# Light-exposure test method by xenon-arc lamp for automotive interior part

## 1. Scope

This standard specifies a method for testing the light-resistance (1) of various industrial materials and products such as fabric polyvinyl chloride, polypropylene, ABS resin, acrylic resin, polyacetal, etc. used for automotive interior parts by a xenone-arc lamp light-exposure tester (hereinafter referred to as "tester")

**NOTE** (1): The light-resistance means a property for which color, gloss,etc. is difficult to change against irradiation of light, and is distinguished form a property (weatherability) for which it is difficult to change against natural phenomena such as sunshine, wind and rain, etc. in the outdoors.

**Remarks** 1. The light-exposure tester means a tester which can irradiate an artificial light similar to sun light to investigate a part of the properties of light-resistance in a short period.

2. The applicable standards to this standard are as follows.

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| **JIS B 7754-1979** | Light-exposure and light-and-water-exposure apparatus (Xenon-arc lamp type) |
| **JIS D 0205-1976** | General rules of weatherability for automobile parts |
| **JIS L 0843-1971** | Testing method for colour fastness to xenon-arc lamp light |
| **JIS Z 8722-1982** | Methods of measurement for colour of reflecting or transmitting objects |
| **JIS Z 8730-1980** | Method for specification of colour differences for opaque materials |
| **JIS Z 8741-1983** | Method of measurement for specular glossiness |

## 2. Definitions of major terms

Definitions of major terms used in this standard shall be as follows.

**(1) Black Panel temperature (hereinafter referred to as "B.P.T.")**
A temperature which is indicated by the black panel thermometer installed on the rack or disk, and represents the surface temperature of a test piece.

**(2) Xenon-arc lamp**
An arc lamp emitting light by xenon-arc discharge.

**(3) Light emitting part**
A part comprising a xenon-arc lamp and a filter.

## 3. Test items to be evaluated and test conditions

### 3.1 Test items to be evaluated

A variation in color, gloss, etc. is evaluated.

### 3.2 Test conditions

The test conditions such as temperature, humidity, irradiance, etc. which affect the test results shall be as follows.

**(1) Setting of temperature**
B.P.T. 89±3°C

**(2) Setting of humidity**
(50±5)% RH

**(3) Irradiance**
48 to 162 W/m$^2$
(within a range of 300 to 400 nm)

**(4) Irradiance ratio**
Under 1.5% of less than 320 nm in a range of 300 to 400 nm

**(5) Irradiation method**
Continuous irradiation

**(6)** Control of test period
According to the amount of irradiant exposure

**Remark:** Acceleration depends upon irradiance. Because the irradiance affects also the sample temperature and heat history, however, a proper irradiance must be selected considering the degree of influence on the sample given by temperature, depending on the sample to be used.

## 4. Apparatus and performance

The tester shall be composed of a test chamber, light emitting part, xenon-arc starting and stabilizing device, irradiance adjusting device, temperature adjusting device, humidity adjusting device, test piece holding device, cooling device, instruments, etc.

### 4.1 Light irradiation

**(1) Construction of light emitting part**

**(a)** The xenon-arc lamp is a long-arc lamp of AC in which an electrode is enclosed at both sides of a silica tube and xenon

gas is sealed and cooled by water or air forcibly.

**(b)** The filter is used to obtain required spectral characteristics and to cool the xenon-arc lamp. A glass filter for cutting off ultraviolet region, flowing water, etc. is used for it.

**(c)** The other materials excellent in weatherability, corrosion resistance, moisture resistance, or electrical insulation are used properly.

**(2) Spectral characteristics of light emitting part**

The xenon-arc lamp should give preferably continuous spectrum over a wave length of at least 250 to 1200 nm, and a construction of light similar to sun light through glass window by combining with the filter.

**(3) Irradiance on test piece**

The irradiance on test piece shall be set between 48 w/m$^2$ and 162 w/m$^2$ over a wave length of 300 to 400 nm.

Also a spectral irradiance on test piece over a wave length of at least 300 to 400 nm shall be indicated for each type of tester.

By mutual agreement between two parties concerned, irradiance in other range of wave length or spectral irradiance at particular wave length may be indicated and used.

The measurement method shall be in accordance with the attachment of **JIS B 7754**.

**(4) Permissible variation range of irradiance on operating period**

±10% of the set irradiance can be maintained.

**(5) Permissible range of irradiance on each surface of test piece**

A difference in irradiance between positions on test piece shall not exceed 10% of the set value.

**(6) Irradiation method**

In general, a specified irradiance shall be irradiated continuously.

### 4.2 Irradiance adjusting device

The irradiance adjusting device is a device to correct the damping of radiation energy accompanied by the use of xenon-arc lamp and filter, and measures irradiance over a wave length of 300 to 400 nm. It shall be provided with either of the following conditions.

**(1)** The lamp power can be adjusted manually so that irradiance may be kept at a constant.

**(2)** The lamp power can be adjusted automatically so that irradiance may be kept at a constant.

**(3)** The lamp power can be adjusted manually and progressively according to use time.

### 4.3 Black panel thermometer

The black panel thermometer shall have a construction in which a heat sensitive element such as bimetal, platinum resistance, thermistor, thermocouple, etc. is installed co-axially with the center of the metal plate, and the heat sensitive element protective tube is fitted closely on it.

The construction and dimensions of it shall be in accordance with Item **5.7 (2)** of **JIS B 7754** and **Attached fig. 1**, Type A.

### 4.4 Test chamber

The devices not specified in the above item such as the xenon-arc starting and stabilizing device, temperature adjusting device, humidity adjusting device, test piece holding device, cooling device, instrument, etc. shall be in accordance with **JIS B 7754**.

### 4.5 Temperature and humidity

The temperature and humidity in the test chamber shall be as follows

**(1) B.P.T. at test piece and its adjustment accuracy**

The black panel temperature at test piece and its adjustment accuracy shall be 89 ±3°C.

By mutual agreement between two parties concerned, the other temperature and its adjustment accuracy may be used.

**Remark:** The temperature depends on the type of xenon-arc lamp and its combination with the filter. Also, the black panel thermometer used shall be in accordance with **JIS B 7754**, Type A.

**(2) Relative humidity and its adjustment accuracy**

Relative humidity should be preferably adjusted to (50±5)% for the indicated temperature stipulated in **(1)**. It shall be measured near the outlet of air in the test chamber.

By mutual agreement between two parties concerned, the other relative humid-

ity may be used.

**5. Adjustment of test piece**

**(1) Size of test piece**

The length of irradiated area on test piece shall be 30 mm or over in longitudinal direction and by mutual agreement between two parties concerned in lateral direction. For materials lined with polyurethane foam, etc., two parties concerned shall agree on density, combination, thickness, etc. each other.

**(2) Others**

For test piece such as cloth, etc. of which fibre pattern has a fixed direction, its mounting direction on the tester shall be indicated.

**6. Operations in test**

**6.1 Test piece**

The test piece shall be installed in the sample holder taking care so that it is not disengaged. When a material such as polyurethane etc. is lined on the back surface of the test piece, it shall be made in contact closely with the back surface of the test piece as far as practicable, and the surface of the test piece shall be free from slackness.

**6.2 Sample holder with test piece**

The sample holder with test piece shall be installed on the rack or disk so that any clearance in not left. If any sample holder without test piece is present, white thick paper, aluminium plate, stainless steel plate, etc. shall be attached on all the holders to keep a thermal equilibrium state in the test chamber.

**6.3 Irradiance**

The irradiance shall be selected from a range of 48 to 162 W/m$^2$ over a wave length of 300 to 400 nm, and the selected irradiance shall be adjusted so that it is kept at a constant during the exposure.

The amount of radiant exposure can be calculated by the following equation.

$$E = I \times t \times C$$

Where $E$ : Amount of radiant exposure (kJ/m$^2$/nm)

$I$ : Irradiance (W/m$^2$/nm)

$t$ : Exposure time (h)

$C$ : Constant 3600 (s/h)

**6.4 Black panel temperature during exposure**

The black panel temperature during exposure shall be adjusted to 89±3°C with the temperature adjusting device.

**6.5 Humidity during exposure**

The humidity during exposure shall be adjusted to relative humidity of (50±5)%.

**6.6 Change of sample position**

When a range of sample position is large, the sample position may be changed at a specified interval to improve test accuracy.

**7. Cautions on operation**

The cautions on operation shall be in accordance with **JIS B 7754** (8. Cautions on handling) and **JIS L 0843** (7. Cautions on operation).

**8. Judgment**

Judgment shall be made by measurement of variation in colour and gloss, etc. of test piece. Variation in colour shall be measured for judgment in accordance with **JIS Z 8722**, and that in gloss shall be in accordance with **JIS Z 8741**. For variation such as in choking, crazing, blooming, crack, stain contamination, etc., measurement shall be made in accordance with **JIS D 0205**, 7.

**9. Marking**

The marking of variation in colour shall be made in accordance with **JIS Z 8730** or by mutual agreement between two parties concerned. The making of variation in gloss shall be in accordance with **JIS Z 8741** or by mutual agreement between two parties concerned. The other markings shall be made in accordance with **JIS D 0205**.

# Explanatory note on JASO M 346-93 Light-exposure test method by xenon-arc lamp for automotive interior part

This explanatory note simply explains the items stipulated in the text of the standard and the related items and not a part of the standard.

## 1. Introduction

Activities of investigation for standardization of the above subject were started in 1990 for the purpose of internationalizing the test method and improving its accuracy. The activities from preparation to establishment of the standard were planned first such that, in preparatory step, a consistency of fundamental conditions (settings on temperature and light) of devices to be used was maintained, in step 1, devices to obtain the re-producibility of test and the management method of the test were investigated, in step 2, test conditions to maintain a correlation with the outdoor exposure test (underglass) were investigated and, in step 3, the results in steps 1 and 2 were finally summarized. Then the investigation was proceeded in accordance with that plan and the standard has been established.

## 2. Purpose

The accelerated exposure test method is used to evaluate, in a laboratory, polymeric materials such as plastics, fibre, etc. deteriorated due to solar radiation. The method in which carbon-arc is used as light source was standardized and has been used in Japan. In the U.S. and European countries, on the other hand, the xenon-arc lamp type is predominant from before and, also in ISO, the test method in which xenon-arc lamp is used as light source is the leading part. In such circumstances, some exposure test methods (hereinafter referred to as "test method")in which xenon-arc lamp is used as light source, which its light is mostly similar to solar light in wave length distribution, are sometimes studied and adopted by automotive companies, with the increased Japan's overseas corporate activities in recent years and the increased quality requirement. Accordingly, the test method has been standardized by JASO.

## 3. Content of investigation and supplementary explanation

Based on the investigation results up to Step 3, the following content was discussed primarily, and the standardized test method has been established as follows.

### 3.1 Test apparatus

For convenience of use by users and to cope with internationalization, three types of apparatuses were selected as a base so that, in Japan, the U.S., and the European countries, at least one can be purchased easily by users and also maintained, and adding a high strength type to them to cope with increased acceleration, the specifications in Attached table have been established.

### 3.2 Type of test and test conditions

Deterioration of polymeric materials depends on a combination of light, heat, water, etc. However, the investigation was proceeded on the assumption that the test for automotive interior parts shall be made in one condition. A correlation between the results of the outdoor exposure test and those in various conditions (Step 1 to 3) has been analyzed, and the standardized test conditions have been established as in **Text 3.**

### 3.3 Validity of standardized test conditions for each material

Polymeric materials deteriorate due to light, heat, water, etc., and the degree of deterioration depends on a combination of them. The validity of the standardized test conditions to market environment is assumed from the test results in this investigation, deterioration factors, and deteriorating mechanism of polymeric materials as follows.

The test conditions used in each step are as

follows.

Step 1: Study on an apparatus to obtain the re-producibility of test and of management method of test

Series 1 (Irradiance in a short wave length of 320 nm or below was adjusted to be less than 1.5% in a range of 300 to 400 nm. (The same as the standardized test conditions.)

Series 2 (Using the black standard temperature [hereinafter referred to as "B.S.T."] lused mainly in the European countries was used to control test temperature instead of B.P.T.)

Series 3 (Using light including a low ultraviolet region of 320 nm or below, a correlation when acceleration was increased was studied.)

Step 2: A correlation when acceleration was increased by adding an light and dark cycle stipulated in SAE standards of the US to the conditions of Step 1, Series 1 was studied.

Step 3: Additional tests to steps 1 and 2 for supplement and verification. Also the correlation ranks (A,B, and C) in Explanatory table 1 indicate:

A: R = 0.80 or more

(R indicates a coefficient of correlation.)

B: R = 0.71 to 0.79

C: R = 0.70 or below

Where numerals are coefficients of correlation.

In general, when a coefficient of correlation is 0.80 or more, the correlation is excellent.

## Explanatory table 1 Correlation of accelerated test conditions for outdoor exposure test

| Type of material | Apparatus | Test conditions | | | | Validity of test conditions |
|---|---|---|---|---|---|---|
| | | Step 1, Series 1 | ——— Series 2 | ——— Series 3 | Step 2 | |
| ABS Resin | a. 80w/m² | A (R:0.80) | B (R:0.75) | C (R:0.49) | A (R:0.84) | Type of Material Used for Test : Heat-resistance grade<br>Colour : Blue, Red, Gray, Brown<br>1. Validity of Test Conditions Based on Outdoor Exposure Results<br>The table on the left shows a correlation between colour differences in the exposure test in Florida (well agreed with the amount of light in the acceleration tests and also well correlated with the exposure tests in the other regions) and each acceleration test.<br>Though there is no difference between the test conditions except for Step 1, Series 3, the Step 1, Series 1 was judged to be appropriate by the following reasons.<br>* Onset wave length (Series 3): A correlation between colour differences is lowest.<br>* Light and dark cycle (Step 2): Though there is no difference in correlation between colour differences, light and dark cycle requires a long time and causes excessive contamination on the test piece.<br>* Temperature control: Though there is no decisive difference between B.P.T. and B.S.T. in correlation, a correlation in B.P.T. is rather better.<br>2. Validity of Test Conditions Based on Deterioration Mechanism<br>The ABS resin is deteriorated by heat and light, remarkably at a wave length of 320 nm or below. The acceleration test Series 3 which matches this condition has the lowest correlation.<br>Also, because the wave length of 320 nm or below of light on automotive interior parts is cut off by the window glass, this condition is not valid to them. Humidity does not affect deterioration in this test conditions. Accordingly, for automotive interior parts, Step 1, Series 1 is considered to be mostly appropriate considering accuracy and acceleration.<br>3. Cautions on Use<br>Irradiance gives effect on acceleration, and also on sample temperature and heat history.<br>Accordingly, it is required to set the irradiance considering the degree of effect by humidity. |
| | b. 100w/m² | A (R:0.93) | A (R:0.84) | C (R:0.67) | A (R:0.82) | |
| | 53w/m² | A (R:0.97) | A (R:0.90) | C (R:0.55) | A (R:0.87) | |
| | c. 48w/m² | A (R:0.97) | A (R:0.97) | A (R:0.87) | A (R:0.89) | |
| | d. 162w/m² | A (R:0.80) | A (R:0.84) | C (R:0.68) | A (R:0.82) | |

| Type of material | Apparatus | Test conditions | | | | Validity of test conditions |
|---|---|---|---|---|---|---|
| | | Step 1, Series 1 | ——— Series 2 | ——— Series 3 | Step 2 | |
| PMMA | a. 80w/m² | A (R:0.93) | A (R:0.98) | A (R:1.00) | A (R:0.95) | Type of Material Used for Test: Impact resistant grade for injection moulding (Class. 2) Colour: Colourless, Transparent red<br>1. Validity of Test Conditions Based on Outdoor Exposure Results<br>① The 6-month exposure results in Florida and 100 MJ/m² (50 MJ/m² for Series 3 only) were compared in Δ E and numerically analyzed. The results showed a remarkably excellent correlation, and Step 1-1 (temporary conditions) was judged to be equivalent to Step 1-2.<br>② The numerical value for gloss and haze is more reliable in Step 1-1, in which the contamination on surface of sample due to adhesion of water drop is less, than in Step 1-2.<br>2. Validity of Test Conditions Based on Deterioration Mechanism<br>* In the UV irradiation (300 to 500 nm) at low temperatures (35 to 40°C) , only lowering of molecular weight occurs, and deterioration due to oxidation and crosslinking does not occur.<br>* Though it is generally said that, depolymerization occurs at high temperature region, effect of heat deterioration is small at 100 °C or less.<br>* Because acceleration of deterioration caused by moisture absorption is small, deterioration in Step 1-1 is assumed to be approximately the same level as in Step 1-2.<br>3. Cautions on Use<br>The Δ E was less than 2 in the one-year test in Florida and even in the accelerated exposure 500 MJ/m² (equivalent to approx. 2.5 years in Florida), which was a minute change difficult to judge visually. |
| | b. 100w/m² | B (R:0.72) | A (R:0.96) | A (R:0.99) | A (R:0.97) | |
| | 53w/m² | A (R:0.94) | A (R:0.96) | A (R:0.99) | A (R:0.95) | |
| | c. 48w/m² | A (R:0.91) | A (R:0.86) | A (R:1.00) | A (R:0.91) | |
| | d. 162w/m² | A (R:0.86) | A (R:0.92) | A (R:1.00) | A (R:0.96) | |

| Type of material | Apparatus | Test conditions | | | | Validity of test conditions |
|---|---|---|---|---|---|---|
| | | Step 1, Series 1 | Series 2 | Series 3 | Step 2 | |
| Engineering plastics | a. 80w/m² | A (R:0.95) | A (R:0.95) | A (R:0.91) | A (R:0.94) | Type of Material used for Test: POM (Homopolymer, Copolymer) PBT, PA6, PA66, PC/ABS<br>Colour: Blue, Red, Gray, Brown, Natural<br>1. Validity of Test Conditions Based on Outdoor Exposure Results<br>The table on the left shows a correlation between ΔE in outdoor exposure tests (12 months) in Gunma, Okinawa, Arizona, and Florida and each acceleration test at 150 MJ (75 MJ for Step 1-1, Series 3). (The R values in the table show the average of each exposure test values.)<br>These are all correlated highly with each other and, therefore, the acceleration test conditions are all judged to be appropriate.<br>2. Validity of Test Conditions Based on Deterioration Mechanism<br>(1) Deterioration Mechanism<br>In general, the deterioration mechanism of engineering plastics due to ultraviolet ray and heat can be explained by the processes of radical formation, peroxide formation, breakage and crosslinking of principal chain, and variation in chemical constitution of principal chain in that order. It shows a characteristic absorption of ultraviolet ray in a wave length region of 320 nm or less (large deterioration). Also most engineering plastics hardly absorbs moisture and, therefore, deterioration due to moisture will not be accelerated. (Even polyamid which absorbs moisture easily hardly causes breakage of molecule due to moisture absorption)<br>(2) Validity of Test Conditions<br>Though there is no large difference between the test conditions, the Step 1, Series 1 was judged to be mostly appropriate by the following reasons.<br>① Temperature Control: There is a slightly small correlation in B.S.T. in some test apparatuses, and there is less variation in B.P.T.<br>② Onset Wave Length: Because deterioration is large in a wave length region of 320 nm or less, the onset wave length shall be set at 320 nm according to condition of materials in use.<br>③ Light and dark: Because there is no difference in correlation, and deterioration is not accelerated due to presence of moisture, test condition without light and dark cycle that the test period becomes shorter has been selected.<br>3. Cautions on Use<br>None |
| | b. 100w/m² | A (R:0.92) | A (R:0.92) | A (R:0.89) | A (R:0.93) | |
| | 53w/m² | A (R:0.94) | A (R:0.94) | A (R:0.89) | A (R:0.94) | |
| | c. 48w/m² | A (R:0.91) | A (R:0.93) | A (R:0.91) | A (R:0.93) | |
| | d. 162w/m² | A (R:0.93) | B (R:0.78) | A (R:0.89) | A (R:0.85) | |

| Type of material | Apparatus | Test conditions | | | | Validity of test conditions |
|---|---|---|---|---|---|---|
| | | Step 1, Series 1 | ——— Series 2 | ——— Series 3 | Step 2 | |
| PP | a. 80w/m² | A (R:0.93) | A (R:0.99) | B (R:0.78) | A (R:0.96) | Type of Material Used for Test:<br>Black polymer, Talc 20%<br>Colour: Blue, Red, Gray Brown, Natural<br>1. Validity of Test conditions Based on Outdoor Exposure Results<br>Based on the acceleration test results, Step 1, Series 1 in the standard test conditions is appropriate.<br>(1) Deterioration Phenomenon in Outdoor Exposure and Acceleration Test<br>① On appearance evaluation (visually or by a 30-magnification magnifying glass), roughly the same craze is produced in both the outdoor exposure and accelerated exposure test. The craze is developed from a minute one to an evident crack with increase of exposure time.<br>② In this test area, discolouration and fading are less in both the outdoor exposure and accelerated exposure test and, therefore, the colour difference is not yet evaluated.<br>③ Because the 60° gross causes dispersion by the bleeding of compounding agent mainly, it is difficult to evaluated it properly.<br>(2) Correlation between Outdoor Exposure and Acceleration Test<br>According to appearance evaluation carried out judging from the result in Item ① above, a correlation in test conditions between the outdoor exposure and each acceleration test is highest in the standard test condition (Step 1/Series 1).<br>2. Validity of Test Conditions Based on Deterioration Mechanism*<br>Based on the following considerations on deterioration mechanism made in addition to a correlation with the outdoor exposure, the standard test condition (Step1/Series 1) can be said to be appropriate.<br>(1) Continuous Irradiation including Short Wave Length Region<br>Since Step 1/Series 3 includes short wave length region, the deterioration acceleration is increased, and evaluation can be made in short period. However, for evaluation of interior parts, light ray through window glass does not match the actual circumstances because it does not include short wave length.<br>(2) Light and dark Cycle (Step 2) Containing Humidifying Conditions<br>The deterioration phenomenon is considered to be caused primarily by deterioration of polymer itself. Though the deterioration is started and continued by radical reaction due to thermal oxidation and light energy mainly, humidification is not necessarily the condition indispensable to accelerate the deterioration in the PP which is low in hygroscopicity.<br>Also, for other physical variation which causes thermal effect, there is crystallization.<br>However, initial history is dominant at a constant temperature, and effect by repeated intermittent heating can be neglected.<br>3. Cautions on Test<br>(1) Relationship between Exposure Amount and Test Time<br>Because the acceleration tests were compared with each other based on the amount of exposure this time, the larger the illuminance of test apparatus is given, the smaller the test time is required when the amount of exposure is the same, and also the smaller the heat history on a sample is given. In such apparatus, it is required to set an evaluation standard considering not only the amount of exposure but also deterioration due to heat.<br>(2) Relationship between Exposure Site and Acceleration Test<br>In the table on the left, the data in the other sites were omitted because a correlation between the exposure result in Florida and that in each acceleration test was maximum in comparison at the same amount of exposure. If analyzing by other factors (such as test time, etc.) than the amount of exposure, it is not conducted this time, but a different results may be obtained. |
| | b. 100w/m² | A (R:0.92) | A (R:0.86) | C (R:0.65) | A (R:0.84) | |
| | 53w/m² | A (R:0.91) | A (R:0.90) | A (R:0.88) | A (R:0.89) | |
| | c. 48w/m² | A (R:0.99) | A (R:0.81) | A (R:0.95) | B (R:0.73) | |
| | d. 162w/m² | A (R:0.83) | C (R:0.28) | C (R:0.69) | - | |

| Type of material | Apparatus | Test conditions | | | | Validity of test conditions |
|---|---|---|---|---|---|---|
| | | Step 1, Series 1 | ——— Series 2 | ——— Series 3 | Step 2 | |
| Fabric | a. 80w/m² | A (R:0.82) | A (R:0.86) | B (R:0.78) | A (R:0.88) | Type of Material Used for Test: Moquette comprising polyester and nylon, fabric tricot (model sample) Colour: Blue, Red, Gray, Brown (Colours used generally for automotive interior parts) 1. Validity of Test Conditions Based on Outdoor Exposure Results The table on the left shows the ranking of correlation coefficients which are combined with the amounts of irradiant exposure in each outdoor exposure results and each acceleration test results ( ΔE* for both) nearest each other and averaged. From these results, it can be found that, because a correlation of Step 1, Series 3 (short wave length onset condition) is low, effect of short wave length in ultraviolet ray region is large, and also light in this wave length region to be cut by window glass is harmful for automotive interior parts. In the other test conditions, the same level of results are obtained, and Step 1, Series 1 test condition was judged to be more appropriate rather than Step 1, Series 2 (B.S.T. control). 2. Validity of Test Conditions Based on Deterioration Mechanism Most of fibres now used for automotive seats are polyester, and its deterioration due to light is primarily caused by light in 320 nm or less. For humidity, synthetic fibre is generally less in hygroscopicity, and difficult to be affected by humidity particularly at temperatures of 100℃ or less. Accordingly, Step 1, Series 3 is not preferable in accuracy for automotive interior parts and, based on acceleration, Step 1, Series 1 is considered to be appropriate mostly. This also matches the test results. 3. Cautions on Use Because irradiance affects sample humidity and heat history, in the condition of high irradiance, a correlation with exposure may be lowered due to effect by heat reserve, depending on samples. Accordingly, adjustment of conditions such as selection of a proper irradiance or release of polyurethane foam from the back surface is required. NOTE (1): Step 3, Series 2 (R:0.91) The same condition as Step 1, Series 1, and polyurethane foam is not installed on the back surface. |
| | b. 100w/m² | A (R:0.90) | A (R:0.90) | B (R:0.75) | A (R:0.86) | |
| | 53w/m² | A (R:0.82) | A (R:0.84) | B (R:0.72) | A (R:0.87) | |
| | c. 48w/m² | A (R:0.92) | A (R:0.87) | A (R:0.83) | A (R:0.86) | |
| | d. 162w/m² | A (R:0.70) | C (R:0.79) | C (R:0.54) | B (R:0.72) | |
| | | | | ——— Step 3 ——— A (R:0.91) | | |

| Type of material | Apparatus | Test conditions | | | | Validity of test conditions |
|---|---|---|---|---|---|---|
| | | Step 1, Series 1 | Series 2 | Series 3 | Step 2 | |
| Polyvinyl-chloride coated Fabric and Polyvinyl-chloride Sheet (Lined with Polyure-thane Foam) | a. 80w/m² | B (R:0.78) | B (R:0.78) | C (R:0.50) | A (R:0.80) | Type of Material Used for Test: Forming sheet for instrument panel, Forming sheet for general purpose, General sheet, Polyvinylchloride coated Fabric for general purpose<br>Colour: Blue, Red, Gray, Ivory<br>1. Validity of Test Conditions Based on Outdoor Exposure Results<br>The R values in the table show the average of correlation coefficients of ΔE obtained by comparing the 3-month, 6-month, and 9-month results of the outdoor exposure test 1 conducted at a total of six locations of Florida, Arizona, and Japan with the acceleration tests at the amount of irradiant exposure of 50 MJ, 100 MJ, and 150 MJ (25 MJ, 50 MJ, and 75 MJ for Step 1, Series 3), respectively. Because a correlation is high in the apparatuses a, b, and c for Step 1, Series 1, the test conditions in Step 1, Series 1 were judged to be appropriate.<br>2. Validity of Test Conditions Based on Deterioration Mechanism<br>The major deterioration mechanism of polyvinylchloride is such that dehydrochlorination reaction is produced by heat and light to form polyene constitution, and compound other than polyene may be formed due to light and discolouring may occur simultaneously due to bleaching effect in presence of oxygen, etc., and a balance of heat and light is considered to be important. From this point of view, the test conditions of Step 1, Series 1 were judged to be appropriate.<br>3. Cautions on Test<br>Vinyl chloride leather and sheet are generally covered with urethane form on the back surface for testing. Due to heat insulation effect by this, the sample temperature becomes higher than that on the black panel thermometer. Especially, in high irradiance, this effect is large, and the deterioration of the sample sometimes does not match the actual deterioration condition, and breaching effect is observed occasionally. Therefore, the test conditions should be preferably adjusted by comparing the deterioration of the sample with the actual deterioration conditions beforehand.<br>NOTE (1) The temperature setting in the test conditions is 94°C in B.S.T. Because this is equivalent to 70 °C in B.P.T. which is different from the temperature setting in the other tests, it is not evaluated.<br>(2) This was conducted in the conditions of Step 1, Series 1 and at a low amount of irradiant exposure of 17 to 25 MJ/ m², and a good correlation could be obtained. |
| | b. 100w/m² | A (R:0.88) | A (R:0.85) | C (R:0.50) | A (R:0.82) | |
| | 53w/m² | A (R:0.93) | A (R:0.84) | C (R:0.67) | B (R:0.76) | |
| | c. 48w/m² | A (R:0.90) | A (R:0.89) | A (R:0.85) | C (R:0.59) | |
| | d. 162w/m² | C (R:0.22) | B(1) (R:0.73) | C (R:0.57) | B (R:0.66) | |
| | | | | Step 3(2) A (R:0.81) | | |

| Type of material | Apparatus | Test conditions | | | | Validity of test conditions |
|---|---|---|---|---|---|---|
| | | Step 1, Series 1 | Series 2 | Series 3 | Step 2 | |
| Polyvinyl-chloride Sheet by Power Slash Molding (Lined with Polyure-thane Form) | a. 80w/m² | A (R:0.81) | A (R:0.82) | A (R:0.83) | C (R:0.61) | Type of Material Used for Test: Vinyl chloride prepared as a model by varying the amount of stabilizer. Colour: Blue, Red, Gray Ivory<br>1. Validity of Test Conditions Based on Outdoor Exposure Results<br>In the xenon-arc light-exposure test, a correlation between the test results in the test conditions of Step 1, Series 3 in which short wave length is included and the exposure in Florida is not good as compared with that which was conducted in the other conditions. Because light through window glass of an actual vehicle does not include short wave length of 320 nm or less, and also based on the test results this time, the standard conditions in which short wave length is not included is better. For setting method of test temperatures, a correlation was better in black panel thermometer system, Step 1, Series 1 than in black standard thermometer, Step 1, Series 2.<br>A correlation was lower in the light and dark cycle, Step 2 than in continuous irradiation, Step 1, Series 1.<br>A correlation in Step 1, Series 1 was mostly excellent and it was judged to be appropriate considering the shortening of test time.<br>2. Validity of Test Conditions Based on Dterioration Mechanism<br>Polyvinyl chloride is said that it forms polyene due to dehydrochlorination by mainly compound action of heat and light, and also forms carbonyl group in presence of oxygen, to discolour and deteriorate. In this test, discolouration occurred earlier as predicted before on the test piece in which less amount of ultraviolet ray absorbing agent is contained.<br>For PVC material, deterioration due to moisture was less and the accelerated deterioration test conditions by light and heat in Step 1, Series 1 were judged to be appropriate.<br>3. Cautions on Test<br>A correlation between the test on a highly strong energy type (irradiance of 162 w/m² ) apparatus and the exposure in Florida was investigated in the condition of Step 3 where the exposure for acceleration test is approximately half the amount in Step 1, Series 1, and the result was excellent. Because, in the highly strong energy type apparatus, the temperature on both sides of the test piece rises 20 °C higher than that in the standard apparatus, however, effect of deterioration due to heat becomes larger. It is required for evaluation in the test on the highly strong energy type apparatus to add that point. |
| | b. 100w/m² | A (R:0.81) | A (R:0.87) | B (R:0.75) | A (R:0.85) | |
| | 53w/m² | A (R:0.88) | A (R:0.84) | C (R:0.68) | A (R:0.80) | |
| | c. 48w/m² | A (R:0.89) | C (R:0.67) | B (R:0.71) | B (R:0.79) | |
| | d. 162w/m² | C (R:0.56) | C (R:0.52) | B (R:0.77) | C (R:0.49) | |
| | | | | Step 3 B (R:0.74) | | |

### 3.4 Consistency with other standards

Many standards on xenon-arc light-exposure test are found in ISO, and US, German, and Japanese Standards as shown in **Explanatory table 2.**

For major standards on "Light-Exposure Test Method by Xenon-Arc Lamp for Automotive Interior Part", ISO 105-B06, DIN-75202 and SAE J 1885 are well known. A comparison of test conditions for these test methods is shown in **Explanatory table 3** in which a consistency with these standards is shown for each item.

**(1) Temperature**

For indication of representative temperature of a sample, two kings of temperatures of black panel temperature (B.P.T.) and black standard temperature (B.S.T.) are in use. In Japan and the US, the B.P.T. is generally used, and the B.S.T. is used primarily in Europe and investigated by ISO. The B.S.T. shows rather higher than the B.P.T., and its difference depends on an irradiance of light source and the type of filter. In this standard, the B.P.T. has been adopted as a standard based on the test results and considering a difference between models, correlation with the outdoors, consistency with the standards in and outside Japan, etc. B.P.T. of 89°C has been judged appropriate and adopted as a standard because, in the outdoor light-exposure test conducted during this experiment, the surface temperature of sample rose to 110 to 116°C in Okinawa (August), 88 to 104°C in Florida (September), and 88 to 110°C in Arizona (November) in measurement by thermo label, and also the B.P.T. of 89°C in SAE and the B.S.T. of 100°C in DIN were already standardized.

**(2) Humidity**

Because humidity of 20% in ISO and DIN is too low as compared with actual one and also a correlation with the conditions in SAE and outdoor light-exposure in this experiment could be obtained, 50% RH has been adopted as a standard.

**(3) Onset wave length of irradiation light**

Though the onset wave length of light passing through window glass is not a constant because the type and thickness of the window glass differ according to vehicle model, there is no window glass for automobiles that passes through a light of 320 nm or below.

Accordingly, the conditions under which a short wave length of 320 nm or below can be cut were considered mostly preferable for practical use, correlation with the outdoors, and internationalization, etc., and adopted as a standard.

**(4) Irradiance**

The irradiance is set in ISO and DIN with an average of solar radiation in subtropical region as a reference and, in SAE, it is increased approximately 1.5 times that in ISO and DIN. Because, in SAE, the onset wave length is 275 nm, some factors which will increase acceleration may be produced in the short wave length region. Therefore, the irradiance in these standards cannot be compared simply by the level of irradiance only. The level of irradiance may be a direct cause to affect photochemical reaction speed and heat history, and its amplitude affects largely on the correlation and acceleration of the material. Accordingly, particularly a limit to which a sample is affected by temperature must be taken into consideration when irradiance is selected. In this standard, an irradiance of 300 to 400 nm over a range of 48 to 162 w/m$^2$ has been adopted to make various tests for a variety of materials used for automotive internal parts, taking correlation and acceleration into consideration.

For indication of irradiance, the narrow band (Ex. point indication such as 340 nm, 420 nm, etc.) method and wide band (Ex. band indication such as 300 to 400 nm, etc.) method are available worldwide. The former is adopted in SAE, and a part of ISO and DIN, and the latter is being studied to adopt in ISO, etc. In this standard, an irradiance of 300 to 400 nm has been adopted as a standard for internationalization and common use in the conventional apparatuses.

**(5) Light and dark**

Though the light and dark cycle is adopted in SAE and as a part of ISO, its effect could not be noticed in this test results. This cycle may cause water-drop due to high humidity to adhere on the surface of sample, and make the estimation difficult.

Considering the efficiency of test time and the ISO and DIN standards, the light and dark cycle was not adopted, and the continuous irradiation has been adopted as a standard.

**3.5 Supplementary explanation of tester**

The permissible variation range of irradiance during the test is stipulated at within ± 10% in ISO, JIS, ASTM, etc. Considering a consistency with them, a variation range of ± 10% has been adopted in this standard. However, it is ± 5% in the tester of automatic irradiance control system now widely used and, therefore, this control system should be preferably used.

Though a tester is stipulated in **JIS B 7754** which is applicable to this standard, a particular tester with which this preliminary test was conducted for standardization will be introduced.

**Explanatory fig. 3** The amount of radiant exposure and exposure time are shown in the form of comparison drawing so that they can be used as a standard for the test time when managed by the amount of radiant exposure in actual testing.

**(1) Explanatory table 4**
List of Specifications of Testers

**(2) Explanatory table 5**
a and b Structure of Light Used in Test

**(3) Explanatory fig. 1**
Spectral Distribution of Solar Light (Through Window Glass)

**(4) Explanatory fig. 2**
Example of Spectral Distribution of Light Emitting Part

**(5) Explanatory fig. 3**
Radiant Exposure Amount and Irradiation Time

**Explanatory Table 2 List of reference standards**

| object | ISO | US | Germany | Japan |
|---|---|---|---|---|
| Fibre | ISO 105/B | AATCC/16E AATCC/16F<br>ASTM/D4355 | DIN/54004 | JIS L 0843 |
| Plastics | ISO 4892 | ASTM/D2565<br>ASTM/D4459<br>ASTM/D5071 | DIN/53386<br>DIN/53387<br>DIN/75202 | |
| Paint | ISO/DIS 2809<br>ISO 787-15 | ASTM/D4303 | DIN/53321 | |
| Automobile | ISO/DIS 105-B06*<br>ISO/TC22/SC11 | SAE/J1885*<br>SAE/J1960 | DIN/75020* | |
| Others | ISO 4665 | ASTM/G26 ASTM/E765<br>ASTM/E781 ASTM/D4434<br>ASTM/D4637 ASTM/D4798<br>ASTM/C732 | DIN/54004 | JIS B 7754 |

## Explanatory table 3 List of test conditions for standards relating to internal parts

| Item | ISO 105-B6 | DIN-75202 | SAE-J1885 |
|---|---|---|---|
| Temperature<br>(Air Temperature) | Air-cooled type<br>No.1•••BST115±3°C<br>No.2•••BST 82±3°C<br>No.4•••BST100±3°C<br>Water-cooled type<br>No.3•••BST100±3°C<br>No.5•••BST 89±3°C<br>Air-cooled type<br>No.1•••45±5°C<br>No.2•••35±5°C<br>No.4•••60±5°C<br>Water-cooled type<br>No.3•••70±5°C<br>No.5•••63±4°C | Air-cooled type<br>•••BST115±3°C<br>BST100±3°C<br>BST100±3°C<br>Air-cooled type<br>•••40~50°C<br>Water-cooled type<br>•••60~72°C | BPT 89±3°C<br>Light cycle 62±2°C<br>Dark cycle 38±2°C |
| Humidity<br>(Relative humidity) | No.1,3,4 (20±10)% No.5<br>No.5 (50±10)% | (20±10)% | Light cycle (50±5)%<br>Dark cycle (95±5)%°C |
| Irradiation light onset wave length | Conditions<br>No.1~No.4 •••320 nm<br>No.5 •••275 nm | 320nm | 275 nm |
| Irradiance | Air-cooled type<br>•••Not specified<br>Water-cooled type<br>•••320 nm onset<br>1.2w/m²(420 nm)<br>•••275 nm onset<br>0.55±0.01w/mm² (340 nm) | Air-cooled type<br>•••To be operated within a range in which a time needed for coming into the reference colour 6 of the colour fastness scale is 80±16 hours.<br>Water-cooled type<br>•••1.2±0.2w/mm² (420 nm) | 0.55±0.01w/m² (340 nm) |
| Light and dark | Continuous irradiation for conditions Nos. 1 to 4 (No dark cycle)<br>For condition No.5, light is turned off for one our after 3.8 hour irradiation. | Continuous irradiation | After 3.8 hour irradiation, light is turned off for one hour. |

## Explanatory table 4 List of specifications of testers

| Items of test condition \ Type of tester | | Air-cooled Xenon-Arc Lamp Type Weatherability tester (a) | Water-Cooled Xenon-Arc Lamp Type Weatherability Tester (b) | Water-cooled Xenon-Arc Lamp Type Weatherability Tester (c) | Water-Cooled Type Xenon-Arc Lamp Type Weatherability Tester (d) |
|---|---|---|---|---|---|
| Construction of Tester | | Refer to JIS B 7754 section 5. | Refer to **JIS B 7754**, Section 5 | Refer to **JIS B 7754**, Section 5. | |
| Cooling System of Lamp | | Air-cooled type | Water-cooled type | Water-cooled type | |
| Number of Lamps | | 3 lamps | One lamp | One lamp | |
| Rated Power of Lamp kW | | 4.5 | 6.5 | 7.0 | |
| Rated Discharge Voltage V | | 370±20 | 192 | 134 | |
| Rated Discharge Current A | | 12.5 | 35 | 52 | |
| Glass Filter (in condition that light passes through window glass) | Shape | Infrared shielding filter: Cylindrical type<br>Outer quartz filter: Cylindrical type<br>Ultraviolet filter: Cylindrical three-split type | Cylindrical type for all filters | Inner/outer filter of cylindrical type<br>Intermediate filter of rectangular type | |
| | Spectral Transmission Factor % | Infrared shielding filter: 10 or more for 275 nm, 50 or more for 300 nm, 80 or more for 400 to 800 nm and 35 or below for 800 nm<br>Quartz (outer)filter : 90 or more for 275 to 700 nm<br>Ultraviolet filter W : 2 or below for 320 nm and 90 or over for 400 to 700nm | Borosilicate 2 or below for 275 nm and 90 or more for 400 to 700 nm<br>Soda Lime 2 or below for 320 nm and 90 or over for 400 to 700 nm | Quartz filter: 90 for 250 to 700 nm<br>Ultraviolet shielding type #275: 2 or below for 275 nm and 90 or over for 400 to 700 nm<br>Ultraviolet shielding type #320: 10 or below for 320 nm | |
| | Combination | Inside : Infrared shielding filter<br>Outside : Quartz filter<br>Outermost : Ultraviolet shielding filter W 3-split type | Inside : Borosilicate<br>Outside : Soda Lime | Inside : Quartz 275<br>Outside : Quartz #275<br>Intermediate : #320 | |
| | Use Time Limit h | Infrared shielding filter: No limitation<br>Quartz filter: No limitation<br>Ultraviolet: shielding filter W: 4000 | Inside : 400<br>Outside : 2000 | Inside : 2000<br>Outside : 2000<br>Intermediate : 2000 | |
| Irradiance on Test Piece Surface W/m² (Wave Length Range 300 to 400 nm) | | 90~40 | 115~23 | 70~20 | 180~60 |
| Variation in Irradiance on Test Piece Surface % | | 5 or less | 5 or below | 5 or below | |
| Black Panel Thermometer | Adjusting Temperature Dimensions Specifications | Refer to **JIS B 7754**, Paragraph **5.7** | Refer to **JIS B 7754**, Paragraph 5.7. | Refer to **JIS B 7754**, Paragraph **5.7** | |
| Test Piece Holder | Distance between Arc Centre Line and Sample Surface mm | 320 | 325 | 480 | 240 |
| | Diameter mm | 610 | 650 | 960 | 480 |
| | Rotational Speed r/min | Approx. 2 | Approx. 1 | Approx. 1 | |
| Temperature Control Range At 23°C of RT and 50% of RH | | 58~90±2 | 55~95±2 | 53~95±2 | |
| Humidity Control Range % RH at 89°C of B.P.T. | | 30~70 | 20~70 | 40~60 | |

## Explanatory table 5.a Constitution Light Used in test (1)

Ⅰ: Spectral Irradiance (W/m²)
Ⅱ: Constitution Ratio (%)

| Type Wave Length Range | a | | b (2) | | c | | d | |
|---|---|---|---|---|---|---|---|---|
| | Ⅰ | Ⅱ | Ⅰ | Ⅱ | Ⅰ | Ⅱ | Ⅰ | Ⅱ |
| 290~300 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 300~310 | 0.00 | 0.00 | 0.20 | 0.37 | 0.10 | 0.20 | 0.40 | 0.20 |
| 310~320 | 0.60 | 0.80 | 0.60 | 1.10 | 0.20 | 0.40 | 0.60 | 0.40 |
| 320~330 | 2.92 | 3.70 | 1.60 | 2.90 | 0.70 | 1.50 | 2.40 | 1.50 |
| 330~340 | 6.12 | 7.70 | 3.20 | 5.80 | 2.10 | 4.40 | 7.00 | 4.40 |
| 340~350 | 8.84 | 11.10 | 4.80 | 9.00 | 3.90 | 8.10 | 13.00 | 8.10 |
| 350~360 | 10.67 | 13.30 | 6.50 | 12.00 | 5.70 | 11.90 | 19.40 | 11.90 |
| 360~370 | 12.20 | 15.20 | 7.60 | 14.20 | 7.20 | 15.00 | 24.30 | 15.00 |
| 370~380 | 12.35 | 15.40 | 8.60 | 16.00 | 8.20 | 17.00 | 27.60 | 17.00 |
| 380~390 | 12.44 | 15.60 | 9.10 | 17.00 | 9.10 | 18.90 | 30.60 | 18.90 |
| 390~400 | 13.80 | 17.20 | 11.60 | 21.54 | 10.90 | 22.70 | 36.70 | 23.70 |
| 290~400 | 80.00 | 100.00 | 53.80 | 100.00 | 48.00 | 100.00 | 162.00 | 100.00 |

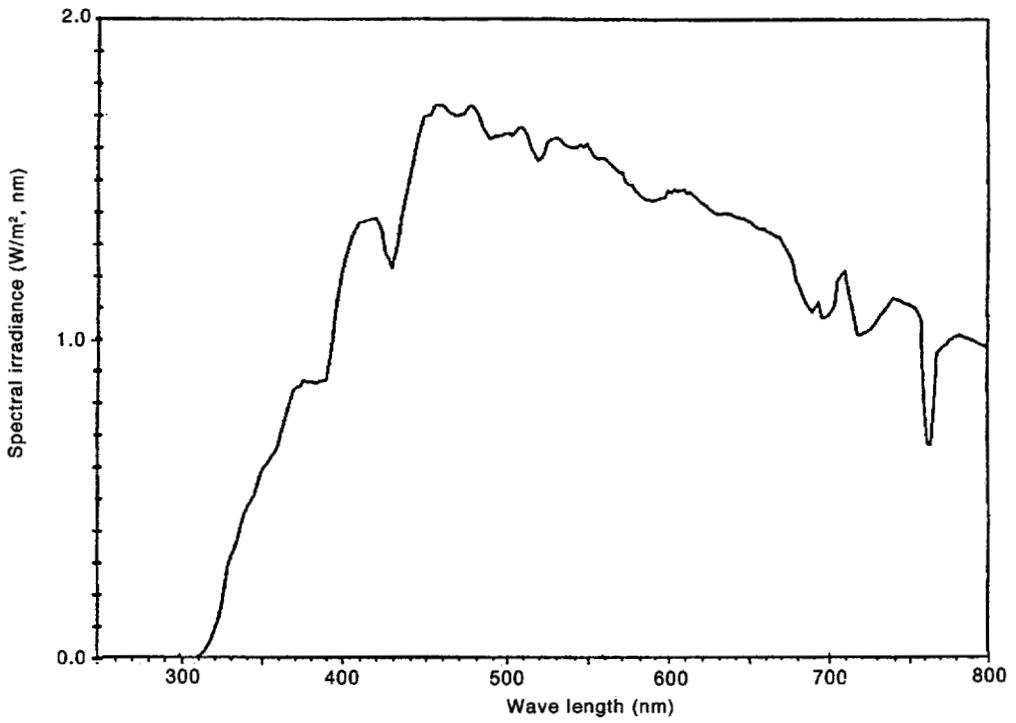
**Note** (1): This is value (initial value) obtained from a new xenon-arc lamp and filter combined with each other and aged for approx. 20 hours.
(2): A spectral irradiance of 100 W/m² is equal to the values in column Ⅱ.

## Explanatory table 5.b Constitution of light used in test

| Wave length range nm | Constitution ratio of spectral irradiance |
|---|---|
| 300 or less | 0 |
| 300~320 | <0.1 |
| 320~360 | 3.0±0.5 |
| 360~400 | 6.0±1.0 |

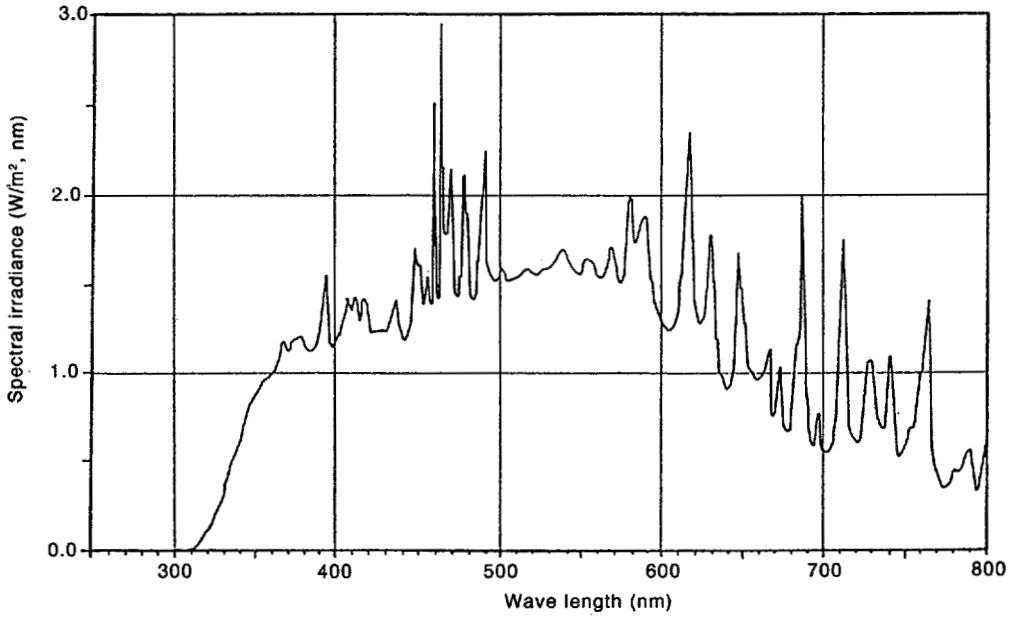
Constitution Ratio when a range of 300 to 800 nm is regarded as 100%

**Explanatory fig. 1 Spectral distribution of solar light (Through window glass)**

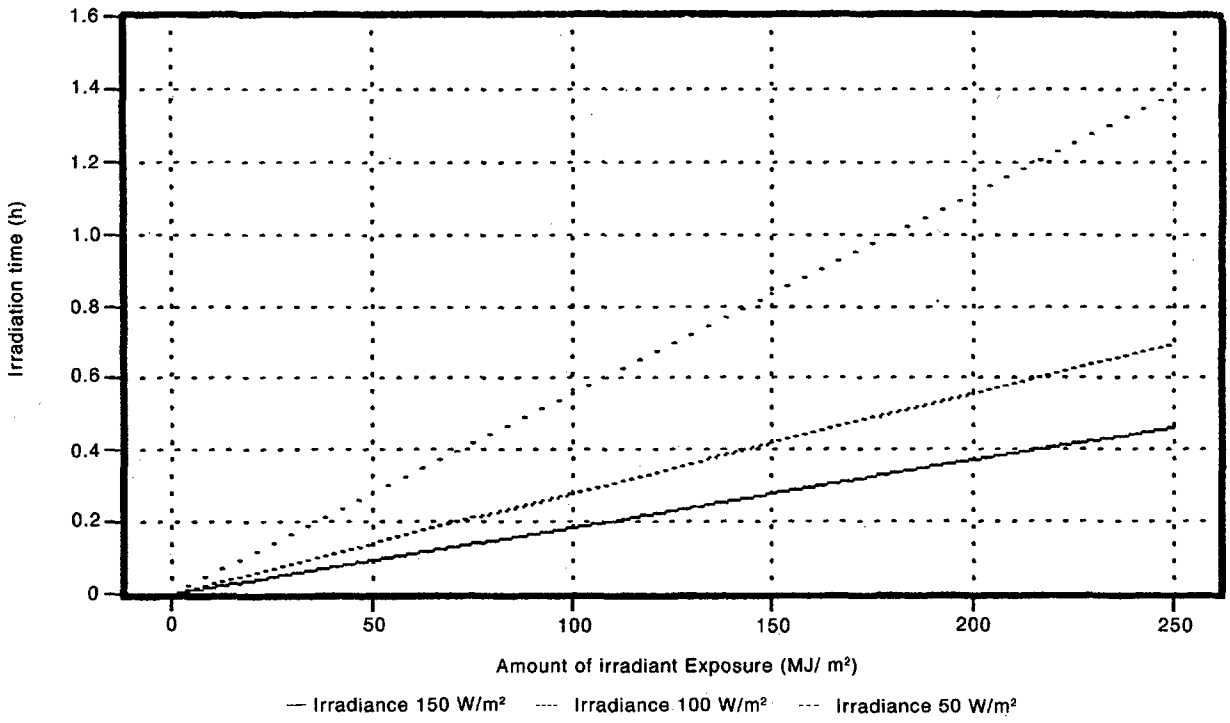



**Explanatory fig. 2 Spectral distribution of light emitting part**

Irradiance 80W/m² (300-400nm)



**Explanatory fig. 3 Radiant exposure amount and irradiation time**



In the event of any doubt, the original
standards in Japanese should be referred.

SI : THIRD PHASED STANDARD

(The standard where SI units and newly values are given and do not using customary units, but it is excepted that the standards are represented in only accustomed metric units as m, A, Hz etc.)

Established by the Standard Council of JSAE
Date of Establishment : 1993-03-26
Sub Committee in which the draft was made : SC of Wathering test with xenon-arc lamp
Technical Committee under which the draft was discussed : TC of Material
Investigating Committee : Standard Committee under the Standard Council

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