Optical Calibration Laboratory,
Fluorescent Reference Standard

# CIE Illuminant C - Instructions for use

## Scope

The following description refers to the calibration and UV adjustment required by the international standard ISO 2470-1:2018, Paper, board and pulps – Measurement of diffuse blue reflectance factor – Part 1: Indoor daylight conditions (ISO brightness).

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## Principle

The appearance of an illuminated object is dependent upon the illumination and viewing conditions. For paper and board product containing fluorescent whitening agents (FWAs), its total radiance factor is the sum of the reflected radiance factor and the luminescent radiance factor (ISO 2470-1:2018). Since the luminescent radiance factor originates from fluorescence of the FWAs, its magnitude depends on the amount of UV radiation of the illumination. It is therefore essential to calibrate not only the radiance (reflectance) factor scale but also the UV content of the illumination used in the measurement apparatus.

The adjustment for the UV content is achieved by adjusting the position of the adjustable UV filter in the apparatus so that the light incident upon the sample has an effective UV content corresponding to that in the CIE illuminant C. The UV filter adjustment is based on the ISO brightness (C/2°) value (ISO 2470-1:2018). It means to match the measured brightness value of the reference standard (type B or FB) with the assigned value provided by RISE Innventia.

The Optical Calibration Laboratory (OCL) at RISE Innventia provides both fluorescent and non-fluorescent reflectance standards. Depending on the illumination condition, one of the following reference standards is needed.

- Type B fluorescent reference standard is used for adjusting the UV content to the CIE illuminant C.
- Type F fluorescent reference standard is used for adjusting the UV content to the CIE illuminant D65.
- Type FB fluorescent reference standard is used for adjusting the UV content to both the illuminants D65 and C.

For apparatus having no movable UV filter, a mathematical UV adjustment method (equivalent to a mathematical UV filter) is employed. The instructions for use are exactly the same, provided the same type of fluorescent reference standard is used.



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# Instructions for use

The fluorescent reference standard of type B (or FB) supplied by OCL is to be used – after prior calibration of the instrument with a non-fluorescent standard.

The following instructions relate specifically to filter instruments. The routine is in principle the same for other instruments. Nevertheless, follow the manufacturer's instructions, to be on the safe side.

1. Make sure that the UV cut-off filter is OUT. The current position of the UV adjustment filter is unimportant – leave the filter as it is.
2. Calibrate the instrument in the normal way with a non-fluorescent reference standard.
3. Place the fluorescent standard in the measurement position and measure the ISO brightness value.
4. Compare the measured value with the assigned ISO brightness value on the label. Too high a measured brightness value indicates that the UV content in the illumination is too high, and too low a measured brightness value indicates that the UV content is too low.
5. Adjust the position of the UV filter and make a new measurement.
6. Repeat steps 4 and 5 until the measurement gives the correct ISO brightness value. It should normally be possible to achieve a setting where the measured value differs from the assigned one by less than 0.2%.
7. Check the calibration of the instrument by measuring the white non-fluorescent standard again. The adjustment of the UV filter's position may disturb the calibration of the instrument. It is necessary to make a new calibration whenever the position of the UV filter has been adjusted. Steps 2–6 must then be repeated.

   *Note: The full procedure involving steps 2–6 may have to be repeated multiple times before the position of the UV filter is found in which the instrument has the correct UV content in the illumination and is also properly calibrated.*
8. It may be an advantage to have a stable fluorescent tile of plastic or similar material for use as a working standard to check the setting from time to time. Measure the ISO brightness of a working standard and record the value obtained. The working standard should only be used to check for a drift from a setting already established with a paper reference standard

### *After a lamp change*

Sometimes, the UV content of the illumination is too low to match the assigned ISO brightness value. There are normally two options. The first is to change the lamps. If the problem remains, one should then consider replacing the GG395-filter with e.g. a UG3-filter. The relative UV content of the illumination reaching the sample may be increased, as the UG3-filter does not reduce the UV radiation as much as the GG395-filter.

A new adjustment of the position of the UV filter must be made whenever the lamps or the filter in the instrument are changed. This applies even after changing the size of the measurement aperture. A paper reference standard rather than a plastic working standard has to be used since the plastic substrate is not as sensitive to the UV radiation over the same wavelength range as the paper reference standard.

If several instruments are available, each instrument should be adjusted using a fluorescent paper reference standard. The plastic tile should not be used for transfer between instruments.

## Calculation of CIE whiteness, C/2°

After adjusting the UV filter to the CIE-illuminant C with the aid of the ISO brightness reference standard, you may calculate the indoor whiteness value according to the following equation:

$$W_{C/2^0} = Y_{C/2^0} + 800(0.31006 - x_{C/2^0}) + 1700(0.31616 - y_{C/2^0}), \quad (1)$$

where $Y_{C/2^0}$ is the Y-value and $x_{C/2^0}$, $y_{C/2^0}$ are the chromaticity coordinates of the standard. On the reverse side of the standard, data are given to provide a basis for checking approximately the validity of the adjustment. The data given are the corresponding tristimulus values and C/2° whiteness value as determined with the RISE Innventia reference instrument, together with the CIE tint value, defined according to:

$$T_{C/2^0} = 1000(0.31006 - x_{C/2^0}) - 650(0.31616 - y_{C/2^0}), \quad (2)$$

where a positive tint value indicates a green tint and a negative value a red tint. If the material is considered as colorimetrically white, its tint value must lie between the limits:

$$-4 < T_{C/2^o} < 2.$$

In addition, information is given relating to the amount of fluorescence in the reference standard. This is quantified as the difference in the R457 value and the CIE C/2° whiteness value respectively with and without UV excitation. A UV exclusion filter with a cut-off at 420 nm, such as a GG420/3-filter is used for the latter measurement.