
British Standard

Basic environmental testing procedures

Part 2.1 Tests

Test Q. Sealing

Essais fondamentaux climatiques et de robustesse mécanique

Partie 2.1 Essais

Essai Q. Étanchéité

Grundsätzliche Umweltprüfverfahren

Teil 2.1 Prüfungen

Prüfung Q. Abdichtung

(This Part should be read in conjunction with Part 1.1 General)

National foreword

This revision of BS 2011 : Part 2.1Q : 1977 has been prepared under the direction of the General Electrotechnical Engineering Standards Committee. It is identical with IEC Publication 68-2-17 : 1978 'Basic environmental testing procedures, Part 2 : Tests — Test Q : Sealing', published by the International Electrotechnical Commission (IEC), and like all other Parts of IEC 68 it is subject to CENELEC Harmonization Document (HD) 323.

This standard has been prepared as a result of international discussions in which the UK took an active part.

This standard supersedes BS 2011 : Part 2.1Q : 1977, from which Tests Qb and Qe have been deleted. Tests Qa and Qf remain technically unchanged. Test Qg : Driving rain, does not appear in this standard, as responsibility for that test has been transferred to a different IEC Sub-committee and the test has been withdrawn. The test gas method of Test Ql, which was included in the 1977 standard, has been withdrawn because it is not used in practice. BS 2011 : Part 2.1Q : 1977 is withdrawn.

Terminology and conventions. The text of the international standard has been approved as suitable for publication as a British Standard without deviation. Some terminology and certain conventions are not identical with those used in British Standards.

Wherever page numbers are quoted in connection with references to figures, they are IEC page numbers.

Cross-reference

International standard	Corresponding British Standard
IEC 529 : 1976	BS 5490 : 1977 Specification for degrees of protection provided by enclosures (Identical)

Additional information. Test R, which is listed in BS 2011 : Part 1.1 : 1980 as 'Unallotted', has now been allotted to a proposed new IEC 'Dripping water and falling rain' test, for which a Draft for Public Comment will be issued in due course. That draft will explain any change required insofar as BS 2011 : Part 2.1R : 1976 is concerned, but that standard is unaffected at this stage.

All Parts of BS 2011 are listed in BSI Sectional List 26 (SL 26), which is usually revised annually.

CONTENTS

	Page
National foreword	1
Survey of sealing tests	3
Clause	
1. Definitions	6
2. Test Qa: Sealing of bushes, spindles and gaskets	7
2.1 Object	7
2.2 Scope	7
2.3 General description of the test	7
2.4 Initial measurements	7
2.5 Conditioning	7
2.6 Final measurements	7
2.7 Information to be given in the relevant specification	7
3. Test Qc: Container sealing, gas leakage	9
3.1 Object	9
3.2 Scope	9
3.3 General description of the test	9
3.4 Test Method 1	9
3.5 Test Method 2	10
3.6 Test Method 3	10
3.7 Information to be given in the relevant specification	11
4. Test Qd: Container sealing, seepage of filling liquid	12
4.1 Object	12
4.2 Scope	12
4.3 General description of the test	12
4.4 Severities	12
4.5 Preconditioning	12
4.6 Initial measurements	12
4.7 Conditioning	12
4.8 Final measurements	13
4.9 Information to be given in the relevant specification	13
5. Test Qf: Immersion	14
5.1 Object	14
5.2 General description of the test	14
5.3 Initial measurements	14
5.4 Preconditioning	14
5.5 Conditioning	14
5.6 Recovery	15
5.7 Final measurements	15
5.8 Information to be given in the relevant specification	15
6. Test Qk: Sealing tracer gas method with mass spectrometer	16
6.1 Object	16
6.2 Scope	16
6.3 General description of the test	16
6.4 Test Method 1 (for specimens not filled with helium during manufacturing)	16
6.5 Test Method 2 (for specimens filled with helium during manufacturing)	18
6.6 Information to be given in the relevant specification	19
7. Test Ql: Bomb pressure test	21
7.1 Object	21
7.2 Scope	21
7.3 General description of the test	21
7.4 Initial measurements	21
7.5 Conditioning	21
7.6 Recovery	22
7.7 Final measurements	22
7.8 Information to be given in the relevant specifications	22
APPENDIX A — Example of a test chamber for Test Qa	23
APPENDIX B — Guidance for Test Qc	26
APPENDIX C — Guidance for Test Qd	28
APPENDIX D — Interrelation of test parameters for Test Qk	29
APPENDIX E — Guidance for Test Qk	32
APPENDIX F — Guidance for Test Ql	34

Amendment No. 1
published and effective from 30 November 1990
to BS 2011 : Part 2.1Q : 1981 (IEC 68-2-17 : 1978)

Basic environmental testing procedures
Part 2.1 Tests
Test Q. Sealing

NOTE. This amendment has been issued to implement Amendment No. 3 to IEC Publication 68-2-17 : 1978. Amendment No. 3 includes Amendments Nos. 1 and 2. The text of Amendment No. 3 can be distinguished by a vertical line in the margin.

The page numbers in the amendment refer to the IEC page numbers which may be found in brackets at the foot of each page of the text of the standard.

The opportunity has also been taken to make additions to the national foreword as a consequence of implementing this amendment.

Revised text

MD 6093
November 1990

National foreword

In the second sentence in paragraph 1, after 'Test Q : Sealing' insert 'and Amendment No. 3 published in 1989'.

Page 31

Test Of: Immersion

Add the following sentence and note to Sub-clause 5.5.1:

If not otherwise prescribed in the relevant specification, de-tensioned water shall be used.

Note.- This may be achieved by adding a commercially available wetting agent to the water.

Page 33

Replace the existing text of Sub-clause 5.5.4 by the following:

5.5.4 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.

Add the following new Item *d)* to Sub-clause 5.8:

d) Whether a wetting agent may be used or not.

Replace the existing letters *d)*, *e)* and *f)* by *e)*, *f)* and *g)* respectively.

Page 35

6.2 Scope

Add at the end of this Sub-clause the following paragraph and note:

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 Appendix E, Clause E15).

6.3 General description of the test

Add the following new Sub-clause:

6.3.5 *Test method 3* consists of exposing one side of the specimen to a vacuum by placing it against a suitable orifice of a vacuum chamber connected to a mass spectrometer. The visible side of the specimen is then covered by a sealed flexible pocket filled with helium (Alternative a)) or swept by a fine jet of helium (Alternative b)).

Alternative a): If leaks occur, some of the helium in the pocket is sucked into the vacuum chamber. The size of the fault (but not its location) can be determined from the readings on the mass spectrometer.

Alternative b): Helium is detected by the detector when the helium jet passes over a sealing fault (leak). The location and size of the leak can then be determined from the readings on the mass spectrometer.

Page 41

Renumber the existing Sub-clause 6.6 as 6.7, and add a new Sub-clause 6.6 as follows:

6.6 *Test method 3* (applicable to specimens to be mounted on bulkheads or panels)

6.6.1 Preconditioning

Clean the specimen so as to remove all contaminants, such as grease, fingerprints, flux or varnish, likely to conceal leaks. After cleaning, dry the specimen in an oven so as to remove all trace of solvents, capillary condensation, etc., which can also conceal leaks.

6.6.2 Initial measurements

With the measuring orifice hermetically isolated from the chamber by a valve, evacuate the chamber, and when the pressure is sufficiently low to allow proper functioning of the mass spectrometer, connect the chamber to the latter.

Note the residual signal caused by the spectrometer with no helium injection.

Check the proper functioning of the spectrometer with a reference helium leak.

6.6.3 Test

Place the specimen over the measuring orifice and expose it to the vacuum by opening the isolating valve. Check that the depression remains sufficient for the proper functioning of the mass spectrometer and continue evacuating until the residual signal stabilizes itself at a value approximately equal to that recorded previously.

Alternative a): Cover the outer side of the specimen with a flexible pocket, of plastic for example, filled with helium. Note the readings of the mass spectrometer.

Alternative b): Sweep the whole outer side of the specimen with a fine jet of helium at low pressure. Note the readings of the mass spectrometer.

Note.- If possible, the helium pressure should be specified in the relevant specification (see Appendix E, Clause E14).

6.6.4 Final measurements

The measured leak rate R is then determined by comparison with that of the reference leak, the residual signal being deducted.

Add at the end of Sub-clause 6.7 (formerly 6.6) the following text:

<i>Test method 3</i>	<i>Sub-clause</i>
i) Alternative a) or b)	6.6.3
j) Helium pressure	6.6.3 b)
k) Acceptance criteria	6.2

Page 61

Appendix D - Interrelation of test parameters for test Qk

Replace the equations in Note 3 of Clause D1 by the following:

$$R = \frac{7.17 L^2 P t_1}{10^{10} V} \quad \text{or} \quad L = 10^5 \sqrt{\frac{RV}{7.17 P t_1}}$$

Appendix E - Guidance for Test Qk

Add on page 69, the following new Clauses:

- E9. Test method 3 can only be applied to specimens capable of withstanding a fairly high vacuum and not degassing excessively.
- E10. Alternative a) (pocket method) is more convenient for relatively large specimens of complex shape. It is then quicker than the Alternative b) (jet method) but does not enable a leak to be localized and hence repaired if necessary. For repairable specimens, it is recommended to retest defective specimens by the jet method. Alternative a) also carries a risk of error where the pocket covers all or part of the joint between the specimen and the test apparatus, since the sealing of this joint may be of considerably poorer quality than that required for the specimen, without rendering the method inapplicable.
- E11. When testing several small-sized specimens, it is convenient to use a ramp with several bleeds isolated from the vacuum chamber by the same number of valves, and fitted with adapters shaped to suit the configuration of the specimens: thus, the whole installation can be evacuated and connected to the spectrometer by only opening the valve corresponding to each individual specimen for the actual test.
- E12. The time lag before the appearance of the signal on the mass spectrometer depends on several factors (configuration of ducts and piping, type of equipment, distance from the leak to the detector, size of leaks, etc.). To verify the calibrations a reference leak should be used. It is therefore recommended to calibrate with a reference leak as close as possible in size to the admissible leakage value. This reference leak should be located in a place where the response lag of the installation is likely to be longer than in the place where the specimen is located. In the case of the jet method, it should be ensured that this time lag does not exceed a few minutes (5 min at the most), since in such a case any attempt to locate a leak would be illusory. In the case of the pocket method, the time lag should be determined so that the measurement can be made after it has elapsed.
- E13. In Alternative b), always begin by applying the jet to the highest parts of the specimen and work systematically downwards to the lower parts, taking care not to overlook any place, so as to minimize the risk of error in locating leaks (e.g. absorption of helium by a leak situated above the zone swept by the jet).

Note.- It is not necessary to expose the specimen to a high vacuum, once the latter is constant and adequate for the proper functioning of the mass spectrometer: the quantity of helium passing through a leak is practically the same whether the pressure is 10^2 Pa or 10^{-3} Pa (10^{-3} bar or 10^{-8} bar).

- E14. The jet method enables leaks to be located very accurately. With a suitable application device, it is possible to detect leaks spaced 5 mm apart. This accuracy obviously depends on the diameter of the nozzle (e.g., a hypodermic needle) and the helium supply pressure (high enough to ensure proper sweeping of the leaks, but low enough for the flow to remain laminar so that the helium concentration is localized).
- E15. As the value of the measured leak rate depends on the concentration of helium at the leak point, Test Method 3 is not well adapted to give an accurate numerical leak rate but is useful for qualitative or investigation purposes.
-

SURVEY OF SEALING TESTS

General

This survey indicates the interrelation between the various tests for sealing in Test Q of IEC Publication 68. Other tests of this category are rain and water tests which are to be included as tests R. At the same time the opportunity has been taken to make reference to similar tests in IEC Publication 529: Classification of Degrees of Protection Provided by Enclosures.

Tests in IEC Publication 68-2-17

Test Q: Sealing, includes a number of tests which use different conditioning procedures appropriate for different applications.

The family tree of all sealing tests is shown in Figure 1.

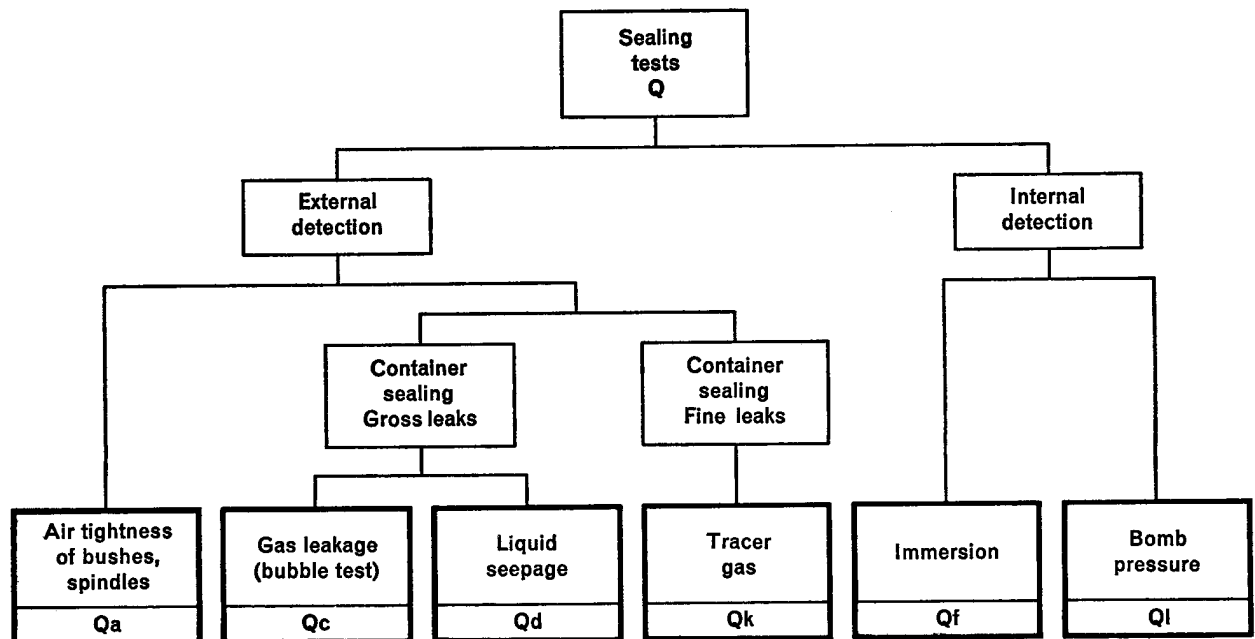


FIGURE 1

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 Qf and Ql are very similar. They are very effective for certain components, for examples, plastic foil capacitors; they are not recommended, however, for most semiconductor

components because electrical changes may become effective only after a long time (for instance, after the test is terminated) owing to the passivation of the surface of the semiconductor.

The tests for external detection are further subdivided according to their application. Test Qa is a bubble test which is used to determine the airtightness of bushings, spindles and gaskets. The other tests, Qc, Qd and Qk, are used to determine leaks in containers (metallic cases, housings, etc.); Test Qc is a bubble test again including three methods with different sensitivities (leaks not less than $1 \text{ Pa} \cdot \text{cm}^3/\text{s}$ ($10^{-5} \text{ bar} \cdot \text{cm}^3/\text{s}$)). Test Qk is the most sensitive of this series; it uses helium and a mass spectrometer. Its sensitivity ranges from $1 \text{ Pa} \cdot \text{cm}^3/\text{s}$ ($10^{-5} \text{ bar} \cdot \text{cm}^3/\text{s}$) to about $10^{-6} \text{ Pa} \cdot \text{cm}^3/\text{s}$ ($10^{-11} \text{ bar} \cdot \text{cm}^3/\text{s}$). Test Qd 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.

Tests in IEC Publication 529

In IEC Publication 529, Classification of Degrees of Protection Provided by Enclosures, degrees of protection are established by tests and identified by numerals as follows:

TABLE I
Degrees of protection indicated by the first characteristic numeral

First characteristic numeral	Degree of protection	
	Short description	Definition
0	Non-protected	No special protection
1	Protected against solid objects greater than 50 mm	A large surface of the body, such as a hand (but no protection against deliberate access). Solid objects exceeding 50 mm in diameter
2	Protected against solid objects greater than 12 mm	Fingers or similar objects not exceeding 80 mm in length. Solid objects exceeding 12 mm in diameter
3	Protected against solid objects greater than 2.5 mm	Tools, wires, etc., of diameter or thickness greater than 2.5 mm. Solid objects exceeding 2.5 mm in diameter
4	Protected against solid objects greater than 1.0 mm	Wires or strips of thickness greater than 1.0 mm. Solid objects exceeding 1.0 mm in diameter
5	Dust-protected	Ingress of dust is not totally prevented but dust does not enter in sufficient quantity to interfere with satisfactory operation of the equipment
6	Dust-tight	No ingress of dust