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**Basic environmental testing
procedures—Part 2 : Tests—
Test Q : Sealing**

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee, as the result of proposal for revision of Japanese Industrial Standard submitted by the Reliability Center for Electronic Components of Japan (RCJ)/ the Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14. Consequently **JIS C 0026 : 1994** is replaced with this Standard.

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Basic environmental testing procedures— Part 2 : Tests—Test Q : Sealing

Introduction This Japanese Industrial Standard has been prepared based on the fourth edition of IEC 60068-2-17 *Basic environmental testing procedures—Part 2 : Tests—Test Q : Sealing* published in 1994 without modifying the technical contents.

“Information” underlined with dots in this Standard is the matter not included in the original International Standard.

1 Scope Test Q: Sealing, includes a number of tests which uses different conditioning procedures appropriate for different applications. The family tree of all sealing tests is shown in figure 1.

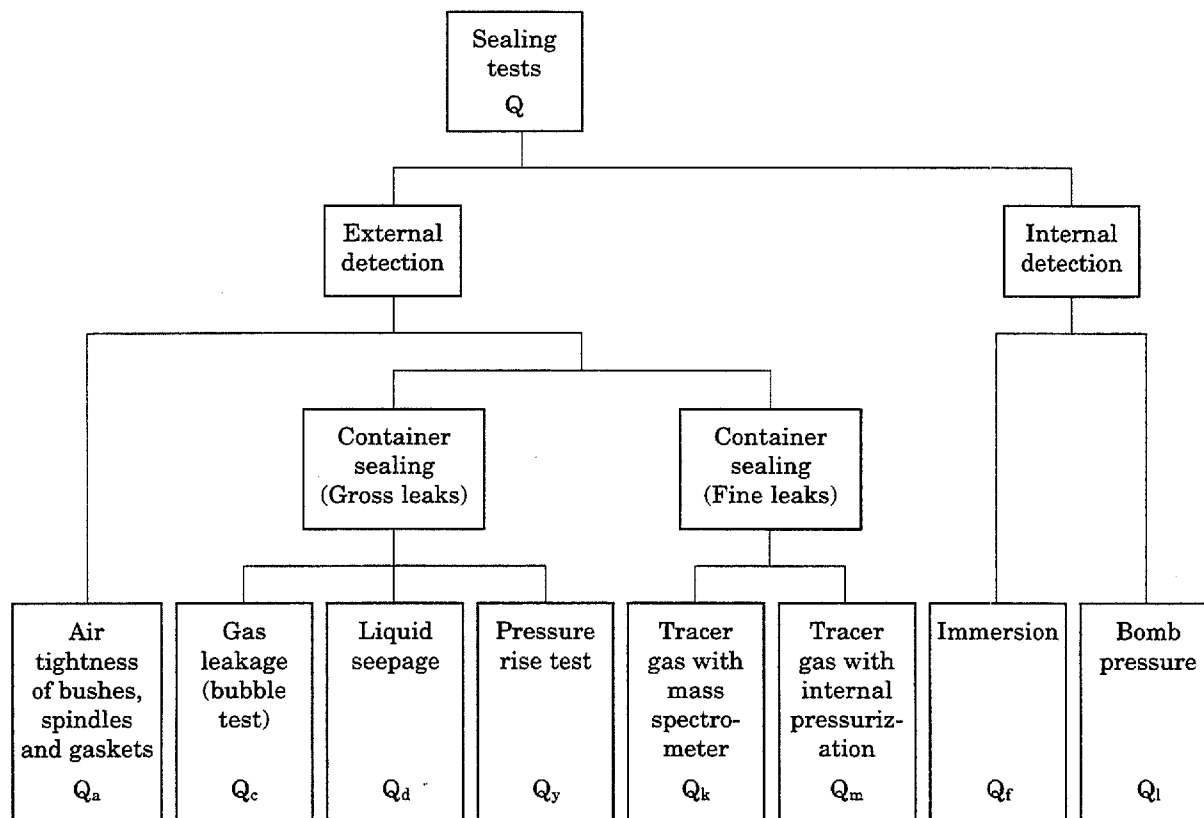


Figure 1 Family tree of all sealing tests

Test Q may be subdivided in the following two sub-groups, distinguished by their detection methods, viz:

- internal detection, which measures changes of electrical characteristics produced by the test medium (liquid or gas) introduced into the specimens through the leak;
- external detection, whereby the escape of the test medium through the leak is observed.

The two tests for internal detection Q_f and Q_i are very similar. They are very effective for certain components, for example plastic foil capacitors; they are not recommended, however, for components in which electrical changes become effective only after a long time (for instance, after the test is terminated).

The tests for external detection are further subdivided according to their application. Test Q_a is a bubble test which is used to determine the air tightness of bushes, spindles and gaskets. The other tests, Q_c , Q_d , Q_k and Q_m are used to determine leaks in containers (metallic cases, housings, etc.); Test Q_c is a bubble test again including three methods with different sensitivities (leaks not less than $1 \text{ Pa} \cdot \text{cm}^3/\text{s}$).

Test Q_k and Q_m are the most sensitive of this series. Their sensitivity ranges from $1 \text{ Pa} \cdot \text{cm}^3/\text{s}$ to about $10^{-6} \text{ Pa} \cdot \text{cm}^3/\text{s}$. Test Q_d is a liquid seepage test which may be applied to specimens filled during manufacture with a liquid or a product becoming liquid at the test temperature.

Remarks : The International Standard corresponding to this Standard is given below.

In addition, abbreviations which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified) and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

IEC 60068-2-17 : 1994 *Basic environmental testing procedures—Part 2 : Tests—Test Q : Sealing* (IDT)

2 Normative reference The following standard contains provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent edition of the standard (including amendments) indicated below shall be applied.

JIS C 0010 *Environmental testing Part 1 : General and guidance*

Remarks : **IEC 60068-1 : 1998** *Environmental testing—Part 1 : General and guidance* is identical with the said standard.

3 Definitions For the purpose of this Standard the following definitions apply:

3.1 Leak rate The quantity of a dry gas at a given temperature that flows through a leak per unit of time and for known difference of pressure across the leak.

NOTE : The basic SI unit for leak rate is “pascal cubic metre per second ($\text{Pa} \cdot \text{m}^3/\text{s}$). The derived unit “ $\text{Pa} \cdot \text{cm}^3/\text{s}$ ” is used in this Standard as they better conform with the orders of magnitude used in common industrial practice.

It is recalled that: $1 \text{ Pa} \cdot \text{m}^3/\text{s} = 10^6 \text{ Pa} \cdot \text{cm}^3/\text{s}$

3.2 Standard leak rate The leak rate under standard conditions of temperature and pressure difference.

For the purpose of this test, the standard conditions are 25°C in temperature and a pressure difference of 100 kPa .

3.3 Measured leak rate (R) The leak rate of a given device as measured under specified conditions and employing a specified test gas.

NOTES 1 Measured leak rates are often determined with helium employed as the test gas under a pressure difference of 100 kPa at 25 °C.

2 For the purpose of comparison with leak rates determined by other methods of testing, the leak rates must be converted to equivalent standard leak rates.

3.4 Equivalent standard leak rate (L) The standard leak rate of a given device, with air as the test gas.

3.5 Time constant (of leakage) (θ) The time required for equalization of partial pressure difference across a leak if the initial rate of change of that pressure difference were maintained. For the purpose of this test, the time constant is equal to the quotient of the internal volume of the specimen and the equivalent standard leak rate.

Information : θ is obtained by the following formula:

$$\theta = \frac{V}{L} P_0$$

where, V : content volume of specimen (cm³);

L : equivalent standard leak rate (Pa · cm³/s);

P_0 : difference of pressure (Pa).

3.6 Gross leak Any leak the equivalent standard leak rate of which is greater than 1 Pa · cm³/s.

3.7 Fine leak Any leak the equivalent standard leak rate of which is smaller than 1 Pa · cm³/s.

3.8 Virtual leak The semblance of a leak caused by slow release of absorbed, adsorbed or occluded gas.

3.9 Leakage meter (Test Q_m) Apparatus consisting of a hand probe for taking a sample of gas mixture and a meter providing a graduated display of the concentration of a predetermined type of gas in the sample.

3.10 Volume of measurement (V_m) (Test Q_m) Volume contained between the gastight sheath collecting the leakage and the specimen.

NOTE : The tracer gas concentration being small in that volume, the sealing of its sheath does not generally need to be perfect.

3.11 Leak detector (Test Q_m) Apparatus consisting of a hand probe for taking a sample of gas mixture and a device sensitive to the presence of a predetermined type of gas and emitting a signal, either acoustic or visual, when the concentration of a predetermined type of gas reaches a preset threshold level.

3.12 Probing (Test Q_m) Action of slowly moving the probe of a leak detector along a specimen in order to locate the leaks.

4 Test Q_a: Sealing of bushes, spindles and gaskets

4.1 Object To determine the effectiveness of seals (airtightness) of bushes, spindles and similar features.

NOTE : For the purpose of this test, two types of seals shall be considered:

- Type A: 100 kPa to 110 kPa in the direction specified in the relevant specification.
- Type B: 100 kPa to 110 kPa in each direction.

4.2 Scope This test can be used for the detection of gross leaks.

4.3 General description of the test The specimen is mounted on the lid of a pressurized test chamber which is submerged in a liquid. If the specimen leaks, the air escaping is collected. The amount of air collected per unit time is a measure of the air leakage. A suitable test apparatus is described in annex A.

4.4 Initial measurements Not required.

4.5 Conditioning

4.5.1 Unless otherwise specified, an air pressure difference, as specified below, shall be applied across each seal or simultaneously across a group of seals forming an assembly.

Type A: 100 kPa to 110 kPa in the direction specified in the relevant specification.

Type B: 100 kPa to 110 kPa in each direction.

Where a higher pressure is required, it shall be 340 kPa to 360 kPa.

NOTE : The test apparatus described in annex A may not be suitable for these higher pressures.

4.5.2 Type B seals shall be tested both in a static condition and while being mechanically operated as required by the relevant specification.

4.6 Final measurements The rate of leakage shall be measured. The limit shall be prescribed in the relevant specification.

4.7 Information to be given in the relevant specification When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

	Subclause
a) Requirements for pressure	4.5.1
b) Direction of application of pressure difference	4.5.1
c) Mechanical operation during conditioning	4.5.2
d) Requirements for leakage rate	4.6

5 Test Q_c: Container sealing, gas leakage

5.1 Object To determine the effectiveness of seals of specimens having an included gas-filled space (e.g. specimens not completely filled with impregnant).

5.2 Scope This test can be used for the detection of leak rates greater than 100, 10 or 1 Pa·cm³/s according to the method chosen.

Test Methods 1 and 3 are applicable only to specimens that are able to withstand full decompression and the compression necessary for the impregnation (see **5.3.3**) without suffering distortion or permanent physical damage (see annex B, clauses **B.1**, **B.2** and **B.3**).

Test Method 2 is applicable to all specimens subject to a significant thermally generated pressure differential being achieved at the maximum ambient temperature of operation of the specimen.

5.3 General description of the test The detection of gross leaks is achieved by submerging the test specimen in a suitable liquid, under controlled conditions and by observing bubbles emanating from the specimen surface (see annex B, clause **B.5**). A positive internal pressure within the test specimen is generated by one of the following test methods:

5.3.1 Test Method 1 Conducting the test in a vacuum environment, thereby increasing the pressure differential across the seals of the test specimen.

5.3.2 Test Method 2 Through immersion in a test liquid maintained at an elevated temperature (see annex B, clause **B.10**).

5.3.3 Test Method 3 Through immersion in a test liquid, following impregnation with another liquid having a boiling point below the test temperature.

5.4 Test Method 1

5.4.1 The test chamber containing the bath required for this test shall be capable of being evacuated, and the bath shall contain sufficient liquid to enable the specimens to be immersed so that the uppermost surface of the specimen enclosure or seal to be tested is at a depth of not less than 10 mm below the surface. The test liquid (see annex B, clause **B.8**) shall be maintained at a temperature between 15 °C and 35 °C. The bath should be capable of being drained of the liquid or having the specimen removed from the liquid before breaking the vacuum.

5.4.2 Specimens shall be immersed in the test liquid with their seals uppermost. The pressure within the test chamber shall then be reduced within 1 min to a value of 1 kPa or as otherwise prescribed in the relevant specification. If no failure has been observed (**5.4.4**) maintain this pressure for a further minute or another duration prescribed in the relevant specification (see annex B, clause **B.9**).

5.4.3 Specimens possessing seals on more than one surface shall be tested in accordance with **5.4.2** with each surface in the uppermost position (see annex B, clause **B.4**).

5.4.4 Failure criteria for this test shall be the observance at any time during the test of a definite stream of bubbles, or more than two large bubbles, or an attached bubble that grows in size (see annex B, clauses **B.6** and **B.7**).

5.5 Test Method 2

5.5.1 The bath required for this test shall contain sufficient liquid (see annex B, clause **B.11**) to enable the test specimens to be completely immersed to a depth of not less than 10 mm above the uppermost part of the enclosure or seal to be tested.

5.5.2 The liquid shall be maintained at a temperature of 1 °C to 5 °C above the maximum ambient temperature of operation for the specimen under test or at the temperature required in the relevant specification.

5.5.3 The specimens, which shall be at a temperature between 15 °C and 35 °C, shall be immersed in the test liquid with their seals uppermost (see annex B, clause **B.11**) for a period of at least 10 min, or as prescribed in the relevant specification (see annex B, clause **B.3**).

5.5.4 Specimens possessing seals on more than one surface shall be tested in accordance with **5.5.3** with each surface in the uppermost position (see annex B, clause **B.4**).

5.5.5 Failure criteria for this test shall be the observance at any time during the test of a definite stream of bubbles, or more than two large bubbles, or an attached bubble that grows in size (see annex B, clauses **B.6** and **B.7**).

5.6 Test Method 3 This method consists of two steps:

5.6.1 Step 1 Step 1 shall be performed at ambient temperature.

The specimens shall be enclosed in a vacuum/pressure vessel and the pressure reduced to about 100 Pa for 1 h. After that time, and without breaking the vacuum, an impregnation liquid (see annex B, clauses **B.12** and **B.13**) shall be drawn into the vessel until the specimens are covered by it.

The specimens shall then be pressurized under the following conditions:

Table 1

Internal cavity volume cm ³	Minimum pressure (absolute) kPa	Minimum duration h
≤ 0.1	600	1
> 0.1	300	2

At the end of this impregnation time, the pressure shall be removed and the specimens maintained in the liquid. They shall be removed from the liquid and allowed to dry in air at ambient temperature for 3 ± 1 min or another duration prescribed in the relevant specification before performing step 2 (see annex B, clauses **B.14** and **B.15**).

5.6.2 Step 2 Test Method 2 shall apply, using a test temperature of 125 ± 5 °C, unless otherwise specified. The specimen shall be observed from the instant of immersion until 30 s after immersion unless otherwise specified in the relevant specification.

5.7 Information to be given in the relevant specification When this test is included in a relevant specification, the following details shall be given, as far as they are applicable:

	Clause or subclause
a) The method	5.3, 5.4, 5.5, 5.6
b) Recommended liquid(s)	B.8, B.11, 5.6.1
c) Test Method 1: pressure and time, if different from 5.4.2	5.4.2
d) Test Method 2: liquid temperature, if different from 5.5.2	5.5.2
e) Test Method 2: immersion duration, if different from 5.5.3	5.5.3
f) Drying time if different from 3 min	5.6.1
g) Test Method 3: Step 2 temperature, if different from 125 °C	5.6.2

6 Test Q_d: Container sealing, seepage of filling liquid

6.1 Object To determine the effectiveness of seals of specimens filled with liquid.

NOTE: This test may also be used for specimens having a filling which is solid at room temperature but which is liquid at the testing temperature.

6.2 Scope This test can be used for the detection of leak rates corresponding to an air leak rate greater than about $1 \text{ Pa} \cdot \text{cm}^3/\text{s}$. The sensitivity of the method depends on the kinematic viscosity of the liquid at testing temperature and the technique employed to detect seepage.

6.3 General description of the test The specimen is examined for seepage of liquid likely to occur when it is brought up to a temperature slightly higher than its maximum ambient temperature of operation.

6.4 Severities A severity is defined as the period of time at which the specimen is maintained at the testing temperature. The relevant specification shall state the applicable severity chosen from the following list:

10 min, 1 h, 4 h, 24 h, 48 h

6.5 Preconditioning The specimen shall be so cleaned (degreased) that possible seepage of liquid is clearly contrasted with all other materials.

6.6 Initial measurements Not required.

6.7 Conditioning

6.7.1 The specimens shall be placed in an air circulating oven, in which the air is heated until the temperature of the surface of the specimens is 1 °C to 5 °C above its maximum ambient temperature of operation. The specimens should occupy an attitude most favourable to reveal leakage.

6.7.2 The specimens shall be maintained at this temperature for a period of time according to the prescribed severity and shall then be removed from the oven.

6.7.3 Specimens having seals on more than one face shall be tested in accordance with **6.7.1** and **6.7.2** with each such face in the downwards position in turn.

6.8 Final measurements The specimens shall be visually inspected for seepage of liquid. There shall be no seepage, unless otherwise specified by the relevant specification.

The relevant specification shall specify the method of detection (see annex C, clause C.2).

6.9 Information to be given in the relevant specification When this test is included in a relevant specification, the following details shall be, given as far as they are applicable:

	Subclause
a) Test temperature	6.7.1
b) Duration of conditioning	6.7.2
c) Method of detecting seepage	6.8

7 Test Q_f: Immersion

7.1 Object To determine the watertightness of components or equivalent or other articles when subjected to immersion under stated conditions of pressure and time.

7.2 General description of the test The specimen is submitted to a specified pressure by immersion in a water tank at a specified depth or in a high-pressure water chamber. After conditioning, the specimen is examined for penetrated water and checked for possible changes of characteristics.

7.3 Initial measurements The specimens shall be visually inspected and electrically and mechanically checked as required by the relevant specification. All sealing features shall be checked to ascertain that they have been correctly mounted.

7.4 Preconditioning Preconditioning of the specimens and seals should be carried out where prescribed by the relevant specification.

7.5 Conditioning

7.5.1 The specimens shall be placed in the position as prescribed in the relevant specification and shall be completely immersed in a water tank or high-pressure water chamber. If not otherwise prescribed in the relevant specification, detensioned water shall be used.

NOTE : This may be achieved by adding a commercially available wetting agent to the water.

7.5.2 The specimens shall be subjected to one of the head-of-water values or the corresponding pressure differences given in table 2, as required by the relevant specification.

When a tank is used, the specified head of water shall be measured above the highest point of the specimen. When a high-pressure water chamber is used, the water pressure shall be adjusted to the pressure difference of table 2.

Table 2 Head of water, corresponding pressure difference

Head of water m	Corresponding pressure difference (at 25 °C) kPa
0.15	1.47
0.40	3.91
1	9.78
1.50	14.7
4	39.1
6	58.7
10	97.8
15	147.0

7.5.3 The duration shall be prescribed in the relevant specification. Preferred values shall be 30 min, 2 h, 24 h.

7.5.4 The temperatures of the specimen and of the water shall be between 15 °C and 35 °C. During the conditioning period the difference in temperature between the water and the specimen shall be as small as possible, but not greater than 5 °C.

7.5.5 Unless otherwise prescribed in the relevant specification, during immersion, the specimen under test shall not be in operation, it shall be switched off and its movable parts shall be at rest.

7.6 Recovery The specimen shall be thoroughly dried externally by wiping or by applying a blast of air at room temperature, unless otherwise specified by the relevant specification.

7.7 Final measurements The specimen shall be examined for water penetration and shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

7.8 Information to be given in the relevant specification When the test is included in the relevant specification the following details shall be given as far as they are applicable:

	Subclause
a) Electrical and mechanical checks prior to conditioning	7.3
b) Pre-conditioning procedure	7.4
c) Position during conditioning	7.5.1
d) Whether a wetting agent may be used or not	7.5.1
e) Head-of-water or pressure difference	7.5.2
f) Duration of conditioning	7.5.3
g) Electrical and mechanical checks after recovery	7.7

8 Test Q_k: Sealing tracer gas method with mass spectrometer

8.1 Object To verify the hermetic sealing of specimens by evaluating the leak rates with a tracer gas and a mass spectrometer.

Helium is the tracer gas most commonly used with a mass spectrometer and the test has been written with reference to this gas (see annex E, E.1).

8.2 Scope This test applies to the detection of leak rate $1 \text{ Pa} \cdot \text{cm}^3/\text{s}$ or under.

NOTE : With respect to the leak rate of approximately $10^{-3} \text{ Pa} \cdot \text{cm}^3/\text{s}$ or under, sufficient care shall be taken in the interpretation of test results.

Test Method 1 is primarily applicable to specimens of small volume (see table 3) whose surfaces are not likely to impair the results by too high a retention of adsorbed helium (such as braids, joints, organic materials, paint, etc.) unless they have been suitably neutralized before the detection phase.

Test Method 2 is intended for specimens that have been filled, during manufacture or for the requirements of this test, with a mixture containing a large proportion of helium.

Test Method 3 (jet and pocket methods) is intended for specimens to be mounted on bulkheads or panels.

NOTE : This method should be used judiciously, because it is possible to release into the room sufficient helium to swamp the spectrometer, resulting in the suspension of the test until the room has been ventilated. The method should not be used where a numerical acceptance limit for leak rate is specified (see annex E, clause E.15).