Report 2

Explanation of International Standard IEC 68-2-66

Environmental testing – Part 2:Test methods – Test Cx: Damp heat, steady state (unsaturated pressurized vapour)

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This standard was established and published in June, 1994. Deliberations on the contents were inaugurated by working group 4 of subcommittee 50B, and about 5 years have passed since concrete activities were begun.

The Japanese Industrial Standard, JIS, conforms to the ISO and the IEC. This standard is soon to be adopted by JIS, and it is expected to be put to practical application in business contracts as one method of environmental testing in such areas as electrical and electronics parts and products.

1. Introduction

As a formal member of WG4, Tabai Espec was deeply involved in creating the original draft together with members from other countries. Tabai Espec's contribution was based on its results of developing testing equipment using test conditions and developing and improving test software. Most of the essential points and the details were proposed by the Japanese participants.

The IEC 68-2-66 test conditions have been formally published by IEC and have been internationally recognized. The Highly Accelerated temperature and humidity Stress Test (HAST) chamber of Tabai Espec has also gained international standing.

Table 1 Composition of standards

Main article	Attached document
1. Appropriate Range	A. Steam Pressure Table†
2. Summary of Test	B. Physical Meaning of the Test
3. Test Equipment	C. Definition of Humidity
4. Test Severity	D. Test Equipment and Handling
5. Initial Measurement	
6. Test	
7. Intermediate measurement	
8. Recovery	
9. Final Measurement	
10. Information to be given in the relevant specification sheets	

† Attached document (Annex) A, the Steam Pressure Table, forms a portion of the main article.

2. Summary of Test Method

2-1 Appropriate Range

- The subjects of testing are small electrical and electronics devices, mainly non-hermetically sealed devices, particularly those sealed in plastic.
- Durability against degradation from temperature and humidity is evaluated using acceleration methods.
- External effects such as corrosion and distortion of test specimens are not considered in this test.

As noted above, the reasons for limiting the type of specimens that are subject to evaluation are as follows. Materials such as plastics can be more economically sealed than metals and ceramics, which require more complicated sealing techniques. However, plastics are extremely porous in the micro range, meaning they are permeable and so extremely poor at sealing out moisture. Despite this, most electric and electronic parts are currently sealed in plastic, and plastics are used in sealing extremely vital functional parts such as IC.

We would like to make very clear that the subject of evaluation is the sealed internal section of the specimen, and that distortion of the external section is not considered.

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2-2 Summary of Test

- Normally the test is performed by applying bias.
- Conditions for extremely accelerated tests are selected after first confirming that the conditions correlate to the failure mode.
- Great care is taken with the highest rated temperature of parts and the critical temperature of sealing material (e.g., the plastic to glass transition temperature).

Thorough consideration must be made in advance to plan acceleration in a harsh environment of high temperature and high humidity, as well as high pressure.

2-3 Test Equipment

2-3-1 Test chamber

- The chamber must create the prescribed test environment, and must be able to maintain the environment during the test process.
- Condensation must not drip onto specimens.
- Material used in constructing the chamber must not contaminate the humidifying water or cause specimens to corrode.
- The temperature and humidity distribution under test conditions inside the chamber at the optional locations for specimens must remain within ±2°C and ±5%RH. The specimens must be arranged so that they don't noticeably impede currents of steam. Steam must not condense on the surface of the specimens.

2-3-2 Humidifying water

- Distilled water or deionized water must be used.
- At 23°C the water must not go below 0.5MΩcm.
- The PH at 23°C must remain within 6.0 – 7.2.

The current Tabai Espec HAST chamber fulfills all of the above conditions.

2-4 Test Severity

Severity is one condition of the test, and a condition that draws considerable interest from users. This value drew a number of suggestions from participants of various countries during the discussions, resulting in the strong insistence of the Japanese participants being adopted. In particular, "exposure time (duration)" is the same as the value in IEC Pub.749 amendment 1 (1991-11) (standards for semiconductor devices). In other words, the character of this standards draft indicates a strong consciousness of the fact that the semiconductors are sealed in plastic.

■ Severity

The exposure time in the Table 2 has values that double for each temperature. The phenomena that are the subject of this test are essentially results of chemical reactions, and are interpreted using Arrhenius' laws of reactions and theory of rate of chemical reactions.

Table 2 Severity

Conditions			Severity		
	Temperature °C[(1)]	Relative humidity %RH[(2)]	Exposure time (h)[(3)] I	II	III
A	110	85	96	192	408
B	120	85	48	96	192
C	130	85	24	48	96

(1) ±2°C (in working space)
(2) ±5%RH
(3) 0, +2h

■ Other Items

- This test method is a steady state test, and is not cyclical.
- Tests requiring restarting are not recommended, but when a test requires a time longer than that given in column III of Table 2, the test must be restarted within 96 hours after the ramp-down period of the previous test.
- Exposure time in Table 2 doesn't include such time as ramp-up, ramp-down, or preparation.

2-5 Initial Measurements

- Each specimen must be visually examined before the test and inspected to insure that it conforms to prescribed characteristics such as dimensions and functions.

2-6 Test

- First, a specimen with a room temperature environment must be installed in a test chamber with the same temperature.
- The installed specimen must not be directly exposed to radiation from the chamber walls or the heater. When using an appropriate mounting structure for installation, both the thermal capacity of the structure and the heat conducted to the specimen by the structure must be small. The structure must not discharge contaminants causing corrosion or degradation of the specimen.
- Bias voltage must be applied based on the relevant individual specifications of the specimen.
- Fig.1 shows the test cycle, the processes from the beginning to the end of the test.

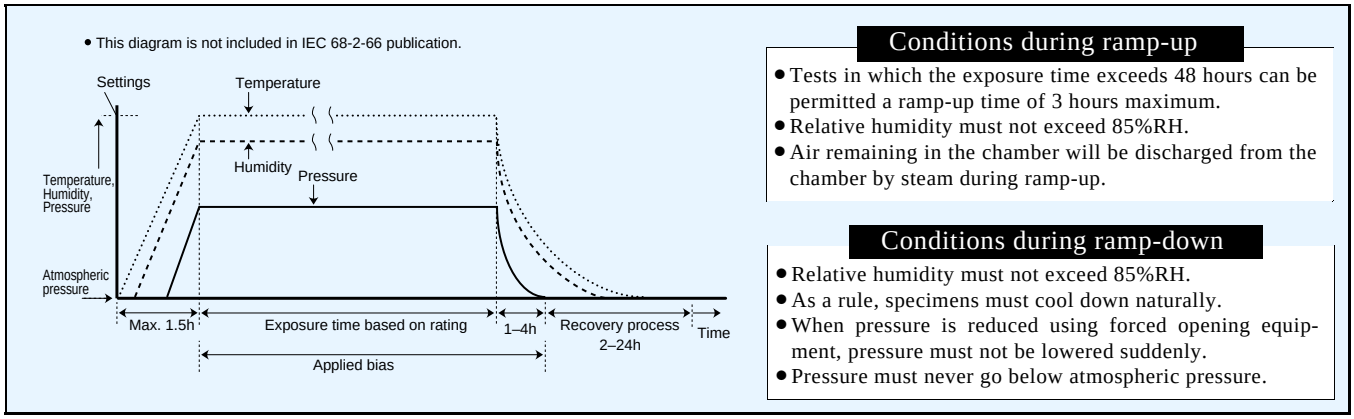

Fig.1 Test Processes

2-7 Intermediate Measurements

- Electrical and physical inspections may be performed during the exposure period if products have relevant individually rated specifications. However, such actions must not disturb the test environment.
- The specimen must not be removed from the chamber when measuring.

2-8 Recovery

- After a specimen has been removed from the chamber, it enters the recovery process in which various measurements and functional tests are performed. These actions must be performed at atmospheric pressure at a minimum of 2 hours and a maximum of twenty-four hours after the test.

2-9 Final Measurements

- Details of final measuring are the same as initial measuring.

2-10 Information to be given in the relevant specification sheets

When product characteristics must be tested, details for the following items must be concretely specified.

a. Differences from Table 2 specifications (compulsory item)
b. Details of initial measurements (compulsory item)
c. Mounting structures
d. Bias voltage (when necessary)
e. Intermediate measurements
f. Final measurements (compulsory item)

■ Annex A

Steam Table from 100°C to 170°C

■ Annex B

Physical Meaning of the Test

- The acceleration is due to the difference in the water vapor pressure between the inside of the specimen and the test environment.
- A historical background is given explaining such factors as how this test was developed as an accelerated test method for testing corrosion of aluminum circuits on integrated circuits sealed in plastic and other semiconductor devices.

■ Annex C

Items Related to a Definition of Humidity

- No method of directly measuring humidity has yet been established for the temperature and humidity range used.
- Humidity must be defined according to theoretical evaluation of a practical method of measurement. In other words, it is permissible to use any measuring method that is possible if it is within a theoretically acceptable deviation.
- Remaining air is discharged during the ramp-up process, but because of dissolved gas in the humidifying water and any gas discharged from the specimens, the interior of the chamber can't be termed a perfect vapor environment. However, it is difficult to believe that such a minute quantity of gas has much influence on the results of the test, so the interior of the chamber hypothetically fulfills the condition of having only steam.
- There are three methods by which humidity may be measured: the temperature method (measuring the temperature inside the working space and the temperature of the humidifying water, or the temperature immediately above the humidifying water), the wet/dry bulb method, and the dew point method.
  Any of these methods of measuring can provide essential control and be used for monitoring, but the dew point method is difficult to use with current technology.

■ Annex D

Test Equipment and Handling

- The test equipment is limited to two types, the single vessel (Tabai type) and dual vessel types. The construction of those two types is shown in Fig.2.
- The steam current must be kept within 0.5 m/sec maximum, the range of a natural convection current.
- Materials causing corrosion or degradation must not be used inside the chamber. The applied bias voltage will "work effectively" for this test, meaning it will accelerate corrosion. That bias voltage and time of application must be adjusted, however, because an opposing surface may be adversely affected, e.g., by preventing moisture absorption through self-heating. For example, the specimen surface temperature must not rise more than 2°C above ambient temperature, so when self-heating is severe, the time of application ratio may be set to ON:OFF = 1:3.
- Lubrication should be done periodically using a soft brush with laboratory detergent in distilled water or de-ionized water.
- As a rule, the test should be completed with the specimen left untouched after delivery of the specimen has been received.
- Diagram showing an outline of representative test equipment construction is included.

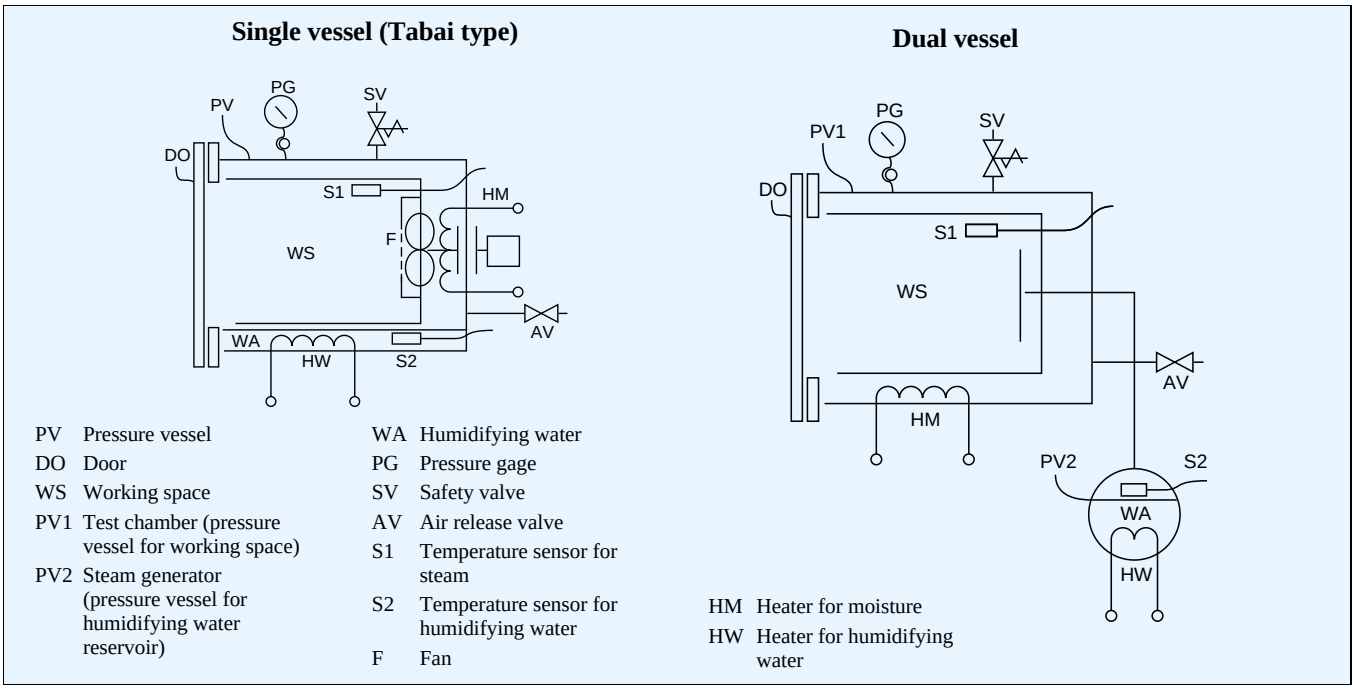

Fig.2 Test equipment construction

Concrete explanations, which had not been described in any traditional IEC Publication Standard, are contained in the above attached documents, and most of the Japanese suggestions have been included.

[Reference Bibliography]

1) Environmental testing-Part2: Test methods-Test Cx: Damp heat, steady state (unsaturated pressurized vapour), IEC International Standard, 1994