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Environmental testing – Part 2-88: Tests – Test XD: Resistance of components and assemblies to liquid cleaning media

Essais d'environnement – Partie 2-88: Essais – Essai XD: Résistance des composants et des assemblages aux produits de nettoyage liquides

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FOREWORD

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IEC 60068-2-88 has been prepared by IEC technical committee 91: Electronics assembly technology. It is an International Standard.

The text of this International Standard is based on the following documents:

Draft	Report on voting
91/2027/FDIS	91/2038/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60068 series, published under the general title *Environmental testing*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

a) Background

Current manufacturing processes preferably do not use cleaning steps for the sake of cost saving, environmental impacts, and potentially detrimental effects to quality and reliability of the equipment. But there are situations, where cleaning of components or assemblies becomes unavoidable, for example when it is necessary to apply protective coatings, or cleaning is required by specific regulations concerning the end use of the equipment. It is the challenge for process engineers to select effective cleaning media and processes at one side, and on the other side to evaluate whether the components and circuit boards exposed to those processes can withstand it without being damaged or their performance being deteriorated.

b) Current industry standard test methods

Current standards, like IEC 60068-2-45 [1][1] and some other component standards describe resistance to solvents tests, but the test liquids used for testing (e.g. alcohols) are not commonly used in real industrial cleaning processes. In addition, the current resistance to solvent test methods are immersion tests without any mechanical load to the components or ultrasonic agitation. The current focus of these tests is mainly on the legibility of marking, etc.

Other standards, like MIL-STD-202 [12], Method 215K, describe very specific qualification processes and solvents, which again are not common in today's manufacturing processes of electronic equipment.

c) To close the gap

It is the intention of this document to close the above-described gap between industrial practice and existing test methods. The approach used is a combination of basic qualification tests to perform on component and unpopulated circuit board level, and a validation test to perform on assembly level, using the real manufacturing processes conditions and media. By this two-step approach, a pre-selection of components suitable for the intended assembly and cleaning processes, the evaluation of its resistance against the selected processes, and detection of material incompatibilities are enabled.

The test liquids specified in this document are representative for solvent families used in cleaning processes of electronics industry.

[1] Numbers in square brackets refer to the Bibliography.

ENVIRONMENTAL TESTING –

Part 2-88: Tests – Test XD: Resistance of components and assemblies to liquid cleaning media

1 Scope

This part of IEC 60068-2 establishes test methods for the resistance of electronic and electromechanical components, unpopulated circuit boards and assemblies to liquid cleaning media and cleaning processes, which are agreed between user and supplier for applications, where cleaning is required. These tests are not applicable to components, unpopulated circuit boards and assemblies, which are not intended to be subjected to cleaning processes.

Tests XD_1 and XD_2 primarily are intended for qualification testing of components and unpopulated circuit boards suitable for cleaning processes but can be adopted as well to testing of material compatibility and specific cleaning media used in manufacturing processes of components and unpopulated circuit boards.

Test XD_3 is intended to determine the resistance of electronic assemblies suitable for cleaning processes to the various cleaning processes to which they are exposed during manufacturing, including the effects of assembly and soldering processes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-20, *Environmental testing – Part 2-20: Tests – Tests Ta and Tb: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60068-2-58, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
compatibility
interaction between material sets which do not negatively impact the end use product

EXAMPLE Removal of flux while not interacting with the markings required for product use.

[SOURCE: IPC 9505:2017, 1.1]

3.2
incompatibility
interaction between material sets which do negatively impact the end use product

EXAMPLE Removal of protective coatings and critical type markings.

[SOURCE: IPC 9505:2017, 1.1]

3.3
validation
confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled

[SOURCE: ISO 9000:2015, 3.8.13, modified – The notes have been removed.]

4 Objective and general aspects

4.1 Objective

The objective of the test methods is to assess the effects of short-term exposure of components and unpopulated circuit boards to specified liquid cleaning media as they are used typically in cleaning processes of electronic assemblies. In addition, Annex A describes a qualification process and the validation of cleaning processes as they are used during manufacturing of electronic assemblies.

Plastic materials show a different behaviour against liquid cleaning media, even when the liquid cleaning media are from the same family with similar contents. A component or circuit board can therefore not generally be regarded as resistant against liquid cleaning media. It can only be stated as resistant to such liquid cleaning media that it has been tested against.

4.2 General

Testing is performed to ensure resistance of a test specimen to liquids to which it could be exposed during manufacturing or assembly and is carried out by immersing the test specimen in a specified test liquid, or group of liquids, for a specified period at a specified temperature. A separate test specimen shall be used for each test liquid and test condition. Properties are measured prior to and after exposure to the liquid.

Components and unpopulated circuit boards should be tested under the same conditions and severities as described in test XD_1 and XD_2, assuming that at a later stage both will be stressed in the same way during the assembly processes.

Components and unpopulated circuit boards shall be tested in as-received condition without cleaning. The tests described do not differ between components or unpopulated circuit boards, which can contain flux residues coming from their manufacturing process (e.g. certain inductors or boards using hot air leveling finishes) and those without flux residues.

WARNING – Intended users of this procedure are cautioned that tests of this nature can involve the use of certain hazardous material, operations and equipment. In particular, some of the fluids that can be used are flammable or can constitute health hazards, or both. Test temperatures should be at least 10 °C below the flashpoint of any fluid being used. Open flame heat sources should not be used with any organic solvents. Test personnel should consult the relevant material's safety data sheets when necessary.

4.3 Qualification and validation process

The qualification of components and unpopulated circuit boards and the validation of resistance against real cleaning processes shall be performed as specified in Annex A.

For qualification of components and unpopulated circuit boards (tests XD_1 and XD_2) it is important:

– to test components and unpopulated circuit boards individually to enable inspection from all sides for any detrimental effects. In assembled stage this would not be possible anymore, for example underneath components;
– to select appropriate test liquids and conditions under consideration of worst-case conditions, to which the components and circuit boards later can be exposed in manufacturing processes of electronic assemblies.

For validation (test XD_3) it is important:

– to use the cleaning media and cleaning equipment as used in the manufacturing process;
– to set cleaning process parameters under worst-case conditions;
– to include all cleaning steps into the test sequence.

5 Test liquids

5.1 Test liquid W_1 – Water based neutral, single phase

5.1.1 Preparation

Mix deionized water, organic solvent and surfactant and mix for 5 min. Wait 30 min to allow the test liquid to stabilize before checking pH value and visual appearance.

5.1.2 Formulation

The composition of the test liquid is described in Table 1.

Table 1 – Test liquid W_1 water based neutral

Composition	Material	Mass fraction [%]
Organic solvent	Dipropylene glycol monomethyl ether (CAS 34590-94-8)	24
Non-ionic surfactant [2]	C10 – C18 fatty alcohol with (8 – 15) EO	1
Water	Deionized, conductivity ≤ 20 µS/cm	75

[2] The following trade names are examples of suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of these products: Greenbentin DE 080, BIO-SOFT N91-8, Lutensol ON 80, Tergitol 15-S-12.

5.1.3 Specification

The pH value of the mixture should be checked by use of a simple method (e.g. indicator paper); typical values are in the range between 5 to 8.

Visual appearance target: Clear and transparent, colourless to yellow.

5.2 Test liquid W_2 – Water based alkaline

5.2.1 Preparation

Mix deionized water and organic solvent and surfactant and mix for 5 min. Add alkanolamine and corrosion inhibitor and stir till both compounds are solubilized. Wait 30 min to allow the test liquid to stabilize before checking pH value and visual appearance.

5.2.2 Formulation

The composition of the test liquid is described in Table 2.

Table 2 – Test liquid W_2 alkaline, single phase

Composition	Material	Mass fraction [%]
Organic solvent	Dipropylene glycol monomethyl ether (CAS 34590-94-8)	23,4
Non-ionic surfactant [3]	C10 – C18 fatty alcohol with (8 – 15) EO	1
Corrosion inhibitor	Sodium metasilicate pentahydrate	0,1
Alkanolamine	2-Aminoethan-1-ol	0,5
Water	Deionized, conductivity ≤ 20 µS/cm	75

5.2.3 Specification

The pH value of the mixture should be checked by use of a simple method (e.g., indicator paper); typical values are in the range between 10 to 13.

Visual appearance target: Clear and transparent, colourless to yellow.

5.3 Test liquid OR_1 – Petroleum based organic solvent, single phase

5.3.1 Preparation

Use solvent as received.

5.3.2 Formulation

The composition of the test liquid is described in Table 3.

[3] The following trade names are examples of suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of these products: Greenbentin DE 080, BIO-SOFT N91-8, Lutensol ON 80, Tergitol 15-S-12.

Table 3 – Test liquid OR_1 – Petroleum based organic solvent

Composition	Material	Mass fraction [%]
Organic solvent	Distillates petroleum, hydrotreated light [4] (CAS 64742-47-8) [a]	100
[a] Alternative products with comparable composition (mixture of hydrocarbons in the range of C9 through C16) and a flash point ≥ 93 °C may be used. In this case the test liquid shall be informed in the test report.		

5.3.3 Specification

Visual appearance target: Clear and transparent, colourless to yellow.

5.4 Test liquid OR_2 – Glycol based organic solvent

5.4.1 Preparation

Mix organic solvents for 5 min.

5.4.2 Formulation

The composition of the test liquid is described in Table 4.

Table 4 – Test liquid OR_2 – Glycol based organic solvent

Composition	Material	Mass fraction [%]
Organic solvent 1	Diethylene glycol monohexyl ether (CAS 112-59-4)	70
Organic solvent 2	Dipropylene glycol monomethyl ether (CAS 34590-94-8)	30

5.4.3 Specification

Visual appearance target: Clear and transparent, colourless to yellow.

5.5 Test liquid D – Deionized water

5.5.1 Preparation

Use solvent as received.

5.5.2 Specification

Conductivity ≤ 20 µ*S*/cm

Visual appearance clear colourless

[4] The following trade names are examples of suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of these products: Shellsol D 100/D 110 or Cobersol H 105.

6 Test apparatus

6.1 Containers

A boro-silicate glass or stainless steel vessel of suitable volume for each test liquid shall be used. Vessels shall be of sufficient size and capacity to permit the test specimens to be immersed until they are fully covered in the selected liquid without violating other physical constraints (e.g. touching one another).

6.2 Miscellaneous laboratory equipment

Beaker, spatula, pipette, magnetic stirrer, basket and holder for boards and components, white absorptive paper.

6.3 Temperature controlled equipment

Hot plate capable for heating up to 100 °C.

Circulating air oven.

6.4 Balance

Analytical balance with a resolution of 0,001 g suitable for masses up to 200 g (for test XD_2).

Balance with a resolution of 0,1 g to 1 g (for test XD_3).

6.5 Thermometer

Capable of measuring temperatures up to 100 °C with a resolution of 0,1 °C.

6.6 pH meter

Suitable pH meter or pH strips (indicator).

7 Test XD_1 – Test procedure for components

7.1 Object

This test is used to determine the resistance of components suitable for cleaning processes to liquid cleaning media. The test specimen can be assembled onto a test board or other suitable fixture, especially in case electrical measurement is necessary.

In case specific cleaning media are required the test should be separately agreed upon between the user and supplier or alternatively test XD_3 shall be applied by the user.

7.2 Preconditioning

The components shall be kept at room temperature for a time sufficient to adopt to the room temperature.

Coatings and varnishes shall be completely cured.

In case it is necessary for the test specimen to be soldered to test coupons, the soldering conditions and solders to be used shall be specified in the component specification, preferably in accordance with the requirements set forth for the resistance to soldering heat tests in IEC 60068-2-20 and IEC 60068-2-58 as the preconditioning under worst-case conditions.

If it is necessary to identify single components, for example for comparison between initial and tested stage, the test specimen shall be marked by use of suitable means, which can withstand the test procedure without impacting the result.

7.3 Initial measurements

7.3.1 Visual inspection

Visual inspection shall be carried out under adequate light with a binocular microscope of magnification in a range of 4x to 100x. The test specimen shall comply to the criteria given in the component specification.

Table 5 contains recommended magnification values related to the size of components.

The test specimen shall comply with the criteria given in the component specification.

Table 5 – Recommended magnification values

Component length mm	Magnification
> 5	4x to 10x
0,25 to ≤ 5	10x to 40x
< 0.25	40x to 100x

7.3.2 Electrical and mechanical measurement

Electrical and mechanical measurement shall be performed as given in the component specification.

Usually, a measurement result shall be assignable to the test specimen. In case many specimens are tested simultaneously, an appropriate statistical method may be applied instead.

7.4 Conditioning

7.4.1 Test conditions and severities

Unless otherwise stated in the relevant specification for Method 1 (see 7.4.2) or Method 2 (see 7.4.3) at least five components shall be tested. If the specimens are assembled to test coupons, testing of at least one coupon is sufficient.

For every test fresh test liquids shall be used.

For qualification purpose the tests shall be performed with test liquid W_1, W_2, OR_1, OR_2 and D. For each test liquid separate samples shall be used.

The test conditions are given in Table 6.

A test duration of 120 min is the recommended condition. Components passing that condition are robust against the most common cleaning conditions, even under consideration of repeated cleaning processes.

Components not passing that condition shall then be tested with a duration of 20 min or another duration as agreed between user and supplier. In this case test XD_3 should be added to assess the suitability for cleaning under real manufacturing conditions.