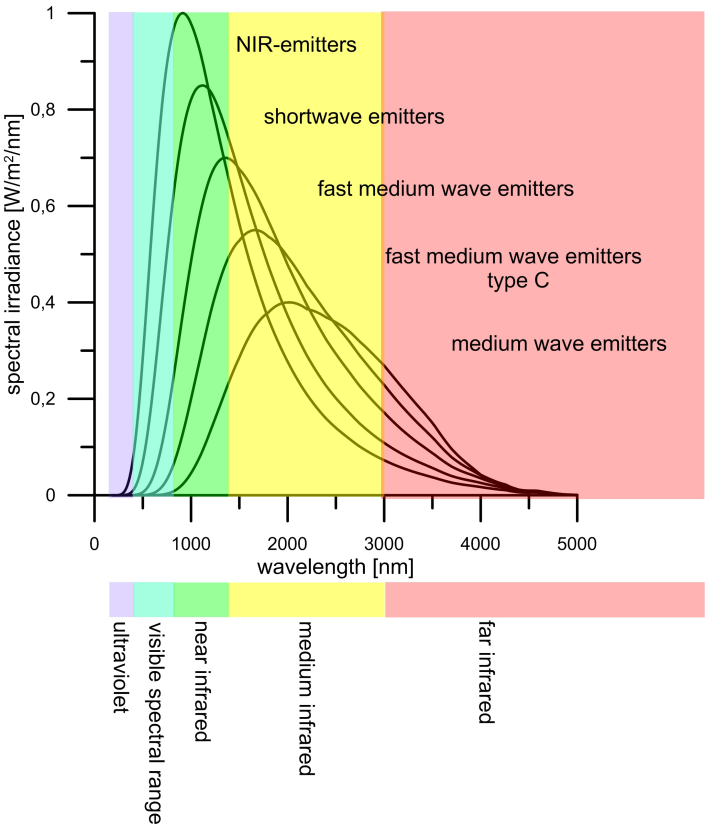
Radiation protection

Infrared emitters are thermal emitters that emit a broad spectrum of intense electromagnetic radiation, like the sun. Depending on the emitter type, the spectra in question range from ultraviolet to far infrared, and they include visible light. By far the greatest proportion of energy lies in the infrared spectrum.

The spectra of our emitters are shown in the illustration on the right. Our ceramic IR-emitters, e.g. the KS1000, have an even longer-wave spectrum (not shown) than the medium wave emitters.



Depending on the spectrum, radiation affects various parts of the eye (retina, cornea etc.) and the skin. Depending on the type of emitter, radiation output and conditions of use (distance, exposure times, radiation direction, etc.), appropriate protective measures must be taken.

The following table shows the proportions of spectral output that are typical of our emitters.

spectral region / emitter type	ultraviolet 200 – 400 nm as percentage	visible light 400 - 780 nm as percentage	infrared > 780 nm as percentage
sun (sea level)	6,1	52,0	41,9
NIR-emitters	0,27	16,5	83,3
shortwave emitters	0,03	7,3	92,7
fast medium wave emitters	$7{,}5*10^{-4}$	1,8	98,2
fast medium wave type C emitters	$1{,}2*10^{-5}$	0,4	99,6
medium wave emitters	$4{,}9*10^{-8}$	0,04	99,96

Therefore, compared with the sun, the UV proportion of our IR emitters is significantly lower, but it is still has to be taken into account, particularly for NIR emitters, and even for short-wave emitters under certain circumstances.

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Protective measures:

In principle, the appropriate protective measures are listed below – the evaluation of the type of emitter and the conditions of use must also be taken into consideration:

1. Use suitable protective goggles (included in our product range) to protect your eyes.
2. Wear suitable clothing and gloves to protect your skin.
3. Put a protective screen (radiation blocker) in place and ensure that the radiation source is in a safe position.
4. Use tinted emitter tubes to reduce glare (included in our product range).
5. Increase the viewing distance.
6. Reduce exposure times.
7. Adhere to break times.
8. Put appropriate hazard warning signs in place.
9. Instruct users about the optical hazards presented by radiation, and advise them to take appropriate protective measures.

Statutory provisions:

The employer is responsible for ensuring compliance with the statutory provisions on employee protection in the workplace. Here is an overview of the most important optical radiation provisions:

1. DIN EN 62471:2008 (IEC 62471:2006, modified), Photobiological safety of lamps and lamp systems.
2. DIN 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; German version.
3. DIN EN 14255-2:2005, Measurement and assessment of personal exposures to incoherent optical radiation – Part 2: Visible and infrared radiation emitted by artificial sources in the workplace.
4. BGI 5006, Maximum permissible exposure limits for artificial optical radiation, October 2004 (German: ‘Expositionsgrenzwerte für künstliche optische Strahlung’).
5. Directive 2007/30/EG of the European Parliament and Council (June 2007).
6. A non-binding guide to Directive 2006/25/EC.
7. OstrV, Regulation on the protection of employees against the hazards of artificial optical radiation, July 2010 (German: ‘Verordnung zum Schutz der Beschäftigten durch künstliche optische Strahlung (Arbeitsschutzverordnung zu künstlicher optischer Strahlung - OStrV)’).

These documents are relatively extensive, detailed and complicated. Only a trained expert with a physics background can calculate the correct exposure limits for specific emitters, take the necessary measures and perform an appropriate risk assessment. We can provide on-site assistance to enable you to optimise your protective measures.

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Classification of hazard types:

In principle, the various types of hazard are distinguished as described below. The entire spectrum from 180 – 3000 nm is significant for the skin and the front of the eye (cornea, conjunctiva and eye lens). Most UV radiation and all medium and far infrared are absorbed by the front of the eye, and only the wave spectrum of 300 – 1400 nm reaches the retina. The relevant hazard types depend on the type of emitter.

a) **Actinic UV:** Radiation in the spectrum between 180 and 400 nm (ultraviolet) may cause damage if eyes or skin are exposed to it. This hazard type is particularly significant at wavelengths in the region of 280 nm.

b) **UV-A:** The spectrum between 315 – 400 nm is especially critical for the eye lens (it causes cataracts).

c) **Blue light hazard:** This is particularly dangerous for the retina. This hazard arises in most of the visible light spectrum and part of the UV radiation spectrum (between 300 and 700 nm). The blue light spectrum (400 – 490 nm) may be especially harmful (it causes photochemical damage). In many cases, the natural response to glare (blink reflex) already provides adequate protection against this hazard.

d) **Infrared damage to the eye:** The spectrum between 780 and 3000 nm may cause thermal damage to the cornea.

e) **Thermal damage to the retina:** According to visibility, a distinction is drawn between strong (380 to 1400 nm) and weak (780 to 1400 nm) visual stimuli. One of the key factors in this evaluation is the apparent size (angle of vision) of the radiation source. Under certain circumstances, the retina is damaged. Apart from lasers, there are practically no known workplace sources that can cause thermal damage to the retina.

f) **Thermal damage to the skin:** The spectrum between 380 and 3000 nm may cause skin burns. Because of the intense pain caused and the resulting defensive reflex reactions, the maximum permitted levels are practically never reached.

Risk groups according to DIN EN 62471:

Risks are divided into groups to give an indication of the potential hazards. Depending on exposure duration and other factors of use, these potential hazards may become real hazards. In order to allocate hazards to risk groups, it is necessary to compare the levels measured with the maximum permissible levels.

Risk group 0 (risk-free group):	This radiation source does not present any photobiological hazards.
Risk group 1 (low risk):	Based on normal restrictions resulting from user behaviour, this source does not present any hazards.
Risk group 2 (medium risk):	Provided that users turn away from the source in the event of glare or thermal discomfort, this source does not present any hazards.
Risk group 3 (high risk):	Even in the event of brief or momentary exposure, this radiation source is hazardous. Additional protective measures must be planned.

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Example of an evaluation of selected OPTRON emitters:

The maximum permissible limits of radiation exposure were calculated on the basis of known spectra and compared with the measured values for a distance of one metre perpendicular to the type of emitter under consideration. The emitters were operated at maximum output (without dimming). Similar studies can be carried out for other measuring distances and/or different positioning of emitters. All of the emitters that were considered have a clear glass tube; tinted tubes modify the radiation spectrum and reduce glare. The following table applies to cases in which the user is directly exposed and is looking directly at the emitter.

Table: hazard assessment for selected OPTRON emitters, distance: 1m

- : safe, +: limit may be exceeded, +/-: in the transitional area

Hazard types / emitter type	a)	b)	c)	d)	e)	f)	risk group
NIR[1)]	+	+	+	+	-	-	2
shortwave[2)]	+/-	-	+/-	+	-	-	0
fast medium wave[3)]	-	-	-	+	-	-	0
fast medium wave type C[4)]	-	-	-	+	-	-	0
medium wave[5)]	-	-	-	+	-	-	0

1) single tube 600.1164 within the module IRD X380N, 3 kW, filament length: 284 mm
2) single tube 600.1101 within the module IRD X380SM, 2 kW, filament length: 280 mm
3) single tube 600.1193 within the module IRD X380SM, 2 kW, filament length: 280 mm
4) module IRE 380ZSM-C with 2 x twin tube 1.5 kW 600.1197, filament length: 286 mm
5) module 600.7054 with 1 x twin tube 1.4 kW 600.7004, filament length: 729 mm

In the 'NIR' example, it is possible to avoid exceeding the limit by reducing cumulative daily exposure time to less than 10 minutes and single exposure time to less than 3 minutes, or by increasing the distance. Alternatively, and for ergonomic reasons (to reduce glare), we recommend our IRS1-5 protective goggles.

In the 'shortwave' example, risks a) to c) are significantly lower. In this case, the maximum permitted cumulative daily exposure time is at least 2 hours, and the maximum permitted single exposure time is 4 minutes. It is inconceivable that anyone would voluntarily tolerate such unpleasant exposure for such a long time. For protection and to reduce glare, we recommend our IRS1-4 protective goggles.

In the above-mentioned examples, wearing our protective goggles ensures that the maximum permitted levels for eye exposure are unattainably high.

Please note: our protective goggles do not provide total glare protection against our IR spotlight (high luminance!) if you look straight at the emitter! In this case, we recommend a protective screen.

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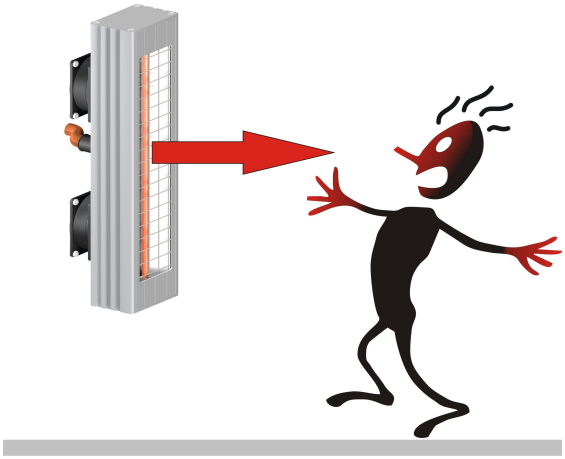
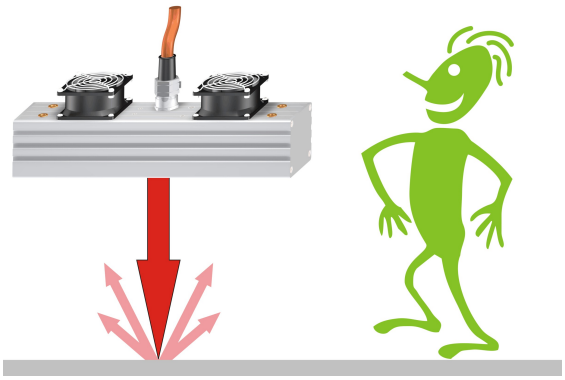
As a rule, users are not directly exposed to radiation. The radiation to be considered generally only takes effect after scattering or diffuse reflection off nearby surfaces, e.g. a plastic panel. This significantly reduces radiation levels, which means that, in many cases, the maximum permissible levels cannot be exceeded.





We accept no liability for this information! In order to make reliable statements, it is essential to perform an on-site evaluation!

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protective goggles

Typ IRS1-4 infrared-protective goggle

Protection:	protective class 4 (welding protection according to DIN EN 169) Protection against infrared radiation of the following emitter types of our delivering program: fast medium wave emitters fast medium wave type C emitters medium wave emitters ceramic IR-emitters reduction of visible light radiation onto 5 percent
carrying properties:	can be worn over the most presribed spectacles 4-stage side arm length pressure-free fit unrestricted field of view
material:	Polycarbonat
Artikel-Nr.:	Z 200100

Typ IRS1-5 infrared-protective goggle

Protection:	protective class 5 (welding protection according to DIN EN 169) UV-protection, protection against glare and infrared radiation of the following emitter types of our delivering program: NIR-emitters shortwave emitters reduction of visible light radiation onto 1.5 percent
carrying properties:	can be worn over the most presribed spectacles 4-stage side arm length pressure-free fit unrestricted field of view
material:	Polycarbonat
Artikel-Nr.:	Z 200101

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