

Hazards of Laser Light

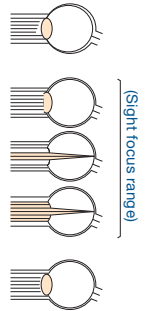
A laser is a special man-made light, with completely different characteristics from natural light. With directional characteristics, and monochromatic action, power is concentrated and reaches high density from the focusing effect of lenses. Under certain conditions a laser can be so strong that it will melt metal in an instant. No matter how well laser workers know these characteristics, if preventive measures are not taken, it is highly likely that disasters can occur with serious bodily harm and lasting effects.

Effects of Laser Light on the Human Body

JIS C6802, the safety standards for laser products, covers the wavelengths ranging from 180nm and 1m with the objective of protecting the human body.

As shown in Fig. 1, the position of harm to the eyes is different depending on the wavelength range of light.

Fig 1 Effect on the Human Body when Exposed to Excessive Laser Light

Overview of absorption in the eyeball	CIE wavelength range (nm)	Effect on, injury to the eyes		
	UV Ultraviolet rays	UV-C 200 UV-B 280 UV-A 315 400	Inflammation accompanied by pain in cornea, conjunctiva due to photochemical action, thermal effect Lenticular opacity (cataracts) due to thermal effect	
	Visible portion	780	Retinal impairment due to photochemical action of visible light	
	IR Infrared rays	IR-A	1400	Retinal injury due to photochemical action, thermal effect, shock wave
		IR-B	3000	Cornea burn, cataracts due to thermal effect
		IR-C	10 ⁶	

* CIE: Abbreviation for Commission Internationale de Eniuminure (International Commission on Illumination)

Laser Safety Guide

Injury to the Eyes

Ultraviolet Range (Below 400nm)

Most ultraviolet light is absorbed by the surface of the cornea, and a partially transmitted portion is absorbed by the crystalline lens of the eye.

If exposed to a high output UV laser, tissue is injured due to photochemical action, inflammation (burns) of the cornea will occur in the short term, while long term exposure might lead to cataracts due to light action.

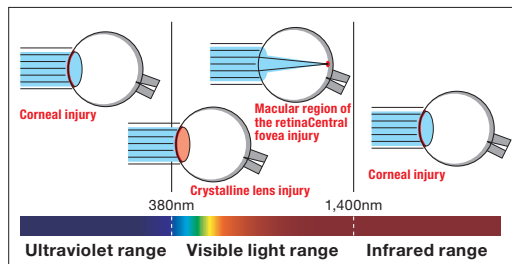
Visible Light Range (400 – 700nm)

Glare is felt immediately, and blinking is a protective response. However there is a temporal limit, it takes about 0.25 seconds for the protective response once the hazard is sensed, during which time the laser enters the eye. Here, the output that is regarded as virtually safe even though the laser enters the eye within this time is basically 1mW or less. At output above that, the retina (Fig. 2) will receive local injury due to thermal effects and focusing effect, even permanent impairment might result.

Near Infrared Range (700 – 1400nm)

The laser reaches the retina in the same way as the visible light range. A point of particular caution is that in the non-visible light range, injury is received without noticing it, so it is a very hazardous wavelength range for the eyes.

Fig 2 Effect on the Retina due to Thermal Effect and Focusing Effect



* The site of injury will vary according to the wavelength of the laser exposed to.

World Safety Standards

[International Organization]

IEC60825-1 [Safety of laser products]

[Japan] JIS C6802 [Safety standards of laser products]

What Is IEC60825-1 “?”

The IEC is the

[International Electrotechnical Commission]

As an organization for international standardization in the electrical and electronic fields, it has the following objectives to facilitate and promote international commerce.

* The promotion of the formulation and promulgation of international standards for the electrical and electronic engineering technical fields.

What Are Laser Safety Standards

IEC60825-1 was created as an international standard for laser equipments, and it is a common safety standard for IEC member nations.

On JIS C6802

The Japanese Industrial Standard based on IEC60825-1 As determined by IEC60825-1 a standard to utilize and manufacture laser products properly world-wide, Japan has also enacted JIS C6802, safety standards for laser products on that basis.

JIS C6802, a translation of IEC60825-1 which is the international standard, is deemed “World Common Safety Standards”.

The provisions of this standard range from the details of safety measures required according to the wavelengths and strength of lasers to the hazard display labels, and it is considered that as long as based on this standard “laser light can be utilized safely”.

Classification of Lasers by Class (IEC60825-1)

Each category by class is defined based on AEL (Accessible Emission Limit: the limit of the laser emission level allowed for that laser class).

Classification of Lasers by Class

Class 1	Low-power level: Regarded as a safe laser under normal operating conditions (reasonably foreseeable operating conditions).
Class 1M	Low-power level (wavelengths of 302.5nm – 4,000nm), parallel large diameter beam or divergent beam Safe with the naked eye, viewing of the laser with optical instruments is hazardous.
Class 2	Low-power visible light (wavelengths of 400nm – 700nm): The same as a conventional visible light laser, safe with blinking and avoidance. Long-term viewing might cause eye injury, particularly hazardous for long-term viewing of blue light. ● Power conditions: CW visible light 1mW or less
Class 2M	Low-power visible light (wavelengths of 400nm – 700nm), parallel large diameter beam or divergent beam Applied in visible lasers, safe with the naked eye if blinking or avoidance responses are possible. Direct viewing of laser light with optical instruments is regarded as potentially hazardous.
Class 3R	Laser light in the wavelengths of 302.5nm – 10 ⁶ nm, and direct viewing of beams is regarded as potentially hazardous. ● Power conditions: CW visible light 5mW or less, otherwise within 5 times of Class 1
Class 3B	Direct intrabeam viewing is hazardous. However, viewing of pulse laser emissions by diffuse reflection not connected to a focal point, is safe under certain conditions. ● Power conditions: Light 315nm or greater, CW laser 0.5W or less
Class 4	Lasers that produce high-output (exceeding the AEL of Class 3B) hazardous diffuse reflection Not merely direct beam contact with the skin or eyes even momentarily is regarded as hazardous, even diffuse reflection is regarded as injurious to skin and eyes. It is also believed to cause fires.

* It is important to confirm the class of lasers to be used, and carry out measures to prevent injury.

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Measures to Prevent Injury by Laser Classes

Directives from the Ministry of Health, Labor and Welfare [On Measures to Prevent Injury from Laser Radiation] formulate specific details for safety and preventive measures in work with lasers, with laser equipments other than Class 1 and Class 2 as the subject.

Details of Measures (item only)			Class of Laser Equipment			
			4	3B	3R	2M and 1M
Assignment of Laser Equipment Managers			○	○	○ ¹	
Controlled Area (Sign, Keep Out)			○	○		
Laser Equipments	Laser light path	Position of optical path	○	○	○	○
		Appropriate design and shielding of optical path	○	○	○ ¹	
		Appropriate termination	○	○	○ ¹	○ ²
	Key control		○	○		
	Emergency stop switches, etc.	Emergency stop switches	○	○		
		Alarm device	○	○	○ ¹	
		Shutter	○	○		
	Interlock system, etc.		○	○		
Emission window display		○	○	○		
Work Management, Health Management, etc.	Operation position		○			
	Measures for optical system adjustment		○	○	○	○
	Protective equipment	Protective eyewear	○	○	○ ¹	
		Work clothes to reduce exposure of the skin	○	○		
		Use of flame-retardant materials	○	○		
	Inspection and maintenance		○	○	○	○
	Safety and hygiene education		○	○	○	○
	Health management	Examination of anterior eye segments (cornea, crystalline lens of the eye)	○	○	○ ¹	
Examination of the fundus of the eye		○				
Other	Notices	Laser equipment managers	○	○	○ ¹	
		Precautions for hazards, toxicity and handling	○	○	○	○
		Display of installation of laser equipments	○	○		
	Display of high voltage components of laser equipments		○	○	○	○
	No hazardous materials allowed		○	○		
	Measures for toxic gas, particulates etc.		○	○		
Medical examination and treatment for those believed injured by laser radiation		○	○	○	○	

○ Indicates that measures are required. Details of the measures summarized by our company are the details determined in [Summary of Measures to Prevent Injury from Laser Radiation]. Always refer to the original document.

*1 Measures are required for laser equipments emitting laser radiation other than the 400 – 700nm wavelengths.

*2 Regarding laser equipments written in JIS Standard 10.6, measures are required for ends of laser light path.

Preventive Measures

There is need to enhance safety measures protecting against laser light to avoid grave injuries and after-effects. Injuries do not occur merely from exposing the body to laser light, secondary injuries are also possible from inhaling toxic gases produced by laser light irradiating objects such as workpieces and peripheral equipment (gases and fine particles). Therefore, there is a need for laser workers and managers to take a variety of measures to avoid laser accidents.

Protection with Laser Shield Windows and Curtains

Windows and curtains made of the similar special materials as laser protective eyewear protect the eyes of not only nearby workers, but also the eyes and skin of people nearby. It is necessary to make a selection based on the type of laser oscillator (wave length) and output power.

Protection with Laser Protective Eyewear

Protection of the eyes with eyewear made of special materials is necessary so that laser light does not accidentally strike the eyes.

It is necessary to make a selection based on the type of laser oscillator (wave length) and output power.

Safety Display to Inform of Laser Use with Panels and Plates

There are panels and plates to post at the entrances of rooms to inform that lasers are being used in the vicinity. These panels and plates need to be posted by users of the laser equipment (device) themselves.

Safety Displays with Stick-on Seals and Labels for Laser Oscillators and Devices

Hazard displays with seals and labels draw attention to the hazard of lasers and processors.

In compliance with JIS C6802 the manufacturer of the laser equipments must display the seals and labels.

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