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IS 9002-6 (1980): Equipment for Environmental Tests for Electronic and Electrical Items, Part VI: Constant Relative Humidity Chamber (non-injection type) [LITD 1: Environmental Testing Procedure]



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Indian Standard

SPECIFICATION FOR
EQUIPMENT FOR ENVIRONMENTAL
TESTS FOR ELECTRONIC AND
ELECTRICAL ITEMS

**PART VI CONSTANT RELATIVE HUMIDITY
CHAMBER (NON-INJECTION TYPE)**

UDC 620.193.23.05 : 621.31 + 621.38.038



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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Price Rs 5.00

Gr 5

September 1980

Indian Standard

SPECIFICATION FOR EQUIPMENT FOR ENVIRONMENTAL TESTS FOR ELECTRONIC AND ELECTRICAL ITEMS

PART VI CONSTANT RELATIVE HUMIDITY CHAMBER (NON-INJECTION TYPE)

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(Continued on page 2)

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IS : 9002 (Part VI) - 1980

(Continued from page 1)

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Indian Standard

SPECIFICATION FOR EQUIPMENT FOR ENVIRONMENTAL TESTS FOR ELECTRONIC AND ELECTRICAL ITEMS

PART VI CONSTANT RELATIVE HUMIDITY CHAMBER (NON-INJECTION TYPE)

0. FOREWORD

0.1 This Indian Standard (Part VI) was adopted by the Indian Standards Institution on 1 January 1980, after the draft finalized by the Environmental Testing Procedures Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 The object of this standard (Part VI) is primarily to guide the environmental equipment manufacturers with respect to broad specifications for their equipment and to assist the users of such equipment to properly define their requirements in the indent for the equipment. The requirements of the equipment largely depend on the conditions of environmental tests to be simulated or created. It is expected that this standard will harmonize the various requirements of the equipment.

0.3 This standard specifies the constructional features and requirements of the conditioning enclosure to be used to create the required atmospheric conditions for the specific tests mentioned in IS : 9000 (Part I)-1977* requiring constant relative humidities at specified temperatures.

0.3.1 In this standard, requirements of chamber for creating constant relative humidity by salt solution method and glycerine-water mixture are given. However, details of chamber creating constant relative humidity by salt solution method only are given as such chambers are used very commonly and in large number.

0.4 In preparing this standard, assistance has been derived from IEC Publication 260 (1968) 'Test enclosures of non-injection type for constant relative humidity' issued by the International Electrotechnical Commission.

*Basic environmental testing procedures for electronic and electrical items: Part I General.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part VI) specifies the performance and constructional requirements for conditioning chambers with forced air circulation being operated at a normal constant temperature within the temperature range from near ambient to +60°C to maintain a nominally constant relative humidity.

NOTE — Chambers designed to operate at temperatures below or just above ambient temperature will require some form of cooling.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions, in addition to those given in IS : 9000 (Part I)-1977†, shall apply.

2.1 Working Space — The part of the chamber where the requirements for the specified conditions for the relevant test are met.

NOTE — The working space does not include the space within 30 mm from the walls or roof.

2.2 Chamber Temperature — Temperature at the centre of the working space.

2.3 Temperature Deviation — The difference at any moment between the chamber temperature and the temperature at any point in the working space.

2.4 Temperature Fluctuation — The short-term change in temperature at any point in the working space.

3. METHODS FOR ACHIEVING THE REQUIRED RELATIVE HUMIDITY

3.0 Two methods of achieving the required relative humidity have been described in this standard, using:

- a) saturated salt solutions, and
- b) glycerine-water mixtures.

*Rules for rounding off numerical values (*revised*).

†Basic environmental testing procedures for electronic and electrical items: Part I General.

3.1 Saturated Salt Solutions Method—Saturated salt solutions provide a large reserve for absorbing or giving up moisture, without affecting the relative humidity.

3.1.1 The atmosphere over a saturated salt solution at constant temperature is maintained at a specific relative humidity which is characteristic of the particular salt solution and the value of temperature.

3.1.2 All solutions shall have an excess of solid salt to ensure saturation.

3.1.3 When using a saturated salt solution for testing, salts which may result in a corrosive atmosphere dangerous to the items shall not be used. For example, ammonium salts are unsuitable for testing items containing copper or its alloys.

3.1.4 Efflorescence or 'creepage' of salt from the solution should be avoided.

3.1.5 A list of salts with the associated relative humidities is given in Table 1.

3.2 Glycerine-Water Mixtures Method—Glycerine-water mixtures are for use where the nature of a salt renders it unsuitable for the item under test. When using glycerine-water mixtures for testing, attention is drawn to the fact that these mixtures may result either in inhibiting or in encouraging deterioration effects.

3.2.1 The concentration of glycerine-water mixtures in terms of the refractive index at 25°C for the desired relative humidity at any temperature between 0°C and 70°C may be calculated as follows:

$$(R_1 + A)^2 = (100 + A)^2 + A^2 - (H + A)^2$$

where

$$R_1 = 715.3 (R - 1.3333),$$

$$A = 25.60 - 0.1950 T + 0.0008 T^2,$$

H = relative humidity in percent,

R = refractive index of the glycerine-water mixture, and

T = temperature of the solution in Celsius degrees.

This formula will give the desired relative humidity with an accuracy of ± 0.2 percent at a constant temperature of 25°C.

TABLE 1 RELATIVE HUMIDITY OF AIR OVER VARIOUS SATURATED SOLUTIONS OF SALTS AT DIFFERENT TEMPERATURES

(Clauses 3.1.5 and 4.12)

Sl. No.	SATURATED SALT SOLUTION	RELATIVE HUMIDITY, PERCENT, AT TEMPERATURE									
		5°C	10°C	15°C	20°C	25°C	30°C	35°C	40°C	50°C	60°C
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
i)	Potassium sulphate, K_2SO_4	98	98	97	97	97	96	96	96	96	96
ii)	Potassium dihydrogen phosphate, KH_2PO_4	—	—	—	—	—	—	—	93	—	—
iii)	Potassium nitrate, KNO_3	96	95	94	93	92	91	89	88	85	82
iv)	Potassium chloride, KCl	88	88	87	86	85	85	84	82	81	80
v)	Ammonium sulphate (NH_4) ₂ SO_4	82	82	81	81	80	80	80	79	79	78
vi)	Sodium chloride, $NaCl$	76	76	76	76	75	75	75	75	75	75
vii)	Sodium nitrate, $NaNO_3$ (see Note 1)	—	—	—	65	65	63	62	62	59	59
viii)	Ammonium nitrate, NH_4NO_3	—	73	69	65	62	59	55	53	47	42
ix)	Sodium dichromate, $Na_2Cr_2O_7 \cdot 2H_2O$	59	58	56	55	54	52	51	50	47	—
x)	Magnesium nitrate $Mg(NO_3)_2 \cdot 6H_2O$	58	57	56	55	53	52	50	49	46	—
xi)	Potassium carbonate, $K_2CO_3 \cdot 2H_2O$	—	47	44	44	43	43	43	42	—	—
xii)	Magnesium chloride, $MgCl_2 \cdot 6H_2O$	34	34	34	33	33	33	32	32	31	30
xiii)	Potassium acetate, CH_3COOK	—	21	21	22	22	22	21	20	—	—
xiv)	Lithium chloride, $LiCl \cdot xH_2O$	14	14	13	12	12	12	12	11	11	11

NOTE 1 — The addition of 1 percent to 2 percent of sodium tetraborate retards discolouration of the solution but reduces the equilibrium relative humidity by approximately 1 percent at 20°C.

NOTE 2 — Some salts are unsuitable for certain items (see 3.1.3).

3.2.2 The relative humidity produced by glycerine-water mixture will change if water is absorbed or give up, and these mixtures shall be checked and adjusted frequently. Also the high viscosity of glycerine may lead to concentration differences at the surface and in the bulk of the solution.

3.2.3 The refractive index shall be measured with a refractometer covering the range 1.33 to 1.47 with an accuracy of ± 0.001 . The concentration of the glycerine-water mixtures can be determined in terms of percentage by mass.

3.2.4 The glycerine concentrations (percent by mass) and mixture densities given in Table 2 shall be used within the temperature range $+15^{\circ}\text{C}$ to $+60^{\circ}\text{C}$ for the tabulated relative humidities. The error obtained in relative humidity is about ± 1 percent. Linear interpolation between the tabulated points gives less than 1 percent additional error.

TABLE 2 GLYCERINE CONCENTRATIONS (PERCENT BY MASS) AND MIXTURE DENSITIES TO BE USED FOR DIFFERENT RELATIVE HUMIDITIES

RELATIVE HUMIDITY	GLYCERINE	DENSITY OF THE MIXTURE AT 25°C	REFRACTIVE INDEX η AT 25°C
(1)	(2)	(3)	(4)
Percent	Percent	g/cm^3	
100	0	0.998 2	1.333
98	10	1.022 1	1.345
95	20	1.047 0	1.357
90	33	1.080 6	1.374
85	44	1.110 2	1.390
80	52	1.131 7	1.401
75	58	1.147 9	1.410
70	63	1.161 4	1.417
65	67	1.172 4	1.423
60	71	1.183 6	1.429
50	78	1.202 5	1.440
40	84	1.218 7	1.449
30	90	1.234 7	1.457

IS : 9002 (Part VI) - 1980

3.2.5 The glycerine-water mixture is circulated over as much as possible of the walls of the test chamber and is also made to cover the floor of the chamber.

NOTE — Circulation is by means of a pump, the temperature and composition of the mixture being controlled in an outer container fitted with heating and cooling elements.

3.2.6 About 0.1 percent by mass of copper sulphate should be added to the glycerine-water mixture to prevent fungus or algae growth in the solution.

NOTE — Attention is drawn to the fact that technical quality glycerine contains various amounts of water.

3.3 Comparison of Two Methods

3.3.1 Saturated Salt Solution Method — The following are the main merits and demerits of the saturated salt solution method:

a) Merits

- 1) Provided that an excess of salt is present, relatively large quantities of water may be transferred to and from the solution without affecting its ability to control the relative humidity of the associated atmosphere.
- 2) The solution may be left unattended for long intervals and ultimately needs changing only because of contamination.
- 3) For salt solutions it is not necessary to measure the relative humidity in the chamber.

b) Demerits

- 1) The range of relative humidities which may be controlled in this way is limited to the salts, including mixtures, for which reliable data exist.
- 2) Some salts are difficult to use because of creepage of the solution along the sides of the container.
- 3) Some salts are very costly.

3.3.2 Glycerine Solution Method — The following are the main merits and demerits of the glycerine solution method:

- a) *Merits* — As the concentration of the solution is continuously variable, any value of relative humidity may be obtained.

b) *Demerits*

- 1) Considerable ageing of the glycerine solution makes it necessary to measure the relative humidity in the chamber. Density measurements are therefore valid only for a short period.
- 2) The test items may become covered by thin layer of glycerine which may produce either inhibiting or deteriorating effects.
- 3) This method requires more attention than the saturated salt solution method because the concentration of the glycerine-water mixture has to be maintained practically constant by suitable measurement and adjustment at frequent intervals.
- 4) With items which absorb a large amount of water, or if the load in the chamber is too large in relation to the amount of solution used, significant changes in concentration may occur. Under such circumstances, the concentration of the solution may not be homogeneous and consequently, selecting a sample solution may be difficult. This sample is needed in order to adjust the concentration to the appropriate value. Steps are to be taken to avoid the growth of fungus or algae in the solution.

3.4 Precautions

3.4.1 The amount of loading permissible will depend on the amount and nature of any absorbent materials being conditioned. Due consideration should therefore be given to the requirements of 7.8.

3.4.2 Overloading a small chamber may decrease the rate-of-rise of humidity in the chamber to such an extent that an unreasonably long time may be required to reach a steady state.

3.4.3 Since the limit of loading depends upon the material being conditioned, such a limit cannot be specified. Care should be taken to allow free access of the conditioning atmosphere to all items.

3.4.4 Pure water shall be used for making-up saturated salt solutions or glycerine-water mixtures. It is important to keep the solution free from impurities at all times.

NOTE— In particular, traces of silicone grease or oil on the surface of the solution may result in the relative humidity deviating appreciably from the desired figure.

3.4.5 It is recommended to prepare the salt solution by adding the salt crystals to boiling water nearly to saturation and then allowing the solution to cool down to laboratory temperature. By this means, a

homogeneous solution is obtained. Otherwise it may happen that, on the surface of the solution, a water layer having, a lower salt solution will exist and, hence, by using solutions for relative humidities less than 80 percent to 90 percent a higher relative humidity than is desired will be obtained.

4. CONSTRUCTION, WORKMANSHIP AND FINISH (CHAMBER FOR SALT SOLUTION METHOD)

4.1 General

4.1.1 The chamber shall be soundly constructed of suitable materials and all electrical and other ancillary fittings shall be readily accessible for maintenance purposes. The design and construction shall be such as to maintain safety against electrical hazards.

4.1.2 The interior of the chamber shall be constructed of suitable corrosion-resistant, non-absorbent material, so fabricated that all joints are leak-proof and not subject to corrosion. The interior surfaces shall be easy to clean.

4.1.3 If possible, the solution shall be so placed that it will not be fouled when test articles are placed in or removed from the chamber. The frame of the door and the front of the chamber shall have sufficient pressure to provide an efficient seal between the interior of the chamber and the external atmosphere when the door is closed.

4.2 Working Volume — The working volume of the chamber should be chosen from the following *preferred values*, unless otherwise specified:

0.25, 0.5, 1, 2.5 m³

4.3 Insulation — The chamber shall be suitably and sufficiently insulated for the temperature range involved. The insulation shall be such as to ensure that the surface external to the chamber does not attain excessive temperature.

NOTE — The maximum permissible external surface temperature has to be specified by the purchaser.

4.4 Doors — The front door shall be capable of full opening to ensure full access to the working space and fitted with suitable gaskets to prevent heat losses.

4.5 Shelves — Removable, perforated shelves capable of supporting without distortion the items of specified mass, shall be provided. The number of shelves and adjustable heights should be as specified.

4.6 Viewing Window — A viewing window of the required dimensions shall be provided on the door preferably of the multipane type, hermetically sealed.

4.7 Terminal Panel — A suitable terminal panel for making external connection with the test items inside the chamber shall be provided, as an optional facility. The relevant details and requirements shall be as specified.

4.8 Port Hole — A port hole of specified dimension may be provided as an optional item at the specified point of the chamber for accommodating wires, hoses, etc. Means shall be provided for sealing of the port hole when not in use to ensure thermal integrity.

4.9 Interior Light — Provision shall be made for illuminating the working space by incandescent lamps. The lamps may be recessed so as not to project into the working space. Provision shall also be made for prevention of condensation of moisture on the lamps.

4.10 Avoidance of Condensation — The design shall be such that condensation of moisture does not occur on any internal surface of the chamber or any cooling surfaces which may be incorporated, when the chamber is in operation.

NOTE 1 — At relative humidities at or above 90 percent, small local patches of condensation may be allowed to occur on the walls, provided that the mean relative humidity in the working space is not affected and that under no circumstances any condensed water will drip into the working space.

NOTE 2 — If an auxiliary heater is provided for the purpose of preventing condensation on the observation window, it shall not adversely affect the temperature and the relative humidity within the working space.

4.11 Air Circulation — The chamber shall be provided with a suitable fan, so arranged that there is adequate circulation of air to all parts of the working space. The air speed over the surface of the salt solution shall be sufficiently high to give rapid transfer of moisture to or from the solution.

4.11.1 The air velocity at the place of the humidity sensing device shall be such that the measurement of relative humidity may be performed with the required accuracy.

NOTE 1 — For the usual mercury-in-glass (wet- and dry-bulb hygrometer) thermometer, the air speed should exceed 3 m/s. Lower air speeds are permissible with bulbs of smaller diameter, with thermocouples, etc.

NOTE 2 — The speed of the circulating air shall not be too high, otherwise small drops of water or grains of salt on the walls of the tray holding the salt solution may be carried over into the atmosphere.

4.12 Salt Tray — The salt tray or container shall be made of suitable material which does not craze and which is unaffected by any of the saturated salt solutions listed in Table 1. The design shall be such that

IS : 9002 (Part VI) - 1980

the tray is easily cleaned. The area of the salt tray should be made as large as possible in order to obtain the maximum rate of moisture transfer.

NOTE — Attention is drawn to the fact that with trays of certain materials, for example, metals, salts, particles may creep along the walls. Hence a tray of polyethylene, for example, may be found more satisfactory.

4.13 Temperature Setting — External means of manually adjusting the temperature shall be provided. The sensitivity of the temperature adjustment shall be such that the temperature in a defined point within the chamber may be brought to within $\pm 2^{\circ}\text{C}$ of the desired value.

4.13.1 If a temperature measuring device with direct reading is provided, it shall be correct to within $\pm 2^{\circ}\text{C}$.

4.14 Workmanship — Workmanship shall be of good current engineering practice.

4.15 Finish — The external and internal finish of the chamber shall be as specified for parts not otherwise covered so as to ensure protection against corrosion and other similar effects.

4.16 Miscellaneous

4.16.1 The chamber shall be designed for optimum performance and economic continuous operation with minimum maintenance requirement. It shall occupy minimum floor area.

4.16.2 The electrical and electronic components and cables shall conform to relevant Indian Standards, wherever applicable.

4.16.3 Provision of castor wheels shall be made for easy movability of the chamber, if required.

5. POWER SUPPLY REQUIREMENTS

5.1 The test equipment shall be capable of operating from an ac supply of 50 Hz either single phase 240 V ± 10 percent or three phase 415 V ± 10 percent. Total power supply input shall be declared by the manufacturer, as required by the purchaser.

6. MARKING

6.1 The equipment shall be marked with the following information:

- a) Manufacturer's name or trade-mark;
- b) Type designation;
- c) Working volume and range of operating conditions;
- d) Power supply requirements; and
- e) Any other additional marking, as required.

7. TESTS

7.1 Each chamber shall be subjected to the following tests:

- a) Visual examination,
- b) Temperature deviation,
- c) Temperature fluctuation,
- d) Long term stability,
- e) Reproducibility of chamber conditions,
- f) Recovery-time, and
- g) Effect of moisture transfer on conditions in the chamber.

7.2 General

7.2.1 Chamber — The chamber shall be tested unloaded but with the shelves, if any, in position. The salt tray shall contain a saturated solution of sodium chloride, up to the operating level, unless otherwise specified in the test. The ambient conditions and operating voltage during the tests shall be within the ranges for which the chamber is designed.

7.2.2 Relative Humidity in the Chamber — The relative humidity obtained in the chamber shall be within the range 75 ± 2 percent when measured by the method described in 7.2.3.

7.2.3 Test for Relative Humidity in the Chamber — The chamber shall be allowed to operate for 2 hours at the upper limit of its temperature range, using a saturated solution of sodium chloride in the salt tray (see 7.2.5).

The relative humidity at a defined point within the working space during a further period of 2 hours shall be measured with a multi-junction differential wet- and-dry-bulb thermocouple. A thermocouple with a wire of diameter 0.5 mm or less is suitable for this purpose. Each dry-bulb junction is loaded with a steel or phosphor-bronze ball as described in 7.2.4.

It is essential that the thermocouple and the associated circuit shall be sufficiently sensitive and stable to allow measurements of temperature differences to 0.1°C to be made.

Measurements are made either by means of a recorder or by any other suitable method which will ensure that the maximum fluctuation in the indicated relative humidity during the period of the test is determined.

The requirement of 7.2.2 is satisfied if the wet-bulb depression in degree Celsius remains within the limits of Table 3.

TABLE 3 SPECIFIED WET-BULB DEPRESSION FOR DIFFERENT TEMPERATURES

TEMPERATURE OF TEST (1)	WET-BULB DEPRESSION (2)
°C	°C
60	5.5 ± 0.5
50	5.0 ± 0.5
40	4.4 ± 0.4
30	3.65 ± 0.3

7.2.4 Loaded Thermocouple for Temperature Measurements — A loaded thermocouple for measurements of temperature, where specified, shall be constructed and used as described below:

A flat area, about 2 mm in diameter shall be ground on a 5 mm steel or phosphor bronze ball. A thermocouple constructed of wires of diameter not exceeding 0.5 mm shall be attached to the flat area of the ball with minimum amount of solder or welding material. The wires shall be suitably insulated and protected from corrosion. After calibrating the thermocouple, the ball shall be cleaned and blackened uniformly by coating thinly with a colloidal graphite preparation.

NOTE — Other means of temperature measurements may be used provided they have approximately the same time constant as the loaded thermocouple described.

7.2.5 Saturated Salt Solution for Tests — Unless otherwise specified in the test, a saturated solution prepared from distilled water and sodium chloride of a recognized analytical reagent quality is used in the salt tray. It is essential to use an ample excess of solid salt in contact with the saturated solution. If desired, a mobile slurry of salt and saturated solution may be used, this being prepared by adding to the solid salt, of suitable particle size, a previously prepared saturated solution of the salt until the desired fluid consistency is obtained.

7.3 Temperature Deviation

7.3.1 Requirements — The temperature deviation when measured by the method described in 7.3.2 shall not exceed $\pm 0.5^\circ\text{C}$.

NOTE — The variation of relative humidity for a temperature deviation of $\pm 0.5^\circ\text{C}$ is given in Table 4. At larger temperature deviations, the relative humidity will show a greater variation.

TABLE 4 VARIATION IN RELATIVE HUMIDITY FOR 0.5°C CHANGE IN AIR TEMPERATURE WITH CONSTANT MOISTURE CONTENT

(Clauses 7.3.1 and 7.4.1)

AIR TEMPERATURE	VARIATION IN RELATIVE HUMIDITY IN PERCENT FOR NOMINAL RELATIVE HUMIDITY OF			
	30 Percent	60 Percent	90 Percent	95 Percent
(1)	(2)	(3)	(4)	(5)
°C				
10	1.0	2.05	3.05	3.22
20	0.95	1.9	2.9	3.06
30	0.9	1.8	2.7	2.85
40	0.8	1.65	2.45	2.58
50	0.75	1.55	2.3	2.43
60	0.7	1.45	2.15	2.27

7.3.2 Method of Measurement — Loaded thermocouples, as described in 7.2.4, are used in conjunction with a multipoint measuring system to measure temperature differences between one thermocouple suspended by its wires as near as possible to the centre of the working space and others suspended at:

- a) the upper corners of the working space;
- b) points as near as possible to the centres of the four sides of the working space; and
- c) points vertically above the lower corners of the working space and 1 cm above the lowest shelf; if this shelf has more than one position, use the lowest for this test.

Commencing 2 hours after the chamber first reaches its operating temperature, three readings are taken at each test point, at intervals of about 5 minutes and the mean temperature determined at each point.

7.4 Temperature Fluctuation

7.4.1 Requirements — The differences between the highest and lowest temperatures at any one point within the working space during a period of 30 minutes shall not exceed 0.5°C at any temperature within the operating range, when measured by the method described in 7.4.2.

NOTE — Without any change in the moisture content of the air, differences in air temperature from point to point within the chamber will produce differences in relative humidity.

IS : 9002 (Part VI) - 1980

The relative humidity will be low at points where the temperature is high and it will be high at points where the temperature is low.

Fluctuations in the temperature with time, at a given point will tend to produce a similar effect. If the fluctuations are slow, the changes in relative humidity will be reduced by the action of the salt solution. Temperature deviations and fluctuations should therefore be controlled to within 0.5°C . The magnitude of this effect is shown in Table 4.

7.4.2 Method of Measurement—Loaded thermocouples, as described in 7.2.4, shall be placed in each of the positions described in 7.3.2. Commencing 2 hours after the chamber first reaches its operating temperature, the actual temperature at each of the specified points in the working space shall be measured during a 30-minute test period, either by means of a recorder or by any other suitable procedure which will ensure that the maximum fluctuation in the indicated temperature during the period of the test is determined.

7.5 Long Term Stability

7.5.1 Requirements

- a) The difference between the highest and lowest chamber temperatures, reached during 72 hours continuous operation without alteration of the thermostat setting, shall not exceed 1°C when measured by the method described in 7.5.2.

NOTE—This difference includes both short-term fluctuations and long-term drift of the chamber temperature.

- b) The difference in mean relative humidity during a half-hour period at the beginning and during a half-hour period at the end of the 72-hour test period shall not exceed 2 percent relative humidity when measured at a given point by the method described in 7.5.2.

7.5.2 Method of Measurement

- a) *Change of chamber temperature*—Beginning 2 hours after the chamber first reaches its operating temperature, a recording thermometer shall be used to determine the maximum change in chamber temperature when the chamber is run for 72 hours without attention or opening, saturated sodium chloride solution, prepared as described in 7.2.5, being used in the salt tray.

It is necessary that the instrument shall measure the maximum temperature change to within 0.2°C throughout the test.

- b) *Change of relative humidity* — At the beginning and end of the 72-hour test period, the mean relative humidity shall be determined during 30 minutes, at a suitable point in the working space by means of a wet- and-dry-bulb hygrometer inserted only for the duration of the measurement. Alternatively, the instrument may be left in position if the wet bulb is used with only a small amount of water at the beginning of the test and is rewetted at the end of the test period.

It is necessary that the instrument shall measure the wet-bulb depression to within 0.1°C .

7.6 Reproducibility of Chamber Conditions

7.6.1 Requirement — Any condition of temperature and relative humidity within the operating range of the chamber shall be reproduced to within $\pm 0.5^{\circ}\text{C}$ and ± 2 percent relative humidity when the chamber is tested by the method prescribed in **7.6.2**.

7.6.2 Method of Measurement

- a) The chamber shall be allowed to operate at the desired condition for at least 2 hours, and the mean temperature and relative humidity at a defined reference point in the working space shall be recorded over 30 minutes.
- b) The chamber shall then be switched off and, without altering the thermostat setting, the chamber shall be left undisturbed for at least 6 hours.
- c) The chamber shall be switched on and the procedure described in (a) shall be repeated.

7.7 Recovery Time

7.7.1 Requirement — The time taken for the initial equilibrium condition of the air in the chamber to be regained, to within $\pm 0.5^{\circ}\text{C}$ and ± 2 percent relative humidity shall not exceed the appropriate value specified in Table 5 when the chamber is tested by the method described in **7.7.2** at 20°C , 30°C or 40°C above ambient temperature. The chamber shall be tested at the highest of these temperatures within its operating range, and at an ambient relative humidity not higher than 70 percent.

7.7.2 Method of Measurement — The measurement shall be made in an ambient atmosphere of relative humidity not higher than 70 percent.

TABLE 5 MAXIMUM RECOVERY TIME AT VARIOUS CHAMBER TEMPERATURES

(Clauses 7.7.1 and 7.7.2)

DIFFERENCE BETWEEN CHAMBER TEMPERATURE AND AMBIENT TEMPERATURE	RECOVERY TIME, Max
(1)	(2)
°C	minutes
20	10
30	15
40	20

The chamber shall be allowed to operate for 2 hours at the temperature specified in 7.7.1 which is nearest to the upper limit of its temperature range, using a saturated solution of potassium nitrate in the salt tray.

NOTE— Apart from the substitution of potassium nitrate for sodium chloride, 7.2.5 applies to the preparation and use of the saturated salt solution.

The temperature and relative humidity at a specified reference point in the working space shall be measured. The chamber door shall be opened fully, closed again after one minute. The temperature and relative humidity shall be measured after the appropriate time given in Table 5.

7.8 Effect of Moisture Transfer on Conditions in the Chamber

7.8.1 Requirements — When the chamber is tested by the method described in 7.8.2, the rate of extraction of moist air, required to reduce the relative humidity in working space by 5 percent relative humidity, shall be such that either:

- a) the rate of return of dry air to the chamber, determined volumetrically and adjusted to 0°C and 101.3 kPa, is not less than 3.2 m³ per hour per cubic metre of working space; or
- b) the rate of extraction of moisture determined gravimetrically is not less than 60 gram per hour per cubic metre of working space. In case of dispute, the gravimetric procedure shall be used.

7.8.2 Method of Measurement — A saturated solution of sodium chloride shall be used in the salt tray and the chamber shall be operated within the temperature range $25 \pm 0.5^{\circ}\text{C}$ for a period of 1 hour. The relative humidity in the working space shall be measured during this period.

By means of suitable arrangement of apparatus, the air shall be extracted continuously from the humidified stream as it enters the working space, the air shall be dried by means of a desiccator and the dry air return to the chamber at a point near where the air leaves the working space.

Details of extraction arrangement are not specified, as these may vary with the design of chamber and the apparatus available.

The rate of air extraction shall be adjusted until the relative humidity of the air in the working space is 5 percent relative humidity below that previously measured under normal operating conditions, and this condition shall be maintained for a period of 5 hours.

The rate of extraction of moisture from the chamber shall be determined either:

- a) by measuring the volume of dry air returned to the chamber, by means of dry gas meter or other suitable meter in the dry air line; or
- b) by determining the increase in weight of the desiccant between the beginning and end of the test period.

The air-volume method is normally the more simple and convenient method, but the weighing method is prescribed in case of dispute.

In this test, the air extraction tube between the chamber and the desiccant container should be thermally insulated to prevent condensation of water vapour in the tube. The mass of desiccant used (activated alumina, silica gel, etc) shall be not less than 10 kg per cubic metre of working space. A diaphragm pump or similar sealed pump should be used to extract and return the air to the chamber in order to prevent ambient air from being drawn into the circuit.

8. INFORMATION TO BE FURNISHED BY THE SUPPLIER

8.1 Suppliers of humidity chambers shall provide to the customers a technical hand book giving the following information:

- a) Principle of operation;
- b) Maximum external dimensions and mass;

IS : 9002 (Part VI) - 1980

- c) Supply voltage and power consumption;
- d) Connection to external supplies (such as, water, gas, etc);
- e) Associated equipment to be used;
- f) Layout of different components;
- g) Maintenance instructions;
- h) Working space and total internal volume;
- j) Test report on the chamber as tested in accordance with this standard; and
- k) Any deviation as agreed to between the customer and the supplier.