Karlsruhe Institute of Technology

Light Technology Institute
Head of Organizational Unit: Dr Rainer Kling
Engesserstr. 13
76131 Karlsruhe

Phone: +49 721-608-4-47064
Fax: +49 721-608-4-42590
Email: Tim.Gehring@kit.edu
Web: www.lti.kit.edu

Official in charge: M.Eng. Tim Gehring
Our reference:
Date: 21.12.2020

KIT-Campus Süd | LTI | Engesserstr. 13 | 76131 Karlsruhe

Dr. Hönle AG
UV Technologie
Herr Dieter Stirner
Lochhamer Schlag 1
82166 Gräfelfing

Measurement protocol according to IEC 62471:2009 (DIN EN 62471) quotation no. 25002350

Object/Type	UV air purifier / SteriAir WHITE Q115 (Ref: 092190 & 092191)
Manufacturer	Dr. Hönle AG
Measurement	Photo biological safety DIN EN 62471
Date of measurement	18.12.2020
Contractor	Dieter Stirner
Temperature during measurement	25°C
Air humidity	46%

1. Description of the measured object

The object of measurement is a UV air purifier. It is designed as a metal box. The unit can be operated with a stand (dimensions L x H x W: 600 x 650x160 mm) or wall or ceiling mounted (dimensions L x H x W: 600 x 600x150 mm). Two UV low-pressure lamps are installed internally. The lamps are exposed to an air flow. The air flow is disinfected by means of the generated UV radiation. A fan system is installed to generate the air flow. The total electrical power consumption during the measurement was 58.3 W. The measurement object is shown in figure 1. The air inlet and outlet are realised by individually shaped air slots (see figure 2). Due to the design, there is a possibility that UV radiation escapes from the air vents. The emission of radiation is measured and evaluated in the following according to IEC 62471:2009 (DIN EN 62471).

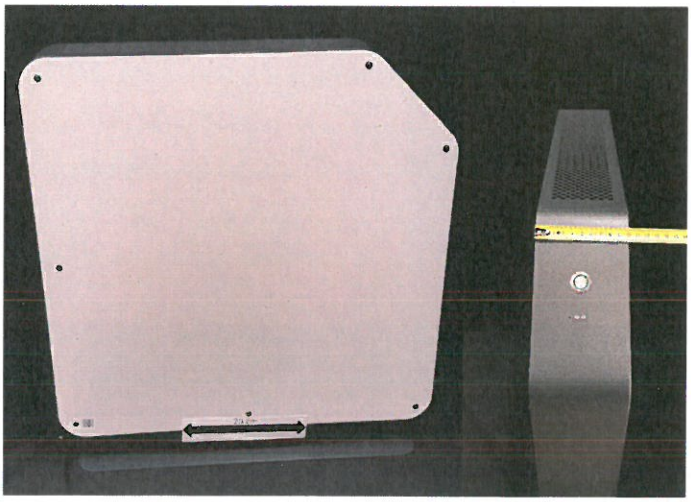

Figure 1: Object of measurement. To clarify the dimensions, a 20 cm scale was attached

Karlsruhe Institute of Technology

2 Measurement methods

2.1 Photobiological safety according to DIN EN 62471

For measurement according to DIN EN 62471, different wavelength ranges must be measured.
The following ranges must be checked for limit values:

Risk	Wavelength [nm]	Hazard for	Measured value
Actinic UV	200 - 400	Skin and eyes	Irradiance E_S
UV-A	315 - 400	Eyes	Irradiance E_{UVA}
Blue light hazard (small source)	300 - 700	Eyes	Irradiance E_B
IR	780 - 3000	Eyes	Irradiance E_{IR}
Thermal	380 - 3000	Skin	Irradiance E_H
Blue light hazard	300 - 700	Retina	Radiance L_B
Thermal	380 - 1400	Retina	Radiance L_R
Thermal [1]	380 - 1400	Retina	Radiance L_{IR}

Table 1 Sources of Hazards p.21 DIN EN 62471

The measured values are compared with the limit values given in the standard and divided into the appropriate groups:

- Free group
- Risk group 1 (low risk)
- Risk group 2 (medium risk)
- Risk group 3 (significant risk)

The limit values are listed in Table 2:

Risk	Free Group	Risk Group 1	Risk Group 2	Unit
Actinic UV E_S	0.001	0.003	0.03	W/m²
UV-A E_{UVA}	10	33	100	W/m²
Blue light hazard L_B	100	10,000	4,000,000	W/m²sr
Blue light hazard E_B [2]	1.0	1.0	400	W/m²
Retina L_R [3]	28,000/α	28,000/α	71,000/α	W/m²sr
Retina L_{IR} [3]	6,000/α	6,000/α	6,000/α	W/m²sr
IR E_{IR}	100	570	3,200	W/m²

Table 2 Limit values p. 25 DIN EN 62471

3. DIN EN 62471

3.1.1 Measurement setup

The measuring equipment used is listed in Table 3.

Type	Manufacturer	Model
Spectrometer with coupling optics	Instrument Sytstems	Spektro 140D with EOP-146 [4]
IR-Detector	THORLABS	PDA10CF
Long-pass filter	SCHOTT	RG780
Power meter (Electrical power)	Zimmer Elektronic Systems	LMG95

Table 3 Measuring equipments used

[1] Weak visual stimulus
[2] "A small source is defined as a source with an angular extent of α<0.011 rad. The field of view for averaging during measurement is 0.1 rad at 10,000s." *p.25, DIN EN 62471* (Not applicable here, for this reason only L_B is evaluated)
[3] To determine the angular expansion, the diameter of the radiation exit surface of the vents was approximated as a circle with diameter d=72 mm. This results in α=0.1 sr
[4] Absolutely calibrated to irradiance with calibrated reference radiator.

Karlsruhe Institute of Technology

An Instrument Systems CAS140D array spectrometer is used for the measurement. The spectrometer covers a wavelength range from 200 to 800 nm. An EOP-146 probe with diffuser is used as the measuring head. The spectrometer is absolutely calibrated to irradiance. The wavelengths between 800-1800 nm were detected by means of an IR detector and a long-pass filter (cut off λ=780 nm) (DIN EN 62471 section B.1.2 broadband detectors). The measurement setup was carried out in an air-conditioned laboratory at 25°C. The measurement axis was defined by an optical rail. Stray light was avoided by setting up the measuring system in a measuring chamber lined with non-reflective fleece. For stabilisation, the light source was operated for one hour before the measurement. Since the DIN EN 62471 standard requires the point of highest irradiance to be evaluated, the ventilation slots were scanned. Here, the highest irradiance was detected at the air inlet. The position of the highest irradiance was in the middle. To clarify the position, the air inlet was photographed in Figure 2 and the location marked in white. When mounted on the stand, this position is additionally covered by the stand at a distance of 45 mm. The present measurement refers to the possibility of ceiling mounting, whereby the values for stand mounting are consequently lower. According to DIN EN 62471 section 6 "Classification of lamps", the measured values has be measured at a distance of 200 mm from the light emission to the detector if the given object is not used for general lighting. Therefore, the detector was placed at a distance of 200 mm from the point of greatest irradiance, taking into account the angle of radiation.

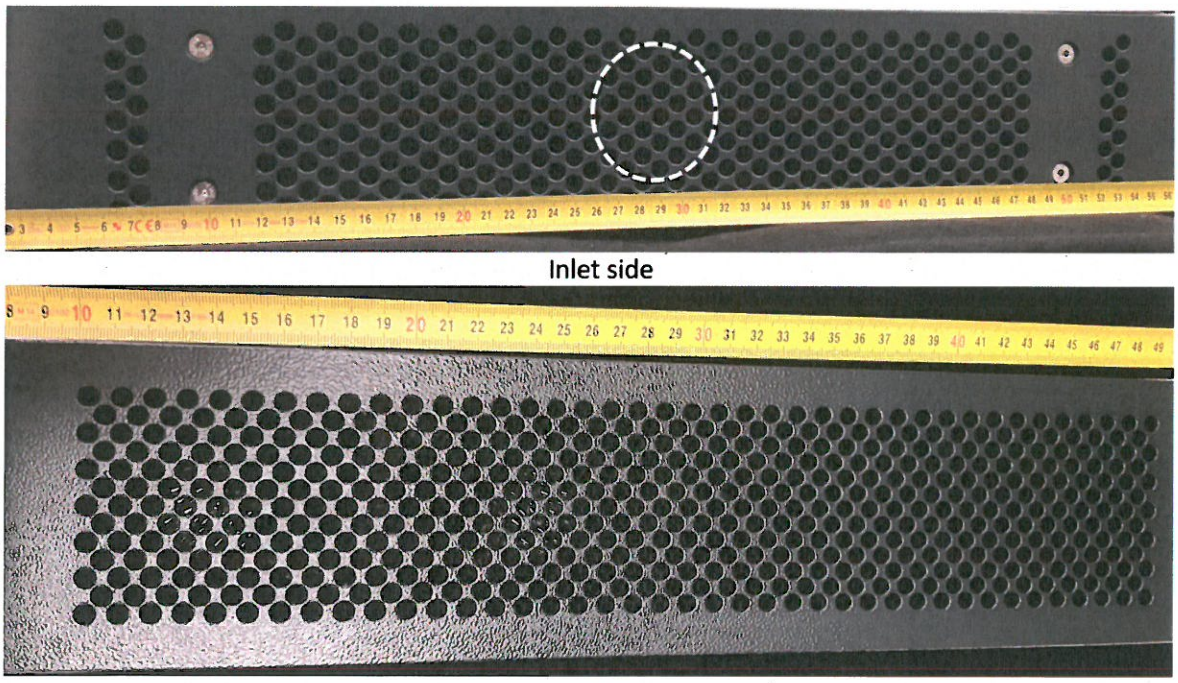

Figure 2: Ventilation slots. The point of highest irradiance is marked by the white circle

3.1.2 Measurement results

In Figure 3, the irradiance of the measured object is plotted against the wavelength.This spectrum is weighted according to the specifications with the various weighting functions SUV, B and R (see appendix). The weighted spectrum is integrated and compared with the limit values given in the standard. The same is done with the radiance. The radiance was determined according to DIN EN 62471 section 5.2.2.2.

When measuring the wavelength range of 780-1800 nm, only noise could be detected by using a broadband detector. For this reason, the radiant powers in this range were described as 0 W/m² and are not shown in the spectral measurement curves.

Karlsruhe Institute of Technology

The total irradiance and radiance values are listed in Table 4 and divided into risk groups.

Risk	Weighting function	Symbol	Measured value	Unit	Classification
Actinic UV	S_{UV}	E_{UV}	2.80E-04	W/m²	Free Group
UV-A		E	8.74E-06	W/m²	Free Group
Blue light hazard	B	L_B	2.80E-03	W/m²sr	Free Group
Retina L_R	R	L_R	3.14E-02	W/m²sr	Free Group
Retina L_{IR}[5]	R	L_{IR}	1.38E-04	W/m²sr	Free Group
Thermal IR E_{IR}		E_{IR}	0	W/m²	Free Group

Table 4 Emissions evaluation of the measured object

Based on the measurement results, the test object (SteriAir WHITE) can be placed in the free group in both installation cases. This means with regard to the light source:

These lamps do not pose a photobiological hazard, not even in the case of continuous, long-term exposure at the reference distance - they are safe under all circumstances[6].

Since the limits are dose values, a maximum exposure duration at the reference distance of 29 hours 45 minutes and 43 seconds was determined (107,143 seconds).

Karlsruhe, 21.12.2020

Head of Department
Dr. Rainer Kling

Measuring Engineer
M. Eng. Tim Gehring

Remark: This report (10 pages) may only be passed on full and unchanged and is only valid with signature. Extracts or amendments require the approval of the issuing testing laboratory. Any modification of the measured system will invalidate this evaluation.

[5] Weak visual stimulus
[6] Photobiological safety of light-emitting diodes (LEDs), Federal Institute for Occupational Safety and Health. https://www.baua.de/DE/Angebote/Publikationen/Berichte/F2115.pdf?__blob=publicationFile&v=4 (Checked: 21.12.2020)

Karlsruhe Institute of Technology

Figure 3 to Figure 10 below show the measured and weighted curves whose integral was used to assess the risk group.

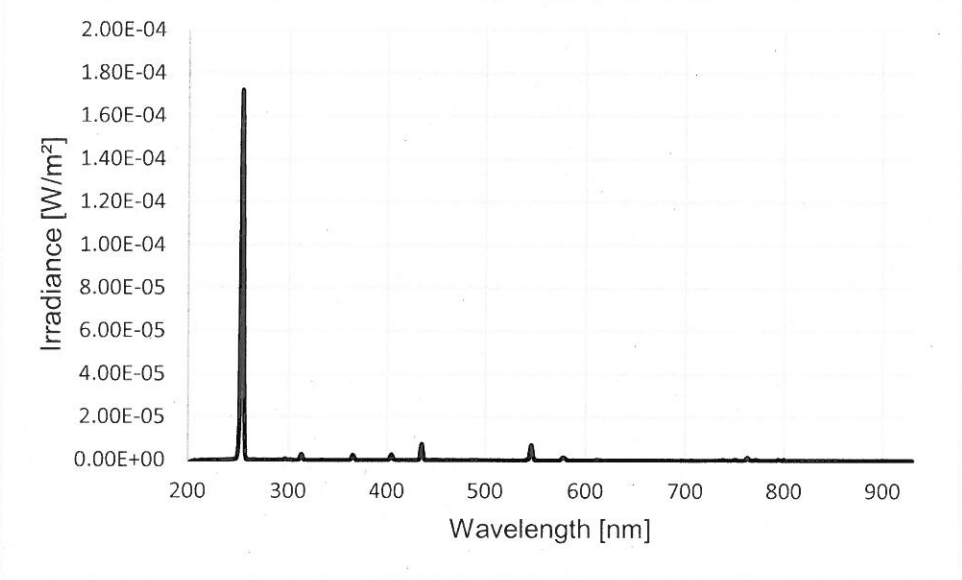

Figure 3: Irradiance

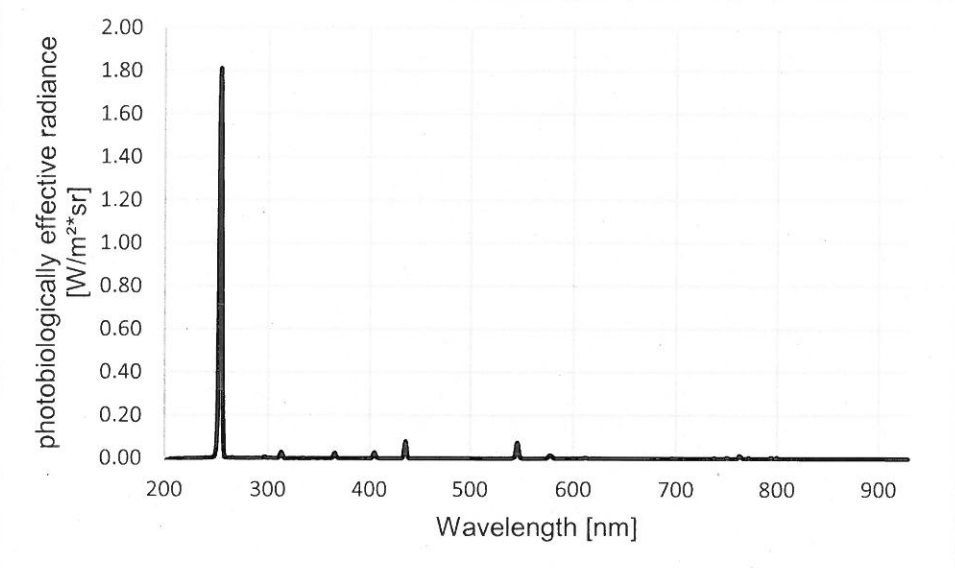

Figure 4: Photobiologically effective radiance (110 mrad average field of view)

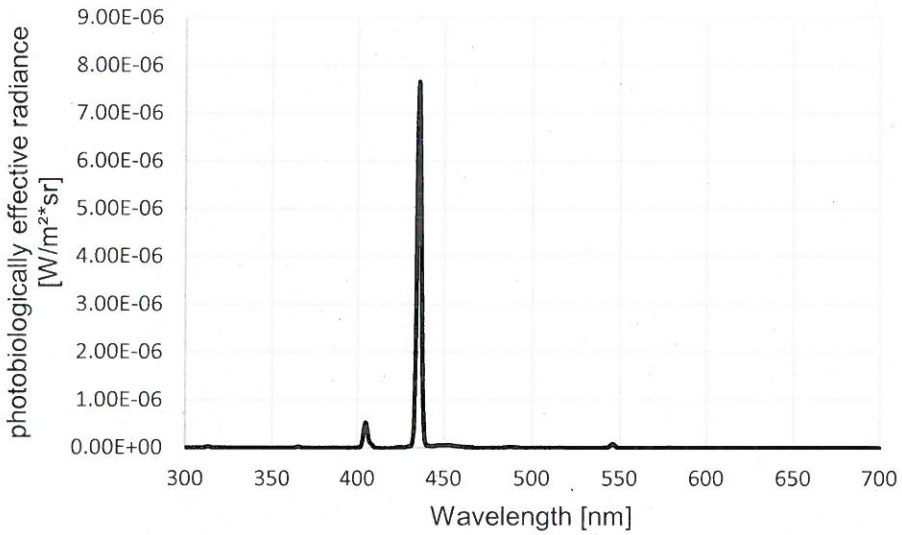

Figure 5: Radiance weighted according to B (blue light)

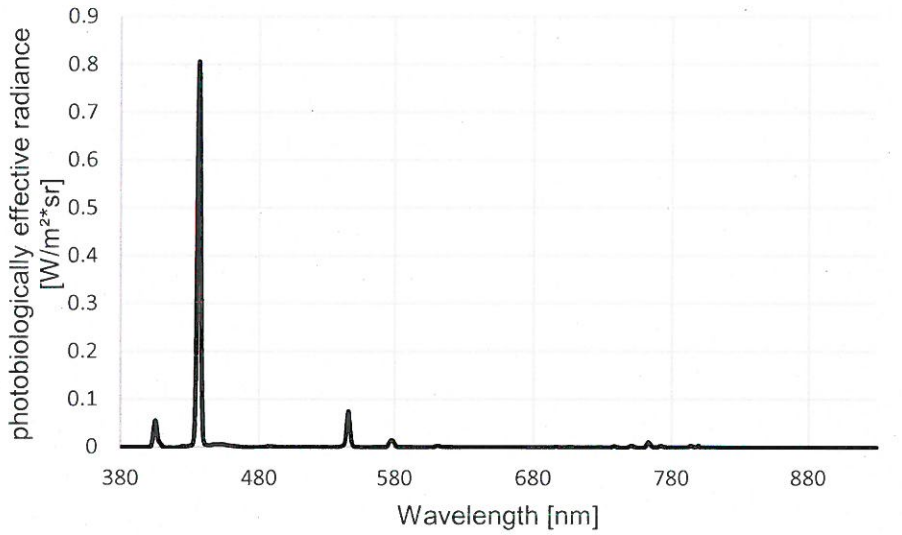

Figure 6: Radiance weighted according to R (retinal thermal damage)

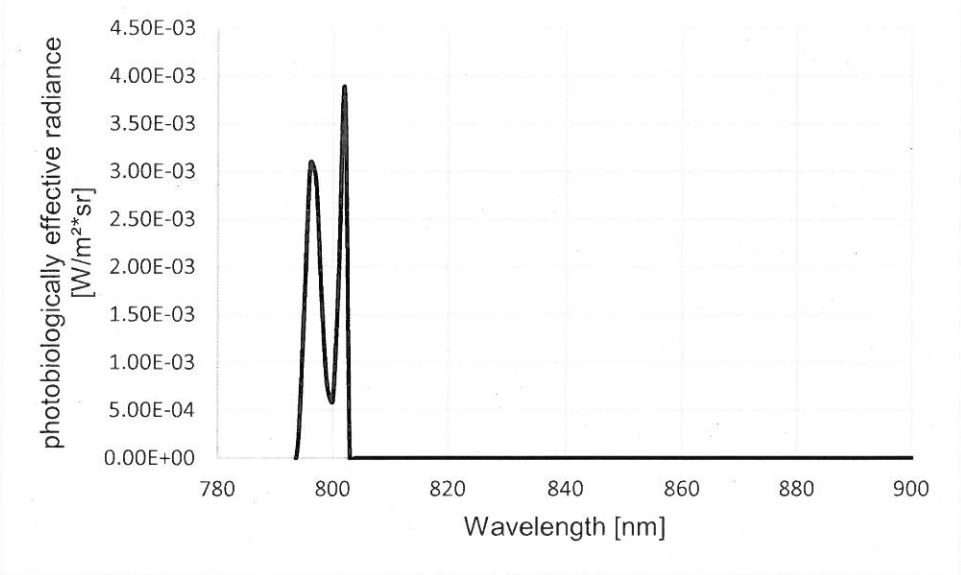

Figure 7: Radiance IR weighted according to R (weak visual stimulus) (noise)

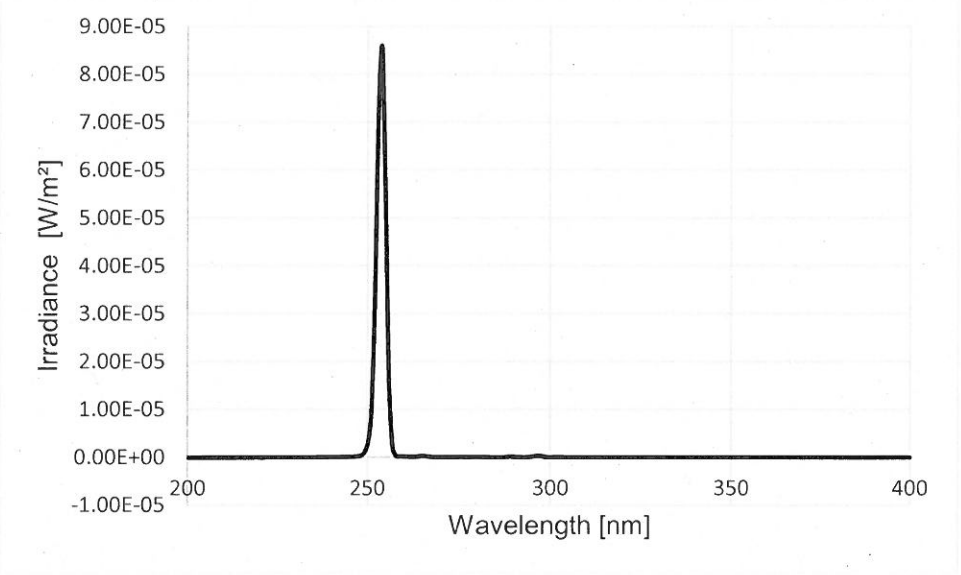

Figure 8: Irradiance weighted according to S_{UV}

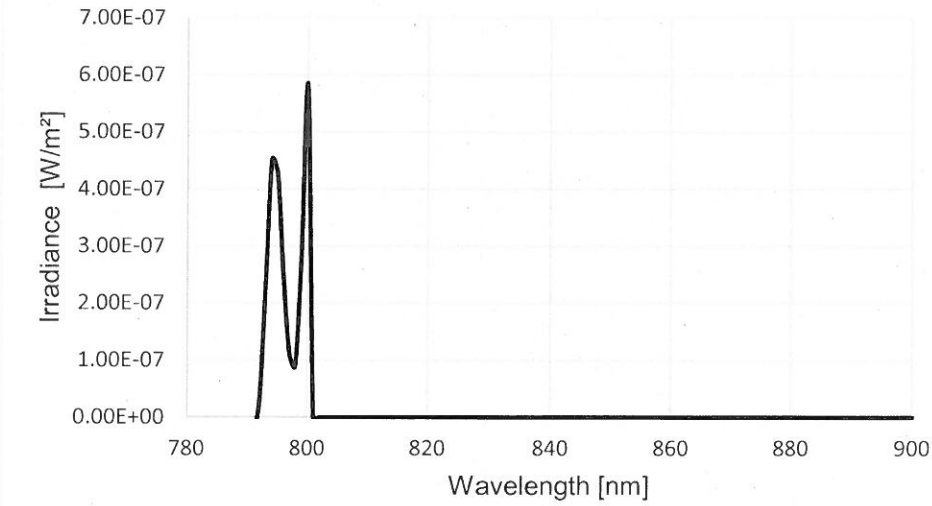

Figure 9: Irradiance IR (noise)

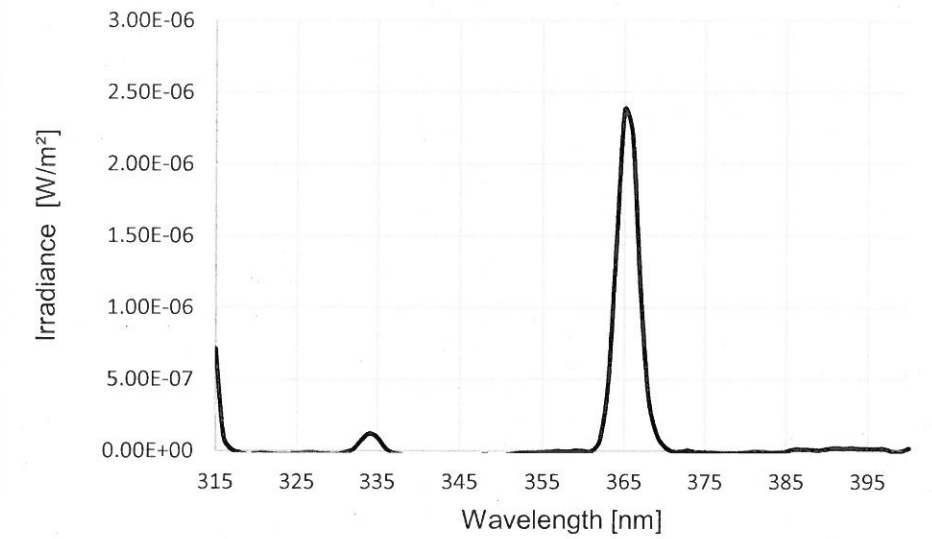

Figure 10: Irradiance near UV

Karlsruhe Institute of Technology

5. Appendix

Weighting functions

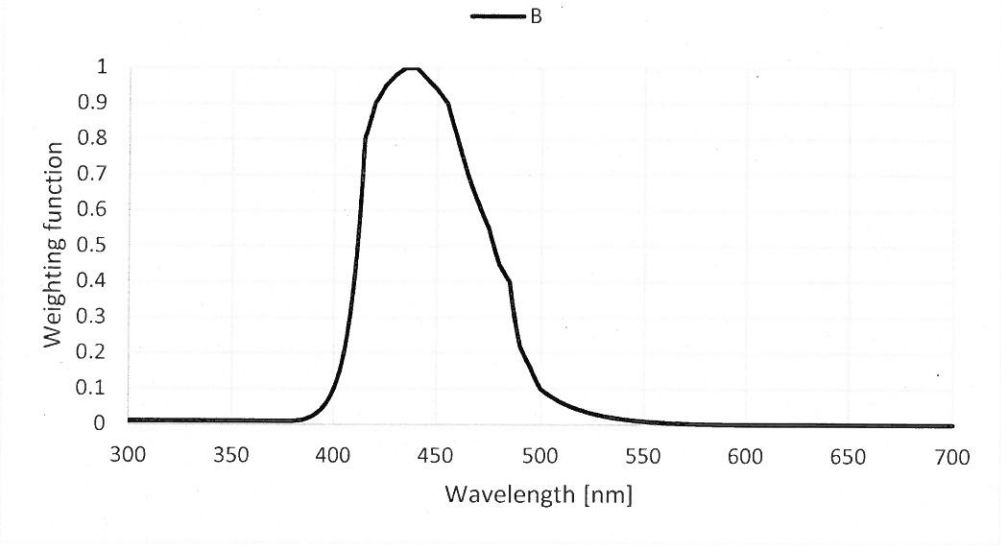

Figure 11: Weighting function B

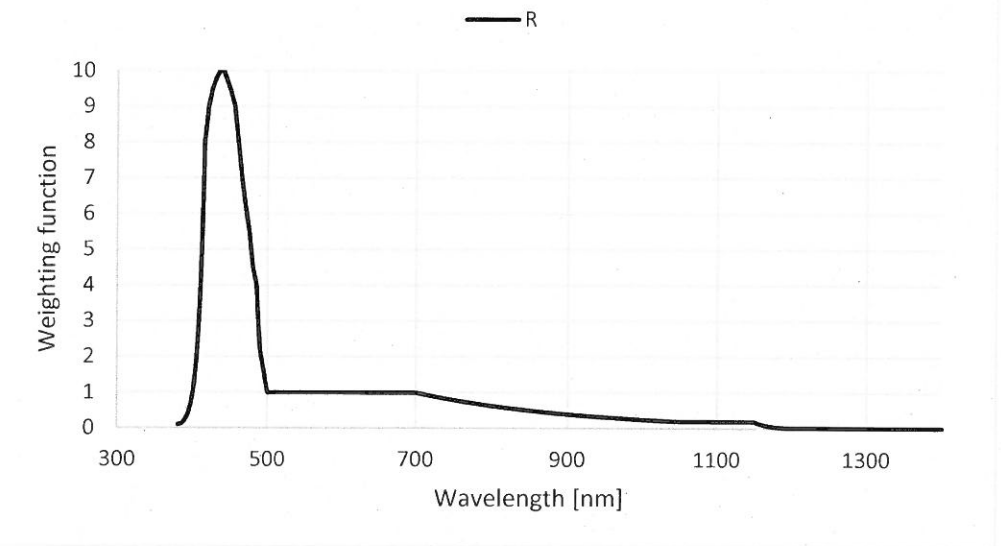

Figure 12: Weighting function R

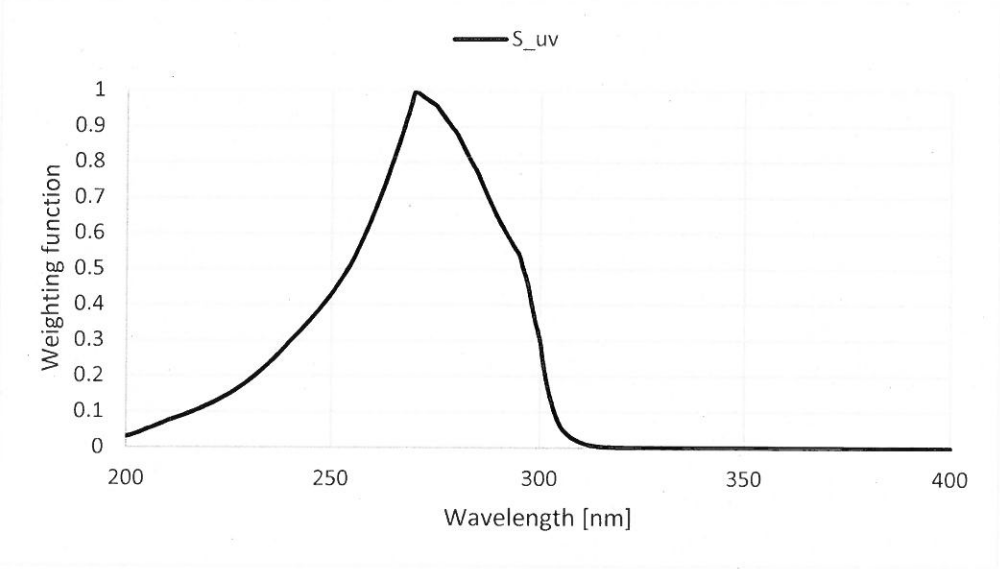

Figure 13: Weighting function S_{UV}