

Safety Guideline for the Projectors with Laser Device as Light Source

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**Japan Business Machine and Information System Industries Association
Data Projector Group
New Light Projector Working Group**

Table of Contents

	Page
Preface	1
1 Scope of application and Object	1
2 Normative references	3
3 Terms and definitions	3
4 Interpretations of the projection light from a projector	6
4.1 In the case of projection of diffused light from laser device as light source	6
4.2 In the case of projection with light source of excitation luminescence by the laser	8
4.3 Assessment responsibility for projection light from the projector	9
5 Classification of laser products	10
6 Measures to prevent damages due to laser light	12
6.1 Manufacture's requirements (IEC 60825-1/JIS C 6802)	12
6.2 Measures standards by class for the laser equipment (Ministry of Health, Labor and Welfare)	14
7 Safety guideline for sales	21
7.1 Requirements for labeling and announcement	21
7.2 Announcement in sales	24
8 Safety guideline in normal use	25
8.1 Requirements for accident avoidance of Intrabeam viewing	25
8.2 Requirements for accident avoidance of intrabeam viewing using optical equipment	25
8.3 Accident avoidance in the case of usually unforeseeable actions	26
8.4 Notes / Consideration / Regard / Attention in the case of remote operation and use of a remote control	26
9 Safety guideline in disassembly	27
9.1 Requirements for the housing cover	27
9.2 Requirements for the light source cover	27
9.3 Requirements for the light source unit	28
9.4 Requirements in the case of breakage	28
9.5 Requirements for user's information	28
10 Safety guideline in the case of failure	30
10.1 Scope of the reasonably foreseeable failure	30
10.2 Emission light from the projection lens	30
10.3 Leaked light	32
10.4 Alert for users	32
11 Others	33
11.1 Requirements in manufacturing	33
11.2 Requirements for servicing information	33

11.3	Requirements in the case of disposal	35
11.4	Requirements concerning optional lens	35
12	Organization table of Draft preparing committee	37
12.1	Members of Data Projector Group	37
12.2	Members of New Light Projector Working Group	38
12.3	Preparation collaborator: Laser Society of Japan	39
	Reference	40

Foreword

This guideline is set so as to make the requirements explicit for safe use of the projectors with laser device as light source.

1 Scope of application and Object

This guideline covers the projectors which use laser device as the light source and the fixed resolution light valves such as LCD (Liquid-Crystal Display) and DMD (Digital Micromirror Device) out of the front projection type projectors, which expand in the images in computers, and sets the requirements for safe use of such devices. This guideline is not applicable to the type of projectors which project images onto a screen by scanning laser light on the screen. Furthermore, this guideline is not applicable to the projectors used as toys for children. As for the interpretation of projection light from a projector, there are several interpretations in terms of laser safety standards; industry organizations and safety certification bodies are now working on it, accordingly, standards are not yet clearly described. For this reason, there are two opinions; one opinion is that projection light is to be seen as a natural light such as general lighting and it is not subject to the safety standard of laser products, and another opinion is that the projection light is to be seen as a laser light and it is subject to the safety standards of laser products. Therefore, this guideline does not provide explicit rules concerning the projection light; based on the view that a laser device is used as light source, general requirements are to be set considering such projector as laser products.

The object of this guideline is to make clear the minimum requirements for the laser products classified by manufacturers according to IEC 60825-1 so as to be able to secure the safety under all conditions of sales, operation, maintenance, service and failure. These requirements are shown Section 7 through Section 11.

- Section 7 : Safety guideline for sales
- Section 8 : Safety guideline in normal use
- Section 9 : Safety guideline in disassembly
- Section 10 : Safety guideline in the case of failure
- Section 11 : Others

As to the items regulated by other IEC product safety standards (Example: IT device IEC 60950-1, audio and video devices IEC 60065 and IEC 62368-1), this guideline comply with these standards.

The MPE (maximum permissible exposure) values were developed for laser radiation and do not apply to collateral radiation. However, if a concern exists that accessible collateral radiation might be hazardous, the laser MPE values may be applied to conservatively evaluate this potential hazard. In addition, it is the responsibility of the manufacturer to provide correct classification of a laser

product, it is to comply with the domestic regulations of each country (Example: Consumer Products Safety Act, Electrical Appliances and Material Safety Act, etc.).

MPE (maximum permissible exposure: IEC 60825-1:2007 / JIS C 6802:2011)

Level of laser radiation to which, under normal circumstances, persons may be exposed without suffering adverse effects.

collateral radiation (IEC 60825-1: 2007 / JIS C 6802:2011)

Any electromagnetic radiation, within the wavelength range between 180 nm and 1 mm, except laser radiation, emitted by a laser product as a result of, or physically necessary for, the operation of a laser

2 Normative references

The following listed standards compose of a part of the provisions of this guideline by being quoted in this standard. As for the citation standards without Christian year, the latest version (including supplement) is applicable.

IEC 60825-1 Safety of laser products - Equipment classification and requirements

JIS C 6802 Safety of laser products

IEC 60065 Audio, video and similar electronic apparatus - Safety requirements

IEC 60950-1 Information technology equipment -safety

IEC 62368-1 Audio/video, information and communication technology equipment
–safety requirements

(ISO/IEC 21118 Information to be included in specification sheets - Data projectors)

(JIS X 6911 Information to be included in specification sheets - Data projectors)

(IEC 61947-1 Electronic projection -Measurement and documentation of key performance criteria
- Part1:Fixed resolution projectors)

(JIS K 6800 Adhesion/Adhesive terms)

3 Terms and definitions

As for the main terms and definitions used in this guideline, in addition to the definitions in IEC 60825-1, JIS C 6802, ISO/IEC 21118, JIS X 6911, and IEC 61947-1, the followings are applicable. In addition, the terms defined in the above described standards and important terms related to this guideline are to be noted in the text as needed.

3.1

Protective housing

It is a component (usually it is attached by manufacturers) of a laser product (including built-in laser products) which is designed so as to protect the laser emission exposure which exceeds regulated AEL to the human body. In this guideline it is a collective term for a housing cover, light source cover, and optical engine cover.

3.2

Housing cover

It is the protective housing which composes of the utmost outer cover or a case.

3.3

Light source cover

It is a part of the housing cover which is opened or closed when attaching or removing of the light source is intended, or access to the light source is intended.

3.4

Light source unit

In this guideline, it is the light source which is to be incorporated in the system as a projection light of a projector, or an assembly part composed of light source and its holding components.

3.5

Optical engine

In this guideline, it is a light source unit and the assembly parts which compose of the optical path where the emitted light from the light source is illuminated to the light valve and projected from the projection lens.

3.6

Optical engine cover

It is the protective housing composes of a part of the optical engine.

3.7

Security seal

It is the seal which is once peeled off, it cannot be stuck again, so that the peeled evidence can be found. Such seals include the “tamper-proof seal” where once peeled, letters appear, “fragile seal” where the seal tears when one tries to peel it.

3.8

Special screw

It is a screw which can be unscrewed by the tool which is not regularly stocked in the usual home so as to prevent being unscrewed by users.

3.9

Main light beam

It is the light beam which emits to the outgoing direction of the optical engine light path.

3.10

Access sensor

It is an interlock which immediately stop laser oscillation when either cover of the protective housing is opened.

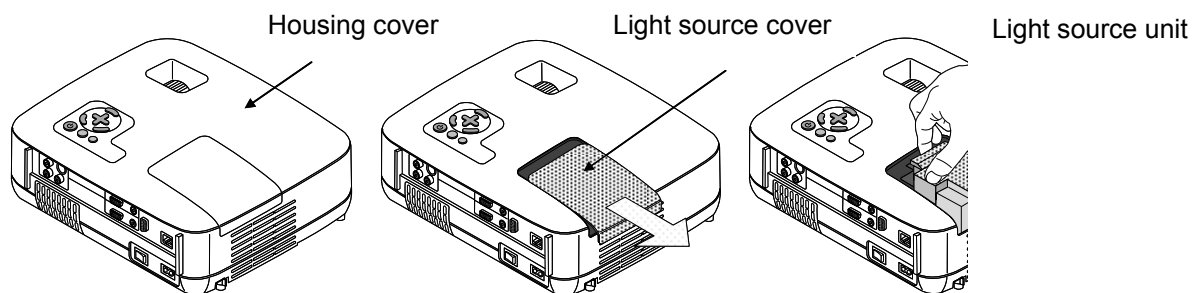


Figure 3.1 Protective housing and light source unit of a projector

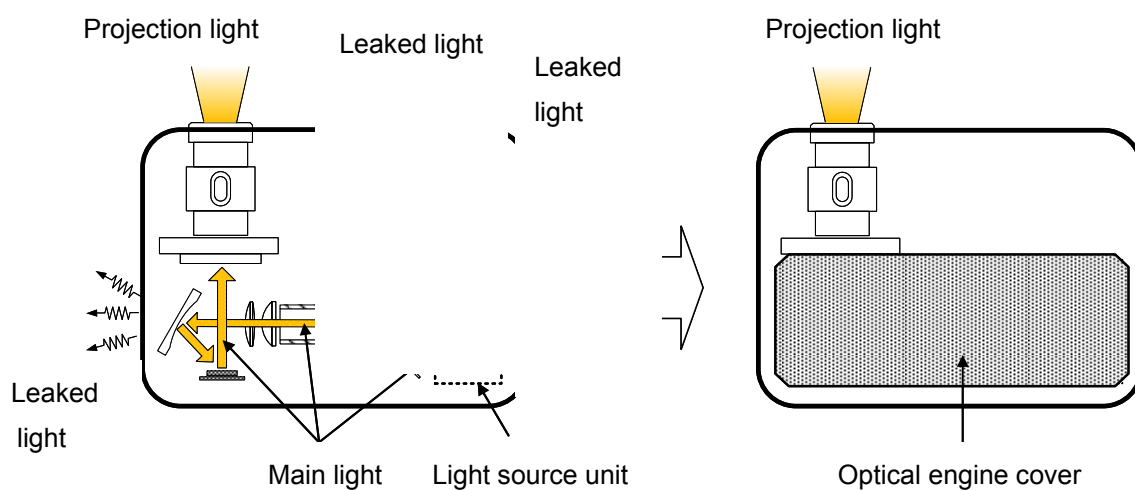


Figure 3.2 Main light and leaked light, and optical engine cover

AEL (accessible emission limit; IEC 60825-1:2007 / JIS C 6802:2011)

The maximum accessible emission permitted within a particular class

4 Interpretations of the projection light from a projector

4.1 In the case of projection of diffused light from laser device as light source

In the case of the front projector which uses laser device as light source and diffuses the beam and forms it into rectangular beam with uniform intensity and illuminates light valve (liquid crystal panel, DMD) with it, and then projects the expanded image onto the screen through the projection lens, how to deal with its projection light is shown below.

4.1.1 Biomedical safety

In the case of general laser pointer, both of the temporal coherence and spatial coherence are kept; accordingly, when laser light (parallel light) emitted from there is collected with lens, as shown in Figure 4.1.1 (a), all emitted light energy is collected on to micro area of the wave length, and very high energy density is kept at the focal point. For this reason, when laser light (parallel light) goes into human eye, its retina may be damaged by the collected light.

On the other hand, in the case of the front projector that illuminates light valve with diffused laser light and projects it onto the screen, temporal coherence, in some cases, may be kept while spatial coherence is lost; accordingly, in the case where the projection light (diffused light) emitted from there is collected through the lens, as shown in the Figure 4.1.1 (b), only a part of emitted light energy is collected on to finite area of uniform illumination intensity, so that the energy density at the focal point is not so large. For this reason, even in the case where the projection light (diffused light) goes into the human eye, the risk to damage the retina by the collected light is considered to be low.

That is to say, light collection ability through the light projection lens of the projector with laser device as light source is almost same the light collection ability through the light projection lens of the projector with natural light (incoherent light) such as a lamp and LED. ※

※ In the case of the highly monochromatic light, that is, the light spectrum of very narrow band width (equal to temporal coherent light), there are opinion that the threshold level of damage is different from that of other natural light (incoherent light); however, at present, it is not clearly specified that what kind of impact it has on the human body when the light spectrum of very narrow band width becomes in specific.

Accordingly, in the case of the projection light of the front projector that illuminates light valve with diffused laser light and projects it onto the screen, it is not particularly hazardous because it uses laser device as light source; in terms of biomedical, it is considered that it can be handled like other light sources (lamp, LED).

However, regardless of types of light (sunlight, lamp light, LED light, laser light), when one continues to stare at strong light, it is likely to damage one's eyes; so equally cautions are necessary.

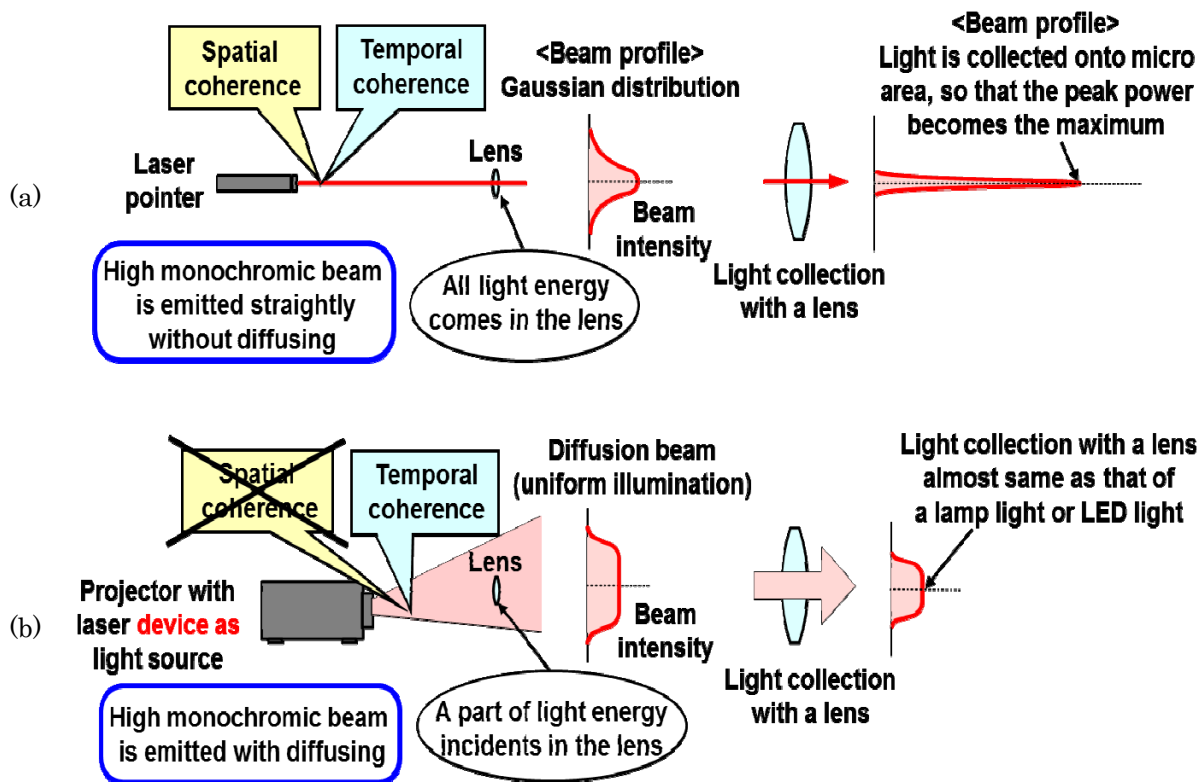


Figure 4.1.1 Light-collection difference between a laser pointer and projector with laser device as light source

Spatial coherence

It is the amount to indicate the degree of light wave coherency at different points. It is expressed by the degree of correlation at different points of the same spot. (JIS Z 8120:2001 Definition of optical terms)

It is the scale to measure uniformity of light wave front. Because laser light has high spatial coherence, it is able to make almost complete plane wave and spherical wave. For this reason, laser light is able to propagate long distance without diffusion, and is able to converge on a very small spot as well.

[Characteristic features that beam go straight without diffusion.].

Temporal coherence

It is the amount to indicate the degree of light wave coherency at different time points. It is expressed by the degree of correlation at different time points of the same spot.

(JIS Z 8120:2001 Definition of optical terms)

It is the scale to represent how long the frequency at the optical electric-field is kept. Because, laser light has high temporal coherence, even though in the case where large optical path difference is given, a clear interference pattern can be obtained. The maximum optical path difference to form an interference pattern is called as "coherence length"; higher the temporal coherence, larger the coherence length. [Spectrum is narrow = High monochromatic characteristics]

4.1.2 Interpretation concerning standards

In the case of the front projector that illuminates light valve with diffused laser light and projects it onto the screen, there are several interpretations concerning handling of the laser safety standards (IEC 60825-1/JIS C 6082) for the projection light; consequently, industry organizations and safety certification bodies are now working on it.

At present, as to the projection light of the projector that illuminates light valve with diffused laser light and projects it onto the screen, according to one interpretation, it is treated as a natural light (incoherent light) same as general lighting and it is not subject to the class determination; while according to another interpretation, it is treated as a laser light and it is subject to the class determination, thus two camps have different judgments. The former interpretation treats such a projector as a Class 1 laser product. The latter interpretation treats such a projector as a laser product of specified Class corresponding to the strength of projection light. ※

※ In either case, it is prerequisite for the interpretation that there is no laser light leak which exceeds Class 1 from the place other than the projection lens.

In addition, in one case, the “coherent light” generated by the stimulated emission is seen and treated as laser light; while in another case, all light generated by the stimulated emission is seen and treated as laser light. In this case as well, as to the definition of the “coherent” light, one interpretation treats it as coherent light as long as either spatial coherence or temporal coherence remains; while, another interpretation treats it as incoherent light when either spatial coherence or temporal coherence is lost.

4.2 In the case of projection with light source of excitation luminescence by the laser

In the case of projection with light source of excitation luminescence by the laser and forms it into rectangular beam with uniform intensity and illuminates light valve (liquid crystal panel, DMD) with it, and then projects expanded image onto the screen through the projection lens, how to treat the projection light is shown below.

4.2.1 Biomedical safety

In the case of luminescence (collateral radiation) excited by laser light, because both the spatial coherence and temporal coherence are lost, generally it is considered as a natural light (incoherent light). For this reason, when projection light goes into eye, it is considered that the risk to damage the retina by collected light through the lens is low as those of other light sources (lamp light, LED light).

However, regardless of types of light (sunlight, lamp light, LED light, luminescence), when one continues to stare at strong light, it is likely to damage one's eyes; so equally cautions are necessary.

4.2.2 Interpretation of the standards

In the case of the front projector which projects onto a screen by irradiating luminescence (collateral radiation) excited by laser light to the light valve, there is no clear reference standard as to how to deal with such a projection light in terms of standards.

Therefore, one interpretation sees luminescence excited by the laser as a natural light (incoherent light) and applies the safety standards (IEC 62471/TS C 0038) for lamp light and LED light, while another interpretation applies laser safety standards (IEC 60825-1/JIS C 6802) to it, although this camp over stresses the safety side.

4.3 Assessment responsibility for projection light from projector

As to the interpretation of the projection light in the case of projecting diffused laser light onto the screen and in the case of projecting excited luminescence by the laser, they are explained in above 4.1 and 4.2.

Accordingly, at present, handling determination of these projections light is left to manufacturers or its agents. (IEC 60825-1: 2007 Section 8.2)

5 Classification of laser products

Laser products are classified corresponding to the degree of hazard; they are classified into 7 general classes ranging from class 1 which is safe laser to the most hazardous class 4. Classification of projectors is carried out by manufacturers or its agents according to Section 8 and Section 9 in IEC 60825-1.

(1) Class 1

Laser products that are safe during use, including long-term direct intrabeam viewing, even when exposure occurs while using optical viewing instruments (eye loupes or binoculars). Class 1 also includes high power lasers that are fully enclosed so that no potentially hazardous radiation is accessible during use (embedded laser product). Intrabeam viewing of Class 1 laser products which emit visible radiant energy may still produce dazzling visual effects, particularly in low ambient light.

Remark: Even though a high power laser is built into a product, if it is structurally designed so as to be unable to expose its laser light, it is classified into Class 1.

(2) Class 1M

Laser products that are safe, including long-term direct intrabeam viewing for the naked eye (unaided eye). The MPE can be exceeded and eye injury may occur following exposure with one of the two categories of optical viewing instruments (eye loupes or binoculars).

The wavelength region for Class 1M lasers is restricted to the spectral region where most glass optical materials used in optical instruments can significantly transmit, i.e., between 302,5 nm and 4000 nm. Intrabeam viewing of Class 1M laser products which emit visible radiant energy may still produce dazzling visual effects, particularly in low ambient light.

Remark: This is a new class in that “it is safe for the naked eye.” Exposure (watching) condition is that the watching by the naked eye at the distance of 100mm from the light source. Accordingly, in this class observation with lens system may damage eye.

(3) Class 2

Laser products that emit visible radiation in the wavelength range from 400nm to 700nm that are safe for momentary exposures but can be hazardous for deliberate staring into the beam. The time base of 0.25 s is inherent in the definition of the class and presumption is that there is very low risk of injury for momentary exposures that are somewhat longer.

The following factors contribute to precluding injury under reasonably foreseeable conditions;

- unintentional exposures would rarely reflect worst-case conditions, for example, of beam alignment with the pupil for a stabilized head, worst case accommodation;
- the inherent safety margin in the MPE upon which the AEL is based;

- natural aversion behavior for exposure to bright light.

Remark: The upper power limit is 1 mW (in the case where light source visual angle is less than 1.5mrad), where the risk is avoided by the feeling of repulsion reaction (≤ 0.25 second). The range of visible light defined here is narrower than the actual visible range; it is confined the wavelength range from 400 nm to 700 nm where the feeling of repulsion reaction occurs at 1 mW.

(4) Class 2M

Laser products that emit visible laser beams and are safe for short time exposure only for the naked (unaided eye). Eye injury may occur following exposure with one of the two categories of optical viewing instruments (eye loupes or binoculars).

Remark: It is a new class like class 1M in that it is safe for the naked eye. Accordingly, the observation with the optical system may damage eye.

(5) Class 3R

Laser products that emit radiation that can exceed the MPE under direct intrabeam viewing, but the risk of injury in most cases is relatively low because the AEL for Class 3R is only 5 times the AEL of Class 2 (visible laser beams) or the AEL of Class 1 (for non-visible laser beams). The risk of injury increases with exposure duration and exposure is hazardous for deliberate ocular exposure. Because of the lower risk, fewer manufacturing requirements and control measures for the user apply than for Class 3B.

(6) Class 3B

Laser products that are normally hazardous when intrabeam ocular exposure occurs (i.e. within the NOHD) including accidental short time exposure. Viewing diffuse reflections is normally safe. Class 3B lasers which approach the AEL for Class 3B may produce minor skin injuries or even pose a risk of igniting flammable materials. However, this is only likely if the beam has a small diameter or is focused.

Remark: Fitting of key or interlock is required for this class and upper class; in-use alarm notice, etc., are required.

(7) Class 4

Lasers products for which intrabeam viewing and skin exposure is hazardous and for which the viewing of diffuse reflections may be hazardous. These lasers also often represent a fire hazard.

Remark: It is necessary to take a measure to block the laser light emitted. Naturally, fitting of key or interlock is required; in-use alarm notice, etc., are required.

6 Measures to prevent damages due to laser light

6.1 Manufacture's requirements (IEC 60825-1/ JIS C 6802)

International standards IEC 60825-1 concerning laser products safety and Japanese standards JIS C 6802 require manufacturers to take measures listed in Table 6.1.1 in order to prevent damages due to laser light.

Table 6.1.1 Summary of manufacture's requirements

Requirement subclass	Classification						
	Class 1	Class 1M	Class 2	Class 2M	Class 3R	Class 3B	Class 4
Description of hazard class	Safe under reasonably foreseeable conditions	As for Class 1 except may be hazardous if user employs optics	Low power; eye protection normally afforded by aversion responses	As for Class 2 except may be more hazardous if user employs optics	Direct intra-beam viewing may be hazardous	Direct intra-beam viewing normally hazardous	High power; diffuse reflections may be hazardous
Protective housing	Required for a built-in laser product	Required for each laser product; limits access necessary for performance of functions of the products					
Safety interlock in protective housing	Designed to prevent removal of the panel until accessible emission values are below that for Class 3R				Designed to prevent removal of the panel until accessible emission values are below that for Class 3B or 3R for some products		
Remote Interlock	Not required					Permits easy addition of external interlock in laser installation	
Manual Reset	Not required						Requires manual reset if power interrupted or remote interlock is actuated
Key control	Not required					Laser inoperative when key is removed	

Emission warning device	Not required		Gives audible or visible warning when laser is switched on or if capacitor bank of pulsed laser is being charged. For Class 3R, only applies if invisible radiation is emitted
Attenuator	Not required		Gives means to temporarily block beam
Location controls	Not required		Controls so located that there is no danger of exposure to AEL above Classes 1 or 2 when adjustments are made
Viewing optics	Not required	Emission from all viewing systems must be below Class 1M AEL	
Class label	Required wording	Figure 1 and Figure 2 and required wording in the IEC60825-1	
Aperture label	Not required		Specified wording required
Service access label	Not required	Required as appropriate to the class of accessible radiation	
Override interlock label	Required under certain conditions as appropriate to the class of laser used		
Wavelength range label	Required for certain wavelength ranges		
User information	Operation manuals must contain instructions for safe use. Additional requirements apply for Class 1M and Class 2M		
Purchasing and service information	Promotion brochures must specify product classification; servicing manuals must contain safety information		

Note 2) The related part is extracted from Annex F: Table F.2 in the IEC 60825-1

Note 3) As to details of each item, see the Section 4 “Engineering specifications” in the IEC 60825-1.

6.2 Measures standards by class for the laser equipment (Ministry of Health, Labor and Welfare)

Meanwhile, in Japan, “Prevention measures plan concerning laser hazard” (Notification No. 39/Notification No. 0325002 (revision)) was prepared by the Health, Labor and Welfare Ministry in order to prevent damage from workers who engage in business to handle laser equipment.

Tables 6.2.1 through 6.2.3 are the summary of the measures by laser equipment class required for business operators according to above plan. Business operators are required to take measures based on “List of measures standards by laser equipment class” shown below. These are applied in order to secure workers’ safety, who engage in the projector manufacturing and its service

Remark: Business operators

Those who operate business and employ workers. (From Article 2 in the Industrial Safety and Health Act)

Table 6.2.1 List of measures standards by laser equipment class (Part 1)

Item			Laser equipment class						Description of measures
			1	1M	3R		3B	4	
			2	2M	Visible	Invisible			
Appointment of the person in charge of laser equipment						○	○	○	◆ The person in charge of the laser equipment should be appointed from those who have enough knowledge and experiences concerning handling of laser equipment and prevention of damage due to the laser light.
Controlled area (sign, off-limits)							○	○	◆ Laser controlled area should be partitioned from other areas by fence, etc., and should be clearly specified by signs, etc. ◆ Only authorized persons are allowed to enter the laser controlled area, and measures such as auto-lock, etc., should be taken at the entrance as needed. ◆ Persons other than authorized persons need to enter the laser control area; they should be act under supervision of the person in charge of the laser equipment.
Laser equipment	Laser light path	Position of a laser light path		○	○	○	○	○	◆ The laser light path should be set avoiding the eye level of workers.

		Appropriate design and shielding of the light path				○	○	○	◆ The laser light path should wherever possible have minimum distance and kinks, and should not cross the walkway and other pathways, and should be shielded. a. Around the place to install the laser equipment, the fence to shield the laser beam should be set up. b. The fence should be opaque, absorbable, and nonflammable against laser light. c. Inside of the fence should be assigned as a controlled area.
		Appropriate terminal		○※ 2		○	○	○	◆ The terminal of the laser light path should be diffuse reflective material or diffuse absorption materials.
	Key control						○	○	◆ Laser equipment structure should be designed as to be operated by a key, etc.
	Emergency stop switch, etc.	Emergency stop switch					○	○	◆ The emergency stop switch which is able to immediately stop the laser light emission should be installed on control panel and other necessary places.
		Alarm equipment				○	○	○	◆ Alarm equipment such as automatic indicator light which is able to indicate the laser light is under emission or ready to emit should be installed.
		Shutter					○	○	◆ At the emission hole of the laser light of the laser equipment, a shutter should be installed in order to prevent unintentional emission of the laser light.
	Interlock system, etc.						○	○	◆ In the case of opening of the fence of the laser control area, or in the case of release of shielding of the laser light path, measures such as interlock functions should be taken to prevent laser light emission.
	Indication of emission hole				○	○	○	○	◆ At the emission hole, such indication should be placed.

The symbol “○” means actions are required.

※1 Visible light is the light of 400nm through 700nm wavelength, and invisible light is the light of wavelength other than such wavelength.

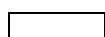
※2 As for the laser equipment listed in the JIS 10.6, the laser light terminal treatment is required.

Table 6.2.2 List of measures standards by laser equipment class (Part 2)

Item			Laser equipment class					Description of measures	
			1	1M	3R		3B		4
			2	2M	Visible	Invisible			
Work management/Health management	Operating position							○	◆ Operation of laser equipment should be carried out at the position as far as possible from the laser light.
	Measures while adjustment of the optical systems			○	○	○	○	○	◆ When adjustment of the optical system is carried out by the laser light, the adjustment should be carried out with the minimum power output of the laser light
	Protective equipment	Protective eyeglasses				○	○	○	◆ Effective eyeglasses should be worn by workers depending on the class of laser. However, in the case measures to prevent damage from eye are taken, it is not applicable. (Note: protective eye glasses for laser should be used.) ◆ Working clothes with less skin exposure and of nonflammable materials should be worn by workers. In particular, chemical fiber clothes which become a ball when melted is undesirable.
		Working clothes with less skin exposure					○	○	
		Use of flame resistance materials						○	

								<ul style="list-style-type: none"> ◆ Before starting work, let the person in charge of the laser equipment check the laser optical path, interlock functions, etc., and the protective equipment. ◆ Within the specified period, let the person who has expertise in the laser equipment check the laser equipment focusing on the following items and fix it. <ul style="list-style-type: none"> a. Presence or absence of abnormality of the output of the laser light, mode, beam diameter, spread angle, oscillating wavelength. b. Presence or absence of abnormality of the input power, exciting voltage, current, insulation, grounding, etc. c. Presence or absence of abnormality of the actuation of the safety equipment, automatic indicator lamp, shutter, interlock functions, etc. d. Presence or absence of abnormality of the power meter, power monitor, etc. e. Presence or absence of abnormality of the movable parts of the fan, shutter, etc. f. Presence or absence of abnormality of the cooling equipment, gas supply equipment, hazardous gas removal equipment, dust removable equipment, etc.
	Checkout/Maintenance		○	○	○	○	○	

	Safety and health education			○	○	○	○	○	<p>◆ In the case where workers who engage in the laser work are newly employed, or change of the workers' work and let them engage in such work, or in the case of change of laser equipment in use, the education according to Section 1 or Section 2 in Article 59 in the Industrial Safety and Health Act should be carried out. In this case, particularly keep in mind the following items are to be included.</p> <p>[Contents of the safety and health education]</p> <p>a. Behavior, risk and hazardousness of the laser</p> <p>b. The principle and structure of the laser equipment</p> <p>c. Handling methods of the laser equipment</p> <p>d. Functions and handling methods of the safety equipment and protective equipment</p> <p>e. Actions and evacuation in case of emergency</p>
	Health management	Anterior eye check (cornea, crystalline lens)				○	○	○	<p>◆ As to workers who usually engage in the laser work, in the case where they are newly employed or change of the job, in addition to eyesight check, anterior eye (cornea, crystalline lens) examination and fundus examination should be carried out.</p>
		Fundus examination						○	



The symbol “○” means actions are required.

※ Visible light is the light of 400nm through 700nm wavelength range, and invisible light is the light of wavelength other than such wavelength range.

Table 6.2.3 List of measures standards by laser equipment class (Part 3)

Item			Laser equipment class						Description of measures
			1	1M	3R		3B	4	
			2	2M	Visible	Invisible			
Others	Notice	The person in charge of the laser equipment				○	○	○	◆ The following items should be noticed at the easy-to-see place such as the entrance of the laser controlled area.
		Risk Hazardousness Items to handle with care		○	○	○	○	○	a. Name of the person in charge of the laser equipment
		Notice of the laser equipment installation					○	○	b. Risk, hazardousness of the laser light, and precautions in handling the laser equipment c. Notice of the laser equipment installation
	Notice of the high-voltage part of the laser equipment			○	○	○	○	○	◆ At the high-voltage parts of the laser equipment, such should be noticed, and measures to prevent electric shock by touching such parts should be taken as well.
	No carry-in hazardous materials						○	○	◆ Explosive materials, flammable materials, etc., should not be carried in the laser controlled area.
	Measures for poisonous gas, dust, etc.						○	○	◆ In the case of laser operation, when poisonous gas, dust, etc., are generated, in order to prevent the health damages due to such materials, measures such as seal-up facilities, local ventilation equipment, gas mask, and dust mask which are prescribed by the Industrial Safety and Health Act should be taken.
Doctor's diagnosis and treatment for persons who suspected to have health damage due to the laser beam.			○	○	○	○	○	◆ Let get doctor's diagnosis or treatment for persons who suspected to have damage due to the laser beam as soon as possible.	

The symbol “○” means actions are required.

※ Visible light is the light of 400nm through 700nm wavelength range, and invisible light is the light of wavelength range other than such wavelength range.

Note 4) This “Measures standards by laser equipment class” is based on the Health, Labor and Welfare Ministry’s Notification No. 0325002 (March 25, 2005) “Damage prevention measures due to the laser beam” and its exhibit “The outline of the damage prevention measures due to the laser beam”; here the laser products of class 1 and class 2 are not included in the scope of application.

Note 5) In the case of revision of the Health, Labor and Welfare Ministry’s “The outline of the damage prevention measures due to the laser beam” which is the source of quotation, the latest ruling is applicable.

Access panel (IEC 60825-1:2007 / JIS C 6802:2011)

It is a part of the protective housing, and when removed or transferred, it would expose someone by the laser emission

Safety interlock (IEC 60825-1:2007 / JIS C 6802:2011)

It is the automatic interlock which interlocked with each part of the protective housing in order to prevent human body laser from emission exposure by Class 3R, Class 3B, or Class 4 laser emission when a part of protective housing of the laser product, is removed, opened, or transferred.

Remote interlock connector (IEC 60825-1: 2007 / JIS C 6802:2011)

It is a part of the laser product which connect to the external control equipment which is installed apart from other parts.

7 Safety guideline for sales

7.1 Requirements for labeling and announcement

7.1.1 Labeling on the projector (Requirements of IEC 68025-1)

Labeling on the projector should comply with the directions for labels shown in Section 5 in IEC 60825-1. Durable labels should be stuck, or they can be directly printed or die stamped on the projector.

• Requirements for labeling

(1) Alarm label

The symbol, outline, color, and size of the alarm label should comply with the Figure 1 in IEC 60825-1. These dimensions are recommended values. As long as they are proportional to the values, the symbol and border may be of any legible size as required to suit the size of the projector.

(2) Explanatory label


The symbol, outline, color, and size of the explanatory label should comply with the Figure 2 in IEC 60825-1. These dimensions are recommended values. The label may be of any size necessary to contain the required lettering and border.

(3) Aperture label

Each Class 3R, Class 3B and Class 4 laser product shall have affixed a label close to each aperture through which laser radiation in excess of the AEL for Class 1 or Class 2 is emitted. The label(s) shall bear the words listed in Table 7.1.1 with arbitrary legible character size.

Table 7.1.1 Requirement for Labeling and the words

Product class	Alarm label	Explanatory label	Aperture label
Class 1	Unnecessary	CLASS 1 LASER PRODUCT ※	Unnecessary
Class 1M		LASER RADIATION DO NOT VIEW DIRECTLY WITH OPTICAL INSTRUMENTS CLASS 1M LASER PRODUCT※	
Class 2	Necessary	LASER RADIATION DO NOT STARE INTO BEAM CLASS 2 LASER PRODUCT	

Class 2M		LASER RADIATION DO NOT STARE INTO THE BEAM OR VIEW DIRECTLY WITH OPTICAL INSTRUMENTS CLASS 2M LASER PRODUCT	
Class 3R		LASER RADIATION AVOID DIRECT EYE EXPOSURE CLASS 3R LASER PRODUCT	LASER APERTURE or APERTURE FOR LASER RADIATION or AVOID EXPOSURE — LASER RADIATION IS EMITTED FROM THIS APERTURE
Class 3B		LASER RADIATION AVOID EXPOSURE TO BEAM CLASS 3B LASER PRODUCT	
Class 4		LASER RADIATION AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION CLASS 4 LASER PRODUCT	

※ Instead of the above labels, at the discretion of the manufacturer, the same statements may be included in the information for the user.

Note: 6) Quoted from Table 1.5.1 of Section 5 in the “Laser safety guidebook 4th edition” (Optoelectronic Industry and Technology Development Association)

(However, a part of the contents are revised in accordance with the latest standards (ITC 60825-1 (2007).)

(4) Labels for panels

According to the standards (IEC 60825-1), the panel which, when removed or displaced permits human access to laser radiation in excess of the AEL for Class 1, shall have affixed labels bearing the words shown in Table 7.1.2. (IEC 60825-1, Section 5.9) is written down.

Remark: Depending on presence or absence of the safety interlock on the panel, contents of phrase to write down are different (See Table 7.1.2 below).

The term panel (access panel) used here means a movable part which is incorporated in user's work procedures (action to open the panel) in order to fulfill functions necessary for the laser product. As for projector, the light source cover is equivalent to such access panel, and corresponds to the service panel in the case where users are allowed to replace the light source unit at the discretion of manufacturers.

Table 7.1.2 The wording of labels for access panels

Laser class protected by the access panel	The panel without safety interlock, or the panel with a safety interlock which cannot be easily unlocked ※ ¹	The panel with a safety interlock which can be easily unlocked
Class 1	Unnecessary	Unnecessary
Class 1M	CAUTION— CLASS 1M LASER RADIATION WHEN OPEN DO NOT VIEW DIRECTLY WITH OPTICAL INSTRUMENTS	CAUTION— CLASS 1M LASER RADIATION WHEN OPEN AND INTERLOCKS DEFEATED DO NOT VIEW DIRECTLY WITH OPTICAL INSTRUMENTS
Class 2	CAUTION— CLASS 2 LASER RADIATION WHEN OPEN DO NOT STARE INTO THE BEAM	CAUTION— CLASS 2 LASER RADIATION WHEN OPEN AND INTERLOCKS DEFEATED DO NOT STARE INTO THE BEAM
Class 2M	CAUTION— CLASS 2M LASER RADIATION WHEN OPEN DO NOT STARE INTO THE BEAM OR VIEW DIRECTLY WITH OPTICAL INSTRUMENTS	CAUTION— CLASS 2M LASER RADIATION WHEN OPEN AND INTERLOCKS DEFEATED DO NOT STARE INTO THE BEAM OR VIEW DIRECTLY WITH OPTICAL INSTRUMENTS
Class 3R	CAUTION— CLASS 3R LASER RADIATION WHEN OPEN AVOID DIRECT EYE EXPOSURE	CAUTION— CLASS 3R LASER RADIATION WHEN OPEN AND INTERLOCKS DEFEATED AVOID DIRECT EYE EXPOSURE
Class 3B	Safety interlock is indispensable ※ ²	CAUTION— CLASS 3B LASER RADIATION WHEN OPEN AND INTERLOCKS DEFEATED AVOID EXPOSURE TO THE BEAM
Class 4	Safety interlock is indispensable ※ ²	CAUTION— CLASS 4 LASER RADIATION WHEN OPEN AND INTERLOCKS DEFEATED AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION

※¹ Even if one open the panel with a safety interlock which cannot be easily unlocked, in the case where the human body is not exposed to the laser radiation which exceeds of the AEL for Class1 due to the action of the safety interlock, labeling is not required.

※² When the panel is removed or displaced, the human body is exposed to the laser radiation of AEL for Class 3B or more, the safety interlock is indispensable.

Note: 7) Quoted from Table 1.5.2 of Section 5 in the “Laser safety guidebook 4th edition” (Optoelectronic Industry and Technology Development Association).

(However, a part of its contents are revised in accordance with the latest standards (IEC 60825-1 (2007).)

7.1.2 Items to be indicated on the outer packaging box and in the operation manual (original requirements for this guideline)

(a) Requirements for outer packaging box

The indication which shows a laser product shall be affixed.

(b) Requirements for operation manual

- (1) Note of caution such as “Don’t stare into the projection lens of the projector” is to be written down.
- (2) Note of caution such as “CLASS xx LASER PRODUCT” is to be written down.
- (3) Particularly, as for the projector which exceeds Class 2, a note of caution such as “In the case where children are likely to touch it, it should be used under the control and supervision of an adult.”

Remark: As to the requirements in the note of caution, it is desirable to use the standardized phrase among manufacturers.

- (4) Legible reproductions (colour optional) of all required labels and hazard warnings to be affixed to the laser product or provided with the laser product. The corresponding position of each label affixed to the product shall be indicated or, if provided with the product, a statement that such labels could not be affixed to the product but were supplied with the product and a statement of the form and manner in which they were supplied shall be provided.

7.2 Announcement in sales

In all catalogues, specification sheets and descriptive brochures, the warning that it is the laser product should be stated so as to buyers are able to recognize the fact that it uses a new light source different from the conventional lamp.

Furthermore, according to Section 6.2 in IEC 60825-1, in all catalogues, specification sheets and descriptive brochures, manufacturers of laser products shall provide or cause to be provided the information concerning the classification of each laser product and the following alarm note depending on each laser class.

[Laser product]	[Information concerning warning]
Class 1	Not particular
Class 1M	Do not View directly with optical instruments
Class 2	Do not stare into the beam
Class 2M	Do not stare into the beam or view directly with optical instruments

Class 3R	Avoid direct eye exposure
Class 3B	Avoid exposure to the beam
Class 4	Avoid eye or skin exposure to direct or scattered radiation

8 Safety guideline in normal use

8.1 Requirements for accident avoidance of Intrabeam viewing

In the case of the projector, regardless of the types of the light source (lamp, LED, laser, etc.) and risk class (risk group, laser class, etc.), it is (potentially) likely to have negative impact on the human body to directly watch strong light projected from the projection lens onto screen from inside the beam for long time, so the following notes of caution should be provided.

(a) Requirements for projector

In the case of the projector which uses laser as light source, same as the case of the lamp-type projector, the no stare into mark is to be indicated nearby the light emission hole and users' awareness is to be promoted. This no stare into mark is to be used according to the write-down in the mark of the lamp-type projector.

Furthermore, as for the projector of Class 3R or more, in addition to above no stare into mark, at the same place (light emission hole), opening label (described in Table 6.1.1 in this guideline) is required.

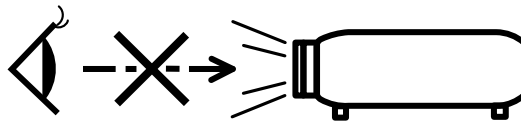


Figure 8.1.1 Example of no stare into mark

(b) Requirements for operation manual

Note of caution such as “Don’t stare into the projection lens.” should be written down.

Remark: The description in Section 7.1.2 in this guideline may be combined, also a supplementary note of caution may be written down.

8.2 Requirements for accident avoidance of intrabeam viewing using optical equipment

In the case of the projector, regardless of the types of the light source (lamp, LED, laser, etc.) and risk class (risk group, laser class, etc.), it is likely to have negative impact on the human body to look into strong light projected from the projection lens onto screen from inside the beam using optical equipment (loupe, mirror reflector, etc.), so the following note of caution should be provided.

- **Requirements for operation manual**

Notes of caution such as “Don’t enter into the beam by using optical equipment (loupe, mirror reflector, etc.)” is to be written down.

8.3 Accident avoidance in the case of usually unforeseeable actions

In the case of use by children, it is hard to completely eliminate the possibility that the accident may be caused by the handling of the projector other than usually reasonably foreseeable handling method, so the following note of caution is to be provided.

- **Requirements for operation manual**

In the case of the projectors which exceed Class 2 or more, a note of caution such as “When it is likely to be touched by children, this should be used under the control and supervision by the adult.” should be written down.

Remark: The description in Section 7.1.2 in this guideline may be combined, also a supplementary note of caution may be written down.

8.4 Notes / Consideration / Regard / Attention in the case of remote operation and use of a remote control

In the case of power-on, consideration has to be made to prevent the projection lens being looked in.

- **Requirements for operation manual**

A note of caution such as “When turn on the projector, consideration has to be made to prevent the projection lens being looked in.” should be written down.

9 Safety guideline in disassembly

In the case of disassembly of the product, it is ideal to prevent misuse of the laser device as light source by its destruction; however, in the case where it is difficult to do so in terms of service activity, in terms of prevention of misuse of the removed laser device as light source and ensuring safety for the maintenance, set up the following requirements in order to prevent the laser device as light source in the product easily being diverted.

9.1 Requirements for the housing cover

- (a) In the operation manual, alert users not to disassemble.
- (b) Housing cover structure should be designed so as not to be easily opened by users.

Remark: For example,

- 1) Use the special screws for tightening of housing cover.
 - 2) Housing cover is designed as can't be removed by one-action
 - 3) Housing cover is designed as to be a structure and combined with screw tightening
- Entrust specific countermeasures to manufacturers

- (c) On the housing cover, placing the indication that represents "Don't open / disassemble the housing cover."

9.2 Requirements for the light source cover

9.2.1 In the case where users are not permitted to replace the light source unit

The requirements similar to those for the housing cover described in Section 9.1 in this guideline are to be applied to the light source cover.

Remark: In the case where due to the size or design of the product, placing the indication that represents "Don't open/disassemble" to both the housing cover and light source cover is impractical, the indication that represents "Don't open/disassemble set." should be placed on either the housing cover or the light source cover. In this case, it is desirable to seal the cover without the notice with security seal, etc.

9.2.2 In the case where users are permitted to replace the light source unit

- (a) Depending on the class, the label for the access panel by class listed in Table 6.1.2 in this guideline should be placed on the light source cover.
- (b) As for the fixing means of the light source cover, the structure where users are able to open it easily is acceptable; however, in the case of opening the light source cover, it is to be designed

so as not to turn on the light source.

9.3 Requirements for the light source unit

In order to prevent the diversion of laser devices, its structure is to be designed so as the laser not easily to be removed from the light source unit.

Remark: These are applicable to the structure where the light source unit is removable from the projector.

For example,

- 1) Use the special screws for fixing the laser.
- 2) Use the security seal on the head of the special screws.
- 3) By applying an anaerobic adhesive to the screw for fixing the laser, the screw is broken in disassembling.

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9.4 Requirements in the case of breakage

In the case of housing breakage due to falling, etc., the structure is to be designed for the main light so as not to emit outside directly.

Remark: For example, to adopt double light shielding structure by the optical engine cover and housing cover

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9.5 Requirements for user's information

Alert users to the fact that the projector should not be disassembled, repaired, and reconstructed without careful consideration.

- (a) Describe in the operation manual that if the user disassemble, repair or modify the unit there is a serious problem about the safety of the user.
- (b) Design to identify easily that the unit is disassembled by the user

Remark: Prepare as a psychological alert for the easy disassembly by the user.

For example,

- 1) Seal the security seal to the eye-catching place by appearance.
- 2) By applying an anaerobic adhesive to the screw, the screw should be broken when disassembling,

Entrust specific countermeasures to manufacturers.

Anaerobic adhesive (JIS K 6800: 1985 Adhesive and adhesive terms)

The adhesive that hardening is inhibited by the existence of oxygen, and when oxygen is blocked out, it becomes hardened.

10 Safety guideline in the case of failure

10.1 Scope of the reasonably foreseeable failure

According to Section 9 in IEC 60825-1, the tests during operation to determine the classification of the product shall be made “under each and every reasonably foreseeable single-fault condition.”

Example of the reasonably foreseeable single-fault condition

- Breakage of the outer housing due to falling of the product.
- Breakage of the inner parts due to falling of the product.
- Failure of the drive circuit of the laser device as light source.
- Breakage of the diffuser of the laser light.
- Aged deterioration of the inner parts such as an optical element.
- Failure of the safety interlock.

10.2 Emission light from the projection lens

In the case of failure, the laser light emitted from the projection lens should not exceed the upper limit of the appropriate class. Particularly, in the failure mode where the degree of hazard is extremely high, the measures to control the emission of the projection light to outside must be taken immediately.

In addition, it is desirable that this protective mechanism is not automatically reset as long as user or the service person carries out a specific operation.

Remark: For example, in the case of the failure mode such as excursion laser output or breakage of the laser light diffuser,

- 1) Stop the power supply to the laser drive circuit and stop the laser light oscillation.
- 2) Block the laser light by using a mechanical shutter of light resistance/heat resistance.

Entrust specific countermeasures to manufacturers.

10.3 Leaked light

In the case of normal use or failure, the laser light leak from the place other than projection lens should not exceed the Class 1 AEL.

Around the optical path of the main light, the protective housing is to be installed in order to prevent the leak of the laser light which exceeds the Class 1 AEL; durability of such protective housing is required to secure the safety under the reasonably foreseeable single-fault condition (Section 10.1 in this guideline).

Remark: Entrust specific countermeasures for the material of protective housing to manufacturers.

As for the projector, the openings for intake air/exhaust air which are installed for cooling may be problematic sometimes; accordingly, it has to be designed for laser light which exceeds Class 1 AEL so as not to leak outside.

Remark: For example,

- 1) To employ the double structure protective housing which has the optical engine cover which covers the optical path of the main light and the housing cover.
- 2) To employ the structure where light does not leak outside by installing pass-each-other walls at the intake air/exhaust air openings.

Entrust specific countermeasures to manufacturers.

In addition, attention has to be paid that the laser light which exceeds Class 1 AEL does not leak outside from the joint of the protective housing. For this reason, it is desirable to design for laser light so as not to leak from the joint of the protective housing by employing the fit structure shown in the following Figure 10.3.1.

Meanwhile, the structure shown in Figure 10.3.1 is one example of prevention for laser light leak; Entrust specific countermeasures to manufacturers.

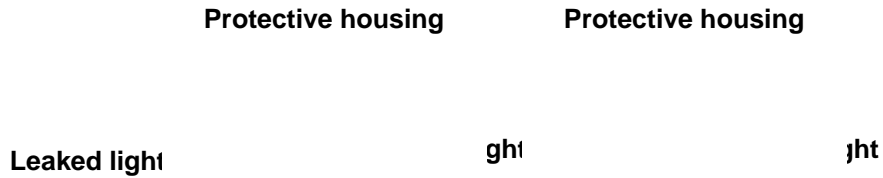


Figure 10.3.1 Example of the prevention for laser light leak by the protective housing

Remark: Entrust specific countermeasures for laser light leak from the protective housing to manufacturers.

10.4 Alert for users

It is hazardous to continue to use the projector in failure state; in some cases, it is likely to damage eye due to laser light. Therefore, it is desirable to alert users by writing down the following note in the operation manual.

- (a) Write down the fact that use of a broken product is not only the cause of “electric shock” and “fire” but also is the cause of eye injury.
- (b) Alert users that when the trouble is found, immediately stop the use, and ask the dealer to repair it.

Single-fault condition (IEC 60825-1: 2007/JIS C 6802: 2011)

All single-fault conditions occur in a product, and the conditions include the inevitable consequent directly caused by such a failure.

11 Others

11.1 Requirements in manufacturing

In manufacturing a projector which uses laser device as light source, it is desirable to prevent workers from exposure to laser light emission which exceeds Class 1 AEL in order to protect workers' eye damages; otherwise, it is necessary to take measures listed in Table 6.1.1 and Table 6.2.1 through Table 6.2.3 in Section 6 in this guideline depending on the emitted laser light class.

Remark: For example, in assembling work of the laser device as light source, so as not to exceed Class 1,

1) By preparing a protective housing for the assembly, and the structure is to be designed so as not be energized unless the laser device as light source is covered.

2) In the assembly work, laser's drive current value should be controlled so as not to emit the laser light exceeds Class 1 .

Entrust specific countermeasures to manufacturers.

Particularly, even though in case of malfunction during the assembly work, in order to protect worker's eye, it is necessary to make arrangements that the assembly work is to be performed at the position where the laser light does not come to worker's eye level and the laser light does not emit toward the worker. In addition, during the assembly work, in order to avoid laser light unexpected specular reflection, due attention has to be paid concerning the surrounding work environment and worker's accessories.

The structure is to be designed so that when the housing cover or light source cover is opened, the light source does not light, or the main light beam cannot be seen.

- The structure is to be designed so that when the housing cover is opened, the light does not light, or the main light cannot be seen in the case of the laser emission exposure exceeding Class 3B or more.
- The structure is to be designed so that when the light source cover is opened, the light does not light, or the main light cannot be seen in the case of the laser emission exposure exceeding Class 1.

Remark: For example,

1) Lighting of the light source is to be controlled by installing an access sensor on the housing cover.

2) Lighting of the light source is to be controlled by installing an access sensor on the light source cover.

Entrust specific countermeasures to manufacturers.

Safety and health education listed in Table 6.2.2 in Section 6 in this guideline should be provided to workers without fail, and it is necessary to let workers know the risk of the laser light.

11.2 Requirements for servicing information

Based on Section 6.2 in the IEC 60825-1, the maintenance schedule necessary to maintain the products, avoidance measures for laser emission exposure, clear alerts to avoid other hazards and the notes of caution should be included in the servicing information for the adjustment work and its procedures of each product for the service agent, retailer, and other persons who request them.

Furthermore, these servicing information must include clear directions about the position of the removable part of the protective housing which may cause laser emission exposure exceed given product's AEL, and the procedures available to persons other than the manufacturers and their agents to increase the laser emission exposure level, the procedures to protect service persons, and clear copies (color is free) of the required labels and hazard warning.

The following matters should be included in the servicing information.

- (a) Maintenance schedule for the service person necessary for maintenance of the product.

Remark: This is designated by the manufacturers, and it is assumed that this is carried out by the service person has special knowledge; accordingly, it is not intended to be carried out by users.

- (b) Warning to avoid the possibility of hazardous laser emission exposure which exceeds Class 1 AEL.

Remark: For example,

- 1) Warning that if you open the protective housing, it is likely to be exposed to hazardous laser emission.
- 2) Warning that you should not look into the laser light
- 3) Warning that if you ignore the warning, there may be serious damage to the human body.

As for the statement, it is desirable to use the standardized phrase among manufacturers.

- (c) In the safety equipment required by the standards, the functions known to the service person who has been designated by the manufacturer and has special knowledge in performing service procedures, must be written down in the servicing information.

Remark: The unlock mechanism of the safety interlock and the notice of warning during unlocking are included.

- (d) Description of the position of removable protective housing. In the case of the protective housing which has the mechanism to unlock the safety interlock, the description of the position of the safety interlock, and the unlock method.
- (e) The list of laser emission control methods, and control position in the service procedures.

Remark: The method of the laser oscillation and the method of control equipment which is able to control the laser output and the position of it are equivalent to this.

- (f) Clear copies (color is free) of all labels stuck to the laser product, and description of the position stuck. As to description the positions, it is desirable to show them diagrammatically.

11.3 Requirements in the case of disposal

- (a) In the case of disposal of the projector, the disposal should comply with the law and ordinance of each country without disassembling it; this should be written down in the servicing information.
- (b) As to handling of disassembly by a collection trader, it should comply with the provisions in Section 9 Safety guideline for disassembly in this guideline.

11.4 Requirements concerning optional lens

This section is applicable to only the projector with interchangeable optional lens.

If the projection lens is replaced while the light source is lighted, the strong light from inside of the projector is projected toward the screen, so risks of “electric shock” as well as “impairment of eyesight” are concerned.

For this reason, the following safety measures must to be taken.

- (a) Alert in the servicing information

The note of caution that in the case of removal of the projection lens or replacement of the projection lens, such should not be performed in the power-on state is to be written down in the servicing information.

- (b) Even in the state of being removed of the projection lens, the projector is to be designed so that the laser light exceeds the specified AEL of the projector does not leak outside.

Remark: For example, as to the safety lock mechanism, it is to be designed so that in the state of being removed of the projection lens, the light source does not light.

Entrust specific countermeasures to manufacturers.

12 Organization table of Draft preparing committee

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(Chief of the Group)	Minoru KATO	Hitachi Maxell, Ltd.
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	Yasuhito SATO	Sharp Corppration
	Satoshi OHNO	Sony Corporation
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Reference

- 1) IEC 60825-1:2007
Safety of laser products - Part1 : Equipment classification and requirements
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