JBMS

Safety requirements for the projectors with laser device as light source

JBMS-86 : 2018

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Japan Business Machine and Information System Industries Association

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Foreword

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Japan Business Machine and Information
System Industries Association Standard

JBMS-86 : 2018
(2023 Confirm)

Safety requirements for the projectors with laser device as light source

Introduction

This document specifies the requirements explicit for safe use of the projectors with laser device as light source.

Regarding projection light from image projector, new international standards have revised or established. In **IEC 60825-1**:2014, projection light from image projectors with fixed resolution light valves can be treated as general light, and **IEC 62471** series is applicable. In Japan, new **JIS Standard JIS C 6802**:2014 harmonized with **IEC 60825-1**:2014 has been established. In June 2015, projector specific standard **IEC 62471-5**:2015 (Photobiological safety of lamps and lamp systems – Part 5: Image projectors) has established as a vertical standard of **IEC 62471** series.

In this document, requirements for projectors with laser light source and requirements for projection light as same hazard level of general light are specified.

For Image projectors, the product standard used to be JIS C 6950-1 (International standard IEC 60950-1). And for its light emission including projection light shall refer to IEC 60825-1:2014.

Recently the product JIS C 6950-1 is transferring to IEC 62368-1. The contents of this document remain the same. Even though IEC 62368-1:2104 do not refer IEC 60825-1:2014, the concept of laser safety are not affected.

The object of this document is to make clear the minimum requirements for projectors the projection light of which is evaluated under **IEC 62471-5** according to **JIS C 6802** so as to be able to secure the safety under all conditions of sales, operation, maintenance, service and failure. These requirements are shown in Clauses 4 to 6. And original requirements of this document are shown in Clause 7.

- Clause 4 : Interpretations of the projection light from a projector
- Clause 5 : Safety of laser products
- Clause 6 : Safety standard for projection light of projectors
- Clause 7 : Original requirements to be considered for laser projectors

1 Scope

This document is applicable to the projectors which use laser device as the light source and the fixed resolution light valves such as Liquid-Crystal Display (LCD) and Digital Micromirror Device (DMD) 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 document is not applicable to the type of projectors which project images onto a screen by scanning laser light on the screen. Furthermore, this document is not applicable to the projectors used as toys for children. In addition, such projecor is to comply with the domestic regulations of each country (Example: Consumer Products Safety Act, Electrical Appliance and Material Safety Law, etc.).

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

JIS C 6802:2014, Safety of laser products

NOTE Correspondent international standard: **IEC 60825-1**:2014, Safety of laser products – Part 1: Equipment classification and requirements**(IDT)**

JIS C 6950-1, Information technology equipment - Safety - Part 1: General requirements

NOTE Correspondent international standard: **IEC 60950-1**, Information technology equipment – Safety – Part 1: General requirements**(MOD)**

JIS X 6911, Information to be included in specification sheets - Data projector

ISO/IEC 21118, Information technology - Office equipment Information to be included in specification sheets - Data projectors

IEC 61947-1, Electronic projection - Measurement and documentation of key performance criteria – Part 1: Fixed resolution projectors

IEC 62471, Photobiological safety of lamps and lamp systems

NOTE Correspondent Japanese Industrial Standard: **JIS C 7550** Photobiological safety of lamps and lamp systems (MOD)

IEC 62471-5:2015, Photobiological safety of lamps and lamp systems – Part 5: Image projectors

Preventive measures for hazard due to laser beam (Ministry of Health,Labour and Welfare: Notification No.39 / Notification No.0325002 (Revised))

IEC 62368-1:2014, Audio/video, information and communication technology equipment – Part 1: Safety requirements

3 Terms and definitions

For the purposes of this document, the terms and definitions given in **JIS C 6802**, **JIS X 6911**, **ISO/IEC 21118**, **IEC 61947-1** and the following apply.

3.1

Protective housing

Component (usually attached by manufacturers) of laser products (including built-in laser products) which is designed so as to protect the laser emission exposure which exceeds regulated AEL (see 3.11) to the human body.

It is a collective term for a housing cover, light source cover, and optical engine cover (see Figure 1)

3.2

Housing cover

Protective housing which composes the utmost outer cover or case (see Figure 1).

3.3

Light source cover

Part of the housing cover which is opened or closed when attaching or removing of the light source unit, or access to the light source unit (see Figure 1).

3.4

Light source unit

Light source which is to be incorporated in the system as the source of the projection light of the projector, or assembly part composed of the light source and its holding components (see Figure 1),

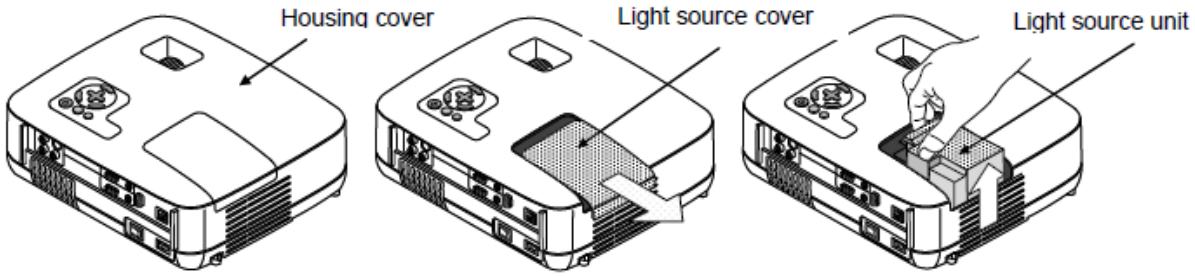


Figure 1 - Protective housing and light source unit of a projector

3.5

Optical engine

Assembly parts which composes the light source unit and 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

Protective housing which composes a part of the optical engine (see Figure 2).

3.7

Security seal

Seal which is once peeled off, it cannot be stuck again, so that the peeled evidence can be found.
It includes 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

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

3.9

Main light beam

Light beam which emits to the outgoing direction of the optical path of the optical engine (see Figure 2).

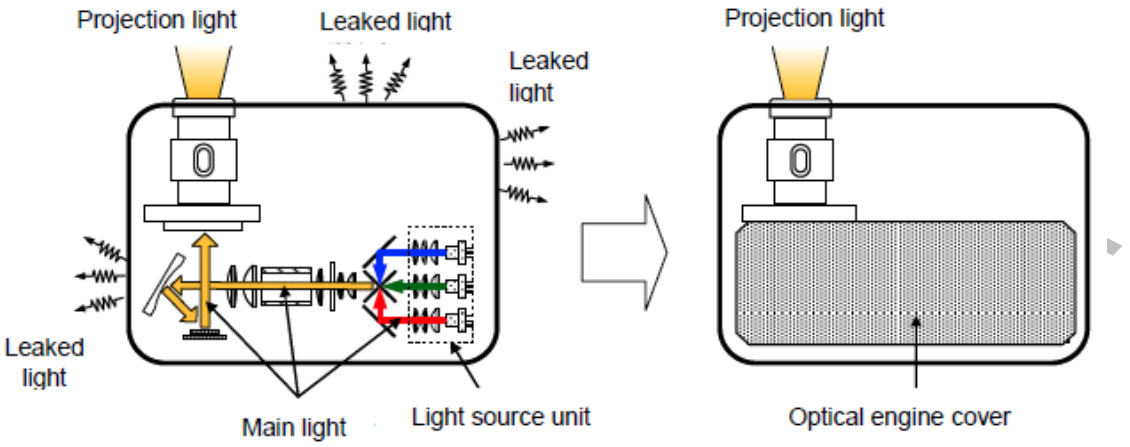


Figure 2 - Main light and leaked light, and optical engine cover

3.10

Collateral radiation

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.

[**JIS C 6802 (IEC 60825-1)**]

3.11

Accessible emission limit

AEL

The maximum accessible emission permitted within a particular class.

[**JIS C 6802 (IEC 60825-1)**]

3.12

Spatial coherence

Amount to indicate the degree of light wave coherency at different points, which is expressed by the degree of correlation at different points of the same spot.

[**JIS Z 8120**]

NOTE It is a 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. Put simply, it means “characteristic features that beam go straight without diffusion”.

3.13

Temporal coherence

Amount to indicate the degree of light wave coherency at different time points, which is expressed by

the degree of correlation at different time points of the same spot.

[**JIS Z 8120**]

NOTE It is a scale to represent how far the periodicity of 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. Put simply, it means “narrow spectrum or highly monochromatic characteristics”.

3.14

Access panel

Part of the protective housing or enclosure which provides access to laser radiation when removed or displaced.

[**JIS C 6802** (**IEC 60825-1**)]

3.15

Safety interlock

automatic device associated with each portion of the protective housing of a laser product to prevent human access to Class 3R, Class 3B or Class 4 laser radiation when that portion of the housing is removed, opened or displaced.

[**JIS C 6802** (**IEC 60825-1**)]

3.16

Remote interlock connector

connector which permits the connection of external controls placed apart from other components of the laser product.

3.17

Anaerobic adhesive

adhesive that cures in the absence of oxygen, curing being inhibited by the presence of oxygen and catalyzed by metallic ions.

[**JIS K 6900**]

3.18

Single fault condition

any single fault that might occur in a product and the direct consequences of that fault.

[**JIS C 6802** (**IEC 60825-1**)]

3.19

Throw ratio

Ratio between distance from the exit pupil to the screen *L* and the width of the projected image *W.*

Throw ratio is given by *L/W*.

3.20

Exit pupil

In the case of projectors, it means a virtual image of the aperture stop seen when staring into the projection lens.

3.21

Maximum permissible exposure

MPE

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

[**JIS C 6802** (**IEC 60825-1**)]

3.22

Nominal ocular hazard distance

NOHD

Distance from the output aperture beyond which the beam irradiance or radiant exposure remains below the appropriate corneal maximum permissible exposure (MPE).

NOTE If the NOHD includes the possibility of viewing through optical aids, this is termed the "extended NOHD (ENOHD)".

［**JIS C 6802** (**IEC 60825-1**)］

3.23

Hazard distance

HD

Distance where accessible emission becomes equal to the RG2 AEL when staring into the projection light.

NOTE 1 The origin of the distance is the closest point of human access (for instance, the front lens surface)..

NOTE 2 Projectors whose hazard distance exceed 1 m are classified into RG3..

4 Interpretations of the projection light from a projector

Biomedical safety and interpretation of the safety standards concerning the projection light from the projector are written down in this clause. As for projectors without laser device as light source are out of coverage of this document. Those do not meet migration conditions in 4.4 in **JIS C 6802** (**IEC 60825-1**) are omitted from this document as well. As to leaked light except the projection lens, classification and handling based on it is required in **JIS C 6802** and shall comply with clause 5.

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 (LCD, 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 3 (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 3 (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.

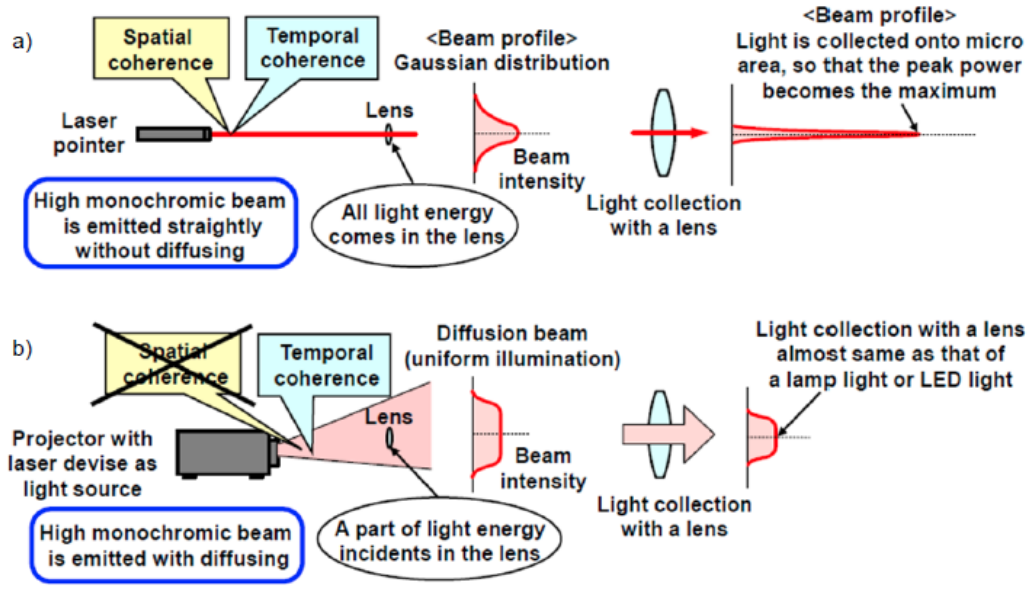


Figure 3 - Light-collection difference between a laser pointer and projector with laser device as light source

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

NOTE 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.

4.1.2 Interpretation concerning safety standards

In the case of the front projector that illuminates light valve with diffused laser light and projects it onto the screen, an exceptive clause for risk evaluation is defined by revised **JIS C 6802**.

When projection light fulfills the following conditions, there is no necessity for risk evaluation under laser safety standards, and that may be evaluated with **IEC 62471** series which are general lamp standards include lamps and LEDs.

- About the radiation light of laser application products, that light source (light emitting part) is not a point source.
- The maximum brightness (the maximum radiance) of the light source (light emitting part) which has

angular subtense more than 5 mrad by distance 200 mm is 1/*α***(MW· m-2· sr-1)**or below .
α means angular subtense of apparent source and its unit is radian. Here apparent source means real or virtual object that forms the smallest retinal image. In the case of projectors, apparent source is considered to be exit pupil of the projection lens that can be seen when staring into the projection light. However, the leaked light out of the housing from the light source and optical path of the optic block except the light emitted from the projection lens, are subject to classification according to the conventional laser light (detailed criteria and methods for determination are described in Clause 5).

In Japan, as for the Electrical Appliance and Material Safety Law, which includes multiple normative references, JIS C 6950-1:2012 has been referred as safety standard concerning projectors, so the latest version for IEC 60825-1 and JIS C 6802 are available as the normative reference of safety standards of laser application products. IEC 62471-5:2015 is also applicable.
As described above, legal changes harmonized with the above new standards have been completed.
As for international standards, it has been confirmed at the general meeting (2017/10, Toronto) has been published as the successor standards of IEC 60950-1, would be able to refer to the latest safety standards (IEC60825-1:2014, IEC62471-5:2015) for the projector using laser as light source. This interpretation was published as INF Document (108/697/INF).
It is also being discussed about the Introduction of this interpretation into the IEC62368-1 standard (it would be 3rd-edition).
Therefore, the interpretation for the safety standards of laser application products concerning projector will be unified.
In each country, including Japan, the progress of legal changes may differ. It is required to follow the applicable standards in each regulation.

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 (LCD, 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 already 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 safety standards

As described in 4.1.2, related safety standards have been revised and in the case of the front-projection type projector where luminescence (collateral radiation) excited by laser light is projected on the screen through projecting it to the light valve, all projection light including luminescence excited by laser are handled by said **IEC 62471-5**. Accordingly, it is unnecessary to determine whether the luminescence excited by laser, is laser light (coherent light) or not.

4.3 Safety standards application flowchart

Application flows of various types of safety standards are shown in Figure 4. Although details are to be referred to each safety standard, points of determination are described at the clauses shown in the flowchart.

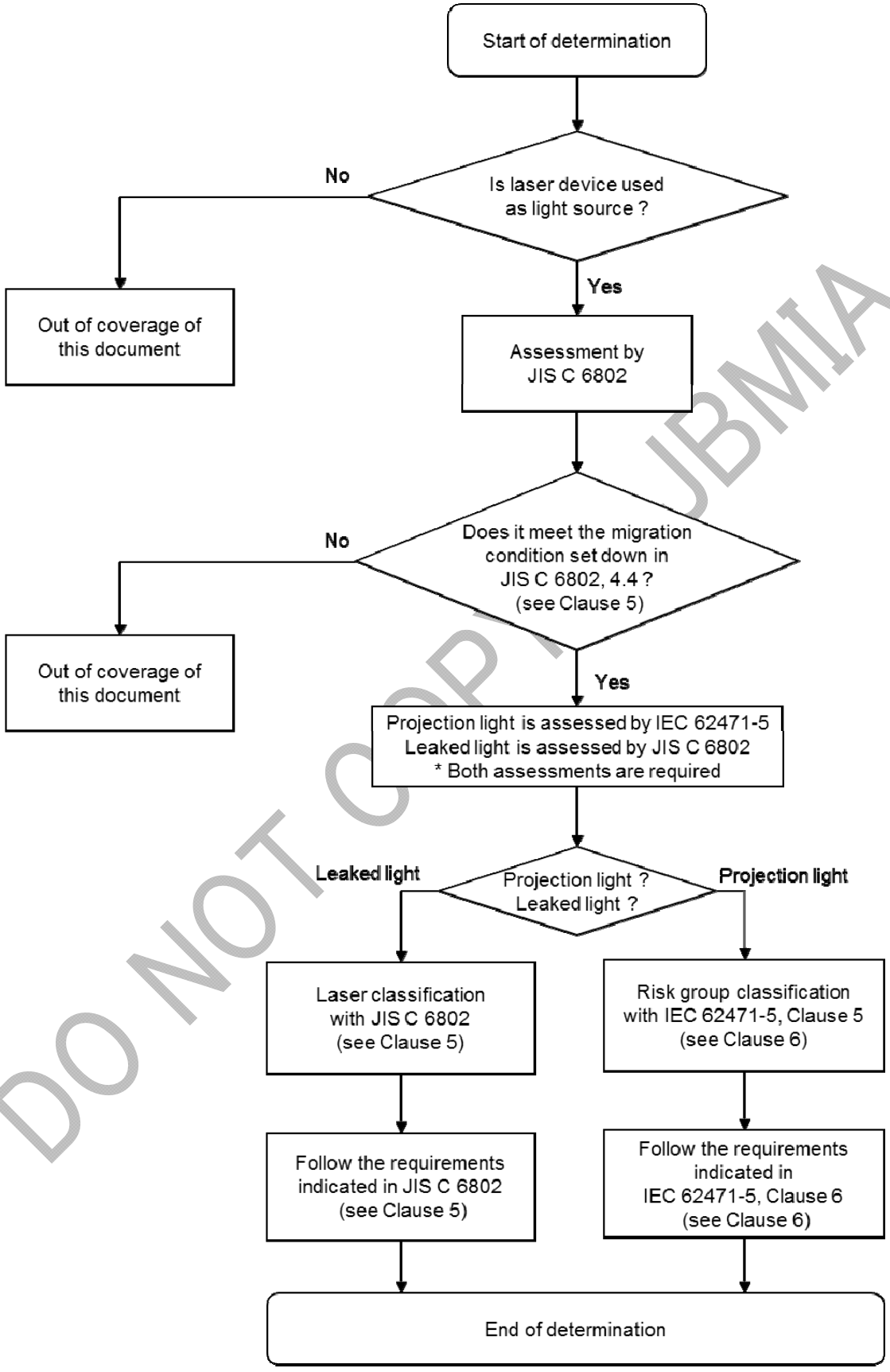


Figure 4 - Flow of various types of safety standards (Flowchart)

4.4 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 4.1 and 4.2.

Handling determination of these projections light is left to manufacturers or its agents (see **JIS C 6802** (**IEC 60825-1**), 4.2).

5 Safety of laser products

The projectors determined to meet conditions set forth in subclause 4.4 in **JIS C 6802** (**IEC 60825-1**) as a result of assessment of the projection light of the projectors going with the safety standards application flow shown in Figure 4, the projection light can be treated same as that of general-use light, so the assessment according to **IEC 62471-5** becomes possible.

As for the leaked light and the projection light fail to meet requirements, they are to be generally classified into seven levels – from Class 1 (safe) to Class 4 (the highest risk) according to the degree of risk. Classification of projectors is carried out by the manufacturers or its agents according to Clauses 4 and 5 in **JIS C 6802** (**IEC 60825-1**). That is, if it meets **JIS C 6802** (**IEC 60825-1**) 4.4 and its leaked light does not exceed the limit of Class 1, such a laser product is treated as Class 1. However, as to the access panel, measures are subject to the highest laser class of exposure to laser are required when the user remove the access panel. Furthermore, in manufacturing processes, necessary measures to protect workers from ocular hazard have to be taken depending on the laser class used for the light source.

This clause shows the outline of the laser classification and measures to prevent injuries. As for the leaked light other than projection light and the projector which does not meet the conditions set forth in 4.4 in **JIS C 6802** (**IEC 60825-1**), the assessment and measures set forth in **JIS C 6802** (**IEC 60825-1**) required.

NOTE 1 As for the projection light of the projector which meets the conditions in **JIS C 6802** (**IEC 60825-1**) 4.4, the assessment and measures set forth in **IEC 62471-5** as explained in Clause 6.

NOTE 2 Class 1C is newly added in the **JIS C 6802**: 2014 (**IEC 60825-1**:2014), however this class is mainly for beauty products, so this is omitted from this document.

5.1 Classification of laser products

The following classification quoted from Section 8.2 “Explanation of the laser class (p.50)” in Part 1 in “Laser safety guidebook: 4th edition” edited by Optoelectronics Industry and Technology Development Association published by Advanced Communication Media Co., Ltd.

a) 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.

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

b) 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 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 4 000 nm. Intrabeam viewing of Class 1M laser products which emit visible radiant energy may still produce dazzling visual effects, particularly in low ambient light.

NOTE This is a 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.

c) Class 2

Laser products that emit visible radiation in the wavelength range from 400 nm to 700 nm 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.

NOTE The upper power limit is 1 mW (if light source angular subtense is less than 1.5 mrad), 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.

d) 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).

NOTE It is class like Class 1M in that it is safe for the naked eye. Accordingly, the observation with the optical system may damage eye.

e) Class 3R

Laser products that emit radiation can exceed the MPE under direct intrabeam viewing. But the risk of injury in most cases is relatively low. Because of the lower risk, fewer manufacturing requirements and control measures for the user apply than for Class 3B.

NOTE The AEL of Class 3R (for non-visible laser beams) is 5 times the AEL of Class 1. And the AEL of Class 3R (for visible laser beams) is 5 times the AEL of Class 2.

f) 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.

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

g) 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.

NOTE 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.

5.2 Measures to prevent damages due to laser light

5.2.1 Manufacture's requirements

JIS C 6802 (**IEC 60825-1**) concerning laser products safety is to require manufacturers to take measures listed in Table 1 in order to prevent damages due to laser light.

Table 1 - Summary of manufacture's requirements (1 of 2)

<table>
<tr><th rowspan="2">Requirement subclauses</th><th colspan="7">Classification</th></tr>
<tr><th>Class 1</th><th>Class 1M</th><th>Class 2</th><th>Class 2M</th><th>Class 3R</th><th>Class 3B</th><th>Class 4</th></tr>
<tr><td>Description of hazard class</td><td>Safe under reasonably foreseeable conditions</td><td>As for Class 1 except may be hazardous if user employs optics</td><td>Low power; eye protection normally afforded by aversion responses</td><td>As for Class 2 except may be more hazardous if user employs optics</td><td>Direct intra-beam viewing may be hazardous</td><td>Direct intra-beam viewing normally hazardous</td><td>High power; diffuse reflections may be hazardous</td></tr>
<tr><td>Protective housing</td><td>Required for a built-in laser product</td><td colspan="6">Required for each laser product; limits access necessary for performance of functions of the products</td></tr>
<tr><td>Access panel and safety interlock</td><td colspan="4">Shall be designed to prevent removal of the panel until accessible emission values are below that for Class 3R</td><td colspan="3">Shall be designed to prevent removal of the panel until accessible emission values are below that for Class 3B or 3R for some products</td></tr>
<tr><td>Remote Interlock</td><td colspan="5">Not required</td><td colspan="2">Permits easy addition of external interlock in laser installation</td></tr>
<tr><td>Manual Reset</td><td colspan="6">Not required</td><td>Requires manual reset if power interrupted or remote interlock is actuated</td></tr>
<tr><td>Key control</td><td colspan="5">Not required</td><td colspan="2">Laser inoperative when key is removed</td></tr>
<tr><td>Emission warning device</td><td colspan="4">Not required</td><td colspan="3">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</td></tr>
<tr><td>Attenuator</td><td colspan="5">Not required</td><td colspan="2">Gives means to temporarily block beam</td></tr>
<tr><td>Location controls</td><td colspan="4">Not required</td><td colspan="3">Controls so located that there is no danger of exposure to AEL above Classes 1 or 2 when adjustments are made</td></tr>
<tr><td>Viewing optics</td><td colspan="2">Not required</td><td colspan="5">Emission from all viewing systems must be below Class 1M AEL</td></tr>
<tr><td>Class label</td><td colspan="2">Required wording</td><td colspan="5">Figure 3 and Figure 4 and required wording in the IEC60825-1</td></tr>
<tr><td>Aperture label</td><td colspan="4">Not required</td><td colspan="3">Specified wording required</td></tr>
<tr><td>Label to access panel</td><td>Not required</td><td colspan="6">Required as appropriate to the class of accessible radiation</td></tr>
</table>

Table 1 - Summary of manufacture's requirements (2 of 2)

<table>
<tr><th rowspan="2">Requirement subclauses</th><th colspan="7">Classification</th></tr>
<tr><td>Class 1</td><td>Class 1M</td><td>Class 2</td><td>Class 2M</td><td>Class 3R</td><td>Class 3B</td><td>Class 4</td></tr>
<tr><td>Safety interlock and label to panel</td><td colspan="7">Required under certain conditions as appropriate to the class of laser used</td></tr>
<tr><td>Warning to visible/invisible laser radiation</td><td colspan="7">Required for certain wavelength ranges</td></tr>
<tr><td>Heat injury warning label</td><td colspan="5">If the accessible emission at the nearest point (aperture 3.5 mm) exceeds the AEL of class 3B, additional description is necessary.</td><td colspan="2">Not required</td></tr>
<tr><td>Radiation output label</td><td>None</td><td colspan="6">Cautionary statement is necessary.</td></tr>
<tr><td>Standard information label</td><td colspan="2">It is necessary in product or information to end-user.</td><td colspan="5">Cautionary statement is necessary.</td></tr>
<tr><td>User information</td><td colspan="7">Operation manuals must contain instructions for safe use. Additional requirements apply for Class 1M and Class 2M</td></tr>
<tr><td>Purchasing and service information</td><td colspan="7">Promotion brochures must specify product classification; servicing manuals must contain safety information</td></tr>
<tr><td colspan="8">Note 1 The related part is extracted from Table F.2 in JIS C 6802: 2014 (IEC 60825-1:2014).
Note 2 As to details of each item, see Clause 6 “Engineering specifications” in JIS C 6802:2014 (IEC 60825-1:2014).</td></tr>
</table>

5.2.2 Measures standards by class for the laser equipment

Meanwhile, in Japan, “Preventive measures for hazard due to laser beam” was prepared by Ministry of Health,Labour and Welfare in order to prevent damage from workers who engage in business to handle laser equipment.

Tables 2 to 4 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”. These are applied in order to secure workers’ safety, who engages in the projector manufacturing and its service.

NOTE 1 Business operators operate business and employ workers (From Article 2 in the Industrial Safety and Health Act).

NOTE 2 “Measures standards by laser equipment class” is based on Ministry of Health,Labour and Welfare’s Notification No.0325002 (March 25, 2005) “Preventive measures for hazard due to laser beam” and its exhibit; here the laser products of Class 1 and Class 2 are not included in the scope.

NOTE 3 In the case of revision of the Ministry of Health,Labour and Welfare’s “Preventive measures for hazard due to laser beam, the latest ruling is applicable.

Table 2 - List of measures standards by laser equipment class (Part 1) (1 of 3)

Item	Laser equipment class						Description of measures
	1	1M	3R [a]		3B	4	
	2	2M	Visible	Invisible			
Appointment of the person in charge of laser equipment				○	○	○	The person in charge of the laser equipment shall 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 shall be partitioned from other areas by fence, etc., and shall be clearly specified by signs, etc. Only authorized persons are allowed to enter the laser controlled area, and measures such as auto-lock, etc., shall be taken at the entrance as needed. Persons other than authorized persons need to enter the laser control area; they shall be act under supervision of the person in charge of the laser equipment.

Table 2 - List of measures standards by laser equipment class (Part 1) (2 of 3)

Item			Laser equipment class						Description of measures
			1	1M	3R [a]		3B	4	
			2	2M	Visible	Invisible			
Laser equipment	Laser light path	Position of the laser light path		○	○	○	○	○	The laser light path shall be set avoiding the eye level of workers.
		Appropriate design and shielding of the light path				○	○	○	The laser light path shall wherever possible have minimum distance and kinks, and shall not cross the walkway and other pathways, and shall be shielded. a) Around the place to install the laser equipment, the fence to shield the laser beam shall be set up. b) The fence shall be opaque, absorbable, and non-flammable against laser light. c) Inside of the fence shall be assigned as a controlled area.
		Appropriate terminal		○ [b]		○	○	○	The terminal of the laser light path shall be diffuse reflective material or diffuse absorption materials.
	Key control						○	○	Laser equipment structure shall 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 shall 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 shall be installed.
		Shutter					○	○	At the emission hole of the laser light of the laser equipment, a shutter shall be installed in order to prevent unintentional emission of the laser light.

Table 2 - List of measures standards by laser equipment class (Part 1) (3 of 3)

Item		Laser equipment class						Description of measures
		1	1M	3R [a]		3B	4	
		2	2M	Visible	Invisible			
	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 shall be taken to prevent laser light emission.
	Indication of emission hole			○	○	○	○	At the emission hole, such indication shall be placed.

NOTE The symbol “circle (○) ” means actions are required.
a Visible light is the light of 400 nm through 700 nm wavelength, and invisible light is the light of wavelength other than such wavelength.
b As for the laser equipment listed in **JIS C 6802**:2014, Annex JA, JA 1.6, the laser light terminal treatment is required.

Table 3 - List of measures standards by laser equipment class (Part 2) (1 of 3)

Item			Laser equipment class						Description of measures
			1	1M	3R [a]		3B	4	
			2	2M	Visible	Invisible			
Work management/Health management	Operating position							○	Operation of laser equipment shall 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 shall be carried out with the minimum power output of the laser light
	Protective equipment	Protective eyeglasses				○	○	○	Effective eyeglasses shall 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 shall be used.)
		Working clothes with less skin exposure					○	○	
		Use of flame resistance materials						○	Working clothes with less skin exposure and of nonflammable materials shall be worn by workers. In particular, chemical fiber clothes which become a ball when melted is undesirable.

Table 3 - List of measures standards by laser equipment class (Part 2) (2 of 3)

Item		Laser equipment class						Description of measures
		1	1M	3R [a]		3B	4	
		2	2M	Visible	Invisible			
	Checkout / Maintenance		○	○	○	○	○	Before starting work, let the person in charge of the laser equipment check the laser light 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. 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.

Table 3 - List of measures standards by laser equipment class (Part 2) (3 of 3)

Item			Laser equipment class						Description of measures
			1	1M	3R [a]		3B	4	
			2	2M	Visible	Invisible			
	Safety and health education			○	○	○	○	○	If 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 shall be carried out. In this case, particularly keep in mind the following items are to be included. [Contents of the safety and health education] a) Behaviour, risk and hazardousness of the laser b) The principle and structure of the laser equipment c) Handling methods of the laser equipment d) Functions and handling methods of the safety equipment and protective equipment e) Actions and evacuation in case of emergency
	Health management	Anterior eye check (cornea, crystalline lens)				○	○	○	As to workers who usually engage in the laser work, if they are newly employed or change of the job, in addition to eyesight check, anterior eye (cornea, crystalline lens) examination and fundus examination shall be carried out.
		Fundus examination						○	

NOTE The symbol "○" means actions are required.

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

Table 4 - List of measures standards by laser equipment class (Part 3)

Item			Laser equipment class						Description of measures
			1	1M	3R [a]		3B	4	
			2	2M	Visible	Invisible			
Others	Notice	The person in charge of the laser equipment				○	○	○	The following items shall be noticed at the easy-to-see place such as the entrance of the laser controlled area. a) Name of the person in charge of the laser equipment b) Risk, hazardousness of the laser light, and precautions in handling the laser equipment c) Notice of the laser equipment installation
		Risk Hazardousness Items to handle with care		○	○	○	○	○	
		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 shall be noticed, and measures to prevent electric shock by touching such parts shall be taken as well.
	No carry-in hazardous materials						○	○	Explosive materials, flammable materials, etc., shall 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 shall 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.

NOTE The symbol "○" means actions are required.

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

5.3 Indication on product

As for the projectors designed to function as conventional lamps, assessment of safety of its emission light by **IEC 62471** standards group is accepted in the latest laser safety standards (see **JIS C 6802** (**IEC 60825-1**:2014), 4.4). However, as for the leaked lights other than the projection light, they are required to be classify according to **JIS C 6802** (**IEC 60825-1**), so placement of labels on the laser product bodies having such projectors shall follow the label indication directions set down in Clause 7 in **JIS C 6802** (**IEC 60825-1**). Furthermore, they are required to follow the indication requirements in **IEC 62471-5** as described in Clause 6.

5.3.1 Labelling on the projector

Labelling on projector shall comply with the directions for labels shown in Clause 7 in **JIS C 6802** (**IEC 60825-1**). Durable labels shall be stuck, or they can be directly printed or engraved on the projector.

a) Warning label

The symbol, outline, color, and size of the warning label shall comply with Figure 3 in **JIS C 6802** (**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.

b) Explanatory label

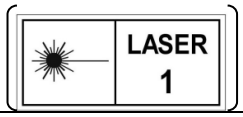
The symbol, outline, color, and size of the explanatory label shall comply with Figure 4 or Figure 5 to Figure 12 in **JIS C 6802** (**IEC 60825-1**). These dimensions are recommended values. As for the projectors that fill the condition of laser safety standards (see **JIS C 6802** (**IEC 60825-1**:2014), 4.4) shall be required the explanatory label for Class1 on the product.

c) Aperture label

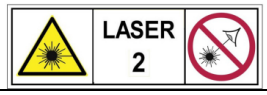
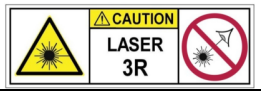
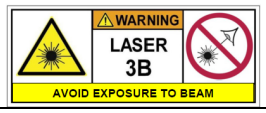
Each Class 3R, Class 3B and Class 4 laser product shall have affixed a label close to each aperture through which laser radiation in excess of the AEL for Class 1 or Class 2 is emitted. The label(s) shall bear the words listed in Table 5 with arbitrary character size.

(see **JIS C 6802** (**IEC 60825-1**), 7.8)

Table 5 - Requirement for labeling and the words

<table>
<tr><th>Product class</th><th>Alarm label</th><th>Explanatory label</th><th>Alternative Label</th><th>Aperture label</th></tr>
<tr><td>Class 1</td><td rowspan="2">Unnecessary</td><td>CLASS 1 LASER PRODUCT [a.b]</td><td> 

[a,b]</td><td rowspan="3">Unnecessary</td></tr>
<tr><td>Class 1M</td><td>LASER RADIATION
DO NOT EXPOSE USERS OF
TELESCOPIC OPTICS
CLASS 1M LASER PRODUCT [a]</td><td> 

[a]</td></tr>
<tr><td>Class 2</td><td rowspan="5">Necessary</td><td>LASER RADIATION
DO NOT STARE INTO BEAM
CLASS 2 LASER PRODUCT</td><td> 
</td></tr>
<tr><td>Class 2M</td><td>LASER RADIATION
DO NOT STARE INTO THE BEAM
OR EXPOSEUSERS OF
TELESCOPIC OPTICS
CLASS 2M LASER PRODUCT</td><td> 
</td></tr>
<tr><td>Class 3R</td><td>LASER RADIATION
AVOID DIRECT EYE EXPOSURE
CLASS 3R LASER PRODUCT</td><td> 
</td><td rowspan="3">LASER
APERTURE
or
APERTURE FOR
LASER
RADIATION
or
AVOID
EXPOSURE –
LASER
RADIATION IS
EMITTED FROM
THIS APERTURE
OR
THE LABEL
BELOW
  </td></tr>
<tr><td>Class 3B</td><td>WARNING - LASER RADIATION
AVOID EXPOSURE TO BEAM.
CLASS 3B LASER PRODUCT</td><td> 
</td></tr>
<tr><td>Class 4</td><td>DANGER - LASER RADIATION
AVOID EYE OR SKIN EXPOSURE
TO DIRECT OR SCATTERED
RADIATION
CLASS 4 LASER PRODUCT</td><td> 
</td></tr>
<tr><td colspan="5">NOTE [a] Instead of the explanatory labels, at the discretion of the manufacturer, the same statements may be included in the information for the user.
[b] As for the projectors that fill the condition of laser safety standards (see JIS C 6802 (IEC 60825-1:2014), 4.4) shall be required the explanatory label for Class1 on the product.</td></tr>
</table>

d) Labels for access panels

According to **JIS C 6802** (**IEC 60825-1**), the access 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 6 is written down. (see **JIS C 6802** (**IEC 60825-1**), 7.10)

NOTE Depending on presence or absence of the safety interlock on the panel, contents of phrase to write down are different (see Table 6).

The term access panel means part of protective housing or enclosure, and a movable part set in one step of work procedures (to open the access panel) enables the laser product exert its necessary functions. In a projector, it corresponds to the light source cover if the manufacturer permits change of light source unit by the user. Also the optical cover included in part of the optical engine is applicable if the worker likely to be exposed to higher radiation by opening it during servicing.

Table 6 - 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 [a]	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 TELESCOPES	CAUTION－ CLASS 1M LASER RADIATION WHEN OPEN AND INTERLOCKS DEFEATED DO NOT VIEW DIRECTLY WITH TELESCOPES
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 TELESCOPES [b]	CAUTION－ CLASS 2M LASER RADIATION WHEN OPEN AND INTERLOCKS DEFEATED DO NOT STARE INTO THE BEAM OR VIEW DIRECTLY WITH TELESCOPES
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	WARNING – [c] CLASS 3B LASER RADIATION WHEN OPEN AVOID EXPOSURE TO THE BEAM [c]	WARNNING－ CLASS 3B LASER RADIATION WHEN OPEN AND INTERLOCKS DEFEATED AVOID EXPOSURE TO THE BEAM
Class 4	DANGER – CLASS 4 LASER RADIATION WHEN OPEN AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION	DANGER－ CLASS 4 LASER RADIATION WHEN OPEN AND INTERLOCKS DEFEATED AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION

NOTE Quoted from Table 1.5.2 of Section 5 of Part 1 in the "Laser safety guidebook 4th edition" [2] However, a part of its contents are revised in accordance with **JIS C 6802-2014** (**IEC 60825-1**:2014)).

NOTE a) Even if one open the panel with a safety interlock which cannot be easily unlocked, if the human body is not exposed to the laser radiation which exceeds of the AEL for Class 1 due to the action of the safety interlock, labelling is not required.

NOTE b) If human bodies likely to exposes to laser the light of the AEL of class 3R or upper when the panels of the products class 2M or lower are uncovered or removed for maintenance or operations, the safety locks are compulsory. As for definition of the maintenance, see 3.56 in **JIS C 6802** (**IEC 60825-1**).

NOTE c) If human bodies likely to exposes to the laser light of the AEL of class 3B or upper when the panels of the products are uncovered or removed for maintenance or operations, the safety locks are compulsory. As for definition of the maintenance, see 3.56 in **JIS C 6802** (**IEC 60825-1**).

5.4 Requirements for operation manual

The following important information shall be described in the manual for users according to subclause 8.1 in **JIS C 6802** (**IEC 60825-1**).

a) To describe precautions to avoid possibilities of exposure to hazardous laser radiation. Enough directions for proper assembling, maintenance and safe use of the laser product including clear warning are to be included.

b) As to laser products of Class 1M and 2M, additional warning that the user should not point the beam at the area where telescopic optical instruments (for example, telescopes and binoculars),

are likely to be used because it may be harmful to eyes to see the laser output.

c) For laser radiation levels above the AEL of Class 1, a description of any radiation pattern(s) emitted from the protective housing during the performance of operation and maintenance procedures. The following items are to be expressed in appropriate units. These have to include inaccuracy such as variation in products and measurement deviation. For example, even if the maximum output was 1 W at the manufacturing point, some laser increases the power with time. If its addition is estimated as 0.5 W, the maximum output has to be expressed as 1.5 W. If the output exceeds the output limit due to power failure etc., the possible maximum output value is to be used except the case where appropriate safety measures against failures are arranged.
   - wavelength,
   - beam divergence,
   - pulse duration and repetition rate (description of irregular pulse pattern),
   - Maximum power or energy output

d) As to embedded laser products and other incorporated laser products, descriptions about the embedded leaser information have to be provided. The information shall also include appropriate safety instructions to the user to avoid inadvertent exposure to hazardous laser radiation. These are necessary if there are possibilities to stare into the beam exceeding the AEL of the radiation exposure level for each class during maintenance of the embedded type laser products classified as Class 1, Class 1M, Class 2 and Class 2M. In this case the manufacturer shall include a warning that intrabeam viewing of the laser shall be prevented.

e) As to Class 3B and Class 4, MPE and NOHD have to be provided. For collimated-beam Class 1M and Class 2M lasers, the extended NOHD (ENOHD) shall be stated, where appropriate and relevant.

f) Information concerning selection of eye protection has to be provided properly. Also, the optical density is to be included which is necessary information same as that of allowable incoming radiance and radiant exposure levels on surface of eye protection equipment. Resistance levels of the eye protection equipment are determined by such values.

   NOTE Many countries have regulations and standards for personal protective equipment. As to these requirements, it is necessary to ask authorities of countries of concerned.

g) Warning labels noticeable to users should be placed on the laser product or copies of all necessary labels and clear hazard warning display (color is black monotone or near label color) to attach the laser product should be provided. In addition, proper position to place each label on the product shall be clearly specified. Or if labels are provided together with the product without placing them on the product (due to limit of the size), the reasons why labels are not placed and attached to the product have to be explained, and how and in what forms they are to be provided have to be explained. In the case of placing graphic alternative labels shown in Figure 5 through Figure 13 in **JIS C 6802** (**IEC 60825-1**) on the product, the texts correspond to them along with copies of graphic labels have to be clearly stated.

h) A clear indication in the manual of all locations through which laser radiation exceeding the Class 1 AEL is emitted.

i) Warning statements including the following text should be included on the lists concerning controls, adjustments and procedures for operation and maintenance.

"Caution – Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure."

j) If the laser product lacks power-supply unit, necessary information concerning appropriate power-supply unit shall be noted in order to ensure safety (Name of the manufacturer and the model of recommended power-supply unit, etc.).

k) The laser products with high-diffusing beam of Class 1, Class 1M, Class 2, Class 2M and Class 3R may emit irradiance high enough to cause skin hazard or iris hazard at near light source or contact point. Furthermore, under these conditions, the product with wavelength of 1000nm or more may cause corneal injury. In order to make users aware of these risks, warnings for users shall be included.

NOTE The descriptions in a) through k) are based on Section 6.1 in Part 1 in the "Laser safety guidebook: 4th edition" edited by Optoelectronics Industry and Technology Development Association published by Advanced Communication Media Co., Ltd. However, the contents are partly updated in accordance with **JIS C 6802**:2014 (**IEC 60825-1**:2014).

5.5 Requirements for servicing information

Based on subclause 6.2 in **JIS C 6802** (**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 shall 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.

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

NOTE This designated by the manufacturers, and it is assumed that this is carried out by the service parson 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. FAs for the statement, it is desirable to use the standardized phrase among manufacturers.

Example 1 Warning that if you open the protective housing, it is likely to be exposed to hazardous laser emission.

Example 2 Warning that you shall not look into the laser light.

Example 3 Warning that if you ignore the warning, there may be serious damage to the human body.

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.

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

d) The position of removable protective housing. In the case of the protective housing which has the mechanism to unlock the safety interlock, 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.

NOTE 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 affixed to the laser product.

6 Safety standard for projection light of projectors

6.1 General

6.1.1 Relation with laser safety standard

The latest laser safety standard permit to assess the safety of optical radiation of the laser products designed to function as conventional lamps according to **IEC 62471** series (see **JIS C 6802** (**IEC 60825-1**), 4.4).

IEC 62471 series is standards concerning photobiological safety for lamps and lamp systems and the safety standard concerning projection light of image projectors (**IEC 62471-5**) has been established as one of them. Consequently, as to the image projectors even if it incorporates laser device as light source, the risks of the projection light can be assessed by **IEC 62471-5** if they meet subclause 4.4 of **JIS C 6802** (**IEC 60825-1**) (see Clause 4).

6.1.2 Scope of IEC 62741-5

The scope of **IEC 62471-5** is shown in Table 7. Image projectors with lamps or LEDs, and laser illuminated projectors meet requirements in subclause 4.4 of **JIS C 6802** (**IEC 60825-1**) are included in the scope (see **IEC 62471-5**, Clause 1).

Table 7 - Scope of IEC 62471-5

	Product example
Applicable products	Image projector with xenon lamp, halogen lamp, extra high pressure mercury lamp, LED. Image projector with diffused light from laser device. Applicable products are limited to the projectors emit visible light.
Inapplicable products	Laser display equipment with laser scanning device. Ultraviolet (UV) projector. Infrared (IR) projector. Lamp for general lighting. Projection lamp for general lighting.

6.1.3 Risk group classification of projectors

By applying **IEC 62471-5**, photobiological risks of projection light of image projectors are assessed and image projectors are classified into four risk groups ranging from safe exempt group (RG0) to the highest risk group (RG3). Explanations of these risk groups and examples of the image projectors are shown in Table 8.

According to **IEC 62471-5**, risk group classification of the projectors shall be done by manufacturers. Manufacturers shall determine the risk groups of the projectors and shall take necessary safety measures depending on the risk group (see 6.2, 6.3 and Annex A).

Table 8 - Risk group classification of image projectors

Risk group	Explanation of the risk	Example
Exempt Group (RG0)	Continuous use does not cause optical hazard.	Pico-projector. Toy-projector.
Risk Group 1 (RG1)	It is safe for almost all applications except for direct observation of the light source for a very long time (100 seconds or more).	
Risk Group 2 (RG2)	Optical hazard does not be caused because of aversive reaction. It is safe to use under almost all conditions except the case of staring into the beam.	Projectors for consumer use.
Risk Group 3 (RG3)	Instantaneous exposures at close distance cause optical hazard. Safety measures are absolutely necessary.	Projectors for professional use.
NOTE Explanations of risks are based on **IEC 62471-5**, 4.1.		

6.2 Basis of risk group determination

6.2.1 Test conditions

According to **IEC 62471-5**, risk assessment of the projection light shall be carried out under the conditions of the maximum emission power by setting the light source to maximum output and projecting all white image. Furthermore, all expected operating conditions appropriate to the intended use of the product shall be considered. Environmental conditions and single fault condition are included in factors to be considered (see **IEC 62471-5**, 5.1).

6.2.2 Assessment items for risks

In **IEC 62471-5**, the risks shown in Table 9 are assessed for the projection light. Necessity of assessment for each hazard depends on types of the light source and transmission characteristics of the optical system. As to the projectors with laser device as light source, the assessments of retinal thermal hazard and retinal blue-light hazard are required (see **IEC 62471-5**, Annex A).

The projectors with laser device as light source may use incoherent light (For example, luminescence excited by laser and light emitted from LED) along with diffused laser light. In this case, the assessments shall be carried out by combining all of the optical radiations.

Table 9 - Assessment items for risks of the projection light

Hazard	Wavelength range
1) Skin & eye UV	200～400 nm
2) Eye UV-A	315～400 nm
3) Retinal blue-light	300～700 nm
4) Retinal thermal	380～1 400 nm
5) Eye IR	780～3 000 nm

6.2.3 Assessment criteria

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) has published guidelines [4] [5] concerning risk assessment of optical radiation. In the ICNIRP guidelines, the exposure limit for each hazard is expressed as a function of exposure time.

In **IEC 62471-5**, time bases for risk assessment are defined (see 6.2.4), and accessible emission limits (AELs) for each hazard are determined by applying the time bases to the ICNIRP guidelines. Additionally, adjustment conditions of the projection lens (see 6.2.5) and measurement distance of the projection light (see 6.2.6) are specified as projector specific assessment conditions.

6.2.4 Time bases

The risks of projection light shall be assessed based on the time bases defined in **IEC 62471-5**. The time bases are permissible exposure time considered for each risk group, and the longest time base is assigned to the exempt group (RG0). However, the time base for retinal thermal hazard is 0.25 second regardless of risk group. This assignment is based on the consideration that the exposure time longer than 0.25 second will not cause any change in risk because of aversive reactions such as eyewinks occur against bright light.

6.2.5 Projection lens

To determine the risk group of projectors, the projection lens shall be adjusted shown in Table 10 (see **IEC 62417-5**, 5.2.1).

Table 10 - Adjustment conditions for projection lens

<table>
<tr><th>Lens system of the projector</th><th>Lens types or the selection method of the interchangeable lens</th><th>Optical zoom adjustment</th><th>Focus adjustment</th></tr>
<tr><td rowspan="2">Non-interchangeable</td><td>Optical zoom lens</td><td colspan="2">Adjust so that the ratio between the radiance and the AEL becomes maximum. a)</td></tr>
<tr><td>Fixed focal length lens</td><td>N/A</td><td>Adjust so that the radiance becomes maximum.</td></tr>
<tr><td rowspan="2">Interchangeable</td><td>If the lens of throw ratio 2.0 is available, such a lens shall be used.</td><td>Set throw ratio at 2.0.</td><td rowspan="2">Adjust so that the radiance becomes maximum.</td></tr>
<tr><td>If the lens of throw ratio 2.0 is not available, the lens with minimum throw ratio greater than 2.0 shall be used.</td><td>Make the throw ratio minimum (In the case of the optical zoom lens).</td></tr>
<tr><td colspan="4">NOTE a) This means that optical zoom and focus are adjusted so that the risk becomes the highest.</td></tr>
</table>

As for the projector with interchangeable lens, risk group determinations are required not only for projector itself but also for the installed conditions of each interchangeable lens. In this case, throw ratio shall be set to maximum value for each interchangeable lens and the focus shall be adjusted so that the radiance becomes maximum (see IEC 62471-5, 6.7).

6.2.6 Measurement distance

To determine the risk group of projectors, the projection light shall be assessed at a distance of 1.0 m from the closest point of human access toward the light source (for instance, the front lens surface) along the axis of the light beam (see **IEC 62471-5**, 5.2.2).

NOTE The background to determine measurement distance as 1.0 m is described in **IEC 62471-5**, Annex D.

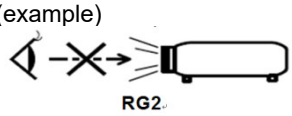
6.3 Requirements for manufacturers

As mentioned above, manufacturers shall determine the risk group of projectors, and take safety measures depending on the risk group. The summary of requirements defined in **IEC 62471-5** is shown in Table 11 through Table 14. As to projectors and interchangeable lenses, manufacturers shall provide information concerning the hazard distance and necessary information on normal operation, maintenance and service to users through the labeling and the manual.

The hazard distance is the distance where accessible emission becomes equal to the RG2 AEL for retinal thermal hazard, and staring into the projection light from the projector within the hazard distance is considered as dangerous behavior. Particularly, the projectors with hazard distance of 1 m or longer are classified into RG3, and require appropriate controls. In the case of the projector with interchangeable lens, the hazard distance may exceed 1 m by installing the lens with larger throw ratio even if the projector is classified into RG2. In this case, controls according to RG3 are necessary.

In designing of projectors, variations in the product installation place and the projection direction (for example, ceiling mounting) shall be considered. Furthermore, in the case of RG2 and RG3 projectors, safety feature at the beginning of the projection (soft start) shall be additionally considered.

Table 11 - Summary of requirements for manufacturers (Part 1)

<table>
<tr><td></td><td colspan="4">Risk group of the projector</td></tr>
<tr><td></td><td>RG0</td><td>RG1</td><td>RG2</td><td>RG3</td></tr>
<tr><td rowspan="2">Accessible emission for 7invisible light (IEC 62471-5, 4.4, 6.1)</td><td colspan="4">Accessible emission for UV, UV-A and IR shall not exceed the following AEL.</td></tr>
<tr><td>AEL of RG0</td><td>AEL of RG1</td><td>AEL of RG2</td><td>AEL of RG2</td></tr>
<tr><td>Soft start (IEC 62471-5, 6.3)</td><td colspan="2">Not required</td><td colspan="2">The initial emission from the projector after power on shall be controlled so that the full power emission start no sooner than one full second after light is first emitted from the lens (the full power emission includes any partial irradiance of the projection area).</td></tr>
<tr><td rowspan="4">Labeling on the products (IEC 62471-5, 6.5)</td><td rowspan="4">Not required</td><td rowspan="4">Not required (the following a) may be placed optionally)</td><td>Any one of the following b), c) and d) shall be placed.</td><td>All of the following e), f) and g) shall be placed.</td></tr>
<tr><td>a) RG1 label
RG1
b) RG2 label (example)
Caution
Do not stare into the beam
RG2
・Similar text including “RG2” is acceptable.
・Text and border shall be black on a yellow background.</td><td>e) RG3 label (example)
Warning!
Do not look into the beam.
No direct eye exposure to the beam is permitted
RG3
Hazard Distance: Refer to the manual
・Similar text including “RG3” is acceptable.
・Text and border shall be black on a yellow background.</td></tr>
<tr><td>c) RG2 caution symbol
 
RG2
・The symbol should be placed near the projection lens.
・The symbol may be directly printed or engraved on the product.</td><td>f) Optical radiation warning symbol
 
・Symbol shall be black on a yellow background.</td></tr>
<tr><td>d) RG2 caution symbol (example)
 
RG2
・Similar design including “RG2” is acceptable.
・The symbol should be placed near the projection lens.
・The symbol may be directly printed or engraved on the product.</td><td>g) Symbol for “Not for consumer use”
  </td></tr>
</table>

NOTE 1 The requirements are quoted and summarized from **IEC 62471-5**, Clause 4 and 6. Relevant subclauses are indicated in the leftmost column.
NOTE 2 The risk group of the projector shall be determined according to **IEC 62471-5**, Clause 5.
NOTE 3 RG3 products are intended for professional use only, not intended for consumer use.
NOTE 4 The labels should be placed so that they are readable without exposing to optical radiation exceeding the AEL of the risk group of the product.
NOTE 5 Laser projectors meet **JIS C 6802** (**IEC 60825-1**), 4.4, generally classified as Class 1, shall follow the labeling requirement of **JIS C 6802** (**IEC 60825-1**), 7.2 as well.

Table 12 Summary of requirements for manufacturers (Part 2)

<table>
<tr><td></td><td colspan="4">Risk group of the projector</td></tr>
<tr><td></td><td>RG0</td><td>RG1</td><td>RG2</td><td>RG3</td></tr>
<tr><td rowspan="5">User information (IEC 62471-5, 6.6.1～6.6.3)</td><td rowspan="5">Not required</td><td>The following h) shall be stated in the manual and the product information.</td><td>The following text in i) shall be stated in the manual and the product information.
The following j) should be included in the manual.</td><td>The following k) shall be included in user information.
The following texts in l) and m) shall be stated in the manual and product information.
The following n) should be included in the manual.</td></tr>
<tr><td rowspan="4">h) “RG1 IEC 62471-5:2015”</td><td rowspan="3">i) “As with any bright source, do not stare into the beam, RG2 IEC 62471-5:2015”
・Similar text including the risk group, standard name and its edition is acceptable.</td><td>k) Hazard information including hazard distance</td></tr>
<tr><td>l) “No direct eye exposure to the beam is permitted, RG3 IEC 62471-5:2015”
・Similar text including the risk group, standard name and its edition is acceptable.</td></tr>
<tr><td>m) “Operators shall control access to the beam within the hazard distance or install the product at the height that will prevent exposures of spectators’ eyes within the hazard distance”
・Similar text is acceptable.</td></tr>
<tr><td>j) Reproductions of all required labels</td><td>n) Reproductions of all required labels</td></tr>
<tr><td rowspan="3">User information for maintenance (IEC 62471-5, 6.6.4)</td><td colspan="4">In the case where the light source of the projector can be replaced, risks and proper procedures shall be clearly stated in the instructions for the replacement.</td></tr>
<tr><td colspan="3"></td><td>The following matters shall be included in user information.
・In the case of maintenance of RG3 projectors, only authorized trained service personnel for RG3 products shall perform these tasks.</td></tr>
<tr><td colspan="4">Advice on safe operating procedures and warnings concerning reasonably foreseeable misuse, malfunctions and hazardous failure modes shall be given in the user manual. Where maintenance procedures are detailed, they shall include explicit instructions on safe practices.</td></tr>
<tr><td rowspan="2">Interchangeable lens (IEC 62471-5, 6.7)</td><td colspan="4">The projectors which can install interchangeable lenses with throw ratio greater than 2.0 and the hazard distance exceeds 1 m shall meet requirements shown in Table 13.</td></tr>
<tr><td colspan="4">The interchangeable lenses with hazard distance longer than 1 m in combination with projectors shall meet requirements shown in Table 14.</td></tr>
<tr><td rowspan="2">Information for servicing (IEC 62471-5, Clause 7)</td><td colspan="4">In addition to user information for maintenance, sufficient information for safety training of servicing personnel shall be provided.</td></tr>
<tr><td colspan="4">Services for laser illuminated projectors contain Class 3B or Class 4 embedded lasers (generally Class 1 laser products during operation) shall be performed only by authorized, trained servicing personnel (IEC 60825-1, IEC TR 60825-14).</td></tr>
<tr><td colspan="5">NOTE 1 The requirements are quoted and summarized from IEC 62471-5, Clause 6 and 7. Relevant subclauses are indicated in the leftmost column.
NOTE 2 The risk group of the projector shall be determined according to IEC 62471-5, Clause 5.
NOTE 3 RG3 products are intended for professional use only, not intended for consumer use.
NOTE 4 It is not mandatory to include reproductions of labels in the manual in IEC 62471-5. However, it is mandatory in JIS C 6802 (IEC 60825-1).</td></tr>
</table>

Table 13 - Requirements for the projectors with interchangeable lenses whose hazard distance exceeds 1 m

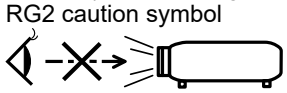
<table>
<tr><td></td><td colspan="4">Risk group of the projector (determined at throw ratio 2.0)</td></tr>
<tr><td></td><td>RG0</td><td>RG1</td><td>RG2</td><td>RG3</td></tr>
<tr><td>Warning labels for the projector (IEC 62471-5, 6.7.2)</td><td colspan="4">The following message or similar shall be added to the RG label or RG2 caution symbol. This warning shall be provided as labels even if the original risk group is RG0 or RG1. Text and border of the warning label shall be black on a yellow background.
(“xxx” in the message is unique value for each projector)</td></tr>
<tr><td></td><td>Example 1) Add warning label
This projector may become RG3 when an interchangeable lens with throw ratio greater than xxx is installed. Refer to the manual for the lens list and hazard distance before operation.
Such combination of projector and lens are intended for professional use only, and not for consumer use.</td><td>Example 2) Add warning message to RG1 label
RG1
This projector may become RG3 when an interchangeable lens with throw ratio greater than xxx is installed. Refer to the manual for the lens list and hazard distance before operation.
Such combination of projector and lens are intended for professional use only, and not for consumer use.</td><td>Example 4) Add warning message to RG2 label
Caution
Do not stare into the beam
RG2
This projector may become RG3 when an interchangeable lens with throw ratio greater than xxx is installed. Refer to the manual for the lens list and hazard distance before operation.
Such combination of projector and lens are intended for professional use only, and not for consumer use.</td><td rowspan="2">Same warning labels as normal RG3 projector are used (see Table 11).</td></tr>
<tr><td></td><td></td><td>Example 3) Add warning label
This projector may become RG3 when an interchangeable lens with throw ratio greater than xxx is installed. Refer to the manual for the lens list and hazard distance before operation.
Such combination of projector and lens are intended for professional use only, and not for consumer use.</td><td>Example 5) Add warning label to RG2 caution symbol
 
RG2
This projector may become RG3 when an interchangeable lens with throw ratio greater than xxx is installed. Refer to the manual for the lens list and hazard distance before operation.
Such combination of projector and lens are intended for professional use only, and not for consumer use.</td></tr>
<tr><td>Manual for the projector (IEC 62471-5, 6.7.4)</td><td colspan="4">The following a) through c) shall be included in the manual.</td></tr>
<tr><td></td><td colspan="4">a) Explanations about changes in risks by installing the interchangeable lens.
The following warning of RG3 projector or similar text shall be included in the explanations.
・“No direct eye exposure to the beam is permitted”
・“Operators shall control access to the beam within the hazard distance or install the product at the height that will prevent exposures of spectators’ eyes within the hazard distance”
The above warning labels (reproductions) shall be included as well.</td></tr>
<tr><td></td><td colspan="4">b) List of model numbers (or model names) of the interchangeable lenses for the projector.</td></tr>
<tr><td></td><td colspan="4">c) Hazard distance at the maximum throw ratio of each lens when interchangeable lenses are installed to the projector.
(The information should be provided to users by easy-to-understand ways such as a table or graph)</td></tr>
<tr><td colspan="5">NOTE 1 The requirements are quoted and summarized from IEC 62471-5, Clause 6. Relevant subclauses are indicated in the leftmost column.
NOTE 2 In the case of projectors that the hazard distance does not exceed 1 m for available interchangeable lenses, measures of this table are not required.</td></tr>
</table>

Table 14 - Requirements for the interchangeable lenses whose hazard distance exceeds 1 m

Marking on interchangeable lenses (**IEC 62471-5**, 6.7.3)	"Throw Ratio Range" or "Model Number" shall be marked with their relevant parameter value. ・The mark may be directly printed or engraved on the interchangeable lenses. ・After installing to the projector, the mark shall be seeable to users. In the case where the mark is unseeable from outside, the information of the mark and the information on the warning label on the projector in Table 13 shall be displayed on the projection screen. The information shall be displayed at the beginning of the projection by emissions below the RG3 until manually ended.
Manual of interchangeable lenses (**IEC 62471-5**, 6.7.5)	The following a) through d) shall be included in the manual.
	a) Explanations about changes in risks by installing the interchangeable lens. The following warning of RG3 projectors or similar text shall be included in the explanations. ・"No direct eye exposure to the beam is permitted" ・"Operators shall control access to the beam within the hazard distance or install the product at the height that will prevent exposures of spectators' eyes within the hazard distance"
	b) Throw ratio range of the lens
	c) List of model numbers (or model names) of projectors with which the lens may be used
	d) Hazard distance at the maximum throw ratio when the lens is installed to typical projector. (The information should be provided to users by easy-to-understand ways such as a table or graph)
NOTE 1 The requirements are quoted and summarized from **IEC 62471-5**, Clause 6. Relevant subclauses are indicated in the leftmost column. NOTE 2 In the case of interchangeable lenses that the hazard distance does not exceed 1 m for installable projectors, measures of this table are not required.	

7 Original requirements to be considered for laser projectors

Requirements in this clause are original requirements of this document, and they are not required in the related reference standards.

7.1 Safety guideline in normal use

7.1.1 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 classification (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 shall be provided.

7.1.1.1 Requirements for projector

As to the projectors upper than RG2 or RG3, placing labels on the products is required in clause 6. However, according to Table 15, this document call users attention using the mark of the projector with lamp system with exit aperture and “Stare-in prohibition mark (see Figure 5)” designed after the symbol in Figure 8 in **IEC 62471-5** which are applicable to any risk groups.

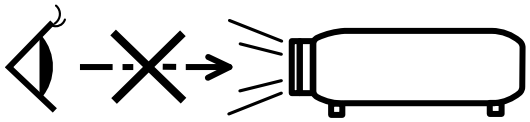
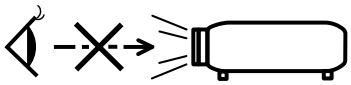
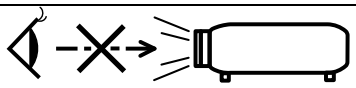
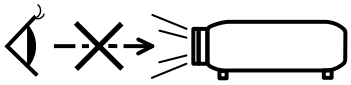


Figure 5 - Example of “Stare-in prohibition mark”

Table 15 - Requirements for Stare-in prohibition mark in this standard and IEC 62471-5

Risk group	Requirements in this standard	Requirements in **IEC 62471-5**
RG0		Not required
RG1		Not required
RG2	Follow **IEC 62471-5**	 注) RG2
RG3		Not required
NOTE In **IEC 62471-5** signage of RG2 in addition to the Stare-in prohibition mark in Figure 5 are required in RG2 category. However, it is acceptable in the warning text as well, and it is one of the options. See table 11 for details.		

7.1.1.2 Requirements for operation manual

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

NOTE The rules in **7.4.3** may be combined, also a supplementary note of caution may be written down.

7.1.2 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 classification (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, etc.), so the following note of caution shall be provided.

7.1.2.1 Requirements for operation manual

A note of caution such as “Don’t enter into the beam by using optical equipment (loupe, etc.)” shall be written down.

7.1.3 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 shall be provided.

7.1.3.1 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 shall be used under the control and supervision by the adult.” shall be written down.

NOTE The rules in 7.1.2 may be combined, also a supplementary note of caution may be written down.

7.1.4 Consideration in the case of remote operation and use of a remote control

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

7.1.4.1 Requirements for operation manual

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

7.1.5 Requirements concerning optional lens

This subclause 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 hazardous of “electric shock” as well as “eye injury” are concerned..

For this reason, the following safety measures shall be taken.

7.1.5.1 Requirements for the operation manual

Note of caution that in the case of removal of the projection lens or replacement of the projection lens, such shall not be performed in the power-on state shall be written down.

7.2 Guideline for the structure design

7.2.1 Overall design

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..

a) Design the structure as to make it hard for users to disassemble the product. The working position shall be access point to remove the light source unit. That is to say, the light source installation structure or the part needed to be disassembled when accessing the light source installation structure shall be worked on. Specific work place is left to the manufacturer's originality and ingenuity, however, it is recommended to make device on housing cover.

Example 1 Use the special screws for tightening of housing cover.

Example 2 Housing cover is designed as can't be removed by one-action.

Example 3 Housing cover is designed as to be a structure and combined with screw tightening.

b)It is recommended to make the structure easy to find the fact that the product was disassembled. Examples of finding disassembling are shown below. Specific structure is left to the manufacturer's originality and ingenuity.

Example 1 Seal off with security seal.

Example 2 By applying an anaerobic adhesive to the screw, the screw shall be broken when disassembling,

In the case of fitting in the detecting device, the point shall be the access point when remove the light source unit. Specific combination of the point and measures is left to the manufacturer's originality and ingenuity, however, it is recommended to fit on eye-catching place such as a housing cover.

7.2.2 Design of the protective housing

Attention shall be paid to the structure of housing seam. Entrust specific countermeasures to manufacturers.

Example 1 To employ the structure where light does not leak outside by installing pass-each-other walls at the intake air/exhaust air openings.

Example 2 It shall be designed for laser light so as not to leak from the join of the protective housing by employing the fit structure shown in the following Figure 6.

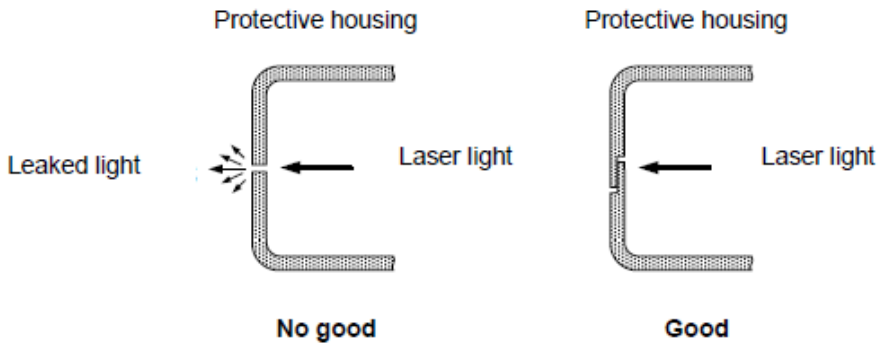


Figure 6 - Example of safe seam of the protective housing

7.2.3 Specific requirements for the housing cover

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

Example On the housing cover, placing the indication that represents “Don’t open / disassemble the housing cover.”

7.2.4 Specific requirements for the light source

In order to prevent diversion of the laser, it should make the structure hard for users to remove the laser from the light source unit. In the case where the light source unit is easily removed and the light source unit is replaceable by users said design shall be implemented surely. Specific measures are left to the manufacturer’s originality and ingenuity.

Example 1 Use the special screws for fixing the laser.

Example 2 By applying an anaerobic adhesive to the screw for fixing the laser, the screw is broken in disassembling.

7.2.5 Requirements for the optical engine

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

7.3 Safety guideline in the case of failure

7.3.1 Scope of the reasonably foreseeable failure

According to clause 5 in **JIS C 6802** (**IEC 60825-1** Ed.3) and 5.1 in **IEC 62471-5**, the tests during operation to determine the classification of the product shall be made “under each and every reasonably foreseeable single-fault condition.”

Explanations of the reasonably foreseeable single-fault condition are shown next.

- 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 inner parts such as an optical element.

7.3.2 Leaked light from the protective housing

As to durability of the protective housing, safety shall be secured in case of failure. In the case of housing breakage due to falling, etc., the structure shall be designed for the main light so as not to emit outside directly. Entrust specific countermeasures to manufacturers.

Example To employ the double structure protective housing which has the optical engine cover which cover the optical path of the main light and the housing cover.

7.3.3 Emission light from the projection lens

In the case of failure, light emitted from the projection lens shall not exceed the AEL of the appropriate risk group. 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 shall 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. Entrust specific countermeasures to manufacturers.

Explanations of the failure mode such as excursion laser output or breakage of the laser light diffuser are shown next.

Example 1 Stop the power supply to the laser drive circuit and stop the laser light oscillation.

Example 2 Block the laser light by using a mechanical shutter of light resistance/heat resistance.

7.4 Others

7.4.1 Requirements for manufacturing

In manufacturing a projector which uses laser devise 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 1 to Table 4 depending on the emitted laser light class. Entrust specific countermeasures to manufacturers.

In assembling work, explanations of countermeasures to prevent workers from exposure to laser light emission which exceeds Class 1 AEL are shown next.

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

Example 2 In the assembly work, laser's drive current value shall be controlled.

Particularly, it is necessary to make arrangements to protect workers' eyes in case of malfunction during assembling by arranging assembling work bench at the height to avoid coming of laser light to the eye height and designing the layout to avoid hitting at workers' eyes. In addition, during the assembly work, in order to avoid laser light unexpected specular reflection, due attention shall be paid concerning the surrounding work environment and worker's accessories.

7.4.2 Requirements for the external packaging box

The indication shall be placed on the external packaging box of the laser product so as to tell buyers that it uses a new light source different from the conventional lamp.

7.4.3 Requirements for the operation manual

The next items shall be described in the operation manual so as to tell buyers that the laser product uses a new light source different from the conventional lamp.

a) Note of caution such as "This product is a laser product of class xx."

b) If the users disassemble, repair or modify the unit there is a serious problem about the safety of the user.

c) 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. 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.

d) When the trouble is found, immediately stop the use, and ask the dealer to repair it.

e) In the case of disposal of the projector, the disposal shall comply with the law and ordinance of each country without disassembling it.

Annex A
(Informative)
Procedure for risk group determination based on IEC 62471-5

A.1 General

As to risk group classification based on **IEC 62471-5**, basic concept is shown in 6.1 through 6.2. This annex describes detailed procedure for risk group determination.

To determine the risk group, accessible emission limit (AEL) and accessible emission (AE) shall be specified. A.2 through A.3 go into details how to calculate these values.

NOTE It is not mandatory to measure AE and angular subtense of apparent source as a parameter of AEL. These parameters can be determined by calculation (see **IEC 62471-5**, 5.1).

According to **IEC 62471-5**, in the case where projection light continues more than 0.25 second and the peak radiation power does not exceed 1.5 times the average radiation power, the projection light is regarded as continuous wave (CW) emission. If this is not the case, the projection light is regarded as pulsed emission. In the case of pulsed emission, more complicated calculation than CW emission is necessary (see A.4).

A.2 Calculation method of accessible emission limit

A.2.1 Accessible emission limit per risk group

Accessible emission limit (AEL) per risk group is defined in **IEC 62471-5**, Table 3. By using this AEL table along with Table A.1, the risk group of projectors is determined (see **IEC 62471-5**, 4.4). If the projection light is pulsed emission, AEL for retinal thermal hazard shall be calculated according to A.4.

NOTE 1 The AELs defined in **IEC 62471-5**, Table 3 is based on the latest ICNIRP guidelines[5], and it is deviated from **IEC 62471**:2006.

NOTE 2 In **IEC 62471-5**, Table 3, two types of AEL for retinal blue-light hazard are defined. Normally, AEL for blue-light hazard is expressed in radiance. However, as for small source, it is expressed in a value converted into irradiance. Small source is the source whose angular subtense α is smaller than 0.011 rad.

Table A.1 - Accessible emission of projection light and risk group of projectors

Risk group of projectors	Accessible emission (AE) evaluated for each hazard
RG0 projector	None exceeds the AEL of RG0
RG1 projector	Some AEs exceed the AEL of RG0 but none exceeds the AEL of RG1
RG2 projector	Some AEs exceed the AEL of RG1 but none exceeds the AEL of RG2
RG3 projector	Some AEs exceed the AEL of RG2
NOTE 1 Accessible emission is measured according to A.3. NOTE 2 RG3 projector shall not exceed the AEL of RG2 for UV, UV-A and IR. (see Table 11)	

A.2.2 Calculation method of angular subtense of apparent source

The AEL for retinal thermal hazard depends on angular subtense α of apparent source. Here apparent source means real or virtual object that forms the smallest retinal image. In the case of projectors, apparent source is considered to be exit pupil of the projection lens that can be seen when staring into the projection light. For this reason, **IEC 62471-5** defines the position of the apparent source as the position of the exit pupil of the projection lens (see **IEC 62471-5**, 5.3).

The angular subtense α of the apparent source is visual angle seen from the measuring point of AE, and it can be calculated by identifying the distance to the source and the source size. The size of the apparent source is defined as full width at half maximum (FWHM) of the light intensity distribution on the exit pupil (see **IEC 62471-5**, Figure 4). If the exit pupil is fully filled with the light emitted from light source, the angular subtense α can be determined by outer diameter of the exit pupil (see **IEC 62471-5**, Figure B.1).

In all cases, angular subtense larger than α_{max} shall be limited to α_{max} and angular subtense smaller than α_{min} shall be limited to α_{min}. In the case of an oblong source, the angular subtense is determined by arithmetic average of two angular dimensions of the source, and they shall be limited prior to the arithmetic averaging.

NOTE 1 In **IEC 62471-5**, the value of α_{min} is 0.0015 rad. The value of α_{max} is 0.1 rad if the projection light is continuous wave (CW) emission. In the case of pulsed emission, the value of α_{max} given by **IEC 62471-5**, Table 7.

Furthermore, in the case where AE to retinal thermal hazard is determined with spatially averaged radiance over the angle of acceptance γ, γ shall be considered as lower limit of angular subtense α.

NOTE 2 If the projection light is CW emission, the value of γ is 0.011 rad. In the case of pulsed emission, the value of γ is 0.005 rad. In both cases, the value of γ is larger than α_{min}**(0.0015 rad)**, so it can be a factor to determine the lower limit of α**(see A.3.3 and A.3.5)**.

A.3 Measurement method of accessible emission

A.3.1 Measuring wavelength range

Measuring wavelength range to determine the accessible emission (AE) is shown in Table A.2. For some hazards, spectral weighting shall be applied. The spectral weighting function to be applied is also shown in Table A.2 (see **IEC 62471-5**, 5.6.3).

Table A.2 - Measuring wavelength range and spectral weighting function for AE

Hazard	Symbol of accessible emission	Wavelength range	Spectral weighting function	Reference standards and table number
1) Skin & eye UV	E_S	200～400 nm	$S_{UV}(\lambda)$	**IEC 62471**, Table 4.1
2) Eye UV-A	E_{UVA}	315～400 nm	—	—
3) Retinal blue-light	L_B,E_B	300～700 nm	$B(\lambda)$	**IEC 62471-5**, Table 8
4) Retinal thermal	L_R	380～1 400 nm	$R(\lambda)$	**IEC 62471-5**, Table 8
5) Eye IR	E_{IR}	780～3 000 nm	—	—
NOTE Spectral weighting functions for retinal blue-light hazard and retinal thermal hazard are based on the latest ICNIRP guidelines[5], and they are deviated from **IEC 62471**:2006.				

A.3.2 Evaluation method

Accessible emission (AE) is measured in radiance for the hazards whose AEL is defined in radiance and measured in irradiance for the hazards whose AEL is defined in irradiance. If the projection light is continuous wave (CW) emission, AE is calculated as average value over the time base defined for each risk group. If the projection light is pulsed emission, AE is calculated by the most restrictive condition for retinal thermal hazard and calculated as average value over the time base for other hazards (see Table A.3).

Table A.3 - Evaluation method of accessible emission

Hazard	In the case of CW emission	In the case of pulsed emission
1) Skin & eye UV	Average value over the time base	Average value over the time base
2) Eye UV-A	Average value over the time base	Average value over the time base
3) Retinal blue-light	Average value over the time base	Average value over the time base
4) Retinal thermal	Average value over the time base	The most restrictive condition
5) Eye IR	Average value over the time base	Average value over the time base
NOTE 1 As to the time bases, see **IEC 62471-5**, Table 4. NOTE 2 As to the most restrictive condition, see A.4.		

A.3.3 Optical system for measurement

As fundamental parameters for measuring accessible emission (AE, radiance or irradiance), there are

measurement distance *l* and angle of acceptance *γ***(see IEC 62471-5, Figure B.1)**. In **IEC 62471-5**, 1.0 m is used as measurement distance *l* (see 6.2.6) and the values in **IEC 62471-5**, Table 1 or Table 2 are used as angle of acceptance *γ*. In the case of evaluation for retinal blue-light hazard, the value of *γ* is 0.011 rad. In the case of evaluation for retinal thermal hazard, the values of *γ* are different whether the projection light is continuous wave (CW) emission or pulsed emission, 0.011 rad for CW emission and 0.005 rad for pulsed emission are used.

A.3.4 Measurement of irradiance

Irradiance can be calculated by measuring radiant flux passing through the aperture stop. The aperture stop shall include the brightest area within the beam cross-section (see **IEC 62471-5**, 5.4).

A.3.5 Measurement of radiance

Radiance can be calculated by measuring radiant flux passing through the field stop. If the size of apparent source exceeds the field stop, the area of the source producing the maximum spatial radiance (hot spot) shall be measured (see **IEC 62471-5**, 5.5).

If the radiance is calculated from the radiant flux passing through the field stop, radiance peak (hot spot) smaller than the angle of acceptance *γ* is spatially averaged. At this time, the value of *α* for AEL calculation shall not be smaller than the angle of acceptance *γ***(see A.2.2)**.

A.4 Evaluation method for pulsed emission

According to **IEC 62471-5**, in the case where the peak radiation power exceeds 1.5 times the average radiation power, the projection light shall be considered as pulsed emission. In the case of pulsed emission, the risk evaluation for retinal thermal hazard shall be carried out by different method from continuous wave (CW) emission (see Table A.4).

In the evaluation of pulsed emission, the most restrictive criteria for single pulse or any groups of pulses shall be applied (see **IEC 62471-5**, 5.6.2.3).

Table A.4 - Differences between continuous wave (CW) emission and pulsed emission concerning risk evaluation for retinal thermal hazard

<table>
<tr><th colspan="3" rowspan="2">Evaluation method</th><th colspan="3">Calculation of AEL</th><th colspan="3">Measurement of AE</th></tr>
<tr><th>Exposure time</th><th>Maximum angular subtense α_{max}</th><th>Coefficient for pulse train</th><th>Sampling time</th><th>Sampling method</th><th>Angle of acceptance γ</th></tr>
<tr><td colspan="3">CW emission</td><td>0.25 s</td><td>0.1 rad</td><td></td><td>0.25 s</td><td>Time average</td><td>0.011 rad</td></tr>
<tr><td rowspan="3">Pulsed emission [a]</td><td rowspan="2">Evaluation of average value [b]</td><td>Regular pulse</td><td>0.25 s</td><td>0.1 rad</td><td rowspan="3"></td><td>0.25 s</td><td rowspan="2">Time average</td><td rowspan="3">0.005 rad</td></tr>
<tr><td>Irregular pulse</td><td>Emission duration [c]</td><td rowspan="2">Depend on exposure time [f]</td><td>Emission duration [c]</td></tr>
<tr><td colspan="2">Evaluation of peak value [d]</td><td>Pulse duration [e]</td><td>C_5</td><td>Pulse cycle</td><td>Peak value</td></tr>
</table>

NOTE
[a] In the case of pulsed emission, both average value and peak value are evaluated, and the risk group is determined based on stricter one.
[b] In the case of evaluation of average values, the AEL is given by **IEC 62471-5**, Table 5.
[c] As to irregular pulse, the emission duration less than 0.25 s shall be considered in order to analyze groups of pulses.
[d] In the case of evaluation of peak value, the value of the AEL given by **IEC 62471-5**, Table 5 shall be multiplied by correction coefficient C_5. The value of C_5 depends on the number of pulses N within the time base (0.25 s) and is given by **IEC 62471-5**, Table 6.
[e] As exposure time, the pulse duration shown in **IEC 62471-5**, Figure 2 is used.
[f] Maximum angular subtense α_{max} is calculated by substituting exposure time into t_p of **IEC 62471-5**, Table 7.

A.5 Flowchart for risk group determination

Flowchart for risk group determination of the projectors with laser device as light source is shown in Figure A.1 through Figure A.3.

NOTE 1 The continuous wave (CW) emission means the case where the output continues 0.25 second or more, and the peak radiation power does not exceed 1.5 times average radiation power.

NOTE 2 The pulsed wave emission means the case where each pulse has the duration less than 0.25 second, and the form of emission is single pulse or a train of pulse. Furthermore, it means the case where a continuous train of pulses or modulated radiation energy has the peak radiation power exceeds at least 1.5 times average radiation power.

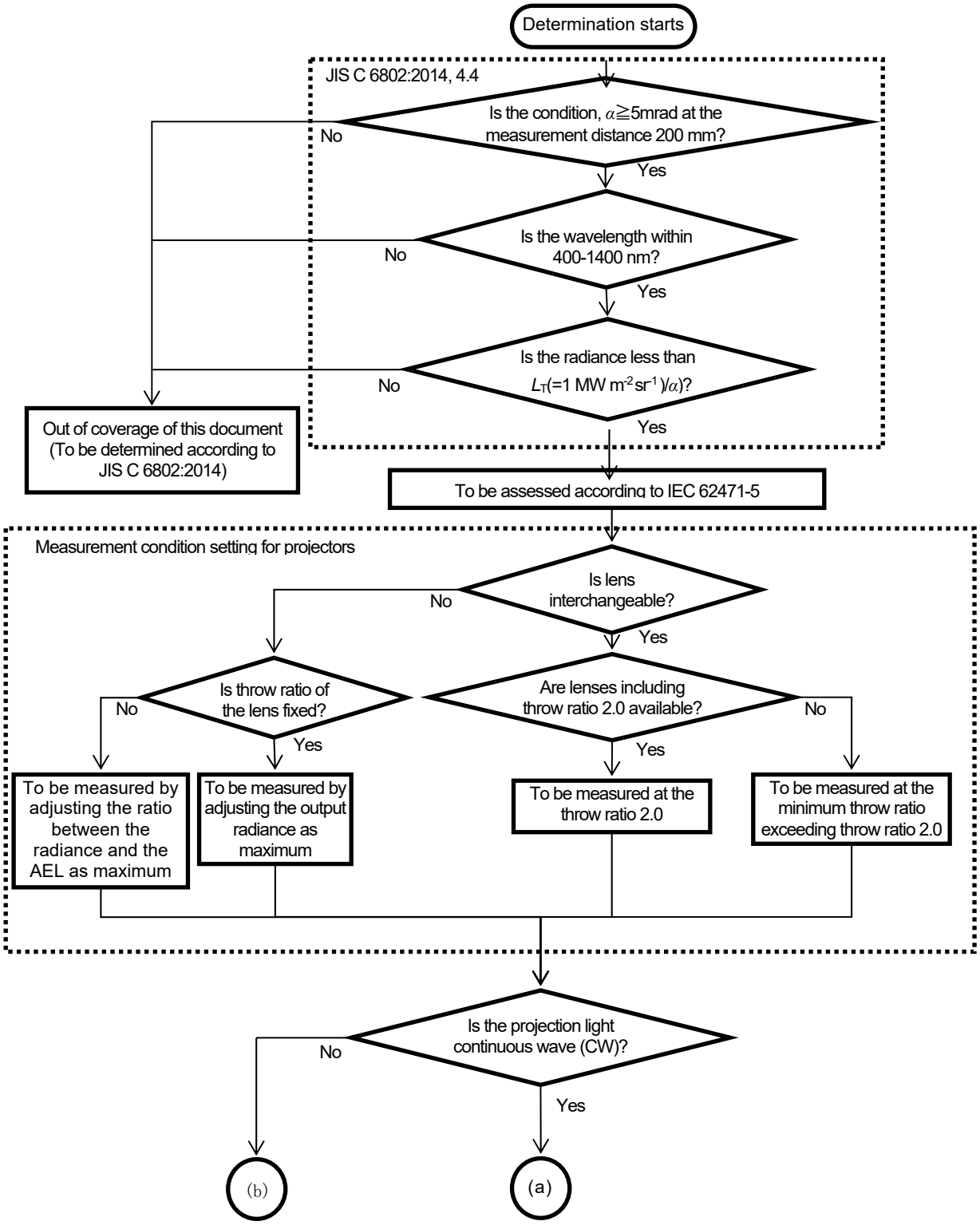
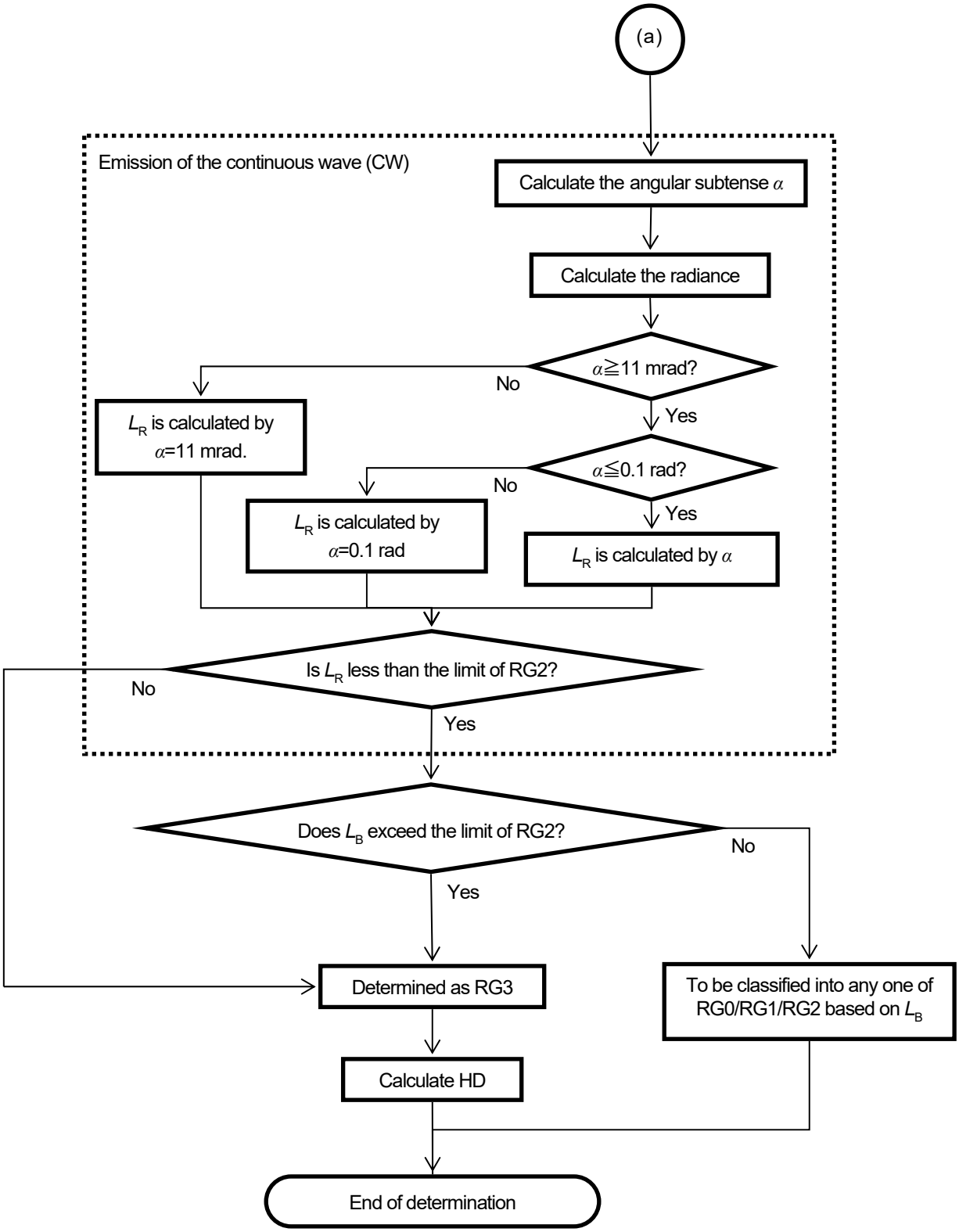
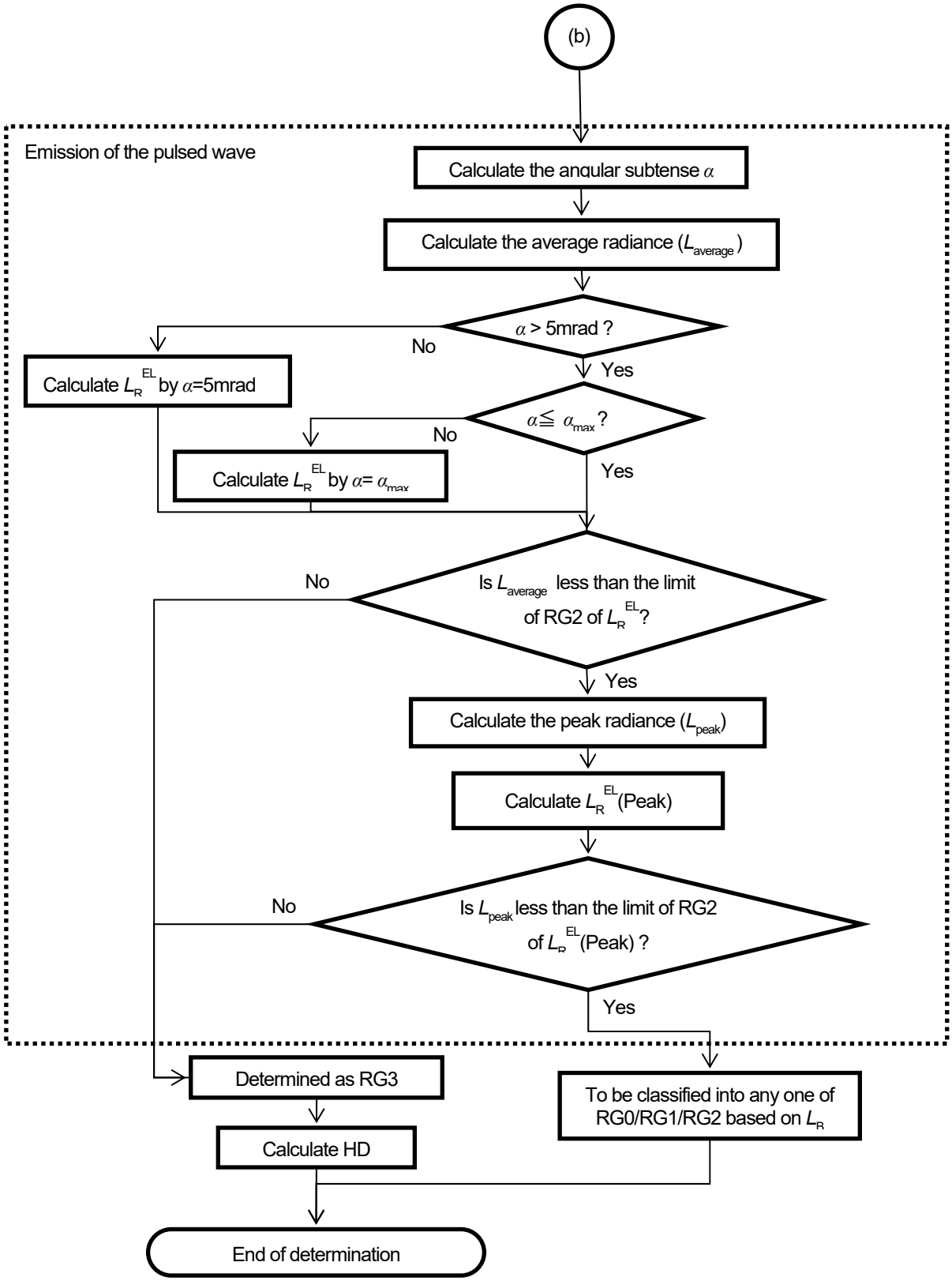


Figure A.1 - Flowchart for risk group determination (Part 1)



NOTE When determined as RG3, it needs to be less than the limit of RG2 except the retinal thermal hazard.

Figure A.2 - Flowchart for risk group determination (Part 2)



NOTE When determined as RG3, it needs to be less than the limit of RG2 except the retinal thermal hazard.

Figure A.3 - Flowchart for risk group determination (Part 3)

Measurement condition setting for projectors shown in Figure A.1 is for risk group determination of projector itself. As for the projector with interchangeable lens, risk group determinations at the installed conditions of each interchangeable lens are also required. In this case, measurement condition shall be set so that throw ratio and radiance become maximum for each interchangeable lens, then subsequent steps shall be applied (see 6.2.5).

A.6 Dependency parameters for accessible emission limit and accessible emission

Accessible emission limit (AEL) and accessible emission (AE) depend on many parameters. These dependencies are shown in Figure A.4 through Figure A.5.

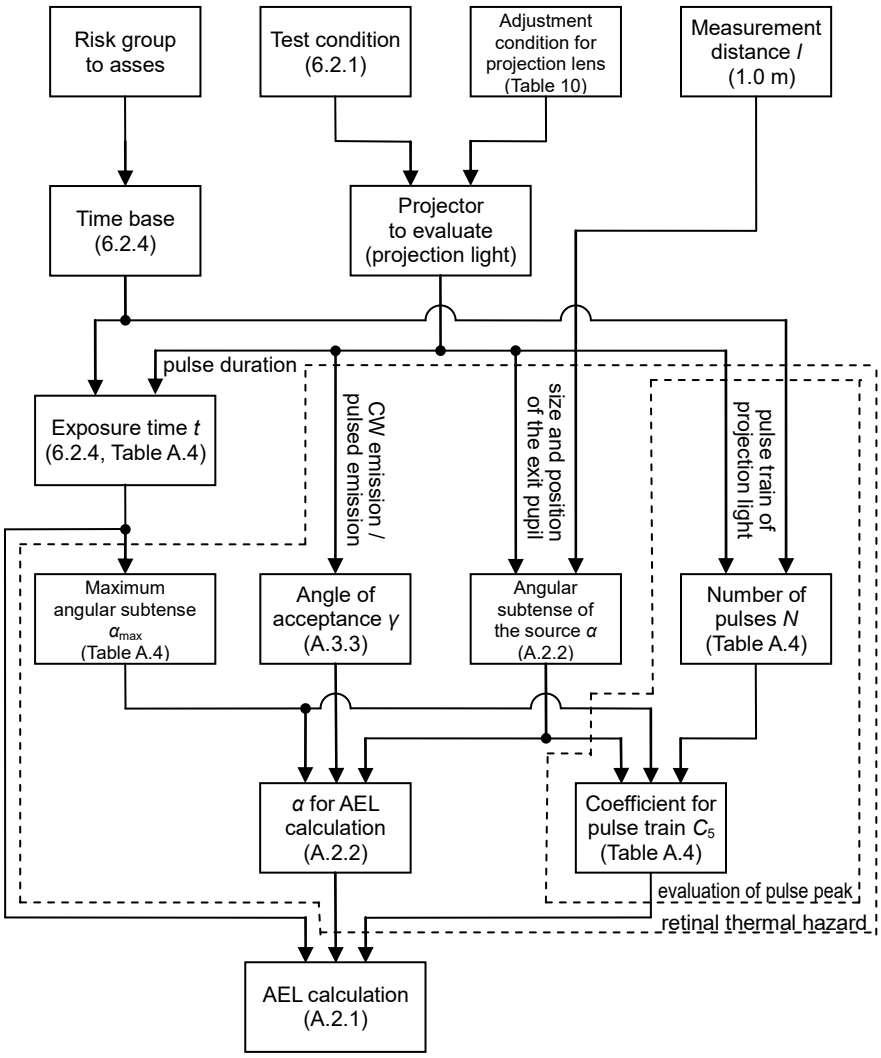


Figure A.4 - Dependency parameters used for the accessible emission limit (AEL) calculation

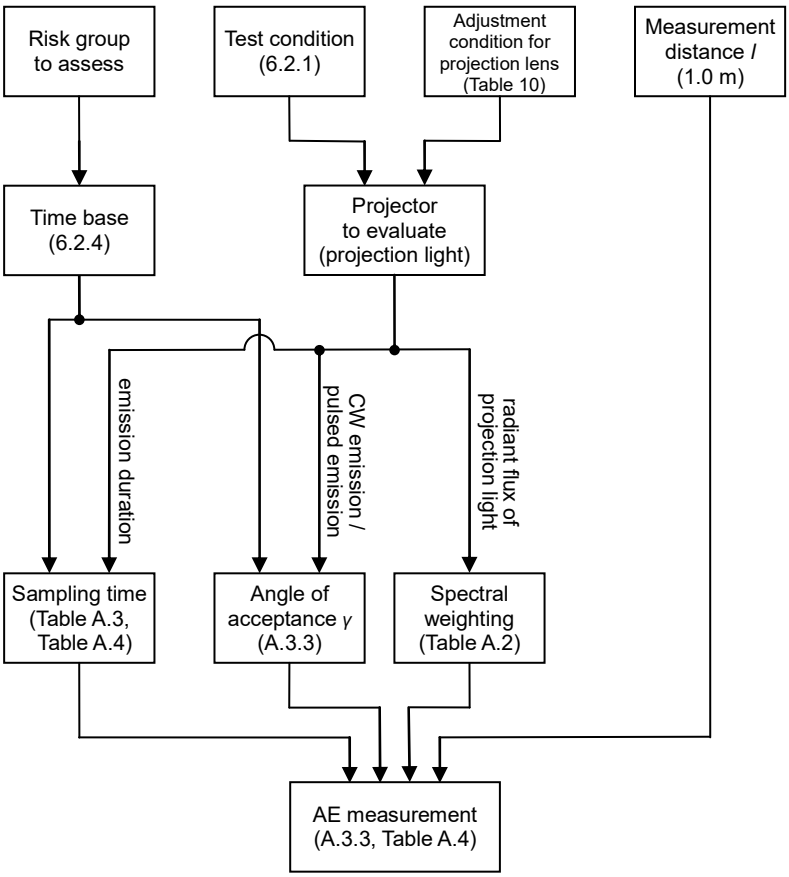


Figure A.5 - Dependency parameters used for the accessible emission (AE) measurement

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Safety requirements for the projectors with laser device as light source

Commentary[KAISETSU]

This commentary is for the purpose of explaining items contained within the body and annex of this standard, and does not form a part of the standard.

The purpose of this 2nd edition of JBMS is to make clear that the concept of laser safety of projector would be same
in the transition period from JIS C 6950-1 (International standard IEC 60950-1) to IEC 62368-1.

Commentary of 1st edition have not been changed.

1 Supplement concerning the scope of this standard

The scope of this standard is the projectors correspond to 4.4 in **JIS C 6802**:2014 (**IEC 60825-1**:2014). Projectors which do not correspond to such and use fixed pixels panel shall comply with JBMIA-TR-27 “Safety guideline for the projectors with laser device as light source”.

2 Supplement concerning normative reference

IEC 62471 and **IEC 62471-5** are normative references in this standard. **JIS C 7550** is correspondent standard of **IEC 62471**; however, it is not normative reference because it is MOD.

3 Acknowledgment

We express our thanks to Mr. Shoji Mitsuhashi (Sony Corporation: IEC/TC 76 expert), Dr. Hideyuki Kanayama (Panasonic Corporation: IEC/TC 76 expert), Mr. Nozomu Inoue (Seiko Epson Corporation: IEC/TC 76 expert) of Laser Safety Standardization Committee, Optoelectronics Industry and Technology Development Association, who gave us interpretation and advices concerning the new international standards (**IEC 60825-1**:2014 and **IEC 62471-5**:2015) in planning this standard.
Also we express our thanks to members of Laser Display Safety Working Group, Technical Committee for Laser Lighting and Display, the Laser Society of Japan (Director: Dr. Sunao Kurimura, National Institute for Materials Science), we turned to them for guidance in planning this standard.

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