

Definition of “Class 1” required for laser equipment and its importance

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Abstract

Recently, laser processing is being used in a variety of industrial fields. Laser equipment is also being used for mass production in the semiconductor industry, but special caution is required when handling lasers, which have a high hazard risk. However, by establishing adequate safety mechanisms on special handling is required. In this review, we introduce the class definitions and some of the laser equipment safety mechanisms. All DISCO laser equipment complies with the class 1 standards so that customers can use them safely in mass production.

1. Hazards of laser radiation

A laser beam has a single wavelength, which can be efficiently focused so that it can process materials with a high level of energy; however, they can be hazardous. Laser radiation hazards can roughly be divided into the following three types.

(1) Negative impact on the human body by a direct beam (eye and skin damage)

Even in the case of visible wavelength laser radiation, the beam path is invisible, and therefore, sufficient attention must be paid when using the laser (Fig. 1).

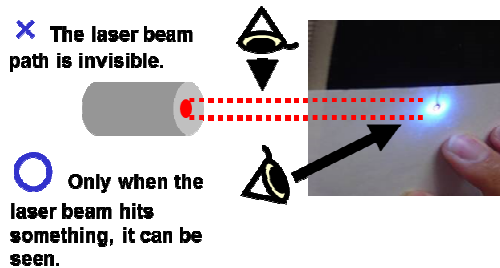


Fig.1 The optical path of the laser radiation is invisible

Laser radiation has a different impact on the human body depending on the wavelength (Fig. 2).

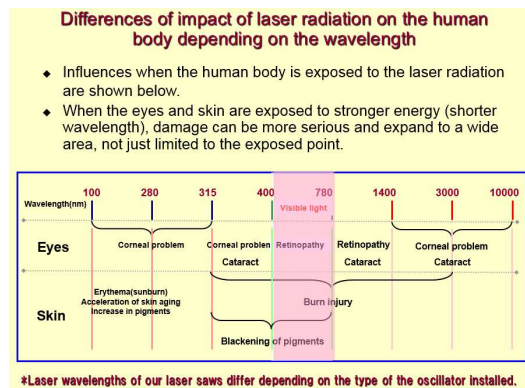


Fig.2 Differences of impact of laser radiation on the human body depending on the wavelength

(2) Fire caused by a direct beam or diffuse reflection beam

If the laser beam hits a combustible, flammable, or explosive material, it may cause a fire or explosion, which is very dangerous.

(3) Generation of harmful substances by laser processing (secondary contamination due to operations near the laser processing point)

During the ablation process using the laser, in some cases high-temperature heating dissolves organic materials or a reaction product is generated by metal oxidation, and these can be emitted to the air as gas or dust. Depending on the materials of the products or tapes to be processed, hazardous substances may be produced; therefore, it is necessary to take preventive measures, such as connecting the discharging system.

2. Laser equipment classification (JIS)

Classification of laser equipment is defined in the standard specified by the International Electrotechnical Commission (IEC) as IEC 60825: Safety of laser products. In Japan, the JIS standard^[1] based on IEC safety standard is applied and the laser equipment is classified based on the type, performance, and degree of impact on the human body. The higher the class number, the greater the risk is (Fig. 3).

Classification of laser equipment		
Class	Definition	Example
Class 1	Lasers that are safe under reasonably foreseeable conditions of operation, including the use of optical instruments for intrabeam viewing	DPL7000 series
Class 1M	Lasers emitting in the wavelength range from 302.5 nm to 4000 nm which are safe under reasonably foreseeable conditions of operation, but may be hazardous if the user employs optics within the beam.	DFL7161
Class 2	Lasers that emit visible radiation in the wavelength range from 400 nm to 700 nm whose eye protection is normally afforded by aversion responses, including the blink reflex.	Laser pointer
Class 2M	Lasers that emit visible radiation in the wavelength range from 400 nm to 700 nm where eye protection is normally afforded by aversion responses including the blink reflex. However, viewing of the output may be more hazardous if the user employs optics within the beam.	-
Class 3R	Lasers that emit in the wavelength range from 302.5 nm to 1063 nm where direct intrabeam viewing is potentially hazardous but the risk is lower than for Class 3B lasers.	-
Class 3B	Lasers that are normally hazardous when direct intrabeam exposure occurs. Viewing diffuse reflections is normally safe.	-
Class 4	Lasers that are also capable of producing hazardous diffuse reflections. They may cause skin injuries and could also constitute a fire hazard	Laser oscillator built in our equipment

Fig.3 Classification of laser equipment

3. Safety mechanisms to make our laser equipment Class 1

The laser oscillator installed in DISCO laser saw series is Class 4, which is the most dangerous class of laser equipment. However, this laser saw itself is a Class 1 laser product because the equipment satisfies the Class 1 requirements specified in the abovementioned IEC and JIS standards.

Specifically, the following safety mechanisms are introduced to our equipment to ensure safety of the users:

- (1) A shield cover and safety shutter that block various types of laser beams (e.g. direct beam, scattered beam, and diffused beam) and prevent them from being radiated to the outside of the equipment (Fig. 4)
- (2) An interlock that turns the laser power off when the shield cover or safety shutter is opened during laser irradiation
- (3) A system that shuts down the laser power if the safety shutter is opened when the interlock is out of order

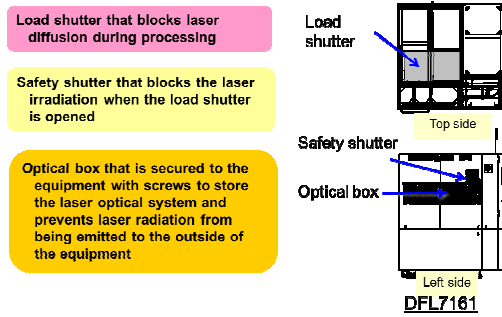


Fig.4 Safety mechanisms installed in the DFL7161

4. Laser safety officer

In the Ministry of Health, Labor and Welfare (MHLW) Notification (Kihatsu No. 39) under the Industrial Safety and Health Act, it is recommended that a laser equipment supervisor is appointed. This person should have sufficient knowledge and experience in handling of laser equipment and prevention of damages caused by laser beams.

In the case of Class 1 equipment, it is not required to appoint the laser safety officer. However, our laser saws become Class 4 during maintenance and a laser controlled area appears, thus we recommend that our customers appoint the laser safety officer. We especially ask the laser safety officer to perform roles 7 and 9 among those specified by the MHLW (Fig. 5).

The maintenance operations for the laser oscillators and optical systems of DISCO laser equipment are provided by our certified service personnel who have completed proper training. During these maintenance operations, the maintenance personnel ensure a safe working environment by installing dedicated beam shield partitions around the equipment to prevent laser radiation from being emitted to the outside,

Roles of the laser safety officer
1. Manage the distinction between the laser controlled area and other areas.
• 2. Manage alarms and warning markings so that other people can recognize the laser controlled area.
• 3. Ensure that only authorized personnel are allowed to enter into the laser controlled area.
• 4. Ensure that personnel who enter the laser controlled area wear proper personal protective equipment.
• 5. Ensure that the emergency stop switch is available in the laser controlled area and manage the switch during laser operation.
• 6. Manage the interlock of a cover that surrounds the laser controlled area.
• 7. Prevent any flammable and/or explosive material being brought into the laser controlled area
• 8. Take action and provide instructions on evacuation in case of emergency.
• 9. Implement on-going safety training.
• 10. Take prompt action in the event of a laser safety incident.
• 11. Conduct health examinations of people who work in and around the laser controlled area (e.g. examination of the ocular fundus).

Fig.5 Roles of the laser safety officer

wearing protective goggles and flame-retardant uniforms, and notifying the operation to the people around the work area.

5. Conclusion

Although the laser oscillator installed in the equipment is classified as Class 4 and is highly hazardous, it is possible to make the equipment safe as Class 1 by providing adequate safety mechanisms. All our laser saws are Class 1 so that our customers can safely use them.

In order to ensure our customers understand laser hazards and their safety countermeasures, we provide laser safety training based on their request.

References

[1] JIS C 6802: 2014 Safety of laser products