

Environmental testing —

Part 2.1 Tests —

Test R and guidance. Water

This Part should be read in conjunction with Part 1.1 General and guidance

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the General Electrotechnical Standards Policy Committee (GEL/-) to Technical Committee GEL/15, upon which the following bodies were represented:

- Association of Manufacturers of Domestic Electrical Appliances
- British Telecommunications plc
- Directorate of Telecommunications
- EEA-the Electronics and Business Equipment Association
- Electronic Components Industry Federation
- Ministry of Defence
- National Supervising Inspectorate
- Society of Environmental Engineers
- Society of Motor Manufacturers and Traders Limited
- Telecommunication Engineering and Manufacturing Association

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

- Biodeterioration Society
- Institute of Metals

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National foreword

This British Standard has been prepared under the direction of the General Electrotechnical Standards Policy Committee. It is identical with IEC Publication 68-2-18:1989 “*Environmental test — Part 2: Test — Test R and guidance: Water*” published by the International Electrotechnical Commission (IEC). Most parts of IEC Publication 68 are endorsed by CENELEC Harmonization Document HD 323 as a general rule, although in some cases an enquiry is made before endorsement.

With the publication of this edition of Part 2.1R the 1976 edition of Part 2.1R: Resistance to fluids, which is not identical with an IEC Publication, is withdrawn. Where a test for resistance to fluids is required reference should be made to BS 2011-2.1XA: 1981 for immersion in cleaning fluids and/or BS 3G 100-2.3.12:1986 for fluid contamination.

Cross-references

International standard ^a	Corresponding British Standard
	BS 2011 Environmental testing
IEC 68-1:1988	Part 1.1:1989 General and guidance (Identical)
IEC 68-2-11:1981	Part 2.1Ka: 1982 Test Ka. Salt mist (Identical)
IEC 68-2-17:1978	Part 2.1Q: 1981 Test Q. Sealing (Identical)
IEC 144:1963	BS 5420:1977 Specification for degrees of protection of enclosures of switchgear and controlgear for voltages up to and including 1 000 V a.c. and 1 200 V d.c. (Identical)
	BS 3456 Specification for safety of household and similar electrical appliances
IEC 335-1:1970	Part 101:1987 General requirements (Technically equivalent)
IEC 529:1976	BS 5490:1977 Specification for classification of degrees of protection provided by enclosures (Identical)
	BS 5724 Medical electrical equipment
IEC 601-1:1977	Part 1:1979 Specification for general safety requirements (Technically equivalent)

^a Undated in the text.

A British Standard related to IEC 34-5:1981 is BS 4999 “*General requirements for rotating electrical machines*” Part 105:1988 “*Classification of degrees of protection provided by enclosures for rotating machinery*”.

NOTE Although the reader’s attention was drawn to the textual error by way on an entry in the national foreword and on the page of the text, the text itself was not corrected. The error is corrected by this amendment.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 26, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Introduction

This standard provides methods of tests applicable to electrotechnical products which, during transportation, storage or in service, may be subjected to falling drops, impacting water or immersion. The primary purpose of water tests is to verify the ability of covers and seals to retain components and equipments in good working order after and, when necessary, under a standardized water dropfield. These tests are not corrosion tests and shall not be considered and used as such. The effects of a large water to specimen temperature difference, such as increased water ingress resulting from pressure changes, as well as thermal shock, are not simulated. Established water tests in other standards are not intended to simulate natural rainfall and their quoted intensities are too high to be adopted for that purpose. Therefore, Test R includes an artificial rain test based upon natural conditions but not taking into account high wind speeds generally associated with natural rain.

2 Survey of water tests

2.1 General

This survey indicates the general structure of various water tests included in this standard. A presentation of other established water tests and a comparison between them and the new IEC Test R is added.

The structuring and a summary of the characteristics of the different tests are given in Figure 1 and Table I.

It should be noted that the tests of IEC 529 have their equivalents in the proposed tests.

Comparison between Test R and other tests is given in Appendix B.

2.2 Description of Test R: Water

The water test is structured into three groups.

- Ra: "Falling drops" which in principle are tests with artificial rain.
- Rb: "Impacting water" where high intensity dropfields or water jets impinge upon the test specimen with a certain force and the dropfields may assume any angle towards the test specimen.
- Rc: "Immersion" where the test specimen is immersed in water to specified depths or equivalent pressures.

2.3 Other established IEC water tests

Water tests of various types are given in the following publications:

IEC 34-5 (1981), *Rotating electrical machines, Part 5: Classification of degrees of protection provided by enclosures for rotating machines.*

IEC 68-2-17 (1978), *Basic environmental testing procedures, Part 2: Tests — Test Q: Sealing. (Test Qf: Immersion.)*

IEC 144 (1963), *Degrees of protection of enclosures for low-voltage switchgear and controlgear.*

IEC 335-1 (1970), *Safety of household and similar electrical appliances, Part 1: General requirements.*

IEC 529 (1976), *Classification of degrees of protection provided by enclosures.*

IEC 601-1 (1977), *Safety of medical electrical equipment, Part 1: General requirements.*

NOTE The test methods of IEC 529 include those of IEC 34-5, 144 and partially 335-1 and 601-1.

3 Definitions

For the purpose of this standard the following definitions apply:

rain

precipitation in the form of waterdrops. Both the amount that falls and the actual falling action of the waterdrops are often called rainfall

drizzle

precipitation in the form of very small, numerous and uniformly dispersed waterdrops that may appear to float while following air currents

raindrop

a drop of water with a diameter greater than 0,5 mm falling through the atmosphere

drizzledrop

a drop of water with a diameter of 0,2 mm to 0,5 mm falling through the atmosphere

rainfall or drizzle intensity (*R*)

the amount that falls per unit of time. Rainfall intensity (*R*) is given in millimetres per hour (mm/h) where $1 \text{ dm}^3/(\text{m}^2 \cdot \text{h})$ equals 1 mm/h

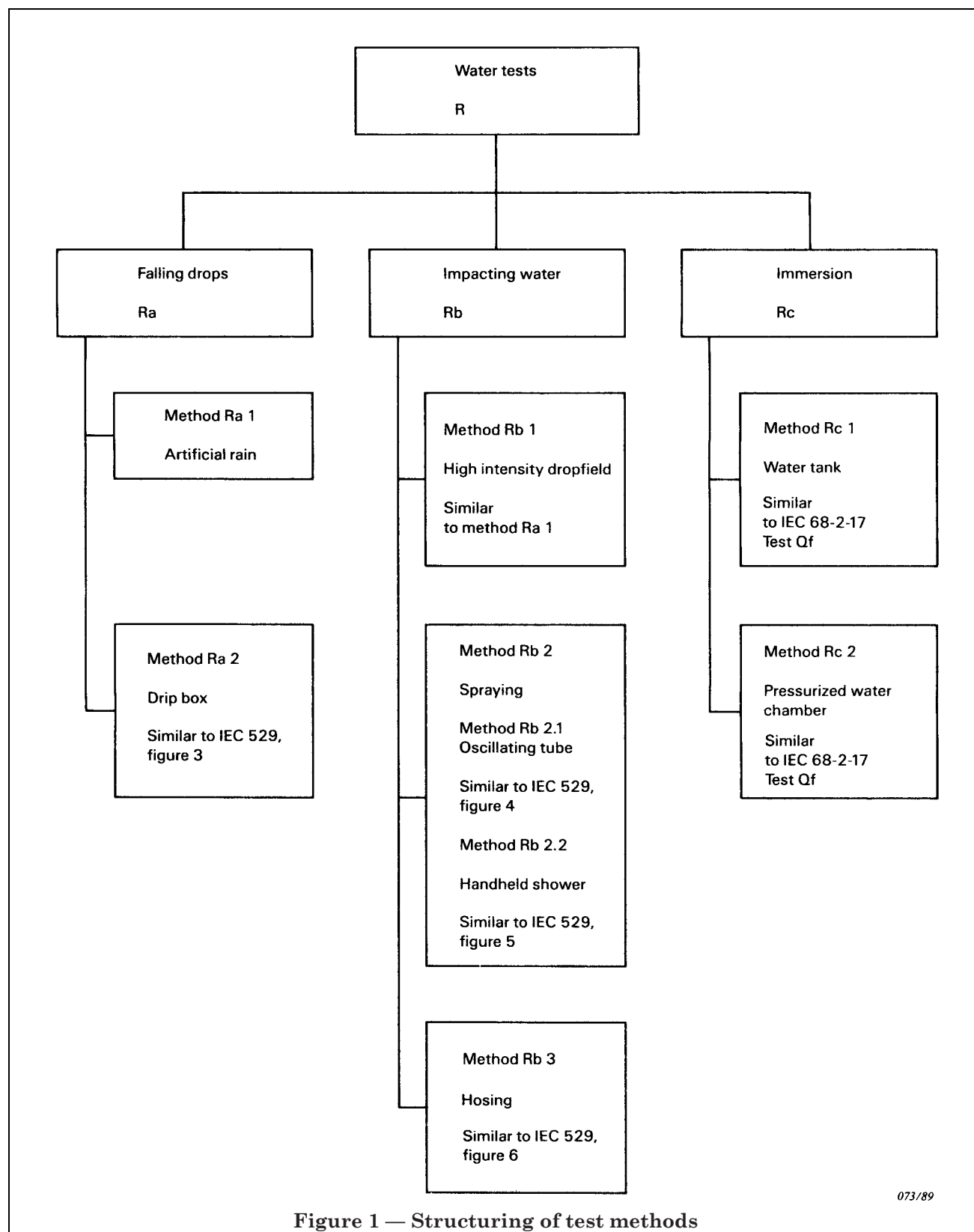


Table I — Summary of test characteristics

Procedure	Severities				Notes
	Intensity mm/h	Over- pressure KPA	Duration min	Spray or tilt angle α°	
<i>Test Ra</i>					
Method Ra 1	10 ± 5	n.a.	10	0	Artificial rain
	100 ± 20		30	15	
	400 ± 50		60	30	
			120	60	
			90		
Method Ra 2	200 – 300	n.a.	3	0	Drip box per Appendix C
			10	15	
			30	30	
			60	45	
<i>Test Rb</i>					Intensity of falling water drops
Method Rb 1	1 000 ± 150	n.a.	10	0	Not to be considered as artificial rain
	2 000 ± 300		30	15	
	4 000 ± 600		60	30	
Method Rb 2.1	$n(0,07 \pm 0,005)$ $n(0,10 \pm 0,005)$ $n(0,60 \pm 0,03)$ dm ³ /min	c.50 c.80 c.400	3 10 30 60	60	Oscillating tube per Appendix D 60° and c.180° oscillation. <i>n</i> is number of nozzles
				90	
				60	
				90	
Method Rb 2.2	10 ± 0,5 dm ³ /min	c.90	5	60	Shower per Appendix D
			15	c.180	
			30		
Method Rb 3	12,5 ± 1	c.30	1	c.180	Nozzle per Appendix D; 6,3 or 12,5 mm diameter
	75 ± 5	c.1 000	3		
	100 ± 5	c.100	10		
	dm ³ /min		30		
	Head of water m	Over- Pressure kPa	Duration	Tilt angle α	
<i>Test Rc</i>					
Method Rc 1	0,15 – 0,40 – 1,0 – 2,0 – 5,0	n.a	30 min 2 h 24 h	n.a	Water tank
Method Rc 2	2 – 5 – 10 – 20 – 50 – 100 – 200 – 500 – 1 000	20 – 50 – 100 – 200 – 500 – 1 000 – 2 000 – 5 000 – 10 000 –	2 h 24 h 168 h	n.a.	Pressurized water chamber
NOTE “n.a.” stands for “not applicable” and “c.” for “approximately.”					

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the mean volume diameter (D_V)

D_V is defined as the diameter of a drop having a volume equal to the total volume of water reaching the ground divided by the number of drops:

$$D_V = \left(\frac{6V}{\pi n} \right)^{1/3} \text{ mm} \simeq 1,71 R^{0,25}$$

where V is the volume of water corresponding to n drops

the median volume diameter (D_{50})

D_{50} is defined as the diameter of a drop whose size is such that 50 % of the volume of water reaching the ground is comprised of smaller (or larger) drops:

$$D_{50} = 1,21 R^{0,19} (\text{mm})$$

liquid water content (L) in air

in rain, the mass of water per unit volume of airspace is determined by the number and size of the drops

data indicate that a linear relationship between liquid water content L (g/m^3) and rainfall intensity R (mm/h) is adequate for estimating purposes:

$$L = 0,042 R \text{ g/m}^3$$

raindrop terminal velocity (V_t)

the terminal velocity is the velocity of a raindrop in still air, attained when the gravitational force on the drops is balanced by the drag of the air through which it is falling:

$$V_t = 5,3 L^{0,12} \text{ m/s}$$

velocity of raindrops (V_r)

velocity of raindrops carried by the wind is given by:

$$V_r = (V_w^2 + V_t^2)^{0,5} \text{ m/s}$$

where

V_r = velocity of drops in wind

V_w = windspeed

V_t = raindrop terminal velocity

light winds under 9 m/s generally have a negligible effect on terminal velocity

4 Test Ra: Falling drops**4.1 Object**

This test is applicable to electrotechnical products which, during transportation, storage or in service may be exposed to vertical falling drops, the origin of these being, for example, natural rain, seepage or condensation. Whether an electrotechnical product tested separately, hereinafter referred to as a specimen, has to function during conditioning or merely to survive conditions of falling drops should be clearly stated in the relevant specification. In either case, the relevant specification shall prescribe the requirement.

4.2 Method Ra 1: Artificial rain**4.2.1 General description of the test**

The test specimen is mounted on an appropriate fixture. It is then subjected to falling waterdrops, which simulate natural rain.

The minimum requirements on the test apparatus are:

— Drop generating nozzle or nozzles

See Appendix C, 2.1 and Figure C.1.

— Fixture for the specimen

The fixture shall simulate as far as possible the mounting structure to be used in the real use of products; for wall-mounted equipment the fixture shall simulate a wall.

The fixture for the specimen shall have a base area which is smaller than the base area of the specimen or suitably perforated (see Figure 2).

The fixture shall be able to support the specimen in its normal operating position and, if necessary, be tilted to a maximum of 90° from the vertical plane.

— Water supply with controls

The water used for the test shall be fresh tap water of good quality. In order to avoid clogging of the nozzles the water shall be filtered and may be demineralized. Water characteristic details are given in Appendix A. The initial water temperature shall be between the specimen temperature and 5 K lower.

4.2.2 Severities

The severities as indicated by tilt angle of specimen, duration, intensity and associated drop size distribution shall be prescribed in the relevant specification. The values shall be selected from those given below. Wind-driven rain is not simulated by this test as the wind velocity is not a parameter of test.

Table II

Severities			
Intensity	Associated dropsize	Duration	Spray or tilt angle
R mm/h	D_{50} mm	min	α°
10 ± 5	$1,9 \pm 0,2$	10	0
100 ± 20	$2,9 \pm 0,3$	30	15
400 ± 50	$3,8 \pm 0,4$	60	30
		120	60
			90
NOTE For drop size distribution reference is made to Appendix A.			

4.2.3 Pre-conditioning

The relevant specification may call for pre-conditioning (see IEC 68-1).

4.2.4 Initial measurements

The specimen shall be visually inspected, electrically and mechanically checked as prescribed in the relevant specification. All features on the specimen likely to affect the test result, e.g. surface treatment, covers or seals shall be inspected to ensure that the instructions of the relevant specification have been followed.

4.2.5 Conditioning

The specimen shall be subjected to artificial rain in accordance with 4.2.2.

The specimen shall be mounted on the support either:

- in its normal operating position, as prescribed in the relevant specification; or
- tilted from the normal operating position and provision made for rotating the specimen in a plane perpendicular to the tilted axis. The rotation may be achieved by a rotating support table or by repositioning the specimen at regular intervals during the test. Alternatively the specimen can be oscillated through an arc of 270° to avoid the need of slipping contacts.

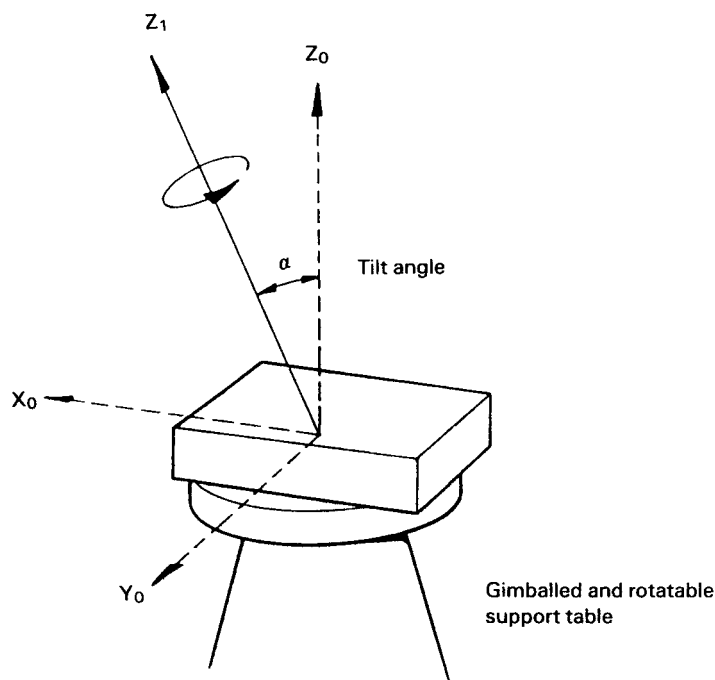
The relevant specification shall specify the tilt angle or angles, the face or faces to be exposed to the drop field and the duration of exposure for each side, or whether the specimen shall be continuously rotated or oscillated through 270° . See also Figure 2.

The specimen shall be subjected to artificial rain with severities as prescribed by the relevant specification.

The relevant specification shall state whether the specimen shall be operated during conditioning and if intermediate measurements shall be made. Appropriate safety precautions shall be taken when testing the specimen in the energized condition.

4.2.6 Final measurements

The specimen shall be examined for excessive ingress of water and electrically and mechanically checked as prescribed in the relevant specification.



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NOTE The support table shall be smaller than the specimen or be suitably perforated.

Figure 2 — Test Ra, definitions of angles and axes