ECO DETECT ЕКО ДЕТЕКТ ДООЕЛ Скопје
Друштво за мерење, анализа, инженеринг и услуги

ECODETECT DOOEL Skopje
st. Varshavska 9 - 4 / 11 Skopje Macedonia
info@ekodetekt.com
www.ekodetekt.com
mob.070 239 979

Report no.

TO:

UVC MAKS DOOEL Skopje

REPORT OF THE TESTING

of performed measurements of optical radiation intensity induced by UVC apparatus - Germinator 1

Release Date:

26.05.2020 год.

Place:
Skopje

1. Terms used in the report

1. **"optical radiation"** is any electromagnetic radiation in the wavelength range between 100 nm and 1 mm, as follows:

- "ultraviolet radiation" is optical radiation of wavelength range between 100 nm and 400 nm. The ultraviolet region is divided into UVA (315-400 nm), UVB (280-315 nm) and UVC (100-280 nm);

- "visible radiation" is optical radiation of wavelength range between 380 nm and 780 nm;

- "infrared radiation" is optical radiation of wavelength range between 780 nm and 1 mm. The infrared region is divided into IRA (780-1 400 nm), IRB (1 400-3 000 nm) and IRC (3 000 nm-1 mm);

2. "non-coherent radiation" is any optical radiation other than laser radiation;

3. "irradiance (E)" or "power density" is the radiant power incident per unit area upon a surface expressed in watts per square meter (W m-2)

4. "level" is the combination of irradiance, radiant exposure and radiance to which a worker is exposed. Article 3 (1) The limit values of exposure for incoherent radiation, different from that emitted by natural sources of optical radiation.

5. "radiant exposure (H)" is the time integral of the irradiance, expressed in joules per square meter (J · m-2) or (Ws/m2);

6. "exposure limit values" is limits on exposure to optical radiation which are based directly on established health effects and biological considerations.

2. General data

Period in which the tests were performed: 15.05.2020, from 10 am to 2 pm.

Source data:

Germinator 1 - A device for disinfecting surfaces using UV radiation in the C electromagnetic spectrum (UVC).
- 8 UV lamps with a power of 36W
- UVC - the wavelength is 254 nm
- disinfection area is 0.172 square meters

Data on measuring equipment:
DeltaOHMHD 2402- Uncontrolled optical radiation meter according to the following frequency measuring areas:

- Sensor for measuring visible light (lux meter) in the spectral range of 380 –
- Sensor for measuring the total UV radiation in the spectral range of 180 - 400 nm with calculated spectral weight factor S (λ),
- Sensor for measuring only UVA radiation in the spectral range of 315 - 400 nm,
- Measurement of blue light in the spectral range of 300 - 700 nm with calculated spectral weight factor B (λ),
- Measurement of infrared radiation in the spectral range of 700 - 1300nm with calculated spectral weight factor R (λ),
- Measurement of infrared radiation in the spectral range of 380 - 3000 nm
    - Certificates of calibration issued by accredited laboratory no. LAT 124 - 16003702 and LAT 124 - 16003703

Temperature and humidity meter:
- Digital thermometer and hygrometer Fisher, model THPen 8709;
- Measurement area: 0% - 99% humidity; -16˚C to + 50˚C temperature;
- Calibration certificate no. N110082.

Distance Measure:
- Laser angle gauge and Leica distance, DistoD5 model;
- Measurement area: -45° to + 45°; 0 m - 200 m;
- Calibration certificate no. 310110729

Reference values, norms and restrictions used:

- ***R u l e b o o k for minimum safety requirements for health care of employees at risk related to exposure to physical agents (artificial optical radiation) - adopted on the basis of the directive cited below***
- ***Directive 2006/25 / EC of the European Parliament and of the Council of 5 April 2006 on the minimum requirements for health and safety in relation to the exposure of workers to the risks arising from physical agents (artificial optical radiation);***

The table below shows the permissible restrictions on all spectral areas for incoherent artificial optical radiation according to the first cited rulebook. Each measured value, depending on the type of radiation, i.e. its and the frequency range, should be compared with the limits given in this table.

Table 1. - Excerpt from the Rulebook on the minimum requirements for safety and health at work of employees from risks related to exposure to physical agents (artificial optical radiation).

Index	Wavelength (nm)	Exposure limit value	Units	Comment	Part of the body	Hazard
a.	180-400 (UVA, UVB and UVC)	$H_{eff} = 30$ Daily value 8 hours	$[J \cdot m^{-2}]$		eye cornea conjunctiva lens skin	photokeratitis conjunctivitis cataractogenesis erythema elastosis skin cancer
b.	315-400 (UVA)	$H_{UVA} = 10^4$ Daily value 8 hours	$[J \cdot m^{-2}]$		eye lens	cataractogenesis
c.	300-700 (Blue light) see note 1	$L_B = \frac{106}{\cup}$ for $t \leq 10\,000$ s	L_B: $[W \cdot m^{-2} \cdot sr^{-1}]$ t: [seconds]	for $\alpha \geq 11$ mrad	eye retina	photoretinitis
d.	300-700 (Blue light) see note 1	$L_B = 100$ for $t > 10\,000$ s	$[W \cdot m^{-2} \cdot sr^{-1}]$			
e.	300-700 (Blue light) see note 1	$E_B = \frac{100}{t}$ for $t \leq 10\,000$ s	E_B: $[W \cdot m^{-2}]$ t: [seconds]	for $\alpha < 11$ mrad see note 2		
f.	300-700 (Blue light) see note 1	$E_B = 0{,}01$ $t > 10\,000$ s	$[W \cdot m^{-2}]$			
g.	380-1 400 (Visible and IRA)	$L_R = \frac{2{,}8 \cdot 10^7}{C\alpha}$ for $t > 10$ s	$[W \cdot m^{-2} \cdot sr^{-1}]$	$C\alpha = 1{,}7$ for $\alpha \leq 1{,}7$ mrad $C\alpha = \alpha$ for $1{,}7 \leq \alpha \leq 100$ mrad	eye retina	retinal burn

h.	380-1 400 (Visible and IRA)	$L_R = \frac{5 \cdot 10^7}{C_\alpha t^{0,25}}$ for 10 μs ≤ t ≤ 10 s	L_R: [W · m^{-2} · sr^{-1}] t: [seconds]	Cα = 100 for α > 100 mrad λ1= 380; λ2= 1 400		
i.	380-1 400 (Visible and IRA)	$L_R = \frac{8,89 \cdot 10^8}{C\alpha}$ for t <10 μs	[W · m^{-2} · sr^{-1}]			
j.	780-1 400 (IRA)	$L_R = \frac{6 \cdot 10^6}{C\alpha}$ for t > 10 s	[W · m^{-2} · sr^{-1}]	Cα = 11 for α ≤ 11 mrad Cα = α for 11≤ α ≤ 100 mrad Cα = 100 for α > 100 mrad (measurement of visual field: 11 mrad) λ1= 780; λ2= 1 400	eye retina	retinal burn
k.	780-1 400 (IRA)	$L_R = \frac{5 \cdot 10^7}{C_\alpha t^{0,25}}$ for 10 μs ≤ t ≤ 10 s	L_R: [W · m^{-2} · sr^{-1}] t: [seconds]			
l.	780-1 400 (IRA)	$L_R = \frac{8,89 \cdot 10^8}{C_\alpha}$ for t < 10 μs	[W · m^{-2} · sr^{-1}]			
m.	780-3 000 (IRA and IRB)	$E_{IR} = 18\,000\ t^{-0,75}$ for t ≤ 1 000 s	E: [W · m^{-2}] t: [seconds]		eye cornea lens	corneal burn cataractogenesis
n.	780-3 000 (IRA and IRB)	$E_{IR} = 100$ for t > 1 000 s	[W · m^{-2}]			
o.	380-3 000 (Visible, IRA and IRB)	$H_{skin} = 20\,000\ t^{0,25}$ for t < 10 s	H: [J · m^{-2}] t: [seconds]		skin	burn

Standards and guidelines for testing:

- MKS EN ISO IEC 17025
  Standard for general requirements for the competence of testing and calibration laboratories,
  Standard for general requirements for the competence of testing and calibration laboratories.

- EN 14255-1: 2005
  Measurement and assessment of personal exposures to incoherent optical radiation
  Part 1: Ultraviolet radiation emitted by artificial sources in the workplace.
  Measurement and assessment of personal exposures to incoherent optical radiation Part 1: Ultraviolet radiation emitted by artificial sources in the workplace.

- MKC EN 50496
  Determination of workers' exposure to electromagnetic fields and assessment of risk at a broadcast site (part zoning).
  Determination of workers' exposure to electromagnetic fields and risk assessment at a broadcast site (part zoning)

- Factory instructions for operation and measurement with the instrument for measuring incoherent optical radiation **Delta OHM HD 2402**

3. Description of the measurements and the obtained results

The UVC-induced optical radiation testing of the Germinator 1 device was performed in accordance with the international standard *EN 14255-1: 2005*, and it was performed in controlled laboratory conditions.

Measurements were made at 8 different measuring points around the device and for each measuring point simultaneous measurements were performed with 6 different sensors that detect intensities in 6 special spectral areas for all optical radiation produced by this device.

From the 6 sensors with their combination, again according to the requirements of this standard, 7 different values are obtained individually for each measuring point, as follows:

1. Visible light (expressed in lux) in the spectral range of 380 - 780 nm,
2. Index **a**, UVA, UVB and UVC radiation in the spectral range of 180 - 400 nm
3. Index **b**, UVA radiation in the spectral range of 315 - 400 nm,
4. Indices **c, d, e** and **f** Blue light in the spectral range of 300 - 700 nm,
5. Indices **g, h** and **i** Visible and IRA, in the spectral range of 380 - 1400 nm,
6. Index **j, k** and **l** IRA in the spectral range of 780 - 1400 nm,
7. Indices **m, n** and **o** IRA and IRB in the spectral range of 300 - 700 nm,

Accordingly, the results obtained in Tables 2 (a, b) are shown in 7 different columns.

According to the international standard MKS EN 50496, when testing the radiation of this device, all possible working positions are taken into consideration, to which the person who will operate with this device would be exposed.

The explanation of the results of the measurements is given in detail in point 5 of this rulebook.

4. Display of measured value

Table 2a. - Measured radiation intensities

Ord. no.	Description of the measurement point	Lux / Lum T. of light [Lux]	a. 180-400 UV A,B,C E measur. [W/m²] N allowed 30 [J/m²]	b. 315-400 UVA E measur. [W/m²] N allowed 10 000 [J/m²]	c.d.e.f. 315-700 Blue light E measur. [W/m²] N allowed 100/t [W/m²]	g.h.i. 380-1400 Vis.+IRA E measur. [W/m²] N allowed [J/m²]	j.k.l. 780-1400 IRA E measur. [W/m²] N allowed [J/m²]	m.n.o. 380-3000 IRA E measur. [W/m²] N allowed [J/m²]
	Measurements with mattress							
1.	Measurement of passing radiation through a mattress with a thickness of 13cm, peak of measurement with the UV device switched on for 1 minute,	1,3	0	0	0,0031	0,0974	0,083	0
2.	A case where the appliance is placed on the mattress and the radiation is measured laterally on the shorter side between the mattress and the appliance at a distance of 16 cm from the joint, measuring time with the UV device on for 1 minute,	6,3	0,00002	0	0,0401	0,6586	0,322	0
3.	Case when the appliance is placed on the mattress and the radiation is measured laterally from the shorter side between the mattress and the appliance at a distance of 30 cm from the joint, the measurement time with the UV device on for 1min.	2,1	0	0	0,0171	0,3358	0,306	0
4.	A case where the appliance is placed on the mattress and the radiation is measured laterally from the longer side between the mattress and the appliance at a distance of 13 cm from the joint, measurement time with the UV device on for 1 minute.	2,3	0	0	0,0176	0,336	0,300	0

Table 2b. - Measured radiation intensities

Ord. no.	Description of the measurement point	Lux / Lum T. of light [Lux]	a. 180-400 UV A,B,C E measur. [W/m²] N allowed 30 [J/m²]	b. 315-400 UVA E measur. [W/m²] N allowed 10 000 [J/m²]	c.d.e.f. 315-700 Blue light E measur. [W/m²] N allowed 100/t [W/m²]	g.h.i. 380-1400 Vis.+IRA E measur. [W/m²] N allowed [J/m²]	j.k.l. 780-1400 IRA E measur. [W/m²] N allowed [J/m²]	m.n.o. 380-3000 IRA E measur. [W/m²] N allowed [J/m²]
	Measurement in a direct beam of radiation at certain distances from the source							
5.	Measurement in a direct beam of radiation at distances of 2.07 m from the device, measurement time with the UV device on for 1 minute,	220	2,87	0,186	0,4179	4,998	1,047	0

6.	Measurement in a direct beam of radiation at distances of 1 m from the device, measurement time with the UV device on for 1 minute,	714	9,15	0,578	1,08	11,65	1,134	0

5. Opinion

The measured results are divided into two tables: Table 2a - Measurements with a mattress and Table 2b - Measurement in a direct beam of radiation at certain distances from the source.

From the measured **values given in Table 2a**, it can be concluded that in case the instrument fits well on the mattress (there is no need for additional pressure on the UVC device) there is no output radiation outside the mattress-device in any part of the optical spectrum. Radiation is not detected in any part of the spectrum or on the back of the device.

The measured radiation **values given in Table 2b** are made in a direct beam in the middle axis of the radiation field at a distance of 1m and 2m. We will compare the measured intensities given in this table with the allowed limitations given in Table 1:

1. From the comparison it can be concluded that the measured values for the optical spectra given in columns 1, 3, 4, 5, 6 and 7 are within the allowed limits and do not pose a threat to the health of the operator of this device at any distance.
2. From column 2 in this table (the values shown in red) it can be concluded that if the operator stays in the direct beam of radiation from this device at a distance of 1 m according to the limitations of the UVC spectrum must not be exposed (face, hands , leather) more than 3.3s, and at a distance of 2m from the source must not be exposed more than 10.5s within 24 hours.

Recommendations:

According to the international standard MKS EN 50496 the employer, the operators of this device should inform (with group or individual acquaintance) about the obtained values shown above and for the same employees to provide appropriate protective equipment. The device has an automatic radiation switch off that is activated when the device separates from the radiating surface. Whit this switch, the operator working with this device is additionally protected.

Warning:

- The attached results refer exclusively to the tested source.
- Test results only apply to the level of wear of UV lamps during measurements.

MP

The tests were performed by:
Masters Degree in Medical Physics
Branko Stepanovski

Дека преводот на овој документ кој го направив од македонски јазик на англиски јазик е верен на оригиналот што ми беше доставен, потврдувам со свој потпис и печат на Овлстен судски преведувач
(**Ангелина Костова**, со Решение број 08 – 1299 / 2 од 13.04.2017 г.)

Во Скопје 08.06.2020

АНГЕЛИНА КОСТОВА
ОВЛАСТЕН СУДСКИ ПРЕВЕДУВАЧ
Од Англиски јазик на Македонски
и обратно при Основен суд Скопје 1 – Скопје и
Основен суд Скопје 2 – Скопје

In witness that the translation of the above document, which I made, and which was originally submitted to me into Macedonian, is true, I do affix my seal and signature of Authorized Court Translator.

(**Angelina Kostova**, with Decision no.08-1299/2 from 13.04.2017)

In Skopje, 08.06.2020

ANGELINA KOSTOVA
AUTHORIZED COURT TRANSLATOR
of English and Macedonian and vice versa
at the Basic Court Skopje 1 - Skopje and
Basic Court Skopje 2 - Skopje