IEC 60068-2-60

Edition 3.0 2015-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Environmental testing – Part 2-60: Tests – Test Ke: Flowing mixed gas corrosion test

Essais d'environnement – Partie 2-60: Essais – Essai Ke: Essai de corrosion dans un flux de mélange de gaz

IEC 60068-2-60:2015-06(en-fr)

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FOREWORD

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International Standard IEC 60068-2-60 has been prepared by IEC technical committee 104: Environmental conditions, classification and methods of test.

This third edition cancels and replaces the second edition, published in 1995, and constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

– updated IEC format;
– updated normative references list;
– addition of information of the working volume;
– revision of the test procedure;
– revision of the figures in Annex B.

The text of this standard is based on the following documents:

FDIS	Report on voting
104/655/FDIS	104/656/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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 publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

ENVIRONMENTAL TESTING –

Part 2-60: Tests – Test Ke: Flowing mixed gas corrosion test

1 Scope

This part of IEC 60068-2 determines the corrosive influence of operating and storage indoor environments on electrotechnical products components, equipment and materials, particularly contacts and connections, considered separately, integrated into a subassembly or assembled as a complete equipment.

It provides test methods giving information, on a comparative basis, to aid the selection of materials, choice of production processes and component design, with regard to corrosion resistance. A guide to the selection of methods and test duration is provided in Annex C.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60512-2-1, *Connectors for electronic equipment – Tests and measurements – Part 2-1: Electrical continuity and contact resistance tests – Test 2a: Contact resistance – Millivolt level resistance method*

IEC 60512-3-1, *Connectors for electronic equipment – Tests and measurements – Part 3-1: Insulation tests – Test 3a: Insulation resistance*

ISO 431, *Copper refinery shapes*

3 Test apparatus

The test apparatus consists of a climatic system, test enclosure, gas delivery system and means for measuring gas concentration.

Details of design and construction are optional but shall be such that the conditions specified for each method are fulfilled throughout the working volume and shall comply with the following requirements:

– water droplets or aerosols shall not be injected into the test enclosure;
– air and water used shall be sufficiently clean in order not to affect performance of the test;
– the test atmosphere shall flow through the enclosure in such a manner as to ensure uniform test conditions within the working volume;
– the sampling point for gas analysis shall be in the working volume of the test enclosure;
– the exhaust gases shall be treated in accordance with the relevant regulatory stipulations;
– the wet bulb pod shall be placed in the test chamber in such a manner not to exceed 0,1 % of the cross-section of the test chamber.

Because of the strong synergistic effect and the so called “memory effect” (i.e., it is difficult to fully remove the chlorine compounds from the chamber, tubes, etc.), it is recommended that enclosures and tubing used for tests that incorporate chlorine only be used for chlorine tests.

The working volume is the volume within which the individual corrosion (mass increase of copper coupons expressed in mg/(dm^2 × day) according to Annex A) at each location differs by a maximum of 15 % from the average corrosion of all coupons within the working volume.

4 Severities

The test severity shall be given in the relevant specification. It is defined by

– the test method, chosen from Table 1,

– the test duration.

Preferred durations, in days, are 4, 7, 10, 14 and 21.

Four methods are defined. The different parameters for each method are summarized in the following Table 1. A guidance for the use of each method is given in Clause C.3.

Table 1 – Test conditions

Parameters	Method 1	Method 2	Method 3	Method 4
H_2S (10^{-9} vol/vol)	100 ± 20	10 ± 5	100 ± 20	10 ± 5
NO_2 (10^{-9} vol/vol)	200 ± 50	200 ± 50	200 ± 50	200 ± 20
Cl_2 (10^{-9} vol/vol)		10 ± 5	20 ± 5	10 ± 5
SO_2 (10^{-9} vol/vol)	500 ± 100			200 ± 20
Temperature (°C) [a]	25 ± 1	30 ± 1	30 ± 1	25 ± 1
RH (%)[a]	75 ± 3	70 ± 3	75 ± 3	75 ± 3
Rate of ventilations per hour	3 to 10	3 to 10	3 to 10	3 to 10
Mass increase of copper coupons mg/(dm^2 × day) according to Annex A	1,0 to 2,0	0,3 to 1,3	1,2 to 2,2	1,2 to 2,4

NOTE Since the nature of the corrosive attack is different for test Methods 1 to 4, neither their numbering nor the corresponding mass increase of copper coupons reflect their severity.

[a] Different temperature and humidity values (e.g. 40 °C and 80 %RH) may be used based upon mutual agreement between the interested parties. The mass increase may be different from the given values.

5 Preconditioning

The relevant specification may require preconditioning of specimens, for example cleaning or mechanical operation.

6 Initial measurements

Initial measurements shall be carried out as required by the relevant specification.

Generally, these measurements are:

– contact resistance measurements for electromechanical product components (see IEC 60512-2-1);
– insulation resistance measurements (see IEC 60512-3-1).

7 Testing

7.1 General

Samples exposed in the tests shall be

– the specimens being evaluated,
– corrosion monitor materials.

7.2 Test specimens

The relevant product specification shall define the conditions of the specimens during the test, for example mated or unmated for connectors; contacts open or closed for switches, operated or electrically loaded.

The duration of the operation or loading of heat-dissipating specimens, shall be such that the temperature and the relative humidity in the working volume remain within the specified tolerances.

The conditions of the specimens and the test chamber shall be such that condensation on the specimens shall not occur when they are introduced into the test chamber.

The total volume of the test specimens should not exceed 10 % of the volume of the working area of the test chamber. If the total volume of the test specimens exceed 10 %, the amount exceeding 10 % shall be included in the test report.

The total surface area of the test specimens should not exceed 10 % of the surface area of the working area of the test chamber. If the total surface of the test specimens exceed 10 %, the amount exceeding 10 % shall be included in the test report.

A minimum space between specimens might be 10 mm so as not to disturb the uniform air flow.

7.3 Corrosivity monitoring materials

Copper coupons shall be exposed with the test specimens in order to verify the conformance of the test condition.

A minimum of five test coupons of copper, prepared in accordance with Annex A, shall be exposed with the test specimens for the same duration. Their mass increase during the test, measured by a balance with a resolution of 0,01 mg, shall be taken as a measure of the corrosion and as a monitor of the reproducibility and repeatability of the test.

Other vehicles, for example, gold-plated coupons or other specimens (see B.6.3) can be used in addition to the copper coupons.

7.4 Testing procedure

One of the following test procedures shall be used:

Test procedure 1

When the test atmosphere does not contain chlorine (Method 1) or when the method for measuring chlorine concentration does not suffer interference from the other gases present in the test atmosphere, the following procedure shall be used:

– after the specified temperature is stabilized, start the flow of humid air, allow to stabilize and adjust temperature and humidity not to accumulate the condensation on the inner wall of the test chamber and the test specimen;

– start the flow of the gases into the humid air stream and allow to stabilize;

– measure and adjust gas concentrations. Allow to stabilize. When it is necessary to measure chlorine concentration, total chlorine (not only chlorine gas, Cl_2) present in the test atmosphere is taken as a measure of chlorine gas concentration. The chlorine added to the test atmosphere shall still only be in the form of chlorine gas, Cl_2;

– introduce the test specimens and the corrosion monitoring materials as prescribed in 7.3. The copper coupons shall be exposed with the test specimens for the first 4 days during a test duration. The copper coupons might be exposed another 4 days during a test duration, if necessary. It shall be included in the test report. The test specimens and the corrosion monitoring materials shall be distributed uniformly in the working volume. They shall not come in contact with one another nor shield one another from the test atmosphere. The test specimens shall be in the condition (for example, mated/unmated, electrically loaded or operated) as stated in the relevant specification. The test duration shall be measured from this point;

– allow the test conditions to stabilize, which may require considerable time. Measure and adjust, if necessary, temperature, humidity and gas concentrations. During these adjustments, any overshooting of gas concentration shall be avoided. Maximum allowed duration of this period of stabilization and adjustments, to prescribed values, is 24 h;

– during the course of testing, temperature, humidity and gas concentrations shall be kept within the prescribed limits. The chamber is allowed to be opened during the test.

  The number of openings shall be limited.

  No opening is allowed for a test duration shorter than 4 days.

  One opening is allowed for a test duration of between 4 and 10 days.

  One opening per week is allowed for a test duration exceeding 10 days.

  The duration of these openings shall be limited to the time necessary to remove and introduce specimens and/or copper coupons;

– at the end of the test period, remove the specimens and the corrosion monitoring materials.

Test procedure 2

When chlorine is present in the test atmosphere (Methods 2 to 4) and when the method for measuring chlorine suffers interference from other gases in the test atmosphere, the following procedure shall be used:

– after the specified temperature is stabilized, start the flow of humid air, allow to stabilize and adjust temperature and humidity so as not to accumulate the condensation on the inner wall of the test chamber and the test specimen;

– start the flow of chlorine into the humid air stream and allow to stabilize;

– measure and adjust the chlorine concentration. Allow to stabilize;

– introduce the test specimens and the corrosion monitor materials as prescribed in 7.2. The copper coupons shall be exposed with the test specimens for the first 4 days during a test duration. The copper coupons might be exposed another 4 days during a test duration, if necessary. It shall be included in the test report. The test specimens and the corrosion monitoring materials shall be distributed uniformly in the working volume. They shall not come in contact with one another nor shield one another from the test atmosphere. The

test specimens shall be in the condition (for example, mated/unmated, electrically loaded or operated) as stated in the relevant specification;

– allow temperature, humidity and chlorine concentration to stabilize, which may require considerable time due to initially high reaction or adsorption rates of chlorine with surfaces. If necessary, measure and adjust the chlorine concentration. During this adjustment, any overshooting of gas concentration shall be avoided. The chlorine concentration shall remain stable for 2 h minimum. The maximum allowed duration of this period of chlorine stabilization and adjustments, to prescribed values, is 24 h;
– start the flow of the remaining gases and allow to stabilize. Measure and adjust, if necessary, temperature, humidity and gas concentrations, excluding chlorine. During these adjustments, any overshooting of gas concentration shall be avoided. The maximum allowed duration of this period of stabilization and adjustments, to prescribed values, is 24 h. The test duration is measured from the moment when all gases are present in the test atmosphere;
– during the course of testing, temperature, humidity and gas concentrations shall be kept within the prescribed limits. Chlorine concentration, however, cannot be controlled during the test. The way to ensure that values remain within the set limits is to carry out the chlorine measurement after finishing the test (see below). The chamber is allowed to be opened during the test.

  The number of openings shall be limited.

  No opening is allowed for a test duration shorter than 4 days.

  One opening is allowed for a test duration of between 4 and 10 days.

  One opening per week is allowed for a test duration exceeding 10 days.

  The duration of these openings shall be limited to the time necessary to remove and introduce specimens and/or copper coupons;
– at the end of the test period, stop the flow of gases except chlorine which shall remain running. Allow sufficient time to empty the chamber of the other gases, to an extent sufficient to avoid interference with chlorine analyses;
– measure the chlorine concentration which shall be within the limits prescribed in order for the test to be valid;
– remove the test specimens and the corrosion monitoring materials.

8 Recovery

After removal of the specimens from the test chamber, they shall be stored in accordance with the relevant specification prior to final measurements.

9 Final measurements

The final measurements shall be carried out as required by the relevant specification which may also require a visual examination of the specimens after the test.

The relevant specification shall provide the criteria upon which the acceptance or rejection of the specimen is to be based.

If the necessary measurements cannot be made within the specified time, the period of storage under recovery conditions may be extended to a maximum of one week. Such an extension shall be mentioned in the test report.

10 Information to be given in the relevant specification

When this test is included in a relevant specification, the following details shall be given, in so far as they are applicable. The relevant specification shall supply information as required in

the clauses listed below, paying particular attention to the items marked with an asterisk (*) as this information is always required.

		Clause
a)	Method*	4
b)	Test duration*	4
c)	Preconditioning of the specimens	5
d)	Initial measurements*	6
e)	Conditions of the specimens during the test*	7
f)	Operation and loading during testing	7
g)	Recovery and duration*	8
h)	Final measurements* and possible visual examination	9
i)	Criteria of acceptance or rejection*	9

11 Information to be given in the test report

Information to be given in the test report is as follows:

– test method;
– test duration;
– preconditioning;
– method and results of initial measurement;
– conditions and duration of test;
– operation and loading during test;
– recovery and duration;
– method and results of final measurement;
– individual mass increase of copper coupon in mg/(dm^2 × day);
– any deviation from the standard.

Annex A
(normative)

Corrosion monitoring copper coupons

A.1 General

Copper coupons are exposed with the test specimen in order to verify the conformance of the test to the limits set out in this standard. The mass increase of the coupons shall be taken as a measure of this conformity.

A.2 Nature and dimension

The coupons shall be made from half hard OFHC copper (Cu-OF according to ISO 431) sheet, maximum thickness of 0,5 mm, and have a total surface area of 0,1 dm^2 to 0,2 dm^2 each. The surface of the coupon is an essentially faultless surface (free from pores, marks, scratches and any light colouration) and a matt finish (arithmetically mean deviation of the profile Ra = 0,15 μm ± 0,1 μm).

A.3 Cleaning procedure

Before the start of the test, the copper coupons shall be cleaned, as described below, weighed by a balance with a resolution of 0,01 mg and stored for a maximum of 120 h in a desiccator with non-corrosive dehydrating agent.

The cleaning procedure of the copper coupons shall be as follows:

– cathodic degrease in 1 N NaOH, for 15 s to 30 s, at 5 V to 10 V, using a stainless steel anode or platinium anode;
– rinse with tap water;
– rinse with demineralized water;
– activate by dipping in 10 % H_2SO_4, for 20 s to 30 s;
– rinse with tap water;
– rinse with demineralized water;
– rinse with alcohol: denatured ethyl alcohol or isopropyl alcohol;
– dry with warm air (about 50 °C).

All solutions shall be prepared with demineralized water, of at least the same quality as used in the climatic system.