidth (mm)
- Configuration (“annular” or “uniplanar”)
- Influx (degrees)
- Efflux (degrees)
- Orientation/Surround of sample (descriptive)

f) **Instrument identification**

- Manufacturer
- Model
- Serial number

g) **Source parameters**

- Source
- Filter
- Polarization

h) **Reference standard (black)**

- Certificate serial number
- To whom it is traceable
- Validity

i) **Reference standard (white)**

- Certificate serial number
- To whom it is traceable
- Validity

j) **UV component**

- Cut-off wavelength (nm)
- Level set

This block covers measurements of radiance factor. The most common geometry is the CIE recommended 0°/45°; however other geometries are also used, especially by multi-angle spectrophotometers. See Table 3.

Table 3 — Spectral radiance factor measurement (C)

Parameter	Type	Description
Wavelength (nm)	Numeric	Wavelength, in nanometres, at which the radiance factor was measured. It has associated value and uncertainty parameters (see below). NOTE This is repeated along with the value and uncertainty (see below) for the number of spectral data points measured. A minimum of 16 wavelength, value and uncertainty data sets, consistent with the calculation of colorimetric data, shall be entered for meaningful colorimetric results (i.e. 400 nm to 700 nm at 20 nm intervals). Wavelength steps shall be at equal intervals and without “holes”.
Value (%)	Numeric	Radiance factor expressed as a percentage. It has associated wavelength and uncertainty parameters. (See also the Note to wavelength.)
Uncertainty ($\pm$ %)	Numeric	Uncertainty in the radiance factor value expressed as $\pm$ %. It has associated wavelength and value parameters. (See also the Note to wavelength.)
Measurement parameters		
Date and time of measurement	Date: time	Expressed as year, month and day; and hours, minutes and seconds (CCYY-MM-DD-hh:mm:ss).
Number of measurements averaged	Integer [default = 1]	Some instruments may average a number of measurements to create the final reported measurement result.
Relative humidity (%)	Numeric	The percentage relative humidity of the sample being measured.
Temperature ($^{\circ}$ C)	Numeric	The temperature, in degrees Celsius, of the sample being measured.
Geometry		
Aperture diameter (mm) and description	Numeric + text	Size, in millimetres, of sample port aperture and textual description, e.g. “large”.
Bandpass corrected (“yes” or “no”)	Text: “yes” or “no”	Has the instrument result been corrected for the bandpass function not being triangular?
Bandwidth (nm)	Numeric	The bandwidth of the measurement, in nanometres.
Configuration	Text: “annular” or “uniplanar”	Two options relating to the overall geometric arrangement of the illumination and detecting beams. Uniplanar if illumination and detecting beams form a single plane. Annular if collection or illumination of the sample is from many positions around the sample at the designated angle, e.g. using a ring illuminator or collector.
Influx (degrees)	Numeric	The illuminating direction, in degrees, with respect to the normal to the sample plane.
Efflux (degrees)	Numeric	The detecting/measuring direction, in degrees, with respect to the normal to the sample plane.
Orientation/Surround of sample (descriptive)	Text	Description of the placement of the sample with respect to the illumination, e.g. up, down or parallel to weave, together with information on the surround to the samples, if relevant to the measurement.
Instrument identification		
Manufacturer	Text	Name of the instrument manufacturer.
Model	Text	Instrument model number.

Table 3 (continued)

Parameter	Type	Description
Serial number	Text	Instrument serial number.
Source parameters		
Source	Text	Source used during measurement. This provides a guide when measuring fluorescent samples. Examples could be "xenon flash" or "tungsten".
Filter	Text	Identifies the use of a physical filter during measurement. Examples could be "D65", "UV" or "none".
Polarization	Text "yes" or "no"	Indicates the use of a physical polarization filter during measurement.
Reference standard (black)		Standard used to calibrate the instrument's dark or black measurements.
Certificate serial number	Text	Certificate serial number or reference.
To whom it is traceable	Text	National standard laboratory, calibration laboratory or other organization to which the certified values are traceable.
Validity	From (date) to (date)	Certified dates (CCYY-MM-DD) between which measurements are valid.
Reference standard (white)		Standard used to calibrate the instrument's 100 % level or white measurements.
Certificate serial number	Text	Certificate serial number or reference.
To whom it is traceable	Text	National standard laboratory, calibration laboratory or other organization to which the certified values are traceable.
Validity	From (date) to (date)	Certified dates (CCYY-MM-DD) between which measurements are valid.
UV component		Some instruments allow the UV component of the illumination light to be excluded.
Cut-off wavelength	Numeric	Wavelength, in nanometres, of the cut-off for an adjustable UV filter, if present.
Level set	Numeric	The UV level set, if adjustable.
Reference standard (UV)		The standard used to set the UV cut-off wavelength or UV level.
Certificate serial number	Text	Certificate serial number or reference.
To whom it is traceable	Text	National standard laboratory, calibration laboratory or other organization to which the certified values are traceable.
Validity	From (date) to (date)	Certified dates (CCYY-MM-DD) between which measurements are valid.

6.2.3 Spectral radiometric measurement (D)

The measurement, as a function of wavelength, of the absolute radiant power emitted by a source, transmitted by a specimen or reflected from a specimen. See Table 4.

- a) Wavelength (nm)
- b) Value ($W \cdot sr^{-1} \cdot m^{-2}$)
- c) Uncertainty ($\pm W \cdot sr^{-1} \cdot m^{-2}$)

d) Measurement parameters

- Date and time of measurement
- Number of measurements averaged
- Relative humidity (%)
- Temperature (°C)

e) Geometry

- Angle subtended (degrees)
- Aperture diameter (mm) and description
- Bandpass corrected
- Bandwidth (nm)
- Distance from sample (m)
- Influx (degrees, “d” or “t”, see Table 4)
- Efflux (degrees)
- Orientation/surround of sample (descriptive)

f) Instrument identification

- Manufacturer
- Model
- Serial number

g) Zero reading

- Correction applied (“yes” or “no”)
- Type (eg. “blocked beam”)

h) Reference standard

- Certificate serial number
- To whom it is traceable
- Type of measurement (source or tile)
- Validity

i) UV component

- Cut off wavelength (nm)
- Level set

j) **Reference standard (UV)**

- Certificate serial number
- Date and validity
- To whom it is traceable

This block records measurements made using a spectroradiometer. The results are expressed in watts per steradian square metre ($\text{W}\cdot\text{sr}^{-1}\cdot\text{m}^{-2}$).

Table 4 — Spectral radiometric measurement (D)

Parameter	Type	Description
Wavelength (nm)	Numeric	The wavelength, in nanometres, at which radiance was measured. It has associated value and uncertainty parameters (see below). NOTE This is repeated along with the value and uncertainty (see below) for the number of spectral data points measured. A minimum of 16 wavelength, value and uncertainty data sets, consistent with calculation of colorimetric data, shall be entered for meaningful colorimetric results (i.e. 400 nm to 700 nm at 20 nm intervals). Wavelength steps shall be at equal intervals and without "holes".
Value ($\text{W}\cdot\text{sr}^{-1}\cdot\text{m}^{-2}$)	Numeric	Radiance expressed in watts per steradian square metre. It has associated wavelength and uncertainty parameters. (See also the Note to wavelength.)
Uncertainty ($\pm \text{W}\cdot\text{sr}^{-1}\cdot\text{m}^{-2}$)	Numeric	Uncertainty in radiance value expressed in watts per steradian square metre. It has associated wavelength and value parameters. (See also the Note to wavelength.)
Measurement parameters		
Date and time of measurement	Date: time	Expressed as year, month and day; and hours, minutes and seconds (CCYY-MM-DD-hh:mm:ss).
Number of measurements averaged	Integer [default = 1]	Some instruments may average a number of measurements to create the final reported measurement result.
Relative humidity (%)	Numeric	The percentage relative humidity of the sample being measured.
Temperature (°C)	Numeric	The temperature, in degrees Celsius, of the sample being measured.
Geometry		
Angle subtended (degrees)	Numeric	This is the cone angle subtended by the radiometer when viewing the sample.
Aperture diameter (mm) and description	Text	Size, in millimetres, of the viewing aperture and text description.
Bandpass corrected ("yes" or "no")	Text : "yes" or "no"	Has the instrument result been corrected for the bandpass function not being triangular?
Bandwidth (nm)	Numeric	The bandwidth of the measurement, in nanometres.
Distance from sample (m)	Numeric	The distance from the sample to the radiometer aperture, in metres.
Influx (degrees, "d" or "t")	Numeric, if degrees Text, if "d" or "t"	For directional illumination, the illuminating direction, in degrees, with respect to the normal to the sample plane (typically 8°). For integrating-sphere illumination, either "d" for diffuse illumination with the specular component excluded, or "t" for diffuse illumination with the specular component included.
Efflux (degrees)	Numeric	The detecting/measuring direction, in degrees, with respect to the normal to the sample plane.
Orientation/surround of sample (descriptive)	Text	Description of the placement of the sample with respect to illumination, e.g. up, down or parallel to weave, together with information on the surround to the samples, if relevant to the measurement.

Table 4 (continued)

Parameter	Type	Description
Instrument identification		
Manufacturer	Text	Name of the instrument manufacturer.
Model	Text	Instrument model number.
Serial number	Text	Instrument serial number.
Zero reading		Details on how instrument dark level has been handled
Correction applied ("yes" or "no")	Text: "yes" or "no"	Has the measurement been corrected for zero-level reading?
Type (e.g. blocked beam)	Text	Details of how the zero reading was arrived at, e.g. the beam was blocked, a shutter was used, etc.
Reference standard		Standard used to calibrate instrument scale.
Certificate serial number	Text	Certificate serial number or reference.
To whom it is traceable	Text	National standard laboratory, calibration laboratory or other organization to which the certified values are traceable.
Type of measurement (source or tile)	Text	Two options are available for the instrument calibration: either using a light source directly or by viewing an illuminated, usually white, tile.
Validity	From (date) to (date)	Certified dates (CCYY-MM-DD) between which measurements are valid.
UV component		Some instruments allow the UV component of the illumination light to be excluded.
Cut-off wavelength	Numeric	Wavelength, in nanometres, of cut-off for an adjustable UV filter, if present.
Level set	Numeric	The UV level set if adjustable.
Reference standard (UV)		Standard used to set the UV cut-off wavelength or UV level.
Certificate serial number	Text	Certificate serial number or reference.
Date and validity	From (date) to (date)	Certified dates (CCYY-MM-DD) between which measurements are valid.
To whom it is traceable	Text	National standard laboratory, calibration laboratory or other organization to which the certified values are traceable.

6.2.4 Spectral transmission measurement (E)

The measurement, as a function of wavelength, of the ratio of the transmitted radiant or luminous flux to the incident flux in the given conditions.

- a) Wavelength (nm)
- b) Value (%)
- c) Uncertainty ($\pm$ %)
- d) **Measurement parameters**
 - Date and time of measurement
 - Number of measurements averaged
 - Reference type (e.g. "air" or "water")

- Relative humidity (%)
- Temperature (°C)

e) **Geometry**

- Aperture diameter (mm) and description
- Bandpass corrected
- Bandwidth (nm)
- Cell-path length/thickness (mm)
- Influx (degrees, “d” or “t”, see Table 5)
- Efflux (degrees, or “d” or “t”, see Table 5)
- Orientation of sample (descriptive)
- Mode: regular, diffuse or total

f) **Instrument identification**

- Manufacturer
- Model
- Serial number

g) **Source parameters**

- Source
- Filter
- Polarization

h) **Zero transmission**

- Correction applied (“yes” or “no”)
- Type (e.g. “blocked beam” or “cavity”)

i) **UV component**

- Cut-off wavelength (nm)
- Level set

j) **Reference standard (UV)**

- Certificate serial number
- To whom it is traceable
- Validity

The most common transmittance measurement is regular transmittance where the beam that passes through the sample without scattering is measured.

The less common measurements are:

- diffuse transmittance, if some or all of the incident beam is scattered and the scattered light is measured;
- or total transmittance, if all scattered and regularly measured light is measured.

See Table 5.

Table 5 — Spectral transmittance measurement (E)

Parameter	Type	Description
Wavelength (nm)	Numeric	Wavelength, in nanometres, at which transmittance was measured. It has associated value and uncertainty parameters (see below). NOTE This is repeated along with the value and uncertainty (see below) for the number of spectral data points measured. A minimum of 16 wavelength, value and uncertainty data sets, consistent with calculation of colorimetric data, shall be entered for meaningful colorimetric results (i.e. 400 nm to 700 nm at 20 nm intervals). Wavelength steps shall be at equal intervals and without "holes".
Value (%)	Numeric	Transmittance expressed as a percentage. It has associated wavelength and uncertainty parameters. (See also the Note to wavelength.)
Uncertainty ($\pm$ %)	Numeric	Uncertainty in transmittance value is expressed as $\pm$ %. It has associated wavelength and value parameters. (See also the Note to wavelength.)
Measurement parameters		
Date and time of measurement	Date: time	Expressed as year, month and day, and hours, minutes and seconds (CCYY-MM-DD-hh:mm:ss).
Number of measurements averaged	Integer [default = 1]	Some instruments may average a number of measurements to create the final reported measurement result.
Reference type	Text	Material used to set the 100 % level to which the results are compared to, e.g. air, vacuum, distilled water, standard or solution.
Relative humidity (%)	Numeric	The percentage relative humidity of the sample being measured.
Temperature ($^{\circ}$ C)	Numeric	The temperature, in degrees Celsius, of the sample being measured.
Geometry		
Aperture diameter (mm) and description	Text	The size, in millimetres, of the sample-port aperture and text description, e.g. "large".
Bandpass corrected ("yes" or "no")	Text: "yes" or "no"	Has the instrument result been corrected for the bandpass function not being triangular?
Bandwidth (nm)	Numeric	The bandwidth of the measurement, in nanometres.
Cell path length/thickness (mm)	Numeric	The path length of the cell or cuvette containing the solution being measured (typically 10 mm for a standard cuvette) or the thickness of the sample.
Influx (degrees, "d" or "t")	Numeric, if degrees Text, if "d" or "t"	For directional illumination, the illuminating direction, in degrees, with respect to the normal to the sample plane. This is 0° for regular transmittance. For integrating-sphere illumination, either "d" for diffuse illumination with the regular component excluded or "t" for diffuse illumination with the regular component included.

Table 5 (continued)

Parameter	Type	Description
Efflux (degrees)	Numeric, if degrees Text, if "d" or "t"	For directional detection, the detecting/measuring direction, in degrees, with respect to the normal to the sample plane. This is 0° for regular transmittance. For integrating-sphere detection, either "d" for diffuse detection with the regular component excluded, or "t" for the diffuse detection with the regular component included.
Orientation of sample (descriptive)	Text	Description of the placement of the sample with respect to the illumination, e.g. up, down, parallel to weave.
Mode	Text : "regular", "diffuse" or "total"	Description of transmittance measurement type. Regular for non scattered beam being measured; diffuse for scattered beam being measured; and total for both regular and diffuse types being measured.
Instrument identification		
Manufacturer	Text	Name of the instrument manufacturer.
Model	Text	Instrument model number.
Serial number	Text	Instrument serial number.
Source parameters		
Source	Text	Source used during measurement. This provides a guide when measuring fluorescent samples. Examples could be "xenon flash" or "tungsten".
Filter	Text	Identifies the use of a physical filter during measurement. Examples could be "D65", "UV" or "none".
Polarization	Text: "yes" or "no"	Indicates the use of a physical polarization filter during measurement.
Zero transmission		Details on how the instrument dark level has been handled
Correction applied ("yes" or "no")	Text: "yes" or "no"	Has the measurement been corrected for the zero-level reading?
Type (e.g. "blocked beam" or "cavity")	Text	Details of how the zero reading was arrived at, e.g. the beam was blocked, a shutter was used, a cavity was placed on the sphere sample port, etc.
UV component		Some instruments allow the UV component of the illumination light to be excluded.
Cut-off wavelength	Numeric	Wavelength, in nanometres, of cut-off for an adjustable UV filter, if present.
Level set	Numeric	UV level set if adjustable.
Reference standard (UV)		Standard used to set UV cut-off wavelength or UV level.
Certificate serial number	Text	Certificate serial number or reference.
To whom it is traceable	Text	National standard laboratory, calibration laboratory or other organization to which the certified values are traceable.
Validity	From (date) to (date)	Certified dates (CCYY-MM-DD) between which measurements are valid.

6.2.5 Colorimetric measurement (F)

The measurement of CIE colorimetric values, for example tristimulus values X,Y,Z and CIELAB coordinates L^*, a^*, b^* .

a) CIE tristimulus values

- CIE XYZ and/or
- CIE $L^*a^*b^*$

b) Uncertainty

- $\pm X \pm Y \pm Z$ and/or
- $\pm L^* \pm a^* \pm b^*$

c) Illuminant

d) Observer (2° or 10°)

e) Measurement parameters

- Date and time of measurement
- Number of measurements averaged
- Relative humidity (%)
- Temperature (°C)

f) Geometry

- Aperture diameter (mm) and description
- Configuration (for sphere geometry, “included” or “excluded”, otherwise “uniplanar” or “annular”)
- Influx (degrees, “d” or “t”, see Table 6)
- Efflux (degrees, or “d” or “t”, see Table 6)
- Orientation of sample (descriptive)

g) Instrument identification

- Manufacturer
- Model
- Serial number

h) Reference standard (black)

- Certificate serial number
- To whom it is traceable
- Validity

i) **Reference standard (white)**

- Certificate serial number
- To whom it is traceable
- Validity

This section is for measurements made by instruments that only yield colorimetric data. If the instrument produces spectral data as well, these results should also be entered as spectral data in the appropriate preceding section. See Table 6.

Table 6 — Colorimetric measurement (F)

Parameter	Type	Description
CIE Tristimulus values		
CIE XYZ and/or	Numeric, Numeric, Numeric	CIE X, Y, Z values. These have associated illuminant and observer values, and may have associated L*, a* and b* values.
CIE L*a*b*	Numeric, Numeric, Numeric	CIE L*, a*, b* values. These have associated illuminant and observer values, and may have associated X, Y and Z values.
Uncertainty		
$\pm X \pm Y \pm Z$ and/or	Numeric, Numeric, Numeric	Uncertainties in CIE X, Y, Z separated by commas. These have associated tristimulus and observer values.
$\pm L^* \pm a^* \pm b^*$	Numeric, Numeric, Numeric	Uncertainties in CIE L*, a*, b* separated by commas. These have associated tristimulus and illuminant values.
Illuminant	Text	Usually a CIE Standard Illuminant.
Observer (2° or 10°)	Numeric (2 or 10)	CIE Standard Observer (degrees).
Measurement parameters		
Date and time of measurement	Date: time	Expressed as year, month and day; and hours, minutes and seconds (CCYY-MM-DD-hh:mm:ss).
Number of measurements averaged	Integer [default = 1]	Some instruments may average over a number of measurements to create the final reported measurement result.
Relative humidity (%)	Numeric	The percentage relative humidity of the sample being measured.
Temperature (°C)	Numeric	The temperature, in degrees Celsius, of the sample being measured.
Geometry		
Aperture diameter (mm) and description	Numeric + text	The size, in millimetres, of the sample port aperture and a qualitative description, e.g. "large".
Configuration	Text "included", "excluded", "uniplanar" or "annular"	Options relating to the overall geometric arrangement of the illumination and detecting beams. The first two options relate to the use of an integrating-sphere and its specular component, either included or excluded. The others relate to non-integrating-sphere geometries: uniplanar, if illumination and detecting beams form a single plane; annular, if the collection or illumination of the sample is from many positions around the sample at the designated angle, e.g. using a ring illuminator or collector.

Table 6 (continued)

Parameter	Type	Description
Influx (degrees, “d” or “t”)	Numeric, if degrees Text, if “d” or “t”	For directional illumination, the illuminating direction, in degrees, with respect to the normal to the sample plane. For integrating-sphere illumination, either “d” for diffuse illumination with the regular component excluded, or “t” for diffuse illumination with the regular component included.
Efflux (degrees, “d” or “t”)	Numeric, if degrees Text, if “d” or “t”	For directional detection, the detecting/measuring direction, in degrees, with respect to the normal to the sample plane. For integrating-sphere detection either “d” for diffuse detection with the regular component excluded, or “t” for diffuse detection with the regular component included.
Orientation of sample (descriptive)	Text	Description of placement of the sample with respect to the illumination, e.g. up, down, parallel to weave.
Instrument identification		
Manufacturer	Text	Name of the instrument's manufacturer.
Model	Text	Instrument model number.
Serial number	Text	Instrument serial number.
Reference standard (black)		Standard used to calibrate instrument for dark or black measurements.
Certificate serial number	Text	Certificate serial number or reference.
To whom it is traceable	Text	National standard laboratory, calibration laboratory or other organization to which the certified values are traceable.
Validity	From (date) to (date)	Certified dates (CCYY-MM-DD) between which measurements are valid.
Reference standard (white)		Standard used to calibrate instrument's 100 % level or white measurements.
Certificate serial number	Text	Certificate serial number or reference.
To whom it is traceable	Text	National standard laboratory, calibration laboratory or other organization to which the certified values are traceable.
Validity	From (date) to (date)	Certified dates (CCYY-MM-DD) between which measurements are valid.

6.2.6 Virtual colour data (G)

Representation of a colour for which no direct measurement has taken place. This may be a theoretical synthetic colour, an illuminant, a reference to a colour-order system, etc.). See Table 7.

a) Value

- CIE XYZ
- CIE L*a*b*
- Spectral reflectance
- Spectral radiance factor
- Spectral transmittance or

- Spectral power distribution
- b) Illuminant
- c) Observer (2° or 10°)
- d) **Geometry**
 - Aperture diameter (mm) and description
 - Bandpass corrected
 - Bandwidth (nm)
 - Cell-path length/thickness (mm)
 - Configuration (for sphere geometry, “included” or “excluded”, otherwise “uniplanar” or “annular”)
 - Influx (degrees, “d” or “t”, see Table 7)
 - Efflux (degrees, or “d” or “t”, see Table 7)
 - Orientation of sample (descriptive)
 - Mode: regular, diffuse or total
- e) **UV component**
 - Cut-off wavelength (nm)
 - Level set

Table 7 — Virtual colour data (G)

Parameter	Type	Description
Value		<u>One</u> of the six types listed below.
CIE XYZ,	Numeric, Numeric, Numeric	CIE X, Y, Z values.
CIE L*a*b*	Numeric, Numeric, Numeric	CIE L*, a*, b* separated by commas.
Spectral reflectance	Numeric, Numeric	Pairs of wavelengths (nm) and reflectance values, expressed as a percentage.
Spectral radiance factor	Numeric, Numeric	Pairs of wavelengths (nm) and radiance factors, expressed as a percentage.
Spectral transmittance or	Numeric, Numeric	Pairs of wavelengths (nm) and transmittances, expressed as a percentage.
Spectral power distribution	Numeric, Numeric	Pairs of wavelengths (nm) and power distribution values.
Illuminant	Text	Usually a CIE standard illuminant.
Observer (2° or 10°)	Numeric (2 or 10)	CIE standard observer (degrees).

Table 7 (continued)

Parameter	Type	Description
Geometry		
Aperture diameter (mm) and description	Text	The size, in millimetres, of the sample-port aperture and text description, e.g. "large".
Bandpass corrected ("yes" or "no")	Text: "yes" or "no"	Has the instrument result been corrected for the bandpass function not being triangular?
Bandwidth (nm)	Numeric	The bandwidth of the measurement, in nanometres.
Cell path length/thickness (mm)	Numeric	The path length of the cell or cuvette containing the solution being measured (typically 10 mm for a standard cuvette) or the thickness of the sample.
Configuration	Text: "included", "excluded", "uniplanar" or "annular"	Options relating to the overall geometric arrangement of the illumination and detecting beams. The first two options relate to the use of an integrating sphere and its specular component, either included or excluded. The others relate to non-integrating-sphere geometries: uniplanar, if illumination and detecting beams form a single plane: annular, if the collection or illumination of the sample is from many positions around the sample at the designated angle, e.g. using a ring illuminator or collector.
Influx (degrees, "d" or "t")	Numeric, if degrees Text, if "d" or "t"	For directional illumination, the illuminating direction, in degrees, with respect to the normal to the sample plane. For integrating-sphere illumination, either "d" for diffuse illumination with the regular component excluded, or "t" for diffuse illumination with the regular component included.
Efflux (degrees)	Numeric, if degrees Text: if "d" or "t"	For directional detection, the detecting/measuring direction, in degrees, with respect to the normal to the sample plane. For integrating-sphere detection, either "d" for diffuse detection with the regular component excluded, or "t" for diffuse detection with the regular component included.
Orientation of sample (descriptive)	Text	Description of placement of sample with respect to illumination, e.g. up, down, parallel to weave.
Mode	Text: "regular", "diffuse" or "total"	Description of transmittance measurement type. Regular for a non-scattered beam being measured, diffuse for a scattered beam being measured and total for both regular and diffuse types being measured. Omitted for a non-transmittance measurement.
UV component		
Cut-off wavelength	Numeric	Wavelength, in nanometres, of the cut-off for an adjustable UV filter.
Level set	Numeric	UV level set, if adjustable.

Annex A (informative)

Colorimetric data format

A.1 XML schema (XSD)

```

1 <?xml version="1.0"?>
2 <xs:schema targetNamespace="http://www.xxx.org.uk/2004/cdf"
  xmlns:xs="http://www.xxx.org.uk/2004/cdf"
  xmlns:cds="http://www.xxx.org.uk/2004/cdf"
  xmlns:cdf="http://www.xxx.org.uk/2004/cdf">
3 <xs:element name="cdf">
4   <xs:complexType>
5     <xs:sequence>
6       <xs:element name="sample">
7         <xs:complexType>
8           <xs:sequence>
9             <xs:element name="name" type="xs:string" minOccurs="0"/>
10            <xs:element name="reference" type="xs:string" minOccurs="0"/>
11            <xs:element name="description" type="xs:string" minOccurs="0"/>
12            <xs:element name="originator" type="xs:string" minOccurs="0"/>
13            <xs:element name="comments" type="xs:string" minOccurs="0"/>
14            <xs:element name="preview" type="xs:string" minOccurs="0"/>
maxOccurs="unbounded"/>
15          <xs:element name="virtual" type="xs:boolean" minOccurs="0"/>
16        </xs:sequence>
17        <xs:attribute name="id" type="xs:ID" use="required"/>
18      </xs:complexType>
19    </xs:element>
20    <xs:element name="spectral" type="spectralType" minOccurs="0"
maxOccurs="unbounded"/>
21    <xs:element name="colorimetric" type="colorimetricType" minOccurs="0"
maxOccurs="unbounded"/>
22  </xs:sequence>
23 </xs:complexType>
24 </xs:element>
25 <xs:complexType name="spectralData">
26   <xs:sequence>
27     <xs:element name="value" minOccurs="16" maxOccurs="unbounded">
28       <xs:complexType>
29         <xs:simpleContent>
30           <xs:extension base="xs:double">
31             <xs:attribute name="nm" type="xs:positiveInteger" use="required"/>
32           </xs:extension>
33         </xs:simpleContent>
34       </xs:complexType>
35     </xs:element>
36     <xs:element name="uncertainty" type="xs:double" minOccurs="0"/>
37   </xs:sequence>
38   <xs:attribute name="type" use="required">
39     <xs:simpleType>
40       <xs:restriction base="xs:string">
41         <xs:enumeration value="radiance"/>
42         <xs:enumeration value="radiometric"/>
43         <xs:enumeration value="reflectance"/>
44         <xs:enumeration value="transmission"/>
45       </xs:restriction>
46     </xs:simpleType>
47   </xs:attribute>
48 </xs:complexType>
49 <xs:simpleType name="fluxType">
50   <xs:restriction base="xs:string">
51     <xs:pattern value="t|d|\d"/>
52   </xs:restriction>

```

```

53 </xs:simpleType>
54 <xs:simpleType name="previewType">
55   <xs:restriction base="xs:string">
56     <xs:length value="7" />
57     <xs:pattern value="#" ([0-9a-fA-F]) {6} />
58   </xs:restriction>
59 </xs:simpleType>
60 <xs:complexType name="calibrationType">
61   <xs:complexContent>
62     <xs:restriction base="xs:anyType">
63       <xs:sequence>
64         <xs:element name="uvccutoff" type="xs:double" minOccurs="0" />
65         <xs:element name="uvlevel" type="xs:double" minOccurs="0" />
66         <xs:element name="certificate" type="xs:string" minOccurs="0" />
67         <xs:element name="traceability" type="xs:string" minOccurs="0" />
68         <xs:element name="validity" minOccurs="0">
69           <xs:complexType>
70             <xs:sequence>
71               <xs:element name="from" type="xs:date" />
72               <xs:element name="to" type="xs:date" />
73             </xs:sequence>
74           </xs:complexType>
75         </xs:element>
76       </xs:sequence>
77       <xs:attribute name="type" use="required">
78         <xs:simpleType>
79           <xs:restriction base="xs:string">
80             <xs:enumeration value="black" />
81             <xs:enumeration value="white" />
82             <xs:enumeration value="source" />
83             <xs:enumeration value="tile" />
84             <xs:enumeration value="uv" />
85           </xs:restriction>
86         </xs:simpleType>
87       </xs:attribute>
88     </xs:restriction>
89   </xs:complexContent>
90 </xs:complexType>
91 <xs:complexType name="geometryType">
92   <xs:sequence>
93     <xs:element name="angle" type="xs:double" minOccurs="0" />
94     <xs:element name="aperture" type="apertureType" minOccurs="0" />
95     <xs:element name="bandpass" type="xs:boolean" minOccurs="0" />
96     <xs:element name="bandwidth" type="xs:double" minOccurs="0" />
97     <xs:element name="distance" type="xs:double" minOccurs="0" />
98     <xs:element name="influx" type="fluxType" minOccurs="0" />
99     <xs:element name="efflux" type="fluxType" minOccurs="0" />
100    <xs:element name="orientation" type="xs:string" minOccurs="0" />
101    <xs:element name="pathlength" type="xs:double" minOccurs="0" />
102  </xs:sequence>
103  <xs:attribute name="mode" use="optional">
104    <xs:simpleType>
105      <xs:restriction base="xs:string">
106        <xs:enumeration value="regular" />
107        <xs:enumeration value="diffuse" />
108        <xs:enumeration value="total" />
109      </xs:restriction>
110    </xs:simpleType>
111  </xs:attribute>
112  <xs:attribute name="configuration" use="optional">
113    <xs:simpleType>
114      <xs:restriction base="xs:string">
115        <xs:enumeration value="included" />
116        <xs:enumeration value="excluded" />
117        <xs:enumeration value="annular" />
118        <xs:enumeration value="uniplanar" />
119      </xs:restriction>
120    </xs:simpleType>
121  </xs:attribute>
122 </xs:complexType>
123 <xs:complexType name="CIEXYZ">
124   <xs:sequence>
125     <xs:element name="X" type="xs:double" />

```

```

126     <xs:element name="Y" type="xs:double"/>
127     <xs:element name="Z" type="xs:double"/>
128     <xs:element name="uncertainty" type="xs:double" minOccurs="0" maxOccurs="3"/>
129   </xs:sequence>
130 </xs:complexType>
131 <xs:complexType name="CIELAB">
132   <xs:sequence>
133     <xs:element name="L" type="xs:double"/>
134     <xs:element name="a" type="xs:double"/>
135     <xs:element name="b" type="xs:double"/>
136     <xs:element name="uncertainty" type="xs:double" minOccurs="0" maxOccurs="3"/>
137   </xs:sequence>
138 </xs:complexType>
139 <xs:complexType name="colorimetricData">
140   <xs:sequence>
141     <xs:element name="CIEXYZ" type="CIEXYZ" minOccurs="0"/>
142     <xs:element name="CIELAB" type="CIELAB" minOccurs="0"/>
143     <xs:element name="observer" type="xs:string" minOccurs="0"/>
144     <xs:simpleType>
145       <xs:restriction base="xs:integer">
146         <xs:enumeration value="2"/>
147         <xs:enumeration value="10"/>
148       </xs:restriction>
149     </xs:simpleType>
150   </xs:sequence>
151   <xs:element name="illuminant" type="xs:string" minOccurs="0"/>
152 </xs:complexType>
153 </xs:complexType>
154 <xs:complexType name="instrumentType">
155   <xs:sequence>
156     <xs:element name="manufacturer" type="xs:string" minOccurs="0"/>
157     <xs:element name="model" type="xs:string" minOccurs="0"/>
158     <xs:element name="serial" type="xs:string" minOccurs="0"/>
159   </xs:sequence>
160 </xs:complexType>
161 <xs:complexType name="parameterType">
162   <xs:sequence>
163     <xs:element name="when" type="xs:dateTime" minOccurs="0"/>
164     <xs:element name="repeats" type="xs:nonNegativeInteger" minOccurs="0"/>
165     <xs:element name="humidity" type="xs:double" minOccurs="0"/>
166     <xs:element name="integration" type="xs:double" minOccurs="0"/>
167     <xs:element name="temperature" type="xs:double" minOccurs="0"/>
168     <xs:element name="reftype" type="xs:string" minOccurs="0"/>
169     <xs:element name="geometry" type="geometryType" minOccurs="0"/>
170     <xs:element name="instrument" type="instrumentType" minOccurs="0"/>
171     <xs:element name="calibration" type="calibrationType" minOccurs="0" maxOccurs="3"/>
172     <xs:element name="zero" type="zeroType" minOccurs="0"/>
173   </xs:sequence>
174 </xs:complexType>
175 <xs:complexType name="zeroType">
176   <xs:sequence/>
177   <xs:attribute name="applied" type="xs:boolean" use="required"/>
178   <xs:attribute name="type" type="xs:string" use="optional"/>
179 </xs:complexType>
180 <xs:complexType name="apertureType">
181   <xs:sequence/>
182   <xs:attribute name="name" type="xs:string" use="optional"/>
183   <xs:attribute name="size" type="xs:double" use="optional"/>
184 </xs:complexType>
185 <xs:complexType name="spectralType">
186   <xs:sequence>
187     <xs:element name="data" type="spectralData"/>
188     <xs:element name="parameters" type="parameterType" minOccurs="0"/>
189   </xs:sequence>
190 </xs:complexType>
191 <xs:complexType name="colorimetricType">
192   <xs:sequence>
193     <xs:element name="tristimulus" type="colorimetricData"/>
194     <xs:element name="parameters" type="parameterType" minOccurs="0"/>
195   </xs:sequence>
196 </xs:complexType>
197 </xs:schema>

```

A.2 Document type definition (DTD)

```

1  <!-- WG12 colorimetric data document type definition. PAR:20040622 -->
2  <!ELEMENT cdf (sample, (spectral+ | colorimetric+ | virtual+))>
3  <!ATTLIST cdf
4    xmlns:xsi CDATA #IMPLIED
5    xsi:noNamespaceSchemaLocation CDATA #IMPLIED
6  >
7  <!ELEMENT sample (name, reference?, description?, originator?, comments?,
8    preview*, virtual?)>
9  <!ATTLIST sample
10    id CDATA #IMPLIED
11  >
12  <!ELEMENT name (#PCDATA)>
13  <!ELEMENT reference (#PCDATA)>
14  <!ELEMENT description (#PCDATA)>
15  <!ELEMENT originator (#PCDATA)>
16  <!ELEMENT comments (#PCDATA)>
17  <!ELEMENT preview (#PCDATA)>
18  <!ELEMENT virtual (#PCDATA)>
19  <!ELEMENT spectral (data, parameters)>
20  <!ELEMENT data (value+, uncertainty?)>
21  <!ATTLIST data
22    x type (radiance | radiometric | reflectance | transmission) #REQUIRED
23  >
24  <!ELEMENT colorimetric (tristimulus, parameters?)>
25  <!ELEMENT tristimulus (CIEXYZ?, CIELAB?, observer?, illuminant?)>
26  <!ELEMENT value (#PCDATA)>
27  <!ATTLIST value
28    nm CDATA #REQUIRED
29  >
30  <!ELEMENT uncertainty (#PCDATA)>
31  <!ELEMENT parameters (when?, repeats?, humidity?, integration?, temperature?, reftype?,
32    geometry?, instrument?, calibration+, zero?)>
33  <!ELEMENT when (#PCDATA)>
34  <!ELEMENT repeats (#PCDATA)>
35  <!ELEMENT humidity (#PCDATA)>
36  <!ELEMENT integration (#PCDATA)>
37  <!ELEMENT temperature (#PCDATA)>
38  <!ELEMENT reftype (#PCDATA)>
39  <!ELEMENT geometry (angle?, aperture?, bandpass?, bandwidth?, distance?, influx?, eflux?,
40    orientation?, pathlength?)>
41  <!ATTLIST geometry
42    configuration (included | excluded | annular | uniplanar) #IMPLIED
43    mode (regular | diffuse | total) #IMPLIED
44  >
45  <!ELEMENT angle (#PCDATA)>
46  <!ELEMENT aperture EMPTY>
47  <!ATTLIST aperture
48    name CDATA #IMPLIED
49    size CDATA #IMPLIED
50  >
51  <!ELEMENT bandpass EMPTY>
52  <!ATTLIST bandpass
53    corrected (true | false) #REQUIRED
54  >
55  <!ELEMENT bandwidth (#PCDATA)>
56  <!ELEMENT distance (#PCDATA)>
57  <!ELEMENT influx (#PCDATA)>
58  <!ELEMENT eflux (#PCDATA)>
59  <!ELEMENT orientation (#PCDATA)>
60  <!ELEMENT pathlength (#PCDATA)>
61  <!ELEMENT instrument (manufacturer?, model?, serial?)>
62  <!ELEMENT manufacturer (#PCDATA)>
63  <!ELEMENT model (#PCDATA)>
64  <!ELEMENT serial (#PCDATA)>
65  <!ELEMENT calibration (uvcutoff?, uvlevel?, certificate?, traceability?, validity?)>
66  <!ATTLIST calibration
67    type (black | white | source | tile | uv) #REQUIRED
68  >
69  <!ELEMENT uvcutoff (#PCDATA)>
70  <!ELEMENT uvlevel (#PCDATA)>

```

```
68 <ELEMENT certificate (#PCDATA)>
69 <ELEMENT traceability (#PCDATA)>
70 <ELEMENT validity (from, to)>
71 <ELEMENT from (#PCDATA)>
72 <ELEMENT to (#PCDATA)>
73 <ELEMENT zero (#PCDATA)>
74 <ATTLIST zero
75     applied (true | false) #REQUIRED
76     type CDATA #IMPLIED
77 >
78 <ELEMENT CIEXYZ ((X, Y, Z), uncertainty*)>
79 <ELEMENT X (#PCDATA)>
80 <ELEMENT Y (#PCDATA)>
81 <ELEMENT Z (#PCDATA)>
82
83 <ELEMENT CIELAB ((L, a, b), uncertainty*)>
84 <ELEMENT L (#PCDATA)>
85 <ELEMENT a (#PCDATA)>
86 <ELEMENT b (#PCDATA)>
87
88 <ELEMENT illuminant (#PCDATA)>
89 <ELEMENT observer (#PCDATA)>
```

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A.3 Samples of XML documents

A.3.1 Example 1 – Containing reflectance

```

1 <?xml version="1.0" encoding="UTF-8"?>
2 <?xml-stylesheet type="text/xsl" href="example.xsl" media="screen"?>
3 <!DOCTYPE cdf SYSTEM "wg12cdf.dtd">
4 <cdf:cdf xmlns:cdf="http://www.xxx.org.uk/2004/cdf"
          xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
          xsi:schemaLocation="http://www.xxx.org.uk/2004/cdf
5 wg12cdf.xsd">
6   <sample id="example1">
7     <name>mushroom</name>
8     <reference>ladybird</reference>
9     <comments>Ladybird Childrenswear (1993)</comments>
10    <preview>#aba59f</preview>
11  </sample>
12  <spectral>
13    <data type="reflectance">
14      <value nm="400">32.88</value>
15      <value nm="420">30.89</value>
16      <value nm="440">31.56</value>
17      <value nm="460">33.71</value>
18      <value nm="480">36.58</value>
19      <value nm="500">38.18</value>
20      <value nm="520">38.42</value>
21      <value nm="540">37.17</value>
22      <value nm="560">38.24</value>
23      <value nm="580">40.46</value>
24      <value nm="600">40.50</value>
25      <value nm="620">40.64</value>
26      <value nm="640">41.87</value>
27      <value nm="660">44.98</value>
28      <value nm="680">50.74</value>
29      <value nm="700">59.05</value>
30      <uncertainty>0.15</uncertainty>
31    </data>
32    <parameters>
33      <when>1993-01-21T10:14:07</when>
34      <repeats>1</repeats>
35      <geometry configuration="included">
36        <aperture name="IAV" size="25"/>
37        <influx>d</influx>
38        <efflux>0</efflux>
39        <orientation>vertical</orientation>
40      </geometry>
41      <instrument>
42        <manufacturer>Macbeth</manufacturer>
43        <model>MS-2020+</model>
44        <serial>230778866</serial>
45      </instrument>
46      <calibration type="black">
47        <traceability>NPL</traceability>
48      </calibration>
49      <calibration type="tile">
50        <certificate>8143</certificate>
51        <traceability>NPL</traceability>
52        <validity>
53          <from>1993-01-01</from>
54          <to>1993-12-31</to>
55        </validity>
56      </calibration>
57      <calibration type="uv">
58        <uv cutoff>700</uv cutoff>
59      </calibration>
60    </parameters>
61  </spectral>
62 </cdf:cdf>

```

example1

Name: mushroom	Reference: ladybird	
Description:		
Originator:		
Comments: Ladybird Childrenswear (1993)		
Spectral reflectance data:		
32.88(400nm), 30.89(420nm), 31.56(440nm), 33.71(460nm), 36.58(480nm), 38.18(500nm), 38.42(520nm), 37.17(540nm), 38.24(560nm), 40.46(580nm), 40.50(600nm), 40.64(620nm), 41.87(640nm), 44.98(660nm), 50.74(680nm), 59.05(700nm)		
Parameters:		
Produced: 1993-01-21T10:14:07	Repeats: 1	Humidity:
Integration Time:	Temperature:	Reference Type:
Instrument: Macbeth MS-2020+ (S/N: 230778866)		
Geometry:		
Angle:	Aperture: 25mm (LAV)	Bandpass:
Bandwidth:	Distance:	Influx: d
Eflux: 0	Orientation: vertical	Pathlength:
Calibration (black):		
Certificate:	Traceability: NPL	
Calibration (tile):		
Certificate: 8143	Traceability: NPL	
Calibration (uv):		
UV Cutoff: 700	UV Level:	
Certificate:	Traceability:	

A.3.2 Example 2 – Containing radiometric data

```

1  <?xml version="1.0" encoding="UTF-8"?>
2  <?xml-stylesheet type="text/xsl" href="example.xsl" media="screen"?>
3  <!DOCTYPE cdf:cdf SYSTEM "wg12cdf.dtd">
4  <cdf:cdf xmlns:cdf="http://www.xxx.org.uk/2004/cdf"
        xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xsi:schemaLocation="http://www.xxx.org.uk/2004/cdf
        wg12cdf.xsd">
5      <sample id="example2"/>
6      <spectral>
7          <data type="radiometric">
8              <value nm="380">1.237e-5</value>
9              <value nm="381">1.169e-5</value>
10             <value nm="382">1.125e-5</value>
11             <value nm="383">8.913e-6</value>
12             <value nm="384">9.601e-6</value>
13             <value nm="385">9.264e-6</value>
14             <value nm="386">1.013e-5</value>
15             <value nm="387">1.465e-5</value>
16             <value nm="388">1.152e-5</value>
17             <value nm="389">1.217e-5</value>
18             ...
19             <value nm="773">2.327e-2</value>
20             <value nm="774">2.336e-2</value>
21             <value nm="775">2.345e-2</value>
22             <value nm="776">2.355e-2</value>
23             <value nm="777">2.365e-2</value>
24             <value nm="778">2.374e-2</value>
25             <value nm="779">2.382e-2</value>
26             <value nm="780">2.393e-2</value>
27         </data>
28         <parameters>
29             <when>1998-08-24T23:09:00</when>
30             <integration>42.0</integration>
31             <temperature>21.3</temperature>
32             <geometry>
33                 <bandwidth>5</bandwidth>
34                 <distance>1.0</distance>
35             </geometry>
36             <instrument>
37                 <manufacturer>Minolta</manufacturer>
38                 <model>CS-1000</model>
39                 <serial>21711013</serial>
40             </instrument>
41         </parameters>
42     </spectral>
43     <colorimetric>
44         <tristimulus>
45             <CIEXYZ>
46                 <X>446.50</X>
47                 <Y>373.70</Y>
48                 <Z>93.39</Z>
49             </CIEXYZ>
50             <observer>10</observer>
51             <illuminant>D65</illuminant>
52         </tristimulus>
53     </colorimetric>
54 </cdf:cdf>

```

C:\Documents and Settings\Peter Rhodes\Desktop\wg12\example2.xml - Microsoft Internet Explorer

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example2

Name:	Reference:
Description:	Originator:
Comments:	

Spectral radiometric data:

1.237e-5(380nm), 1.169e-5(381nm), 1.125e-5(382nm), 8.913e-6(383nm), 9.601e-6(384nm), 9.264e-6(385nm), 1.013e-5(386nm), 1.465e-5(387nm), 1.152e-5(388nm), 1.217e-5(389nm), 1.154e-5(390nm), 1.422e-5(391nm), 1.662e-5(392nm), 1.493e-5(393nm), 1.744e-5(394nm), 1.842e-5(395nm), 1.844e-5(396nm), 2.072e-5(397nm), 2.336e-5(398nm), 2.573e-5(399nm), 2.648e-5(400nm), 3.108e-5(401nm), 3.307e-5(402nm), 4.094e-5(403nm), 4.916e-5(404nm), 5.654e-5(405nm), 6.691e-5(406nm), 7.893e-5(407nm), 9.592e-5(408nm), 1.115e-4(409nm), 1.327e-4(410nm), 1.565e-4(411nm), 1.852e-4(412nm), 2.144e-4(413nm), 2.462e-4(414nm), 2.821e-4(415nm), 3.151e-4(416nm), 3.518e-4(417nm), 3.903e-4(418nm), 4.231e-4(419nm), 4.601e-4(420nm), 4.943e-4(421nm), 5.240e-4(422nm), 5.555e-4(423nm), 5.820e-4(424nm), 6.077e-4(425nm), 6.335e-4(426nm), 6.584e-4(427nm), 6.824e-4(428nm), 7.058e-4(429nm), 7.290e-4(430nm), 7.531e-4(431nm), 7.750e-4(432nm), 7.981e-4(433nm), 8.208e-4(434nm), 8.447e-4(435nm), 8.673e-4(436nm), 8.910e-4(437nm), 9.116e-4(438nm), 9.342e-4(439nm), 9.570e-4(440nm), 9.782e-4(441nm), 9.992e-4(442nm), 1.019e-3(443nm), 1.038e-3(444nm), 1.059e-3(445nm), 1.078e-3(446nm), 1.098e-3(447nm), 1.117e-3(448nm), 1.138e-3(449nm), 1.158e-3(450nm), 1.177e-3(451nm), 1.197e-3(452nm), 1.217e-3(453nm), 1.237e-3(454nm), 1.257e-3(455nm), 1.277e-3(456nm), 1.297e-3(457nm), 1.317e-3(458nm), 1.337e-3(459nm), 1.357e-3(460nm), 1.377e-3(461nm), 1.397e-3(462nm), 1.417e-3(463nm), 1.437e-3(464nm), 1.457e-3(465nm), 1.477e-3(466nm), 1.497e-3(467nm), 1.517e-3(468nm), 1.537e-3(469nm), 1.557e-3(470nm), 1.577e-3(471nm), 1.597e-3(472nm), 1.617e-3(473nm), 1.637e-3(474nm), 1.657e-3(475nm), 1.677e-3(476nm), 1.697e-3(477nm), 1.717e-3(478nm), 1.737e-3(479nm), 1.757e-3(480nm), 1.777e-3(481nm), 1.797e-3(482nm), 1.817e-3(483nm), 1.837e-3(484nm), 1.857e-3(485nm), 1.877e-3(486nm), 1.897e-3(487nm), 1.917e-3(488nm), 1.937e-3(489nm), 1.957e-3(490nm), 1.977e-3(491nm), 1.997e-3(492nm), 2.017e-3(493nm), 2.037e-3(494nm), 2.057e-3(495nm), 2.077e-3(496nm), 2.097e-3(497nm), 2.117e-3(498nm), 2.137e-3(499nm), 2.157e-3(500nm), 2.177e-3(501nm), 2.197e-3(502nm), 2.217e-3(503nm), 2.237e-3(504nm), 2.257e-3(505nm), 2.277e-3(506nm), 2.297e-3(507nm), 2.317e-3(508nm), 2.337e-3(509nm), 2.357e-3(510nm), 2.377e-3(511nm), 2.397e-3(512nm), 2.417e-3(513nm), 2.437e-3(514nm), 2.457e-3(515nm), 2.477e-3(516nm), 2.497e-3(517nm), 2.517e-3(518nm), 2.537e-3(519nm), 2.557e-3(520nm), 2.577e-3(521nm), 2.597e-3(522nm), 2.617e-3(523nm), 2.637e-3(524nm), 2.657e-3(525nm), 2.677e-3(526nm), 2.697e-3(527nm), 2.717e-3(528nm), 2.737e-3(529nm), 2.757e-3(530nm), 2.777e-3(531nm), 2.797e-3(532nm), 2.817e-3(533nm), 2.837e-3(534nm), 2.857e-3(535nm), 2.877e-3(536nm), 2.897e-3(537nm), 2.917e-3(538nm), 2.937e-3(539nm), 2.957e-3(540nm), 2.977e-3(541nm), 2.997e-3(542nm), 3.017e-3(543nm), 3.037e-3(544nm), 3.057e-3(545nm), 3.077e-3(546nm), 3.097e-3(547nm), 3.117e-3(548nm), 3.137e-3(549nm), 3.157e-3(550nm), 3.177e-3(551nm), 3.197e-3(552nm), 3.217e-3(553nm), 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4.397e-3(612nm), 4.417e-3(613nm), 4.437e-3(614nm), 4.457e-3(615nm), 4.477e-3(616nm), 4.497e-3(617nm), 4.517e-3(618nm), 4.537e-3(619nm), 4.557e-3(620nm), 4.577e-3(621nm), 4.597e-3(622nm), 4.617e-3(623nm), 4.637e-3(624nm), 4.657e-3(625nm), 4.677e-3(626nm), 4.697e-3(627nm), 4.717e-3(628nm), 4.737e-3(629nm), 4.757e-3(630nm), 4.777e-3(631nm), 4.797e-3(632nm), 4.817e-3(633nm), 4.837e-3(634nm), 4.857e-3(635nm), 4.877e-3(636nm), 4.897e-3(637nm), 4.917e-3(638nm), 4.937e-3(639nm), 4.957e-3(640nm), 4.977e-3(641nm), 4.997e-3(642nm), 5.017e-3(643nm), 5.037e-3(644nm), 5.057e-3(645nm), 5.077e-3(646nm), 5.097e-3(647nm), 5.117e-3(648nm), 5.137e-3(649nm), 5.157e-3(650nm), 5.177e-3(651nm), 5.197e-3(652nm), 5.217e-3(653nm), 5.237e-3(654nm), 5.257e-3(655nm), 5.277e-3(656nm), 5.297e-3(657nm), 5.317e-3(658nm), 5.337e-3(659nm), 5.357e-3(660nm), 5.377e-3(661nm), 5.397e-3(662nm), 5.417e-3(663nm), 5.437e-3(664nm), 5.457e-3(665nm), 5.477e-3(666nm), 5.497e-3(667nm), 5.517e-3(668nm), 5.537e-3(669nm), 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6.717e-3(728nm), 6.737e-3(729nm), 6.757e-3(730nm), 6.777e-3(731nm), 6.797e-3(732nm), 6.817e-3(733nm), 6.837e-3(734nm), 6.857e-3(735nm), 6.877e-3(736nm), 6.897e-3(737nm), 6.917e-3(738nm), 6.937e-3(739nm), 6.957e-3(740nm), 6.977e-3(741nm), 6.997e-3(742nm), 7.017e-3(743nm), 7.037e-3(744nm), 7.057e-3(745nm), 7.077e-3(746nm), 7.097e-3(747nm), 7.117e-3(748nm), 7.137e-3(749nm), 7.157e-3(750nm), 7.177e-3(751nm), 7.197e-3(752nm), 7.217e-3(753nm), 7.237e-3(754nm), 7.257e-3(755nm), 7.277e-3(756nm), 7.297e-3(757nm), 7.317e-3(758nm), 7.337e-3(759nm), 7.357e-3(760nm), 7.377e-3(761nm), 7.397e-3(762nm), 7.417e-3(763nm), 7.437e-3(764nm), 7.457e-3(765nm), 7.477e-3(766nm), 7.497e-3(767nm), 7.517e-3(768nm), 7.537e-3(769nm), 7.557e-3(770nm), 7.577e-3(771nm), 7.597e-3(772nm), 7.617e-3(773nm), 7.637e-3(774nm), 7.657e-3(775nm), 7.677e-3(776nm), 7.697e-3(777nm), 7.717e-3(778nm), 7.737e-3(779nm), 7.757e-3(780nm), 7.777e-3(781nm), 7.797e-3(782nm), 7.817e-3(783nm), 7.837e-3(784nm), 7.857e-3(785nm), 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9.037e-3(844nm), 9.057e-3(845nm), 9.077e-3(846nm), 9.097e-3(847nm), 9.117e-3(848nm), 9.137e-3(849nm), 9.157e-3(850nm), 9.177e-3(851nm), 9.197e-3(852nm), 9.217e-3(853nm), 9.237e-3(854nm), 9.257e-3(855nm), 9.277e-3(856nm), 9.297e-3(857nm), 9.317e-3(858nm), 9.337e-3(859nm), 9.357e-3(860nm), 9.377e-3(861nm), 9.397e-3(862nm), 9.417e-3(863nm), 9.437e-3(864nm), 9.457e-3(865nm), 9.477e-3(866nm), 9.497e-3(867nm), 9.517e-3(868nm), 9.537e-3(869nm), 9.557e-3(870nm), 9.577e-3(871nm), 9.597e-3(872nm), 9.617e-3(873nm), 9.637e-3(874nm), 9.657e-3(875nm), 9.677e-3(876nm), 9.697e-3(877nm), 9.717e-3(878nm), 9.737e-3(879nm), 9.757e-3(880nm), 9.777e-3(881nm), 9.797e-3(882nm), 9.817e-3(883nm), 9.837e-3(884nm), 9.857e-3(885nm), 9.877e-3(886nm), 9.897e-3(887nm), 9.917e-3(888nm), 9.937e-3(889nm), 9.957e-3(890nm), 9.977e-3(891nm), 9.997e-3(892nm), 1.017e-2(893nm), 1.037e-2(894nm), 1.057e-2(895nm), 1.077e-2(896nm), 1.097e-2(897nm), 1.117e-2(898nm), 1.137e-2(899nm), 1.157e-2(900nm), 1.177e-2(901nm), 1.197e-2(902nm), 1.217e-2(903nm), 1.237e-2(904nm), 1.257e-2(905nm), 1.277e-2(906nm), 1.297e-2(907nm), 1.317e-2(908nm), 1.337e-2(909nm), 1.357e-2(910nm), 1.377e-2(911nm), 1.397e-2(912nm), 1.417e-2(913nm), 1.437e-2(914nm), 1.457e-2(915nm), 1.477e-2(916nm), 1.497e-2(917nm), 1.517e-2(918nm), 1.537e-2(919nm), 1.557e-2(920nm), 1.577e-2(921nm), 1.597e-2(922nm), 1.617e-2(923nm), 1.637e-2(924nm), 1.657e-2(925nm), 1.677e-2(926nm), 1.697e-2(927nm), 1.717e-2(928nm), 1.737e-2(929nm), 1.757e-2(930nm), 1.777e-2(931nm), 1.797e-2(932nm), 1.817e-2(933nm), 1.837e-2(934nm), 1.857e-2(935nm), 1.877e-2(936nm), 1.897e-2(937nm), 1.917e-2(938nm), 1.937e-2(939nm), 1.957e-2(940nm), 1.977e-2(941nm), 1.997e-2(942nm), 2.017e-2(943nm), 2.037e-2(944nm), 2.057e-2(945nm), 2.077e-2(946nm), 2.097e-2(947nm), 2.117e-2(948nm), 2.137e-2(949nm), 2.157e-2(950nm), 2.177e-2(951nm), 2.197e-2(952nm), 2.217e-2(953nm), 2.237e-2(954nm), 2.257e-2(955nm), 2.277e-2(956nm), 2.297e-2(957nm), 2.317e-2(958nm), 2.337e-2(959nm), 2.357e-2(960nm), 2.377e-2(961nm), 2.397e-2(962nm), 2.417e-2(963nm), 2.437e-2(964nm), 2.457e-2(965nm), 2.477e-2(966nm), 2.497e-2(967nm), 2.517e-2(968nm), 2.537e-2(969nm), 2.557e-2(970nm), 2.577e-2(971nm), 2.597e-2(972nm), 2.617e-2(973nm), 2.637e-2(974nm), 2.657e-2(975nm), 2.677e-2(976nm), 2.697e-2(977nm), 2.717e-2(978nm), 2.737e-2(979nm), 2.757e-2(980nm), 2.777e-2(981nm), 2.797e-2(982nm), 2.817e-2(983nm), 2.837e-2(984nm), 2.857e-2(985nm), 2.877e-2(986nm), 2.897e-2(987nm), 2.917e-2(988nm), 2.937e-2(989nm), 2.957e-2(990nm), 2.977e-2(991nm), 2.997e-2(992nm), 3.017e-2(993nm), 3.037e-2(994nm), 3.057e-2(995nm), 3.077e-2(996nm), 3.097e-2(997nm), 3.117e-2(998nm), 3.137e-2(999nm), 3.157e-2(1000nm).

Parameters:

Produced: 1998-08-24T23:09:00	Repeats: 1	Humidity:	Temperature: 21.3°C
Reference Type: 21.3	Instrument: Minolta CS-1000 (S/N: 21711013)		

Geometry:

Angle:	Aperture:	Bandpass:
Bandwidth: 5nm	Distance: 1.0m	Influx:
Eflux:	Orientation:	Pathlength:

Colorimetric data: D65/10°

X = 446.50	Y = 373.70	Z = 93.39
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