Nissan Engineering Standard

N E S	Weatherability and Light Resistance Test Methods for Synthetic Resin Parts

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Normative References: See page 24.

1. SCOPE

This Standard specifies the test methods for weatherability (particularly exterior parts) and light resistance (interior parts) (hereinafter referred to as test methods) and quality standard for automotive synthetic resin parts. Therefore, coated parts must be tested in accordance with NES M 0141 (Methods of Test for Coating of Synthetic Resin).

2. DEFINITION OF TERMS

The main terms used in this Standard have the following meanings.

(1) Weatherability
Resistance of parts to aging([1]) caused by sunlight, ozone, rain and snowfall, temperature and humidity, and other environmental conditions to which the parts are exposed.

(2) Light resistance
Resistance of parts to aging([1]) when exposed to sunlight.

(3) Exposure test equipment
A test specimen holding frame and other related devices used to expose specimens to outdoor environmental conditions.

(4) Exposure surface
External surfaces of specimens which are directly exposed to sunlight, ozone, rain and snowfall, and other environmental conditions.

(5) Irradiance
An amount of sunlight irradiance energy received by the exposure surface of specimens. It is expressed in langleys (MJ/m^2).

(6) Standard specimen
Standard parts, standard test pieces, standard scales for observation, and limit samples, which are used for periodic observation or for comparison with tested specimens, and which are stored in a dry, cool and dark place maintained under specified conditions so as not to be affected by sunlight, temperature, humidity, dust, etc.

(7) Effective surface
The surfaces of each part which are of practical importance, such as:
(a) Surfaces that are visible from any direction when the part is placed in actual service.
(b) Surfaces whose property changes can affect the function of the part.

(8) Discoloration
Color fading (changes in saturation and lightness) due to degradation of colorants, such as dyes and pigments; color changes (changes in color hue, e.g., yellowing and turning dark brown) due to deterioration of components other than colorants; and a combination thereof.

(9) Gloss
The gloss range is divided into the following categories depending on the specular gloss measured at an incident angle of 60°.
No gloss: 20 units, max.
Semi-gloss: 20 to 80 units
Gloss: 80 units, min.

(10) Crazing
Fine cracks developed on the surface of parts due to oxidation by sunlight, etc.

(11) Chalking
Chalk-like appearance of the surface caused by deterioration.

(12) Peeling
Peeling or blistering at bonded or surface coated sections.

(13) Cracking
Cracks caused by exposure to natural environment or by internal stresses.

Note ([1]): Deterioration which progresses with passage of time

3. CLASSIFICATION OF TEST APPLICATIONS

Test applications are classified into two methods and eleven classes as shown in Table 1, according to the mounting location of parts and the amount of light received. Method 1 refers to the inside cabin conditions and method 2 refers to the outside cabin conditions.

Table 1 Classification of test applications and test applications method

Classification of test applications		Application	Destination ([2])	Applicable parts example ([3])	Test applications		
					Accelerated exposure test		Outdoor exposure test
					Sunshine weathero-meter method	Xenon weathero-meter method	
Method 1 Inside cabin conditions	Class 1A	Interior parts located horizontally and above the beltline, strongly affected by sunlight.	S	Instrument panel upper surface, rear parcel shelf upper section, rear seatback upper section, outward shoulder sections of front seats (including headrests), steering wheel, inside rearview mirror	Method 1-I-1	Method 1-II-1A Method 1-II-1B Method 1-II-2 Method 1-II-3	Method 1-III
	Class 1B		D				
	Class 2A	Interior parts located above the beltline and strongly affected by sunlight	S	Instrument panel upper slope surface, door trim upper surface, front pillar, rear pillar, inside lock knob			
	Class 2B		D				
	Class 3A	Interior parts located in areas affected by sunlight	S	Instrument panel vertical surface, door trim center, seats, center pillars, sun visor, center console, seat belts			
	Class 3B		D				
	Class 4A	Interior parts located in areas slightly affected by sunlight	S	Roof and floor			
	Class 4B		D				
Method 2 Outside cabin conditions	Class 1	Exterior parts located in horizontal areas affected by sunlight	All areas	Ornaments, Cover cowl top, Antenna base, hood louver, wiper pivot cover, bumpers, outside mirrors, emblems, washer nozzles	Method 2-I-1	Method 2-II-1 Method 2-II-2 Method 2-II-3	Method 2-III
	Class 2	Exterior parts located in incline area affected by sunlight	All areas	Radiator grille, rear finisher, pillar side guard molding			
	Class 3	Exterior parts located in areas slightly affected by sunlight	All areas	Wheel covers, wheel caps, mudguard			

Note ([2]) S: North America, Australia, Middle and Near East, Africa, tropical zones of Southeast Asia
D: Japan, General exports

Note ([3]) The applicable parts shown in table 1 are just examples. For an actual application, part shape and installation part shall be fully reviewed and application classification chosen. In addition, a horizontal surface, an incline surface, and a vertical surface shall be 80 to 90 degrees, 30 to 80 degrees and 30 degrees or less as a guideline toward the vertical line respectively.

4. WEATHER (LIGHT) RESISTANCE TEST METHOD CLASSIFICATION

For weather (light) resistance test, accelerated exposure test (Method I: sunshine weatherometer method, method II: xenon weatherometer method), outdoor exposure tests are prescribed.

5. ACCELERATED EXPOSURE TEST METHOD

5.1 Atmospheric condition of accelerated exposure tester setting location

Atmospheric condition of tester setting location shall be as a rule, standard temperature 5th grade (20±5°C of JIS Z 8703 (Standard atmospheric condition for testing).

5.2 Method I Sunshine weatherometer method

(1) Equipment

a. Light source
Lamp consists of formed arc between carbon electrodes in open air. Or, radiation reaches to test sample through filter. Specification of light source and filter shall conform to Table 2.

b. Testing tank (See APPENDIX 1, Figure 3)
The testing tank is equipped with a frame for mounting of the test piece and which rotates around the light source, a fan device for temperature control, and a device for program control of the test cycle.

c. Radiant flux density meter
The specifications for the radiant flux density meter conform to 5.2 of JIS K 7350-1.

d. Black panel thermometer
The specifications for the black panel thermometer conform to 5.1.5 of JIS K 7350-1.

e. Relative humidity regulating device
The relative humidity of the air which flows over the test piece is measured by a device which is mounted in such a way that it is shielded from the light of the test tank's internal lamp.

f. Spray device
Deionized water of 6 to 8 pH and $10^5\ \Omega \cdot$ cm is used for the spray.
Ion exchange, reverse osmosis processing, and the like shall be used to achieve the required water quality.

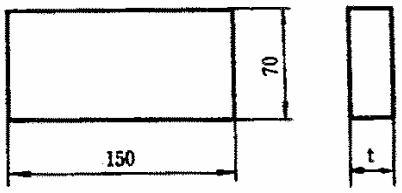
g. Test piece holder
Either an open-type frame which exposes the rear surface of the test piece or an item which lines the test piece shall be used as the test piece holder. Said holder shall be manufactured from an alloy of aluminum, stainless steel, or some other metal which does not oxidize.

(2) Test piece

Although it is a fundamental principle that test pieces for use in accelerated exposure and outdoor exposure tests are untreated single components, for the purpose of appearance evaluation, it is permitted to use a cutout test piece which conforms with the dimensions shown in Figure 1 - or in situations where the properties of the materials used in the test piece would not be adversely affected - a test piece which has been manufactured to said dimensions in advance. Furthermore, test pieces for the evaluation of mechanical and physical properties must be determined through consultation with the relevant parties.

Figure 1 Test piece

Units: mm



(3) Test conditions

The black panel temperature, relative humidity, and spray conditions are indicated in Table 2.

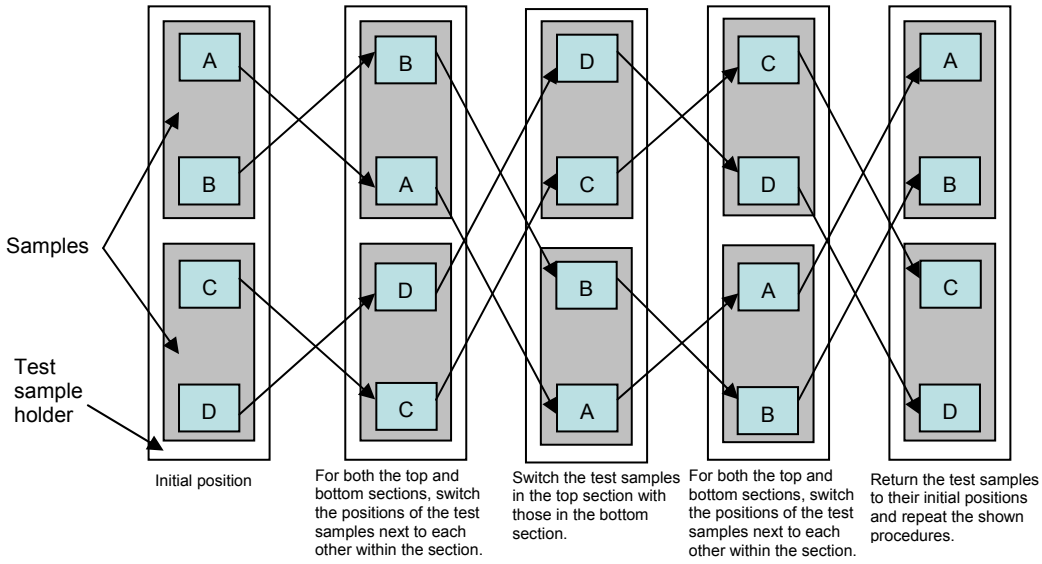
(4) Operations

a. Preparation of the test pieces
The sample name, test start and proposed finish dates, the control number, and any other required information shall be indicated on the rear of each test piece in such a way that they will not be removed during testing.

b. Test piece mounting
The test pieces shall be placed in holders in such a way that they are not subjected to stress.

c. Exposure to the light source
Before the test piece holder is assembled to the tester, it shall be confirmed that said tester can operate in accordance with the required conditions as set forth in Table 2, and these conditions shall be maintained during exposure. Further, when the test sample rack is a straight type (inclined types excluded), in order to ensure that all samples are exposed for the same duration, in principle, switch the positions of the test samples once a week.

Figure 2 Switching positions of test samples



d. Measurement of the degree of radiation exposure
The radiant flux density meter shall be mounted in such a way that the irradiance of the test piece's exposed surface can be indicated. Generally, exposure times shall be determined based on the selected wavelength range and shall be indicated in units of spectral radiant energy per unit surface area of the exposed surface (W/m^2).

e. Removal of test pieces
After the required period of time, the test pieces shall be removed and evaluation shall be carried out in accordance with 7.5.

(5) Maintenance control during testing
Carbon arc replacement, filter replacement, and cleaning shall be carried out in an appropriate period of time and in accordance with the instructions of the manufacturer. For more precise details pertaining to actual usage, refer to APPENDIX 1 “How to Operate Sunshine Weatherometer”.

Table 2 Sunshine weatherometer test equipment specification and conditions

Test conditions \ Test equipment			Sunshine weatherometer method	
			Method 1-I-1 (Method 1: Inside cabin conditions)	Method 2-I-1 (Method 2: Outside cabin conditions)
Test equipment specification	Equipment structure		Refer to Reference Drawing 2.	
	Arc lamp shape		Open type	
	No. of lamps		1	
	Carbon electrodes	Upper	Copper-covered sunshine carbon (1) Φ23 × 305 (24 hrs) (2) Φ36 × 350 (60 hrs) (3) Φ36 × 410 (78 hrs)	
		Lower	Copper-covered sunshine carbon (1) Φ23 × 305 (24 hrs) (2) Φ36 × 350 (60 hrs) (3) Φ36 × 410 (78 hrs)	
	Mean discharge voltage	(V)	50 (±2%)	
	Mean discharge current	(A)	60 (±2%)	
	Specimen rotating frame	Arc center-to-specimen surface (mm)	476 to 482	
		Diameter (mm)	960	
		Rotating speed	Approx. 1 rpm {min^{-1}}	
	Light intensity on specimen surface (W/m^2)		255 (±10%) (300 to 700 nm) 78 (±10%) (300 to 400 nm)	
	Filter		I type (#255) Permeation ratio 255 nm ≤ 1% 302 nm 71% to 86% ≥ 360 nm > 91%	
Operating condition	Black panel thermometer	Control temperature (°C)	83±3	63±3 (or 83±3) ([4])
	Fresh water spray conditions	Pressure (kPa)	No spray specification	78 to 127
		Flow rate (ml/min)		2,100±100
		Spray time		18 minutes during 120-minute irradiation cycle
		Water quality		Deionized water with a pH of 6 to 8 and electric conductivity of 5 μS/cm or less
	Operation cycle		Continuous light irradiation	Continuous light irradiation (18 minutes during 120-minute irradiation cycle)

Note ([4]) Black panel thermometer control temperature 83±3°C shall be agreed between the concerned parties.

5.3 Method II Xenon weatherometer method

(1) Equipment

a. Light source
The xenon-arc lamp outputs light in a range from below wavelengths of 270 nm and in the ultraviolet, visible light, and infrared spectrum. In situations where it is required to simulate inside cabin conditions, a filter which reduces irradiance below 320 nm (as indicated in Table 3) shall be used. Furthermore, in situations where it is required to simulate outside cabin conditions, a filter from Table 4 shall be implemented in such a way that the spectral distribution for the radiation energy is similar to that of natural ground light as set forth in CIE No. 85.

The irradiance at the surface of the test piece shall be within ±10% at two optional points on the surface of a test piece holder which is parallel to the light-source lamp.

b. Testing tank (See APPENDIX 2, Figure 6)
The testing tank is equipped with a frame for mounting of the test piece holders, a fan device for temperature control, and a device for program control of the test cycle.

c. Radiant flux density meter
The specifications for the radiant flux density meter conform to 5.2 of JIS K 7350-1.

d. Black standard thermometer/black panel thermometer
The specifications for the black standard thermometer/black panel thermometer conform to 5.1.5 of JIS K 7350-1.

e. Relative humidity regulating device
The relative humidity of the air which flows over the test piece is measured by a device which is mounted in such a way that it is shielded from the light of the test tank's internal lamp.

f. Water spray system
Deionized water of 6 to 8 pH and $10^5\ \Omega \cdot$ cm is used for the spray.
Ion exchange, reverse osmosis processing, and the like shall be used to achieve the required water quality.

g. Test piece holder
Either an open-type frame which exposes the rear surface of the test piece or an item which lines the test piece shall be used as the test piece holder. Furthermore, said holder shall be manufactured from an alloy of aluminum, stainless steel, or some other metal which does not oxidize.

(2) Test pieces
Test pieces shall conform with 5.2 (2).

(3) Test conditions
Inside cabin conditions: The irradiance, black panel temperature/black standard thermometer, and relative humidity are indicated in Table 3.
Outside cabin conditions: The irradiance, black panel temperature/black standard thermometer, relative humidity, and spray conditions are indicated in Table 4.

(4) Operations
a. Preparation of the test pieces
The sample name, test start and proposed finish dates, the control number, and any other required information shall be indicated on the rear of each test piece in such a way that they will not be removed during testing.

b. Test piece mounting
The test pieces shall be placed in holders in such a way that they are not subjected to stress.

c. Exposure to the light source
Before the test piece holder is assembled to the tester, it shall be confirmed that said tester can operate in accordance with the required conditions as set forth in Table 3 and Table 4, and these conditions shall be maintained during exposure.

d. Measurement of the degree of radiation exposure
The radiant flux density meter shall be mounted in such a way that the irradiance of the test piece's exposed surface can be indicated. Exposure times shall be determined based on the selected wavelength range and shall be indicated in units of spectral radiant energy per unit surface area of the exposed surface (W/m^2).

e. Removal of test pieces
After the required period of time, the test pieces shall be removed and evaluation shall be carried out in accordance with 7.5.

(5) Maintenance control during testing
Xenon arc replacement, filter replacement, and cleaning shall be carried out in an appropriate period of time and in accordance with the instructions of the manufacturer. For more precise details pertaining to actual usage, refer to APPENDIX 2: How to Operate Xenon Weatherometer.

Details pertaining to the tester specifications and testing methods for the xenon weatherometer are indicated in Table 3 (Inside cabin conditions) and Table 4 (Outside cabin conditions).

Table 3 Xenon weatherometer test equipment specifications and test conditions
(Method 1: Inside cabin conditions)

Test equipment		Xenon weatherometer			
		Method 1-II-1A	Method 1-II-1B ([5])	Method 1-II-2	Method 1-II-3
Test equipment specification	Light source	Water-cooled Xenon lamp	Air-cooled Xenon lamp	Water-cooled Xenon lamp	Air-cooled Xenon lamp
	No. of lamps (specimen rack)	1		1	3
	Light filters	Inner: Quartz Intermediate: #320 Outer: #275 or Inner: Quartz Outer: #320		Inner: Boro silicate type S Outer: Soda lime	Inner: IR filter Intermediate: Quartz Outer: UV filter (3-partition)
	Rising wave-length	320 nm		320 nm	320 nm
	Light intensity control	300 to 400 nm		300 to 400 nm	300 to 400 nm (280 to 800 nm)
	Light intensity on specimen surface	162 W/m^2		53 W/m^2	80 W/m^2
	Light uniformity	Within ±5%		Within ±5%	Within ±5%
	Specimen rotating frame (speed)	Approx. 2 rpm		Approx. 1 rpm	Approx. 2 rpm
Operating condition	Temperature control	(Black panel temperature) During light irradiation: 89±3°C		(Black panel temperature) During light irradiation: 89±2°C	(Black panel temperature) During light irradiation: 89±2°C
	Humidity inside tank	During light irradiation: 50±5%RH		During light irradiation: 50±5%	During light irradiation: 50±10%
	Wind velocity	Approx. 1 m/sec		—	—
	Operation cycle	Continuous light irradiation		Continuous light irradiation	Continuous light irradiation
(Reference test equipment type)		Suga test equipement Co. SX120,SX75 SX2-75F, XEL-2WN	Wacom WT-341	Atlas Co. Ci35, 65, 3000, 4000, 5000	Atlas Co. 1200CPS, 1200LM, BetaLM

Note ([5]): Method 1-II-1 B applies only to fabric tests.

Table 4 Xenon weatherometer test equipment specifications and test conditions
(Method 2: Outside cabin conditions)

Test equipment			Xenon weatherometer		
			2-II-1	2-II-2	2-II-3
Test equipment specification	Light source		Water-cooled Xenon lamp	Water-cooled Xenon lamp	Air-cooled Xenon lamp
	Light filter		Inner: Quartz Outer: #275	Inner: Quartz Outer: Boro silicate type S	Inner: IR filter Intermediate: Quartz Outer: UV filter
	Rising wave-length		290 nm	280 nm	290 nm
	Light intensity control		300 to 400 nm	300 to 400 nm (340 nm point control)	300 to 400 nm (280 to 800 nm)
	Light intensity on specimen surface		180 W/m^2	60 W/m^2 (0.55 W/m^2)	85 W/m^2 (550 W/m^2)
	Light uniformity		Within ±10%	Within ±10%	Within ±10%
	Temperture control		(Black panel temperature) During light irradiation: 63±3°C During raining: 28±3°C	(Black panel temperature) During light irradiation: 70±2°C During raining: 38±2°C (Air temperature) During light irradiation: 47±2°C During raining: 38±2°C	(Black standard temperature) During light irradiation: 63±2°C During raining: No specification
	Humidity inside tank		During light irradiation: 50±5%RH During raining: 95%RH or more	During light irradiation: 50±5% During raining: 95%±5%	During light irradiation: 70±10% During raining: No specification
	Wind velocity		Approx. 1 m/sec	—	—
	Specimen rotation frame		Approx. 2 rpm	Approx. 1 rpm	Approx. 2 rpm
	Water spray condition	Cycle	360 minutes spray during 24 minutes	During light irradiation: 20 minutes spraying during 120 minutes During non light irradiation: 60 minutes spraying during 60 minutes	18 minutes spraying during 120 minutes
		Water spray rate	Approx. 1000 ml/min	Approx. 300 ml/min.	Approx. 600 ml/min.
		Water temperature	20±1°C	—	—
		Water quality	Deionized water of greater than 10^5 ohms-cm with a pH of 6 to 8	←	←
	Operation cycle		Continuous light irradiation (24 minutes spray during 360 minutes)		Continuous light irradiation (18 minutes spraying during 120 minutes)
(Reference test equipment type)			Suga Test Instruments Co. SX120, SX75, SX2-75, XEL-2WN	Atlas Co. Ci35, 65, 3000, 4000, 5000	Atlas Co. 1200CPS, 1200LM, BetaLM

6. OUTDOOR EXPOSURE TEST

6.1 Environment for the outdoor exposure test

As a fundamental principle, Okinawa shall be the location for testing. Furthermore, said testing location shall be free of any items which would block sunlight in the ranges from due east to due south and from due south to due west, and over the period from 30 minutes after sunrise to 30 minutes before sunset. Said location also shall be free of dust, soot, sand, and the like. In addition, note that consultation of the relevant parties will be required with regard to other testing locations.

6.2 Methods for the outdoor exposure test

(1) Test equipment

a. Construction
The exposure equipment shall have a solid and durable construction. Furthermore, it shall be fitted with installation fittings which are matched to the type, shape, and dimensions of the test piece, and to the purpose of testing. The frame shall be of sturdy construction on a ground surface which is not adversely affected by storms, snow buildup or the like. Furthermore, said frame shall be correctly installed and all sections and fittings shall be provided with suitable rust-prevention treatment.

b. Glass plates
With regard to method 1-III (Inside cabin conditions), test pieces shall be covered and sealed using glass panels in order to prevent exposure to rain and snow (4-mm polished plate glass in accordance with JIS R 3202 (Float plate glass and polished plate glass)). The distance from the top surface of the test piece to the glass plate shall be 5 cm minimum.

c. Cumulative luminance meter
The exposure device shall be fitted with a cumulative luminance meter, the active surface of this meter's light-receiving section shall be oriented at the same angle as the exposure surface, and it shall be covered with an ultraviolet-transmitting glove.

(2) Test piece
Test pieces are to conform with 3.2 (2).

(3) Test conditions
The inclination of the exposure surface and the installation angles are set forth in Table 5. As a fundamental principle, the exposure surface shall be positioned at least 50 cm higher than the standard surface for mounting of the frame (floor or ground surface).

Table 5 Outdoor exposure test conditions

	Inclination of the exposure surface	Installation angle	Method 1-III (Inside cabin conditions)	Method 2-III (Outside cabin conditions)
Apr. to Sep.	Due south	20°-minus latitude with respect to horizontal	Indirect exposure using glass plates	Direct exposure
Oct. to Mar.	Due south	5°-minus latitude with respect to horizontal		

(4) Operations

a. Preparation of the test pieces
The sample name, test start and proposed finish dates, the control number, and any other required information shall be indicated on the rear of each test piece in such a way that they will not be removed during testing.

b. Test piece mounting
The test pieces shall be assembled to the exposure tester in such a way that they are not subjected to stress. Although it is a fundamental principle that the rear plate is not to be used for test piece mounting, this is permitted in situations where support is required as a result of shape and material conditions. An alloy of aluminum, stainless steel, or some other metal which does not oxidize shall be used.

c. Exposure
Exposure shall be carried out in accordance with the conditions of Table 5. In the case of test method 1-III, contamination adhering to the surface of the glass shall be removed at regular intervals.

d. Removal of test pieces
After exposure for the required period of time, the test pieces shall be removed and evaluation shall be carried out in accordance with 7.5.

Figure 3　An example of testing equipment for outdoor weather (light) resistance

7. EVALUATION

7.1 Evaluation items

Visual examination methods are set forth with regard to the evaluation of material properties for test pieces which have completed accelerated exposure testing and/or outdoor exposure testing. Note that, where necessary, evaluation of mechanical and physical properties shall be carried out with respect to the types and locations of covering materials, carpets, floor mats, and the like. The corresponding testing methods shall be in accordance with the relevant NES or shall be determined through consultation of the relevant parties.

Table 6　(Reference) NES Standards for physical-property evaluation after weather (light) resistance testing

		Evaluation item						
		Tensile strength	Tensile elongation	Wear resistance	Stitch-removal strength	Peeling strength	Scratch	Contamination characteristics
NES M 7100	Fabrics for Automobiles	O						
NES M 0164	Testing Methods Polyurethane Leather for Seat and Door of Automobiles	O	O					
NES M 0155	Testing Methods of Seat/Door Leather for Automobiles			O				
NES M 7103	Automotive Carpet	O		O	O			
NES M 7105	Floor Mat for Automobiles		O					
NES M 7081	Polyvinylchloride Coated Fabric for Automobiles	O	O					
NES M 7083	Vinyl Sheet for Automobiles		O					
NES M 7084	Vacuum-Formed Sheet for Instrument Panel Pad		O					
NES M 8022	PVC Slush - Molded Skin		O					
NES M 7108	Thermoplastic Olefin Sheet for Automobiles		O					
NES M 0152	Testing Methods for Flocked Interior Parts			O		O	O	
NES M 8523	Protective Film for Interior Parts of Automobile	O				O		O

7.2 Methods and exposure conditions for exposure testing

(1) Selection of testing methods
Either accelerated weather (light) resistance testing (light) or outdoor exposure testing shall be selected in accordance with Table 7 and based on material types and application locations. Testing methods for these tests shall conform with the details of 5. or 6. accordingly.

Table 7 Selection of testing methods

Part classification	Material		NES No.	Outdoor exposure test (Okinawa)	Accelerated weather (light) resistance testing	
					Method II Xenon weatherometer method	Method I Sunshine weatherometer method
Method 1	Plastic material	PP	M8021	O	O	(O)
		PPC	M8012	O	O	(O)
		ABS	M8011	O	O	(O)
		POM	M8014	O	O	(O)
		PA	M8015	O	O	(O)
		PBT	M8016	O	O	(O)
		PMMA		O	—	O
		PVC		O	—	O
		Others		O	—	O
	Surface covering material	PVC				
		Leather	M7081	O	O	(O)
		Sheer	M7083	O	O	(O)
		Slash	M8022	O	O	(O)
		PVC/ABS	M7084	O	O	(O)
		Fabric	M7100	O	O	(O)
		Leather	M7102	O	—	O
		Carpet	M7103	O	—	O
	Others	Flocked fabrics		O	O	O
Method 2	PP		M8021	O	O	(O)
	PPC		M8012	O	O	(O)
	PVC			O	O	(O)
	POM		M8014	O	O	(O)
	PMMA		M8018	O	O	(O)
	PC		M8017	O	O	(O)
	PC/PET, PC/PBT			O	O	(O)
	AES, AAS			O	O	(O)
	Others			O	—	O

Remark 1: Details regarding the actual implementation of, and testing personnel for, outdoor exposure shall be determined as agreed upon between the parties concerned. Furthermore, this testing shall be carried out wherever so required.

Remark 2: The priority sequence for the results of testing shall conform with the order of outdoor exposure, xenon weatherometer, sunshine weatherometer. Furthermore, this is the reason for the addition of parentheses to the sunshine weatherometer for accelerated weather (light) resistance testing in Table 8.

(2) Selection of test conditions
Test conditions shall be selected from Table 8 (Method 1: Inside cabin conditions) or Table 9 (Method 2: Outside cabin conditions) based on testing methods and material types. Moreover, in cases where the material types are not described in Tables 8 and 9, or where the weather (light) resistance is pointed out as a concern for the material composition, it is allowed to determine the test conditions and the judgement criteria by agreement between the parties concerned.

Remark 1: The testing energies have been calculated for the test durations and the exposure energies in the 300 to 400 nm range of wavelengths for each tester as indicated in Table 2, Table 3, and Table 4. Furthermore, the relationship between testing energies and testing times is as follows:
Testing time (s) = Testing energy (J/m^2) / Irradiance (W/m^2) (W = J/s)
Although the testing energy (MJ/m^2) is generally used for the control of testing conditions, the specific details of the testers require that exposure time (hours) is used for this purpose in the case of Methods 1-I, 2-I, and 1-II-1B.

Table 8 Each plastic accelerated light resistance load condition (Method 1: Inside cabin conditions)

			Light irradiation time (Hr)/testing energy (MJ/m^2) [ ]: Reference value							
			S (Hot areas)				D (Japan, General export)			
Test methods	Applicable material type		Type 1A	Type 2A	Type 3A	Type 4A	Type 1B	Type 2B	Type 3B	Type 4B
1-I Sunshine weather-ometer	Plastic material Surface covering material, Others	Exterior view (6)	600/[170]	400/[110]	300/[80]	200/[60]	500/[140]	300/[80]	200/[60]	100/[30]
		Physical property (6)	1,000/[280]	800/[230]	600/[170]	200/[60]	1,000/[280]	600/[170]	400/[110]	200/[60]
1-II-1A Xenon weather-ometer	Plastic material	PP	[360]/210	[240]/140	[180]/105	[111]/65	[240]/140	[154]/90	[120]/70	[69]/40
		PPC	[274]/160	[189]/110	[137]/80	[86]/50	[189]/110	[129]/75	[94]/55	[60]/35
		ABS POM	[326]/190	[215]/125	[163]/95	[103]/60	[223]/130	[154]/90	[111]/65	[69]/40
		PA	[377]/220	[249]/145	[189]/110	[120]/70	[257]/150	[172]/100	[129]/75	[77]/45
		PBT	[172]/100	[120]/70	[86]/50	[51]/30	[120]/70	[77]/45	[60]/35	[34]/20
	Surface covering material, Others	PVC leather, sheet, slash, PVC/ABS	[69]/40	[51]/30	[34]/20	[26]/15	[51]/30	[34]/20	[26]/15	[17]/10
		Fabrics, Leather, Carpet, Flocked fabrics	[230]/134	[154]/90	[120]/70	[69]/40	[154]/90	[103]/60	[77]/45	[51]/30
1-II-1B	Surface covering material	Fabric	144/[-]	100/[-]	70/[-]	40/[-]	100/[-]	60/[-]	50/[-]	30/[-]
1-II-2 Xenon weather-ometer	Plastic material	PP	[1,363]/260	[917]/175	[681]/130	[419]/80	[917]/175	[629]/120	[472]/90	[288]/55
		PPC	[681]/130	[472]/90	[341]/65	[210]/40	[472]/90	[314]/60	[236]/45	[157]/30
		ABS POM	[943]/180	[629]/120	[472]/90	[288]/55	[629]/120	[419]/80	[314]/60	[210]/40
		PA	[1,572]/300	[1,048]/200	[786]/150	[472]/90	[1,048]/200	[708]/135	[524]/100	[314]/60
		PBT	[472]/90	[314]/60	[236]/45	[157]/30	[314]/60	[208]/40	[157]/30	[105]/20
	Surface covering material, Others	PVC leather, PVC sheet	[786]/150	[524]/100	[393]/75	[236]/45	[524]/100	[367]/70	[262]/50	[157]/30
		PVC slash	[629]/120	[419]/80	[314]/60	[210]/40	[419]/80	[288]/55	[210]/40	[131]/25
		PVC/ ABS	[840]/160	[577]/110	[419]/80	[262]/50	[577]/110	[393]/75	[288]/55	[183]/35
		Fabrics, Leather, Carpet, Flocked fabrics	[393]/75	[259]/50	[210]/40	[131]/25	[262]/50	[183]/35	[131]/25	[80]/15
1-II-3 Xenon weather-ometer	Plastic material	PP	[590]/170	[399]/115	[295]/85	[191]/55	[399]/115	[278]/80	[208]/60	[122]/35
		PPC	[347]/100	[233]/70	[174]/50	[104]/30	[243]/70	[174]/50	[122]/35	[87]/25
		ABS POM	[556]/160	[382]/110	[278]/80	[174]/50	[382]/110	[260]/75	[191]/55	[122]/35
		PA	[799]/230	[538]/155	[399]/115	[243]/70	[538]/155	[365]/105	[278]/80	[174]/50
		PBT	[278]/80	[191]/55	[139]/40	[87]/25	[191]/55	[139]/40	[104]/30	[69]/20
	Surface covering material, Others	PVC leather, sheet	[556]/160	[382]/110	[278]/80	[174]/50	[382]/110	[260]/75	[191]/55	[122]/35
		PVC slash	[260]/75	[172]/50	[139]/40	[87]/25	[174]/50	[122]/35	[87]/25	[52]/15
		PVC/ ABS	[625]/180	[417]/120	[312]/90	[191]/55	[417]/120	[278]/80	[208]/60	[139]/40
		Fabrics, Leather, Carpet, Flocked fabrics	[243]/70	[174]/50	[122]/35	[87]/25	[174]/50	[122]/35	[87]/25	[52]/15

Table 8 Each plastic accelerated light resistance load condition (Method 1: Inside cabin conditions) cont'd

			Exposure period							
			S (Hot areas)				D (Japan, General export)			
Test methods	Applicable material type		Type 1A	Type 2A	Type 3A	Type 4A	Type 1B	Type 2B	Type 3B	Type 4B
1-III Outdoor exposure (Okinawa)	Plastic material	PP, PPC ABS POM PA PBT PMMA PVC	12 months							
	Surface covering material	PVC leather, sheet, slash PVC/ABS	12 months							
		Fabrics, Leather, Carpet	6 months							
	Others	Flocked fabrics	12 months							

Note ([6]): For physical property, xenon cannot cope with the heat problem, only the sunshine-type shall be used.

Table 9 Each plastic accelerated light resistance load condition (Method 2: Outside cabin conditions)

		Light irradiation time (Hr)/testing energy (MJ/m^2) ([6]) [ ]: Reference value		
		All areas		
Test methods	Applicable material type	Type 1	Type 2	Type 3
2-I Sunshine weatherometer	Plastic material (Except for PVC, POM)	2,000/[562]	1,320/[371]	600/[168]
2-II-1 Xenon weatherometer	PP	[2,000]/1,300	[1,320]/860	[600]/390
	PPC	[2,000]/1,300	[1,320]/860	[600]/390
	ABS, AES, AAS	[800]/520	[528]/345	[240]/155
	POM	[2,400]/1,560	[1,584]/1030	[720]/470
	PMMA	[2,400]/1,560	[1,584]/1030	[720]/470
	PC, PC/PET, PC/PBT	[1,000]/650	[660]/430	[300]/195
	PVC	[800]/520	[530]/345	[240]/155
2-II-2 Xenon weatherometer	PP	[2,000]/430	[1,320]/285	[600]/130
	PPC	[2,000]/430	[1,320]/285	[600]/130
	ABS, AES, AAS	[1,200]/260	[790]/170	[360]/80
	POM	[2,400]/520	[1,584]/340	[720]/155
	PMMA	[2,400]/520	[1,584]/340	[720]/155
	PC, PC/PET, PC/PBT	[2,000]/430	[1,320]/285	[600]/130
	PVC	[1,200]/260	[792]/170	[360]/80
2-II-3 Xenon weatherometer	PP	[2,000]/610	[1,320]/400	[600]/180
	PPC	[2,000]/610	[1,320]/400	[600]/180
	ABS, AES, AAS	[1,200]/370	[792]/245	[360]/110
	POM	[2,400]/730	[1,585]/480	[720]/220
	PMMA	[2,400]/730	[1,585]/480	[720]/220
	PC, PC/PET, PC/PBT	[2,000]/610	[1,320]/400	[600]/180
	PVC	[1,200]/370	[790]/245	[360]/110
2-III Outdoor exposure (Okinawa)	Plastic material	24 months	12 months	

7.3 Equipment

(1) Discoloration gray scale as set forth in JIS L 0804.
(2) Color difference gauge as set forth in JIS Z 8722.
(3) Light-transmittance measurement device as set forth in JIS K 7361-1.
(4) Gloss meter conforming with the mirror-gloss measurement device as set forth in JIS Z 8741.
(5) Standard light source conforming with the D_{65} standard light source as set forth in JIS Z 8720.

7.4 Test pieces

(1) Post-exposure test pieces
These are the test pieces that have completed exposure testing in accordance with the conditions of 7.2. As a fundamental principle, these test pieces shall be dried after having the surfaces water washed using gauze or another similar material. Note, furthermore, that in accordance with the agreement between the parties concerned, it is permitted to wipe off said surfaces using genuine Nissan wax or genuine Nissan interior trim cleaner.

(2) Stored test pieces for comparison
These are the test pieces that come from the same lot as those subjected to testing and are stored for the purpose of later comparison. Storage of said pieces shall be carried out in a dark room or a light-sealed container with grade-5 standard conditions (20°C±5°C) and grade-5 standard-humidity conditions (65±5%) in accordance with JIS Z 8703.

7.5 Evaluation methods

Visual evaluation shall be carried out comparing the post-exposure test pieces from 7.4 (1) with the stored test pieces from 7.4 (2).
Using a D_{65} standard light source, the test pieces shall be illuminated at approximately 1,000 Lx and shall be examined by the naked eye at a distance of approximately 25 cm.

(1) Surface condition
The surface of the exposed section shall examined and investigated for the presence of appearance abnormalities (creasing, chalking, stains, peeling, and cracking).

(2) Gray scale discoloration
For achromatic color test samples, using a grayscale, compare variations in color displayed on the test sample after being tested with those shown by each gradient of the grayscale. For specimens of chromatic color, evaluation should normally be done using a color comparison measuring instrument. However, if instrumental evaluation is not feasible for some reason, visual comparison with standard samples may be used as agreed upon between concerned parties.

(3) Color difference
a. For test pieces of chromatic color, use a color difference gauge and measure the comparison test pieces that have been stored and test pieces after exposure. Calculate the color difference by the following expression according to the provision of JIS Z 8730 (color indication method - color difference of substance color) 7.1.

$$\Delta Eab = [(\Delta L^*)^2+(\Delta a^*)^2+(\Delta b^*)^2]^{1/2}$$

b. For optical parts (e.g., lamp lenses), according to the procedure specified in JIS Z 8722 (Methods of colour measurement - Reflecting and transmitting objects) to determine chromaticity.

(4) Permeation ratio
Transmittance evaluation shall be made by measuring light transmittance (%) according to JIS K 7361-1, and determine changes in transmittance using the following formula.

$$\text{Rate of change} = \frac{\text{(Transmittance before test) - (Transmittance after test)}}{\text{Transmittance before test}} \times 100\ (\%)$$

(5) Gloss
Measure gloss before and after the test according to the procedure specified in JIS Z 8741 (Method of measurement for specular glossiness) and calculate gloss-retention rate using the following formula.

$$\text{Gloss-retention rate} = \frac{\text{60° specular gloss after test}}{\text{60° specular gloss before test}} \times 100\ (\%)$$

Remarks: When a glossmeter is used, it shall be capable of reading up to an angle of 1°.

8. MARKING

Following the implementation of testing in accordance with the methods from Section 7.2 and evaluation in accordance with the methods from Section 7.5, mark the following information in details.

(1) Test method
(2) Tester type (manufacturer and model)
(3) Test conditions (exposure time and irradiance)
(4) Test piece (material type, shape)
(5) Results of evaluation
   a. Surface condition: Presence of creasing, chalking, stains, peeling, and cracking; and other specific items
   b. Grayscale discoloration: Evaluation grade
   c. Color difference: ΔE
   d. Permeation ratio: Variation in light transmittance (%)
   e. Gloss: Gloss-retention rate (%)

* The results of evaluation shall be, in principle, recorded using a form equivalent to Table 10 “Weatherability test result recording form”.

Table 10. Weatherability test result recording form

Weatherability test result recording form

1. Detailed information of test sample

Part name		Part No.	
Testing method	SWOM - XWOM	Test equipment manufacturer	
Test time (H)		Irradiance (W/m2)	
Material supplier		Material type	
Material grade		With or without surface treatment	
Test sample used	Portion cut from part	Surface treatment material	

2. Test results

2. Test results

Check item		Before testing	After testing	Measurement results	Judgment criteria	Judgment
Surface conditions	Photograph of appearance		 Reference: <Before washing> 	-	-	-
	Creasing	Present/Absent	Present/Absent	-	Shall be free of visible creasing. Shall keep photographs of appearance and samples.	OK/NG
	Chalking	Present/Absent	Present/Absent	-	Shall be free of visible chalking. Shall keep photographs of appearance and samples.	OK/NG
	Stains	Present/Absent	Present/Absent Inspection results at a magnification of 100 times when"Present"	-	Shall be free of visible stains. However, when there are stains, shall inspect at a magnification of 100 times to confirm whether there is any cracking. (If cracking is present, it is judged to be NG).	OK/NG
	Peeling	Present/Absent	Present/Absent	-	Shall be free of visible peeling. Shall keep photographs of appearance and samples.	OK/NG
	Cracking	Present/Absent	Present/Absent	-	Shall be free of visible cracking. Shall keep photographs of appearance and samples.	OK/NG
Grayscale discoloration		-	-	Grade	Grade 3.0 or more	OK/NG
Color difference ⊿E*		Photograph indicating the area measured			3.0 or less (2.0 or less when it is the same as the vehicle body color) The area measured shall be reported using a photograph of the appearance.	OK/NG
		L: a: b:	L: a: b:			OK/NG
Variation in light transmittance					20% or less	OK/NG
Gloss-retention rate					No easily-noticeable variation. Alternatively, in the case of glossed items, 50% or more; in the case of semi-glossed items, 20% or more.	OK/NG

9. JUDGEMENT CRITERIA

Table 10 presents the judgement criteria to be implemented with respect to the results of visual examination following exposure testing. However, in situations where judgement criteria are set forth in the relevant NES, these shall be implemented.

Table 11 Appearance evaluation grades

Item \ Application point and test method		Method 1: Inside cabin conditions	Method 2: Outside cabin conditions
		Method 1-I	Method 2-I
		1-II-1A, B, 1-II-2, 1-II-3 method	2-II-1, 2-II-2, 2-II-3 method
		1-III method	2-III method
		Class A	Class B
Surface condition	Creasing	Shall be free of visible creasing.	
	Chalking	Shall be free of visible chalking.	
	Stains	Shall be free of visible stains. However, when there are stains, shall inspect at a magnification of 100 times to confirm whether there is any cracking. (If cracking is present, it is judged to be NG).	
	Peeling	Shall be free of visible peeling.	
	Cracking	Shall be free of visible cracking.	
Grayscale discoloration		Grade 4 above	Grade 3 above
Color difference: ΔE		2 or less	3 or less (2 or less when the same as the vehicle color)
Variation in light transmittance		15% or less	20% or less
Gloss-retention rate		Almost no variation. Alternatively, in the case of glossed items, 80% or more; in the case of semi-glossed items, 50% or more.	No easily-noticeable variation. Alternatively, in the case of glossed items, 50% or more; in the case of semi-glossed items, 20% or more.

Note ([7]): Carpets and flocking shall conform to Grade B. Furthermore, cloth shall conform to NES M 7100.

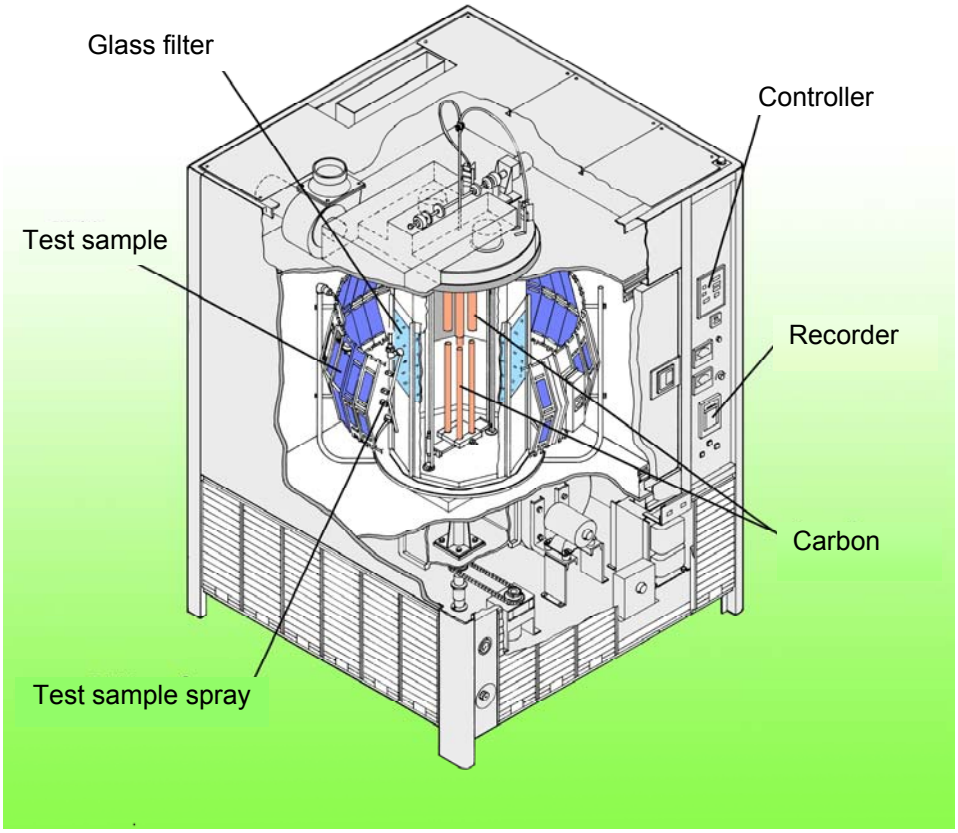
* Evaluation criteria for mechanical and physical properties following weather (light) resistance testing shall be in accordance with the relevant NES or shall be determined by agreement between the parties concerned.

APPENDIX 1　How to Operate Sunshine Weatherometer

1. Test equipment

Test equipment is shown as follows.

Figure 4　An example of sunshine weatherometer test equipment



2. Handling standards for the sunshine carbon weatherometer

For reference, the handling standards for the sunshine weatherometer of Suga Test Instruments are shown below.

2.1 Carbon-arc lamp

(1) Confirm that the discharge voltage and current are 50 V and 60 A respectively.
(2) Inspect the insulation materials whenever the carbon-arc lamp is being replaced, and confirm that there is no damage to these items. Furthermore, clean the inside of the lamp housing, the carbon holder, and other similar items.

2.2 Filters

(1) The service period for filters is set at 2,000 hours maximum, and if this level has been exceeded, replace the filter with a new part as soon as possible.
(2) Filter replacement shall be carried out in pairs at intervals of 500 hours.
(3) Filter cleaning shall be carried out whenever the carbon-arc lamp is replaced.
(4) Gloves shall be used for filter replacement and contact with hands shall be avoided.

2.3 Black panel temperature gauge

(1) The black panel temperature gauge shall be replaced with a new part once every year.
(2) In situations where the black panel temperature gauge is mounted to the tester, care shall be taken to ensure that water cannot enter the connectors.

2.4 Dry and wet-bulb temperatures

(1) If the wet-bulb temperature is the same as the dry-bulb temperature during illumination, water shall be supplied to the wet-bulb pot within the tank.
(2) If the wet-bulb gauze hardens, it shall be replaced as soon as possible.
(3) The humidity generator shall be cleaned once every month.

2.5 Sample assembly

(1) During testing, operation shall be carried out with racks fully assembled.

2.6 Spray

(1) The pressure of spray water shall be adjusted to 98 kPa.
(2) Each nozzle shall generate a spray of a uniform condition.

2.7 Others

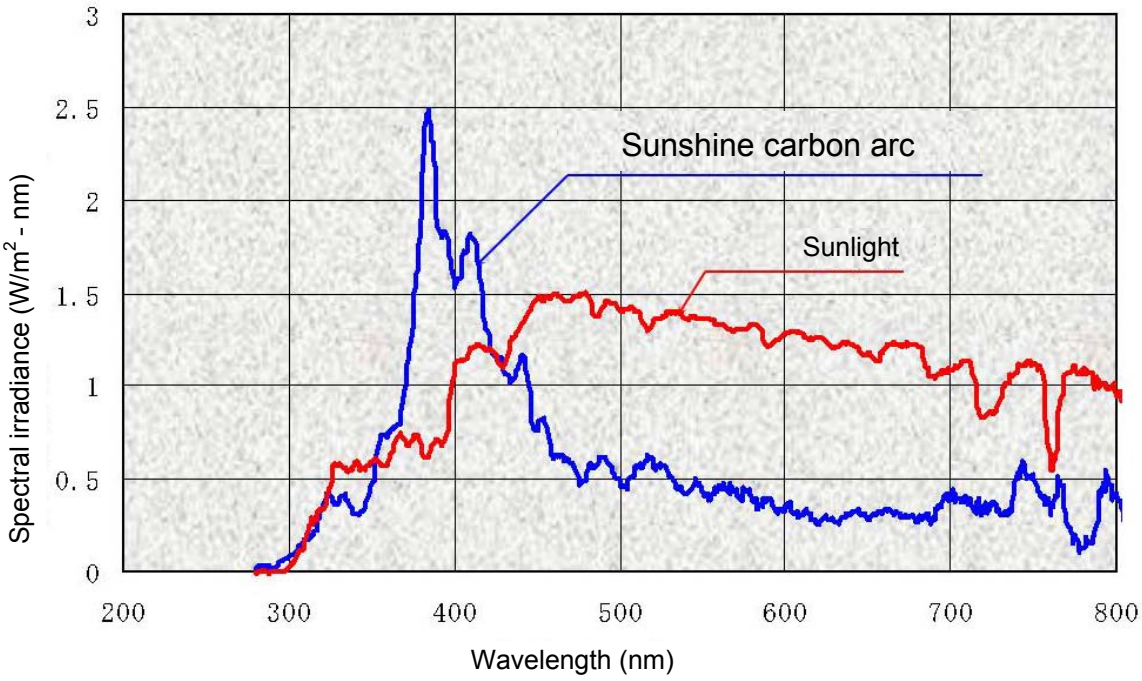
(1) In situations where the safety lamp turns on, action shall be taken in accordance with the section Faults and Countermeasures from the user's manual.
(2) If not used for extended periods of time, a full supply of water shall be provided to the tank and the humidity generator.
(3) The input power-supply voltage shall remain constantly at 200 V ± 20 V.

2.8 Precautions

(1) To turn operation on and off during illumination, the "Stop" button shall be used. Note that the "Power" button is not to be used for this purpose. If testing is interrupted in such a case, the "Power" button shall be turned on for 15 minutes and then turned off.

3. Sunshine weatherometer test frequencies

Figure 5 Test frequencies for the sunshine weatherometer

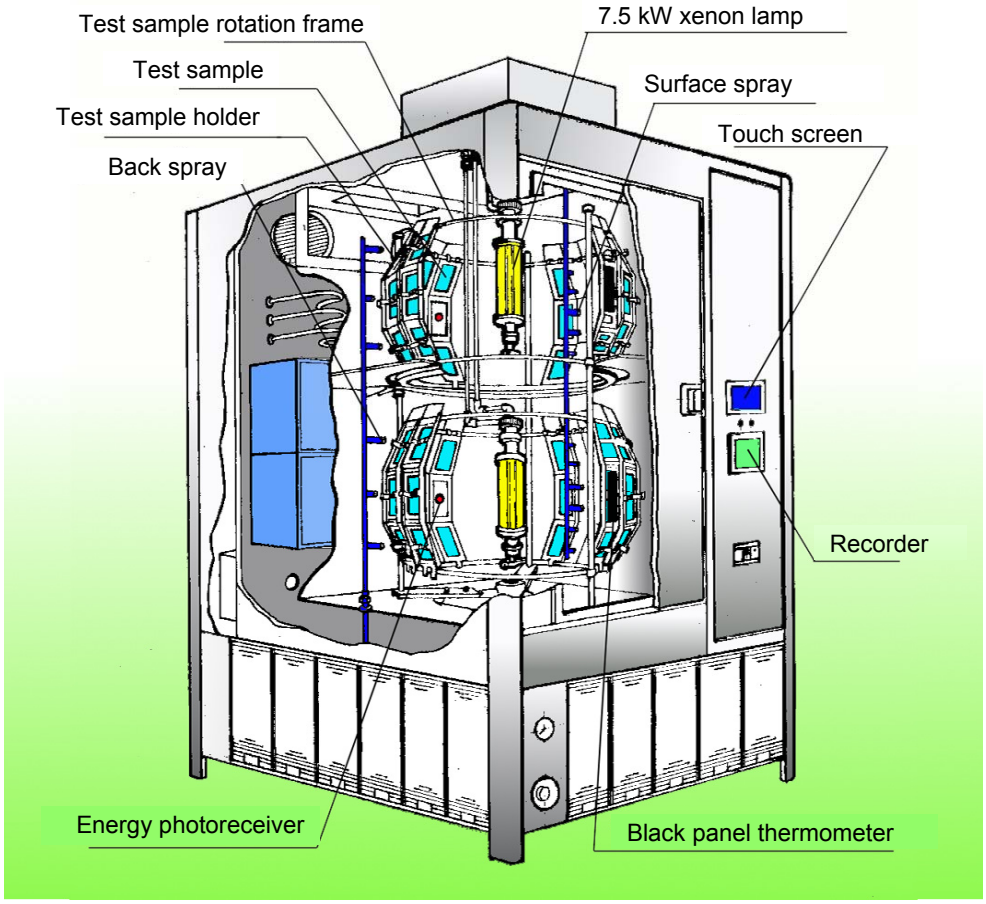


APPENDIX 2　How to Operate Xenon Weatherometer

1. Test equiment

An example of xenon weatherometer test equipment is shown as follows.

Figure 6　An example of xenon weatherometer (2 lamps)



2. Handling standards for the xenon weatherometer

For reference, the handling standards for the sunshine weatherometer of Suga Test Instruments are shown below.

2.1 Lamp

(1) The irradiance of the xenon arc lamp will change with usage; accordingly, the service period for this item is set at 1,000 hours maximum, and if this level has been exceeded, replace the lamp with a new part as soon as possible.
(2) If lamp breakage occurs, it shall be replaced with a new part as soon as possible.
(3) Newly replaced lamps shall be aged for a period of 20 hours before actual use.

2.2 Filter

(1) The service period for filters (outer, inner) shall be within 1,000 hours, and if this level has been exceeded, replace the filter with a new part as soon as possible.
(2) Gloves shall be used for filter replacement and contact with hands is to be avoided.
(3) After transferring the lamp-cooling water to the special container, the lamp-coolant tank shall be filled with this liquid.
(4) The power supply must always be turned off when performing lamp and/or filter replacement.

2.3 Irradiance

(1) Adjustment shall be carried out using the radiation-voltage setting knob so that the standard irradiance can be achieved (162±5 W/m^2 for inside cabin conditions; 180±5 W/m^2 for outside cabin conditions).
(2) Top and bottom replacement of the radiant flux density meter shall not be carried out.
(3) Calibration by the manufacturer shall be carried out once every year.

2.4 Black panel temperature gauge

(1) The black panel temperature gauge shall be replaced with a new part once every year.
(2) In situations where the black panel temperature gauge is mounted to the tester, care shall be taken to ensure that water cannot enter the connectors.

2.5 Lamp coolant water

(1) All of the distilled water in the tank shall be replaced once every month.
(2) When the water level has dropped, the tank shall be filled up accordingly.

2.6 Dry and wet-bulb temperatures

(1) If the wet-bulb temperature is the same as the dry-bulb temperature during illumination, water shall be supplied to the wet-bulb pot within the tank.
(2) If the wet-bulb gauze hardens, it shall be replaced as soon as possible.
(3) The humidity generator shall be cleaned once every month.

2.7 Sample assembly

(1) During testing, operation shall be carried out with both the upper and lower racks fully assembled.

2.8 Spray

(1) The pressure of spray water shall be adjusted to 49 kPa.
(2) Each nozzle shall generate a spray of a uniform condition.

2.9 Others

(1) In situations where the safety lamp turns on, action shall be taken in accordance with the section “Faults and Countermeasures” from the user’s manual.
(2) If not used for extended periods of time, remove lamp and filter, and water in the tank and the humidity generator shall be drained.
(3) The input power-supply voltage shall remain constantly at 200±20V.
(4) To turn operation on and off during illumination, the “Stop” button shall be used. Note that the “Power” button is not to be used for this purpose. If testing is interrupted in such a case, the “Power” button shall be turned on for 15 minutes and then turned off.

2. Xenon weatherometer test frequencies

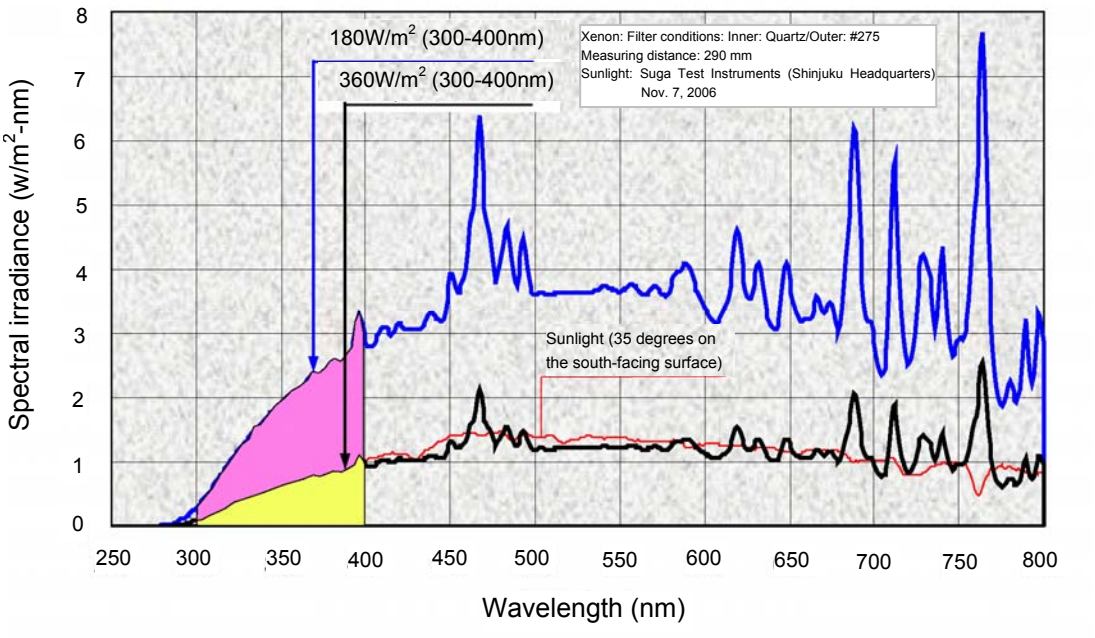


Figure 7 Suga Test Instrument Filter: Quartz/#275

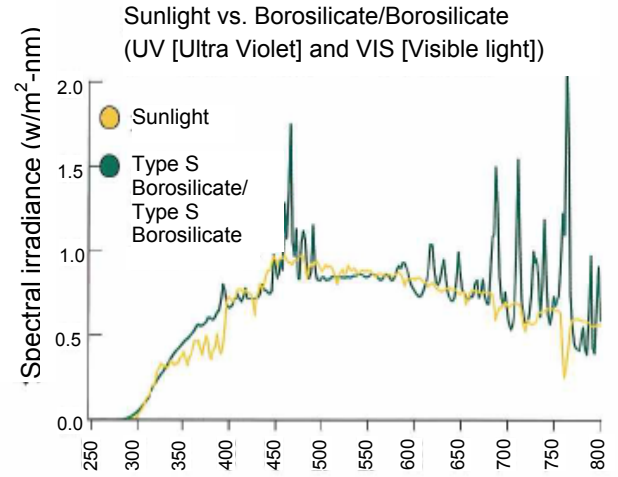


Figure 8 Atlas Filter: Type S/Type S

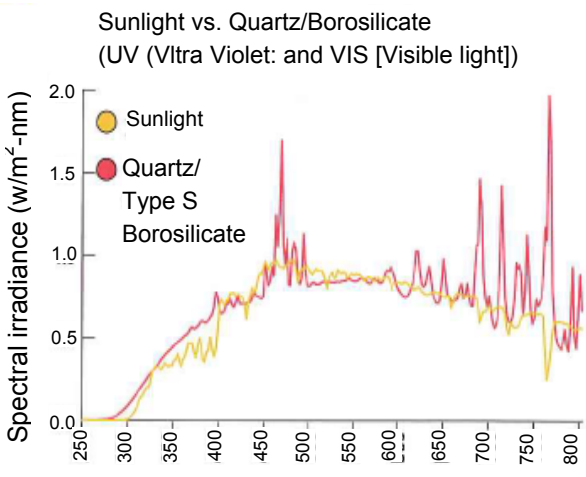


Figure 9 Atlas Filter: Quartz/Type S

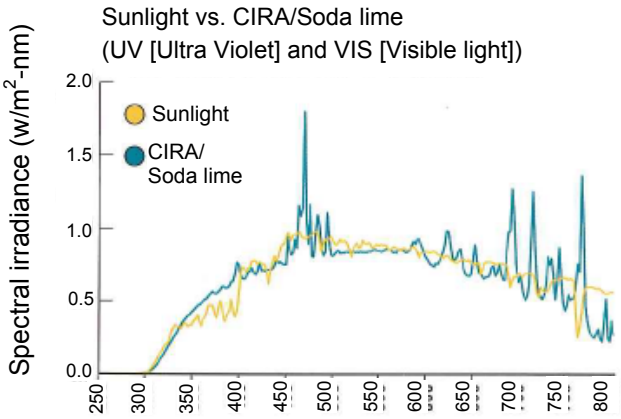


Figure 10 Atlas Filter: CIRA/Soda lime

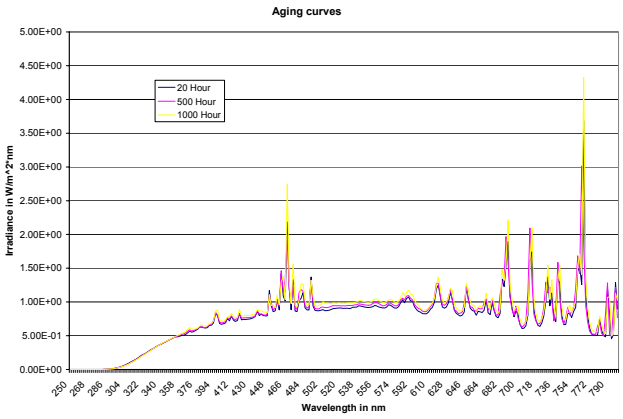


Figure 11 Aging deterioration behavior of Atlas xenon lamp

Normative References:	NES M 0141-2006-2	Methods of Test for Coating of Synthetic Resin
	NES M 0154-2005-1	Testing Methods of Fabrics for Automobiles
	NES M 7081-2006-N	Polyvinylchloride Coated Fabric for Automobiles
	NES M 7083-2005-N	Vinyl Sheet for Automobiles
	NES M 7084-2005-N	Vacuum-Formed Sheet for Instrument Panel Pad
	NES M 7100-2005-N	Fabrics for Automobiles
	NES M 7102-2007-N	Seat and Door Leather for Automobiles
	NES M 7103-2005-N	Automotive Carpet
	NES M 8022-2006-N	PVC Slush – Molded Skin
	NES M 8011-2004-1	ABS, AAS, AES Resin (Contained Polymer Alloy Resin with Another Resin)
	NES M 8012-2005-N	Filler Reinforced Polypropylene
	NES M 8014-2005-N	Polyacetal
	NES M 8015-1999-N	Polyamide
	NES M 8016-1999-N	Polybutylene Terephthalate (PBT)
	JIS R 3202: 1996	Float glass and polished plate glass
	JIS Z 8701: 1999	Colour specification - The CIE 1931 standard colorimetric system and the CIE 1964 supplementary standard colorimetric system
	JIS Z 8703: 1983	Standard atomospheric conditions for testing
	JIS Z 8720: 2000	Standard illuminants and sources for colorimetry
	JIS Z 8722: 2000	Methods of colour measurement - Reflecting and transmitting objects
	JIS Z 8730: 2002	Colour specification - Colour differences of object colours
	JIS Z 8741: 1997	Specular glossiness -- Method of measurement
	JIS K 7219: 1998	Plastics - Methods of exposure to direct weathering, to weathering using glass-filtered daylight, and to intensified weathering by daylight using Fresnel mirrors
	JIS K 7350-1: 1995	Plastics - Methods of exposure to laboratory light sources
	JIS K 7361-1: 1997	Plastics - Determination of the total luminous transmittance of transparent materials - Part 1: Single beam instrument
	JIS K 7362: 1999	Plastics Determination of changes in colour and variations in properties after exposure to daylight under glass, natural weathering or laboratory light sources

ANNEX

1. Revision objectives

In recent years, we have received customer complaints about the quality of resin parts without coating. Consequently, a complete review (test durations and judgment criteria) of the standard is being studied. In general, as the light deterioration mechanism of high polymers differs depending on the type of material, the speed of deterioration also differs even when the same load (light, heat, and water) is applied in the market. Therefore it is necessary to ascertain the deterioration mechanism of each type of material. This revision has been made in order to avoid vague expressions in judgment criteria for the accelerated exposure test and reduce the test data variations.

1.1 Revision contents

1) Handling of test samples for the sunshine weatherometer

As for testing using sunshine weatherometer (for straight type test sample racks only, inclined types are excluded), it has been stipulated that the positions of the test samples shall be switched at specified intervals. This is to reduce variations in the weatherability deterioration time because the irradiated energy of the light varies depending on the position of the test samples (due to difference in the distance from the carbon arc and position changes caused by burning).

2) Storing data of test samples used for judgment

No data (photographs) on the test samples used for the judgment has sometimes been retained. In such case, it took a long time to respond to customer complaints in the market because no detailed data at the development was available. Therefore, it has been decided to record the weatherability test results in a form equivalent to the recommended one.

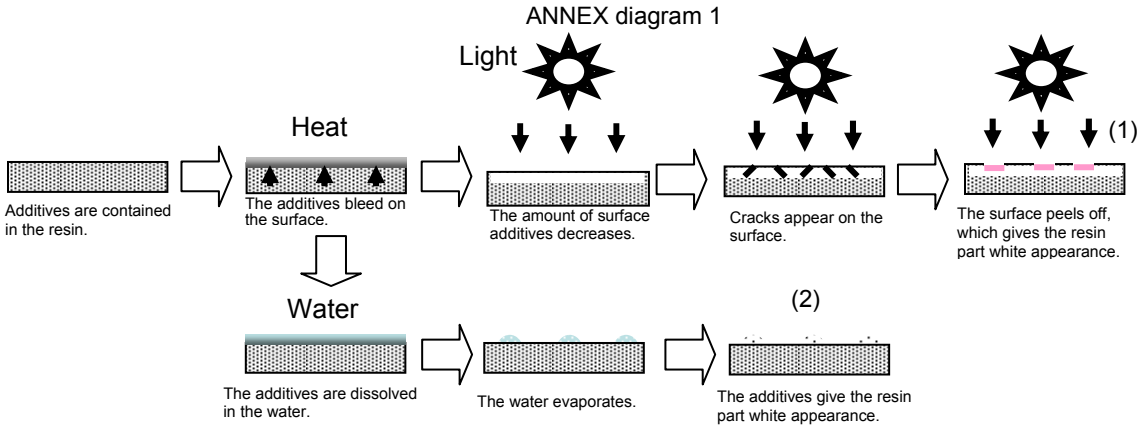
1.2 Reference materials

The investigation of whitening mechanism of PP material used for exterior resin parts without coating has revealed the following deterioration mechanism. The effects of heat, water and light contribute to the weatherability deterioration. The additives in resin that have bled on the surface due to heat cause the following deterioration.

(1) The surface additives are gradually reduced by light (primarily ultraviolet), the resin deteriorates, cracking appears and the resin peels off. As a result, the reinforcing material (talc, glass fiber, etc.) exposed on the surface give the resin part white appearance (refer to ANNEX diagram 1).

(2) The surface additives extracted by water or acid rain are dissolved in water. Those that remain even after the water evaporates give the resin part white appearance.

ANNEX diagram 1



In consideration of the deterioration mechanism above, it is important to closely observe the status of the surface after being subject to the accelerated exposure test. In the future the deterioration mechanisms of materials other than PP shall be clarified and the test duration of each type of test shall be reviewed while confirming market correlation.

2. Previous revision objectives (2006)

Five years have passed since the previous revision, therefore, Normative References, etc. were reviewed to match with the latest Standards. Moreover, adaptation of resin parts without coating is increasing recently. From now on, it is planned to review Standards totally (test time, judgement criteria), however, for the revision this time, only the description of “in cases where the material types are not described in Tables 8 and 9, or where the weather (light) resistance is pointed out as a concern for the material composition, it is allowed to determine the test conditions and the judgement criteria by agreement between the partied concerned.” was given in 7.2 (2) on P. 11. From now on, the test methods will be reviewed as soon as the data acquisition is completed.

3. Purpose of previous revision (2001)

This Standard was established in 1974 as the weatherability and light resistance test methods of automotive synthetic resin parts, and it has been used widely as the environmental resistance evaluation methods of resin parts.
The revision this time was mainly made for the adaptation of the weather (light) resistance test method to conform to the ISO, application classification of the test methods and review of the load conditions. Moreover, as a result of several times of part revision in the past, it was pointed out that the configuration of the Standard is slightly hard to be understood, therefore, overall configuration was reviewed by taking operation convenience into consideration.

3.1 Revision contents

3.1.1 Application classification and load conditions

By the former Standard, application classification was defined by six categories that are two exterior categories and four interior categories, however, the load conditions by the application classification were not set for other than the sunshine weatherometer method for the interior and the xenon weatherometer method for the exterior. This time, the load ratio by the application classification was clarified, and the load conditions corresponding to the load ratio were set for the sunshine weatherometer method for the interior and exterior and the xenon weatherometer method for the interior and exterior. Moreover, the application classification for the exterior was changed from two to three categories as accompanied with it.

	Application classification	Locations	Parts example	Load ratio of solar radiation quantity
Interior	Class 1	Interior parts located horizontally and above the beltline, strongly affected by sunlight.	Instrument panel upper surface, rear parcel shelf upper section, rear seatback upper section, outward shoulder sections of front seats (including headrests), steering wheel, inside rearview mirror	1
	Class 2	Interior parts located above the beltline and strongly affected by sunlight	Instrument panel upper slope surface, door trim upper surface, front pillar, rear pillar, inside lock knob	0.66
	Class 3	Interior parts located in areas affected by sunlight	Instrument panel vertical surface, door trim center, seats, center pillars, sun visor, center console, seatbelts	0.5
	Class 4	Interior parts located in areas slightly affected by sunlight	Roof and floor	0.33
Exterior	Class 1	Exterior parts located in horizontal areas affected by sunlight	Ornaments, cowl-top grille, antenna cap, hood louver, wiper pivot cover, bumpers, outside mirrors, emblems, washer nozzles	1
	Class 2	Exterior parts located in incline area affected by sunlight	Radiator grille, rear finisher, pillar side guard molding	0.66
	Class 3	Exterior parts located in areas slightly affected by sunlight	Wheel covers, wheel caps, mudguard	0.3

Moreover, the above load ratio was introduced by the measuring result of solar radiation quantity on the actual vehicle in Arizona (P11) and at the NTC (A33). Therefore, market research will be made in Fiscal 2001, and appropriateness of the load ratio shall be verified.

3.1.2 Ultraviolet rays carbon weatherometer

By the former Standard, the ultraviolet rays carbon weatherometer was set as a test method, however, it is not used currently, therefore, it was determined to discontinue it by the revision this time.

4. ANNEX OF THE REVISION IN 1996

4.1 Purpose of revision

This Standard was established in 1974 as the weatherability and light resistance test methods for the automotive synthetic resin parts, and it was used widely as the environmental resistance evaluation methods of resin parts. Later, the first revision was made in 1983, and the environmental conditions on the market were researched and studied, then the test conditions by the destination and by the vehicle portion were specified. In 1990, the second revision was made, and the xenon weatherometer was set as the accelerated light resistance test method for reference for the purpose of improving the test accuracy and corresponding to internationalization. Furthermore, by the revision in 1993, the test method by the xenon weatherometer was standardized as the accelerated weather (light) resistance test method for the interior resin and surface materials in general and part of the external resin materials. The Standard was set based on the standard machine in each region so as to make the Standard correspond to Japan, USA and Europe.

By the revision this time, resin materials that were not specified by the previous revision were standardized newly, in regard to the exterior resin material test method by the xenon weatherometer. Accordingly, it becomes possible to correspond to almost all of the external resin materials (excluding coating parts) by the test using the xenon weatherometer.

4.2 Revision contents

4.2.1 Scope

This Standard specifies the weather (light) resistance test method for the interior resin and surface materials and the external resin materials used for automobiles.

However, this Standard is not applied to coating parts but NES M 0141 (Methods of Test for Coating of Synthetic Resin) is applied.

4.2.2 Test method

· Outdoor exposure test

By the former Standard, the outdoor exposure location was not clarified, therefore, it was clarified this time that Okinawa shall be the reference for the exposure location.

· Accelerated weather resistance test (Method 2 external resin materials)

For the following external resin materials that were not specified by the former Standard, the test conditions for the xenon weatherometer were specified newly. Same as usual, in regard to the xenon weatherometer, the test conditions were set respectively for the standard machine in each region of Japan, USA and Europe for corresponding to internationalization.

	Material	Applicable parts
Materials for which xenon was specified by the former Standard	PVC	Outside molding, window seal molding, etc.
	PP	Bumper, cowl cover, etc.
	POM	Outside door handle, etc.
Materials for which xenon was specified by the revision this time	PMMA	Lamp lens, etc.
	PC	Headlamp lens, etc.
	AES, AAS	Door mirror housing, radiator grille, license plate finisher, etc.
	PC/PET, PC/PBT	Outside door handle, etc.

As the test conditions of method 2 class 1 (portions of external parts that are affected by the sunlight), the outdoor exposure test (up to two years) and the accelerated weather resistance test by the xenon weatherometer shall be carried out for the above materials. Change of the color difference, gross and permeation ratio of each material were examined, and the test conditions of the xenon weatherometer (accumulated irradiation energy, time) for deteriorating the weather resistance equivalent to two years of exposure in Okinawa were set.

(As a reference, a typical example of weather resistance deterioration data by the exposure test in Okinawa and the accelerated test by the xenon weatherometer is attached to the Explanation Figure 1.)

Moreover, by the former Standard, the test conditions of the xenon weatherometer were not specified for method 2 class 2 (portions of external parts that are less affected by the sunlight), however, the test conditions were standardized for these portions also for this time. As the test conditions, the load conditions equivalent to one year of exposure in Okinawa were set. (1/2 load of method 2 class 1)

4.3 Others

The test conditions of the accelerated weather (light) resistance test by the xenon weatherometer differ by the material type. (Reference material is attached.) Therefore, for the resin materials not specified at this stage, the xenon weatherometer test conditions shall be set in order from now on.

4.4 Explanation of former Standard

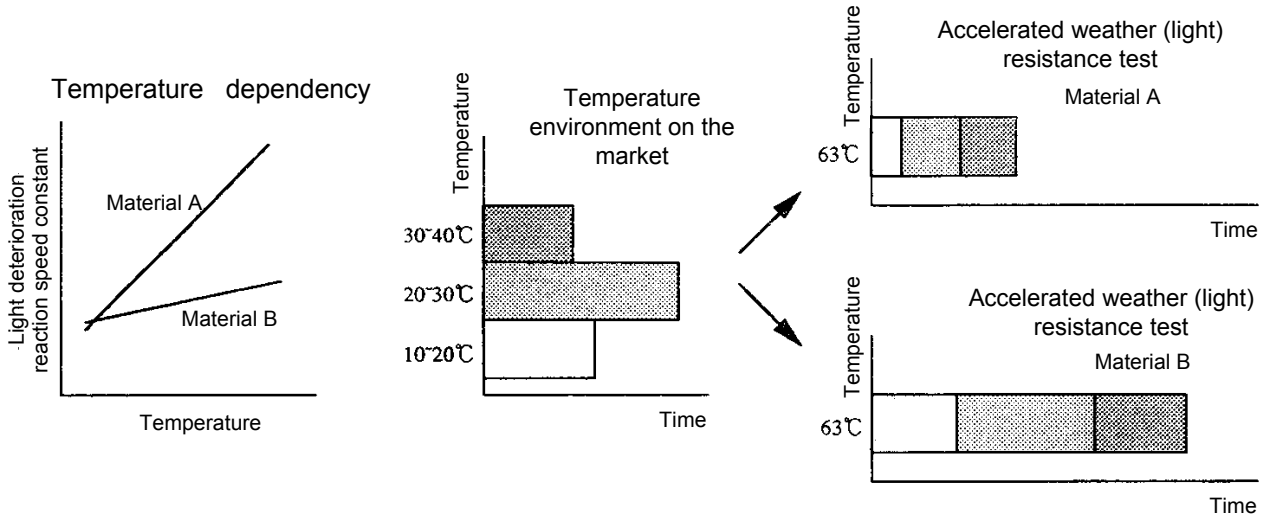
Explanation at the previous revision is attached.

[Reference material]

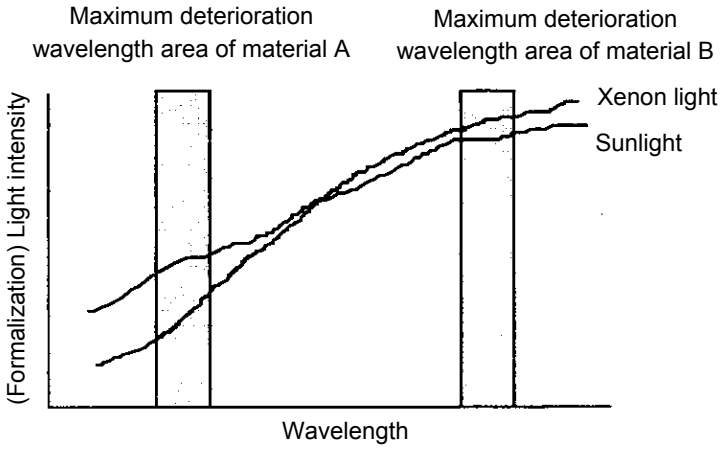
For the accelerated weather (light) resistance test by the xenon weatherometer, the test conditions are set by the material type/machine type, and it is because of the following reasons.

[1] Difference of test conditions by the material type

1) In general, the acceleration ratio of light deterioration of high polymers by temperature (temperature dependency of light deterioration speed) differs by the material type. Therefore, even if each material is subjected to loads of the same light, heat, (and water), a phenomenon where the light deterioration speed differs by the accelerated weather (light) test conditions (constant test temperature) occurs for one material whose light deterioration reaction is sensitive to temperature and another material whose reaction is dull to temperature.



2) The maximum deterioration wavelength of high polymers differ by the material type. On the other hand, the wavelength distribution of a xenon lamp is similar to that of the sunlight, however, the ratio of the xenon light energy and the sunlight energy in the fine wavelength area differ by the wavelength. Therefore, this energy ratio differs in the deterioration wavelength area for each material type, and the deterioration speed differs.

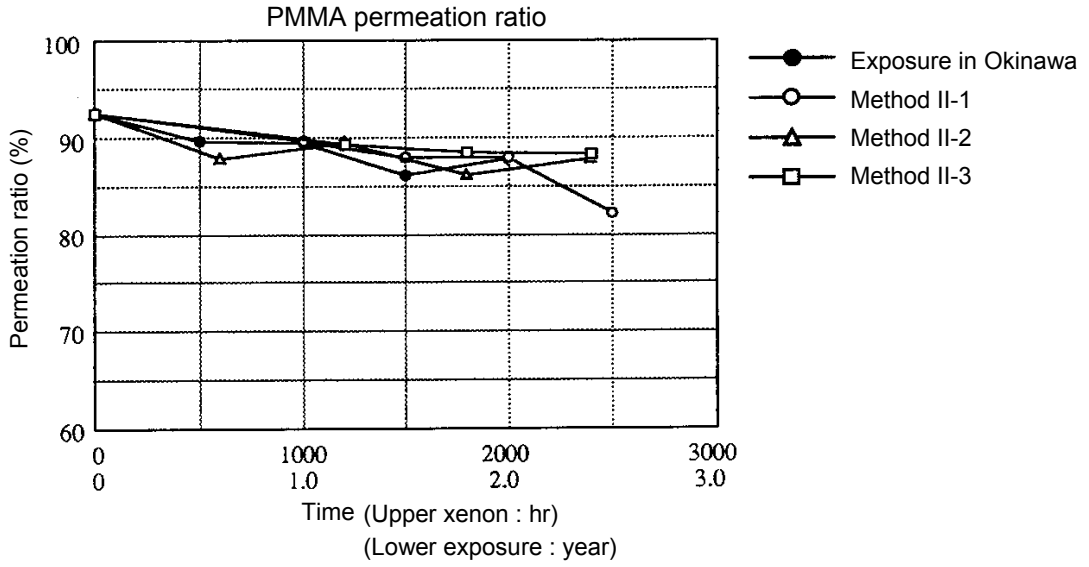


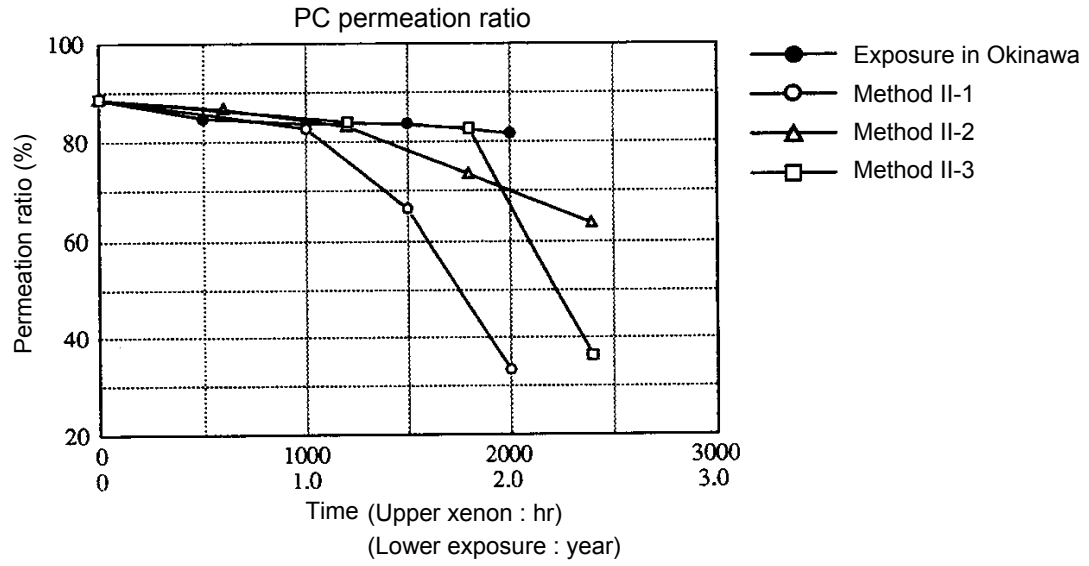
The above 1) and 2) are the main reasons, therefore, for the accelerated weather (light) resistance test conditions by the xenon weatherometer, and the test conditions (time, energy) are set for each material type even for the same machine type

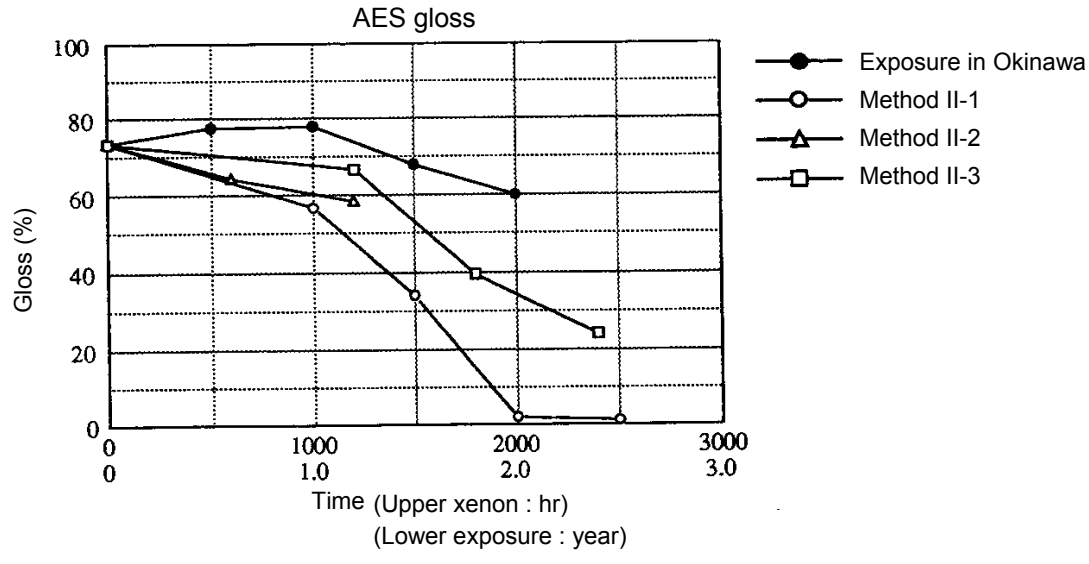
[2] Difference of test conditions by machine type

Because the specifications/operation conditions of the xenon weatherometer that is the standard in each region (Japan, USA, Europe) are different, it is necessary to set the test conditions for each machine type. (Refer to Tables 4 and 6 in the text.)

ANNEX Figure 1 Outdoor exposure test/xenon weatherometer accelerated weather resistance test result example (Method 2)







ANNEX of former Standard

1. PURPOSE OF REVISION

This Standard was established in 1974 as the weather and light resistance test methods of synthetic resin parts, and it has been widely used as the examination methods of durability of automotive synthetic resin parts against the environmental conditions, by the related departments inside and outside the company. The first revision was made in 1983, the environmental conditions for Japanese models and export models and at various portions of vehicles were researched and studied, and the test conditions were subdivided. Furthermore, by the revision in 1990, the xenon weatherometer that is an accelerated test machine using the light source of a xenon lamp whose wavelength distribution is similar to that of the sunlight was set for resin molding materials for reference, for the purpose of improving the test accuracy for the market and corresponding to internationalization.

By the revision this time, resin materials in general including the surface materials for interior and exterior resin parts were covered by the scope of this NES, therefore, this Standard was integrated as a summit of the system of Standards of the weather (light) resistance for the interior and exterior resin parts excluding coating, and the xenon weatherometer was standardized formally.

Moreover, the evaluation conditions corresponding to the respective accelerated test machines used widely in Japan, USA and Europe were set to internationalize the test methods.

2. MAIN REVISION CONTENTS

2.1 Scope

So far, cloths, headlinings, and carpets were excluded from this Standard because they were entrusted to the NES for each. However, thinking this situation from the standpoint of those who are using this Standard such as designers of resin parts, it is inconvenient. Therefore, this time the scope was configured as the interior and exterior resin parts in general, and the contents, etc. were revised, thus, it has become possible to start evaluation smoothly by quoting this Standard.

2.2 Accelerated weather (light) resistance test machine

The development of the light resistance evaluation method by the accelerated test machine using a light source of a xenon lamp promoted for the purpose of corresponding to internationalization reached a level of application to main resin materials, therefore, it was standardized formally. Moreover, the energy management was applied as the test management to improve the accuracy.

2.3 Internationalization of test method

To smoothly promote the overseas vehicle development and adoption evaluation of overseas parts and materials, the evaluation conditions corresponding to Japan, USA and Europe were set.

3. EXPLANATION OF STANDARD CONTENTS

3.1 Scope

As described in 2.1, the scope covers interior and exterior resin parts in general. However, it is necessary to refer to each Standard for details of the test methods, especially for surface materials, etc., therefore, it was described clearly.

3.2 Accelerated weather (light) resistance test machine

As described above, application of the xenon weatherometer that was handled as a reference for the main resin materials so far was standardized this time. Moreover, as accompanied with such activities of improving the accuracy, the ultraviolet rays carbon weatherometer for the interior materials that was not used currently was excluded from this Standard.

3.3 Accelerated test conditions

As the accelerated test conditions for the xenon weatherometer, three conditions for external parts and four conditions for interior parts were set to correspond to Japan, USA and Europe.

3.4 External parts

It was pointed out that the current test by SWOM cannot cope with PVC and POM because of whitening of PVC molding and POM door handle.

Therefore, for the external PVC and POM parts mounted on the vehicle, the result by the xenon weatherometer shall be used for judgement.

3.5 Outdoor exposure execution

So far, the execution was not described, therefore, it was clarified that the execution shall be determined by the consultation between parties concerned at the time of test planning.

3.6 Judgement

3.6.1 Idea of judgement

Each accuracy differs by the test method. Therefore, priority of each result for judgement was clarified. Therefore, it was clarified that the handling of each result shall be discussed at the time of test planning in cases where different test machines are used between parties concerned.

3.6.2 Judgment criteria

The description of judgement criteria (Table 13) was revised as accompanied with the development of the scope.

4. ACCELERATED WEATHER RESISTANCE TEST METHODS FROM NOW ON

As described in the text and the explanation, for the interior and exterior resin materials in Table 8 to which the xenon weatherometer is not applied, the test methods will be shifted to those by the xenon weatherometer in order from now on, for the purpose of improving the accuracy and corresponding to overseas situations.

5. ENGINEERING EXPLANATION OF XENON DEVELOPMENT

In regard to the evaluation conditions for the xenon weatherometer using a light source of a xenon lamp, the development history is explained roughly.

The basic test conditions for the interior parts were those of the Nissan xenon method that was standardized already for cloths and has been operated for several years, and the development started from the study of the test accuracies and the load conditions for other interior materials by this method.

The development flow is as described in the attached Figure 2.

The correlation figure that shows the correlation between the outdoor exposure and the bench test results for some materials among those to which xenon weatherometer is applied newly by the revision this time is listed as the attached Figure 3.

6. OTHERS

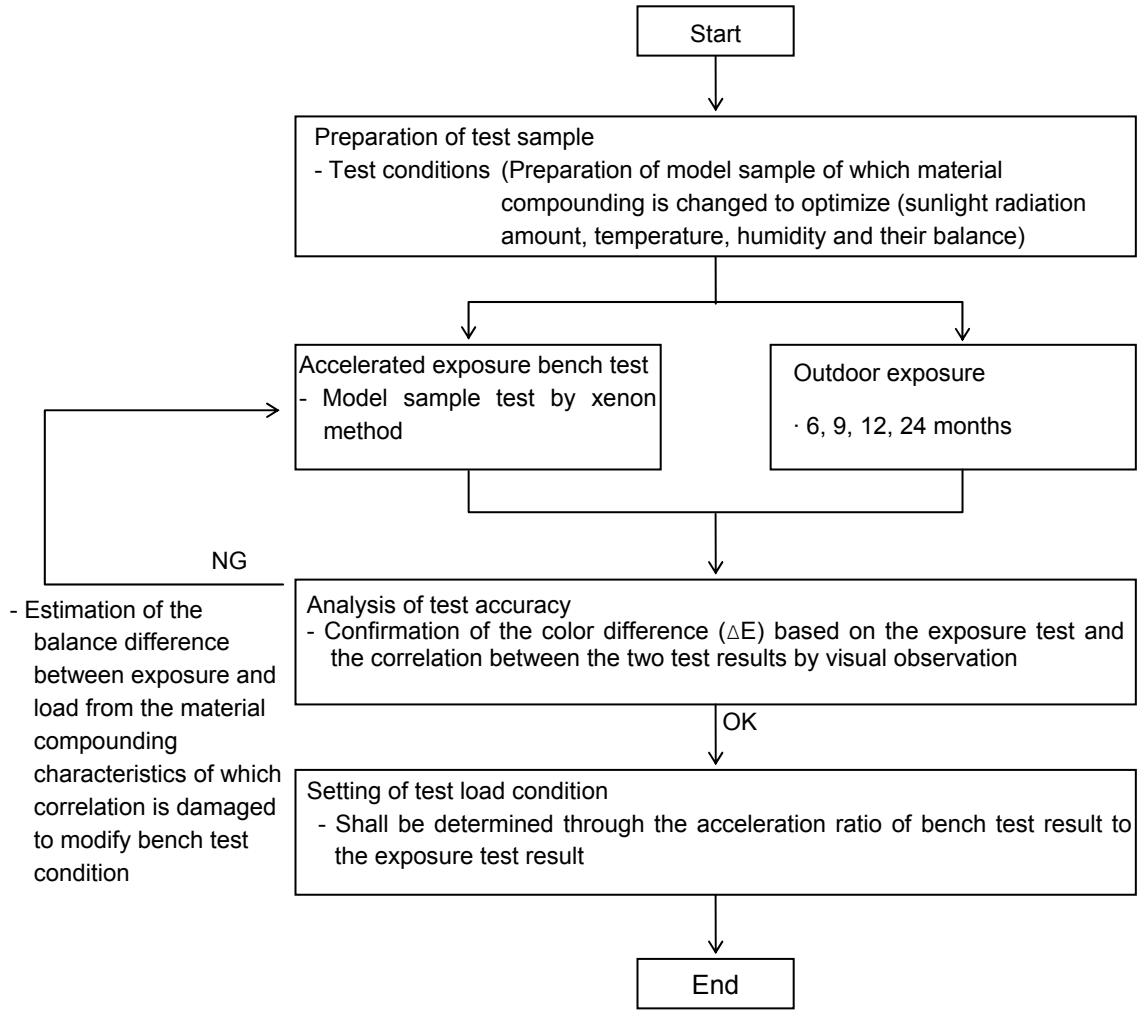
6.1 Evaluation of new materials

The test conditions for the xenon method differ by material. Therefore, in the case of evaluating new materials not specified currently, it is necessary to determine the conditions including the execution of the outdoor exposure by following the attached Figure 2.

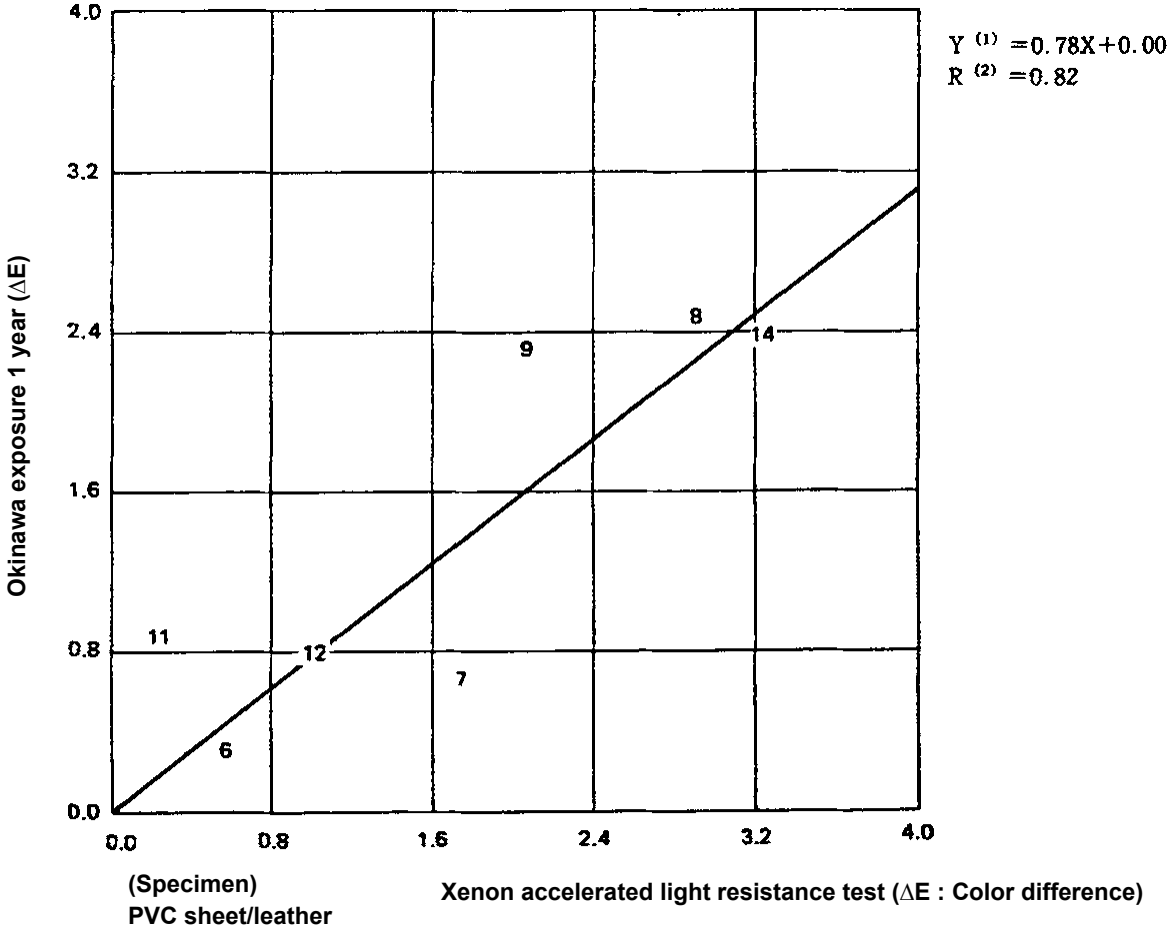
6.2 Outdoor exposure location

The outdoor exposure is based on the data of the Okinawa weathering test place of the Material Engineering Department of Nissan Motor Co., Ltd. in Okinawa. For reference of executing the outdoor exposure overseas, the load value map (interior parts) for each area based on the solar radiation quantity is shown in the attached Figure 4.

Attached Figure 2 Light resistance evaluation method development flow



Attached Figure 3 Example of correlation figure of Okinawa exposure and xenon accelerated light resistance test results for vinyl chloride sheet/leather



Note ([1]) Inclination 0.78 represents the acceleration characteristic of the xenon accelerated light resistance load quantity for one year of Okinawa exposure shown by this example.
([2]) R represents correlation, and it is judged good when it is 0.8 to 1.0.

Attached Figure 4 Map of load ratio for each area with 12 months of Okinawa outdoor exposure (interior parts) as 1.0