STANDARD
FOR
ENVIRONMENTAL TESTING OF TELECOMMUNICATION EQUIPMENT

SD:QM-333
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HISTORY SHEET:

GR TITLE	GR No.	REMARKS
Standards for Environmental Testing of Telecommunication Equipment.	SD: QM-333 Issue: March 2010	Document is in new format by thorough revision of "standards for environmental testing of Electronic Equipment for Transmission and Switching use" published vide QM-333/Issue-I/September 1990 by then Telecom Quality Assurance Circle, Bangalore of Department of Telecommunications.

SECTION-1

GENERAL INFORMATION

1.1.0 INTRODUCTION

The QM-333/Issue-March 2010 standard for environmental testing of *Telecommunication Equipment* has been framed by Telecommunication Engineering Centre (TEC), considering climatalogical conditions prevalent in different parts of India. This standard has been framed, keeping in view that certain amount of risk management of failures has to be undertaken in technological development and balanced with cost effectiveness. This standard provides for test conditions for assessing the design capability of equipment and for qualification of manufacture and associated process.

It is not intended to be an accelerated test for reliability assessment, nor is it intended to be an electronic stress screen, although the cycles provide for some amount of stress screening under storage. It is to be kept in mind that the basic aim of the standard is qualification of design and the ability to perform under different climatological conditions.

It has been the experience that the results of such environmental tests provide close correlation to acceptable performance of the equipment in the field during the life time of the equipment. There may also be cases where the field observations do not co-relate with the satisfactory performance during environmental test. Such cases will have to be viewed carefully by analysing the sequence of events which gave rise to the mismatch, though found exceptionally.

The QM-333 standard is to be applied in general for most types of Telecommunication equipment. There could be products whose standards preclude the application of some portion of the test cycle. The application of this test cycle will have to be studied in such cases and exceptions made, if necessary.

The test clauses given in the individual Equipment's Generic Requirements (GR)/ Tender/ Purchase Order Standard issued by Telecom Engineering Centre or Purchaser will have overriding authority to any of the test clauses of this standard, if they are found to be at variance.

1.2.0 SCOPE

1.2.1 This standard describes standard procedures and conditions for environmental tests for Telecommunication equipment and all other type of equipment used in the Indian Telecom Network. Subsystems which are being used in equipment should also meet these standards.

1.2.2 This standard includes environmental conditions obtainable in the laboratory such that if equipment is exposed to these conditions and it continues to operate in a satisfactory manner, a high degree of confidence would have been established, that the equipment would survive the field environment during its expected operational

and storage life. The tests described herein are not to be interpreted as an exact and conclusive representation of actual operational and storage conditions. It is also the purpose of this document to standardise environmental tests in order to obtain as much as possible, reproducible test results and to serve as a guide for those engaged in the design of equipment and sub assemblies. This standard should therefore be used at all times in conjunction with the standards for the equipment to be tested.

1.2.3 The acceptable performance limits of the equipment when subjected to environmental test are not included in this standard. The relevant equipment standard shall define the acceptable performance limits.

1.2.4 The environmental categories and tests included in this standard do not cover all contingencies and operational and storage environments. Any additional tests deemed necessary in particular cases may be specified in the relevant equipment standard at the time of procurement, drawing reference to current Indian or International Standards applicable. The relevant equipment standard may also stipulate where the special environmental conditions provided herein will apply, and may specify the deviations in test procedure which may be warranted or necessary when applying any of these tests or may lay down special procedures which may be required.

1.2.5 The standard defines the requirements for environmental conditions under which the equipment must be tested, so as to ensure their satisfactory operation in service, transportation or storage. It also defines the environmental tests to which the equipment will be subjected to ensure satisfactory operation of the equipment under normal environmental conditions with a margin of safety to meet extreme environmental conditions applicable to particular equipment at some time of the service / storage life. They consist of a series of operations in order to determine the effect of environmental conditions on the equipment.

1.2.6 The tests prescribed in this standard are not meant as reliability tests but as quality tests. The tests are non-destructive and the equipment is reusable at the end of the tests. Components for the equipment should have been adequately qualified before hand. The periodicity of application of tests prescribed in this standard shall be as per the relevant equipment standard or shall be laid down by the acceptance authority for the equipment.

1.2.7 Alternative methods of demonstrating that the equipment will meet the objectives in a manner at least as rigorous as that specified herein are acceptable by negotiation and agreement with the issuing authority.

1.2.8 There shall be an analysis of the failure, revealed during the application of the standard, so that the technical causes of the failures are understood and corrective action is taken on that basis with the approval of the user.

1.2.9 In order to distinguish the equipment that it has undergone environmental tests, it would be preferable for the manufacturer to provide a distinct indelible marking on all the modules and bays.

1.3.0 DEFINITIONS

1.3.1 Equipment

For the purpose of this standard, equipment is any functional unit, other than component and shall include printed circuit boards, sub-assemblies, and finished equipment configured in a fashion as they would normally operate in service.

1.3.2 Test

A test is a complete series of operations and will normally consist of the following:

a) Pre-conditioning (when required)
b) Initial measurements
c) Conditioning
d) Intermediate measurement
e) Recovery (when required)
f) Final measurements

A particular test may specify intermediate measurements during conditioning and / or recovery.

1.3.2.1 Pre-conditioning

Pre-conditioning is the treatment of equipment with the object of removing or partly counteracting the effects of its previous history. Where called for, it is the first process in the test procedure.

1.3.2.2 Burn-in

For the purpose of this document, burn-in is a condition where the equipment is kept under pseudo simulated conditions as envisaged during its storage / service for a duration of 168 hours or at 50° C for a duration of 72 hours under laboratory conditions or any other test conditions mutually agreed upon.

1.3.2.3 Visual examination

Visual examination is generally made before and after the conditioning in each test and form a part of Initial and Final Measurements. During the visual examination of the equipment, defects in construction, the presence of foreign bodies, moisture, dust etc, corrosion of metal parts and any form of deterioration of materials and finishes, distortion or mechanical imperfections shall be noted.

1.3.2.4 Defect Classification List (DCL):

a) Verification of equipment with documents
b) Check of component approval status

c) Check of workmanship such as mounting of components, quality of soldering, marking and identification etc.

1.3.2.5 Initial measurements

This consists of inspection by, DCL (Defect Classification List) and testing of the equipment for the standard guaranteed or specified critical operative parameters prior to conditioning to determine the characteristics of the equipment. The parameters so selected shall be such that they indicate the overall health of the equipment under test and shall be measurable in a stipulated time. This also includes checking any physical parameters when specified.

1.3.2.6 Conditioning

Conditioning is the exposure of the equipment to an environmental condition in order to determine the effect of such a condition on it.

1.3.2.7 Intermediate measurement

This is a measurement taken during or at the end of the conditioning period. The intermediate measurements are of two types.

For ***carrying out these*** measurements, the equipment may be removed from the environmental test chamber only under unavoidable circumstances.

1.3.2.7.1 Standard check

The equipment shall be tested electrically for specified critical parameters, those selected during initial measurements as per 1.3.2.5. The parameters measured ***shall comply with*** the relevant standard. The duration of standard check shall not be more than ***one hour***.

1.3.2.7.2 Functional check

The equipment shall be tested electrically for specified critical parameters, those selected during initial measurements as per 1.3.2.5. The equipment shall remain operational without any irreversible damage. The duration of functional check shall be as short as possible.

1.3.2.8 Recovery

Recovery is the treatment of the equipment after conditioning in order that the properties of the equipment may be stabilised before final measurement.

1.3.2.9 Irreversible damage

This means that the equipment does not recover on its own to its normal operating condition without making any change in hardware or software part of the equipment or without resetting the input supply to the equipment.

1.3.2.10 Final examination and measurement

This consists of inspection by, DCL (Defect Classification List) and testing of the equipment for the standards guaranteed or specified critical operative parameters at the conclusion of a test, so that a comparison with the initial measurements will show the effect of the test on the equipment. This also includes changes in physical parameters when specified. Results of final examination and measurements made at the end of one test may be taken as the initial examination and measurements for the subsequent test.

1.3.3 Temperature equilibrium

Temperature equilibrium is considered to have been reached when the temperature of any part of the equipment in the non-energised condition is within 2° C of the temperature of the immediate surroundings. In the case of large test chambers, however, where ± 2° C tolerances may not be attainable, it shall be acceptable to permit ± 3° C limit as equilibrium condition.

1.3.4 STANDARD ATMOSPHERIC CONDITIONS

1.3.4.1 Standard testing conditions

Measurements and mechanical checks may be carried out at any combination of temperature, relative humidity and pressure within the following limits:-

Temperature	15° C to 35° C
Relative humidity	45 % to 75 %
Air pressure	86 to 106 kPa

NOTE

1. The temperature range may be extended beyond these limits, say, up to 10° C to 40° C for large equipment.
2. The limits of variations of temperature and relative humidity during a series of measurements carried out as part of one test on any equipment shall, if necessary, be specified in the relevant equipment standard.
3. Where it is impracticable to carry out measurements within the limits of the standard atmospheric conditions for testing, a note to this effect stating the actual conditions of tests shall be added to the test report.

1.3.4.2 Standard Reference conditions

i) If the parameters to be measured depend on temperature and / or pressure and if the law of dependence is known, the values are measured at conditions specified under 1.3.4.1 and if necessary, corrected by calculation at the following reference values:

Temperature	:	+ 20° C
Air pressure	:	101.3 kPa

Note: No requirement for relative humidity is given because a correction by calculation is generally not possible.

ii) If the parameters to be measured depend on temperature and / or air pressure and if the law of dependence is unknown, the measurements shall be made under the following conditions: -

Temperature	:	25° C ± 1° C
Relative humidity	:	50% ± 2 %
Air Pressure	:	86 to 106 kPa

Note: In the case of large equipment or test chambers where temperature and relative humidity and / or air pressure limits specified above are difficult to maintain, wider tolerance shall be permissible. In such cases, the actual values used shall be given in the test report.

1.3.4.3 Standard Recovery conditions

The standard recovery conditions shall be the actual laboratory conditions. When different recovery conditions are needed for the interval after conditioning and /or to be used for pre-conditioning or at any other time in order to bring the state of the equipment to a standard condition, these recovery conditions shall be specified under each test.

1.4 VOLUME OF CHAMBERS

Equipment undergoing test should be placed centrally in the test chamber. The volume of the test chamber is as per Cl. 4.2.1. under Section 4. In case this is not practicable, this can be mutually agreed between the supplier and the acceptance authority after a technical examination of the constraint due to inadequate volume of chamber.

1.5 RELEVANT EQUIPMENT STANDARD

A document specially drawn-up or provided, this lays down the characteristics and performances of an equipment under specified conditions of use.

1.6 SELECTION OF TEST LIMITS

Where an option in test severity is permitted, the relevant equipment standard shall specify the approximate severity of the test.

1.7 CRITERIA FOR FAILURE

For the purpose of acceptance decision, a failure is a condition where the equipment fails to fully meet the specified performance.

An analysis of failure and a study of its effect on the performance should be carried out for considering acceptability of equipment. Frequent failures or major failures may entail the termination of the tests. In case of infrequent or minor failures, tests may continue by replacing the sub-assembly or components at the discretion of acceptance authority. However, in all cases of failures, analysis of the causes of the failures shall be conducted. This may require additional testing of the particular sub-assembly where failures have occurred.

The relevant equipment standard may define if necessary specific terms as to what constitutes a failure under each of the environmental stress conditions.

SECTION-2

EQUIPMENT ENVIRONMENT CATEGORIES AND APPLICABLE TESTS WITH RECOMMENDED SEQUENCE

2.1 CATEGORIES: The Table 2.1 gives the categories in which Telecommunication equipment can be divided, based on operating environment.

Table 2.1

ENVIRONMENT WISE EQUIPMENT CATEGORIES

Category	**Location and exposure condition**	**Equipment** (Illustrative only) - The list is not exhaustive and the relevant standard should be referred
A	Installed in air-conditioned buildings which have temperature and humidity control. Air-conditioning failure of less than 2 hours duration at a time is permissible	**Typically:** Equipment such as Electronic Switching Exchanges of capacity of 500 lines or more; Ground communication equipment for Satellite Earth Station (Main and Primary); WLL system, Base Station Controller (BSC), Base Transceiver Station (BTS) for Indoor use & Mobile Switching Centre (MSC) of Mobile Network for CDMA/GSM based Wireless Systems, Network Management System etc.
B	B_1- Building with air condition with possibility of failure of air conditioning for a duration of 2 hours or more at a time	**Typically**: PC driven hardware and its peripherals; Optical Fibre Line Terminal Equipment; Digital Multiplex equipment; Radio Terminal Equipment; UHF/VHF and other wireless systems; Transmission Repeater equipment inside buildings; Hub Stations of VSAT Systems, Hub Stations (Indoor) Equipment for other Satellite Services. Base Transceiver Station (BTS) for CDMA / GSM based Wireless systems.
	B_2 - Buildings without air conditioning where adequate ventilation may or may not be available.	**Typically:** Electronic Switching Equipment of capacity less than 500 lines. SDH systems; Digital Cross-connect switches, MDF. Telephone Instruments (EPBTs) (please see note 4), all kinds of Network Terminals, VSAT terminals (indoor) MCPC/SCPC remote terminals, Satcom equipment required for extended satellite derived circuits to TAX. Optical and Electrical Measuring Instruments; SMPS Power Plants; Inverter, UPS and VRLA Batteries. Optical Telephones; Optical Fibre Splicing machines; Hand Held Terminals for Control of Transmission Equipment. Hand Held and Fixed Wireless Terminals and Mobile SIM Cards. Satellite Earth Station Equipment for stations located in Islands & Coastal Areas.

C	Buried underground or installed in manholes	**Typically**: Underground Regenerator / Repeater equipment for optical and other line systems. Any other equipment installed in closed underground / buried enclosures.
D	Installed in cabinets / containers or huts protected from direct sunlight without any ventilation	**Typically:** Pole mounted and wall mounted equipment working in outside atmosphere; over ground repeaters / optical and other line systems; outdoor antenna sub systems (LNA etc.) for VSATs, SPV Panels etc. Base stations and remote terminal of WLL & GSM system. Outdoor equipment for VSAT Hub Stations, VSAT Remote terminals, other satellite equipment. Other equipment housed in enclosures working in open atmosphere.
E	Passive Equipment installed in indoor / outdoor / underground / overground	**Typically:** Fibre Distribution Frames; Digital Distribution Frames; OF Termination Box; Optical Joint Closures; VHF / UHF Microwave Antennas and Feeds; Feeder Cable; Waveguides; Optical Fibre Cables; PIJF Cables; PLB HDPE Ducts; DWC; Insulation accessories & fixtures; Dropwire accessories all other mechanical items used in Telecom.

Note 1: If there is possibility of equipment being used in more than one category, the most severe of the test conditions will be applied.

Note 2: It should be noted that categorisation of a product under Category A, B_1 or B_2 is based on an assessment of the practicability of providing air-conditioned environment, thus reducing the burden on the product design. Where it is impracticable to provide air-conditioned environment in the dispersed areas of operation of the equipment, the burden has necessarily to be transferred to the product design for ensuring that it will conform to standards in the more difficult non air-conditioned environment. In any case, provision of air-conditioned environment to any electronic product during its operational life will have the effect of prolonging the useful life of the product.

Note 3: The general environment categories detailed above may need to be qualified in particular cases by the presence of special environment conditions such as salt-laden atmosphere in sea-coast areas or the equipment may be required to function at high ground altitudes (higher than 3000 meters above mean sea level). Some of the equipment may also be pressurised even at normal altitudes and operation. It will be proper to recognise these different environmental conditions in the matter of determination of the climatic and durability tests to be applied.

Note 4: In case of all types of telephone instruments, the environmental tests shall be conducted as per relevant equipment standard.

Table 2.2 presents the recommended sequence of Environment Tests, the Climatic and Durability Tests, to be applied to the equipment of different categories for Environmental Test as per this standard. It shall be acceptable, however if the equipment supplier and the acceptance authority by mutual agreement modify the test sequence depending upon the local condition.

Table 2.2

Sequence No.	***Test No***	***Environmental Test***	***Category of Equipment***						
			A	**B**	**C**	**D**	**E**		
							Indoor	**Outdoor**	**Under Ground**
01.	1	Low Temperature (cold)	YES	YES	YES	YES	**NO**	**NO**	**NO**
02.	2	High Temperature (Dry heat)	YES	YES	YES	YES	**NO**	**NO**	**NO**
03.	3	Tropical Exposure (Damp Heat Cyclic)	YES	YES	YES	YES	**NO**	**NO**	***NO***
04.	4	Rapid Temperature Cyclic	YES	YES	YES	YES	**YES Note-3**	**YES Note-3**	**YES Note-3**
05.	5	Damp Heat Steady State	YES	YES	YES	YES	**YES Note-3**	**YES Note-3**	**YES Note-3**
06.	6	Vibration	YES Note-2	YES Note.1&2	YES Note-1&2	YES Note-1&2	**YES** Note-1&2	**YES** Note-1&2	**YES** Note-1&2
07.	7	Sealing (gas tightness)/ High Altitude test	NO	NO	YES Note-4	YES Note-4	**YES Note-2**	**YES** ***Note-2***	**YES Note-2**
08.	8	Water Immersion	NO	NO	YES	YES *Note-4*	**NO**	**NO**	**YES Note-2**
09.	9	Corrosion - salt	NO	YES Note-5	YES Note-5	YES Note-5	**YES**	**YES**	**YES**
10.	10	Drop test	YES Note-6	YES Note-6	YES Note-6	YES Note-6	**YES Note-2**	**YES Note-2**	**YES Note-2**

Sequence No.	Test No	Environmental Test	Category of Equipment						
			A	B	C	D	E		
							Indoor	Outdoor	Under Ground
11.	11	Toppling test	YES Note-6	YES Note-6	YES Note-6	YES Note-6	**YES** Note-6	***YES*** *Note-6*	**YES** Note-6
12.	12	*Fall Test*	YES Note-7	YES Note-7	YES Note-7	YES Note-7	NO	*NO*	NO
13.	13	Bump / Roadability Test	NO	YES	YES	YES	YES Note-2	YES Note-2	YES Note-2
14.	14	*Rain*	NO	NO	NO	YES Note-2	**NO**	**YES Note-2**	***NO***
15.	15	Dust	NO	YES Note-8	NO	YES Note-8	**NO**	**NO**	***NO***

a) YES: Test to be conducted
b) NO: Test not applicable

Note-1: For some of the category B equipment which are generally installed in subscriber premises like FWTs, IFWTs, Modems, CPEs systems, EPBTs, etc., category C, D & E equipment vibration may be done in unpacked condition.
Note-2: Test shall be conducted only when called for in the relevant Generic Requirements (GR).
Note-3: The temperature ranges / No. of cycles will be as per relevant Generic Requirements (GR), if specified.
Note-4: Test shall be necessary where equipment is pressurised or required to operate at altitudes in excess of 3000 meters above mean sea level.
Note-5: Test shall be necessary where equipment is to operate in salt laden atmosphere (sea coast areas, saline soil and islands)
Note-6: Drop/Toppling test need be performed only on portable equipment where no dimension exceeds 60 cms.
Note-7: Applicable for telephone instruments and other portable equipment, if called for in the relevant Generic Requirements (GR).
Note-8: Test shall be necessary only when equipment is exposed to desert environment.

2.3 Range of temperature and humidity

The ranges of ambient temperatures and maximum humidity within which the equipment performance standards shall be met as well as the ranges within which the equipment is to remain operational without any irreversible damage for each environmental category are shown in Table 2.3.

Table 2.3

Applicable Temperature Range & Relative Humidity (RH) Values

Sl. No.	***Requirements***	***Cat.A***	***Cat.B***	***Cat.C***	***Cat.D*** ***(Note-5)***	***Cat.E***		
						Indoor (I/D)	***Under Ground (U/G)***	***Out Door (O/D)***
I. Applicable for Thermal Cycle only:								
1.	*Ambient Temperature Range over which equipment is to remain operational without irreversible damage (50% RH maximum)* ***(Note-2 &3)***							
	Min.	*0 °C*	*-5 °C*	*5 °C*	*-15 °C*	*--*	*--*	*--*
	Max.	*35 °C*	*55 °C*	*40 °C*	*60 °C*	*--*	*--*	*--*
2.	*Ambient Temperature range over which standards are guaranteed (50% RH max. temp.)* ***(Note-2 &3)***							
	Min.	*20 °C*	*0 °C*	*15 °C*	*-10 °C*	*--*	*--*	*--*
	Max.	*30 °C*	*50 °C*	*35 °C*	*55 °C*	*--*	*--*	*--*
3.	*Storage Temperature (50% RH max. at the max. temp) without causing irreversible damage* ***(Note-2 &3)***							
	Min.	*-5 °C*	*-5 °C*	*-5 °C*	*-15 °C*	***-5 °C***	***-5 °C***	***-15 °C***
	Max.	*60 °C*	*60 °C*	*60 °C*	*60 °C*	***60 °C***	***60 °C***	***60 °C***
II. Applicable for Damp Heat Cyclic and Damp Heat Steady State:								
1.	*Maximum temperature for which standard are guaranteed at 95% RH* ***(Note-4)***	*35 °C* ***(Note-1)***	*35 °C*	*35 °C*	*35 °C*	*--*	*--*	*--*
2.	*Maximum temperature for which equipment shall survive at 95% RH* ***(Note-4)***	*40 °C*	*40 °C*	*40 °C*	*40 °C*	*--*	*--*	*--*

Note-1: For category A, the temperature and humidity condition corresponds only to operational conditions without irreversible damage. Ambient measurements can be taken at 30° C and 90-95% Relative Humidity (RH), ensuring that condensation does not take place.

Note-2: The tolerance in temperature is ± 2° C in the case of small test chambers, but where a single large walk-in test chamber is employed, the temperature tolerance value shall be ± 3° C.

Note-3: The figure of 50% RH Max. applies in cases where the nominal temperature of the chamber is 35°c or less. At temperatures higher than 35° C, it shall be permissible to maintain an absolute humidity of 20gm/m^3 in case of test chamber limitation against realisation of 50% RH maximum. These limits apply to Dry Heat, Dry Cold and Rapid Temperature Cycle Tests.

Note-4: Maximum relative humidity shall be 95% for the Damp Heat Cycles and shall not be less than 90% at any point of test chamber at any time of the conditioning period calling for this maximum humidity.

Note-5: For equipment falling under category D, successful performance during Environmental Tests over the following temperature shall be satisfactory for more than 98% locations and time in the country.

Guarantee Range	:	0° C to 55° C
Operational Range	:	-5° C to 60° C
Storage Range	:	-5° C to 60° C

Location in India which require tests of higher severity for low temperatures are around Srinagar and Leh.

Note 6: For equipment falling under category B_1, results will be examined if failures occur and discussed between the manufacturer and acceptance authority.

2.4 CLIMATIC TESTS

2.4.1 Recommended climatic test sequence

The recommended sequence for climatic testing shall consist of the following tests as applicable vide table 2.2 in the order given below.

1. Cold (Low Temperature)
2. Dry Heat (High Temperature)
3. Damp Heat Cyclic (Tropical Exposure)
4. Rapid Temperature Cyclic
5. Damp Heat Steady State

2.4.2 Interval between tests

As far as possible, an interval of not more than 3 days is permitted between any two of these test cycles.

2.4.3 Equipment performance and operation

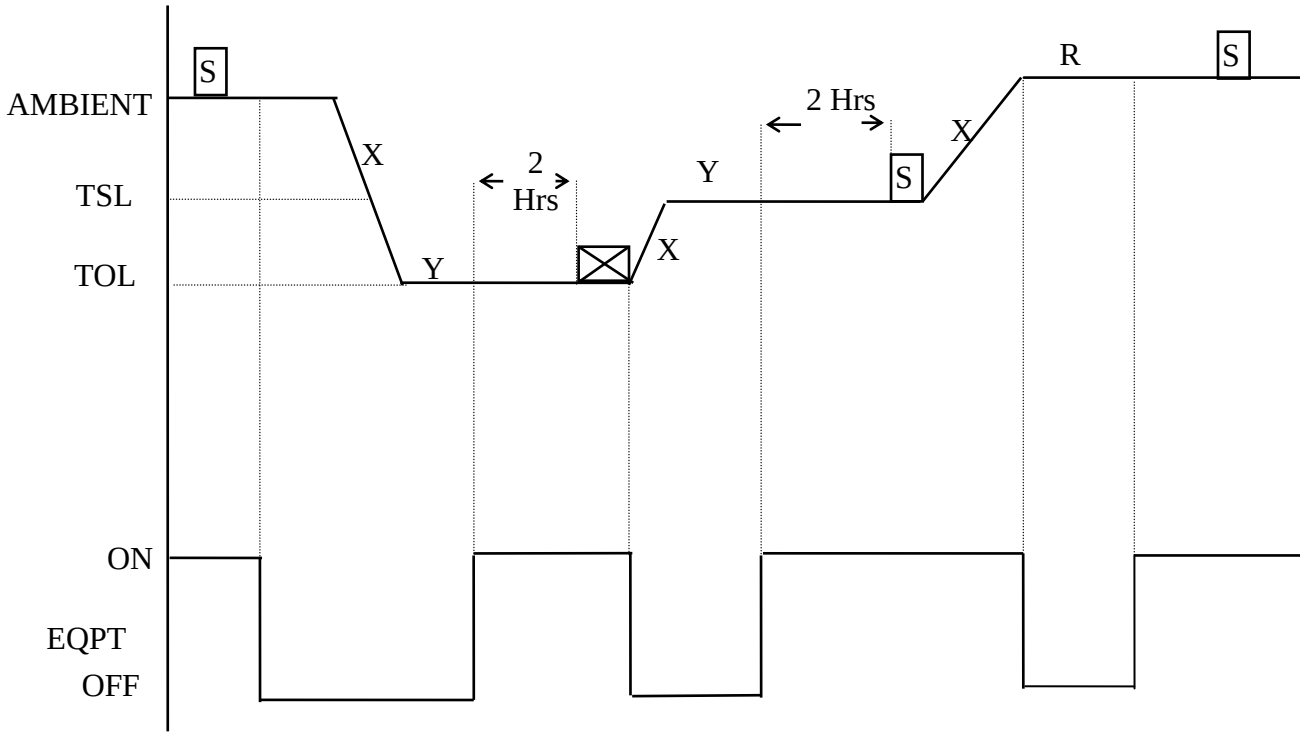
The range of ambient temperature and the maximum relative humidity over which the equipment performance and operation shall be met are given in Table 2.3.

SECTION- 3

DESCRIPTION OF TEST METHODS

TEST NO. 1

LOW TEMPERATURE (COLD) CYCLE



	CAT. A	CAT. B	CAT. C	CAT. D
TSL	20°C	0°C	15°C	-10°C
TOL	0°C	-5°C	5°C	-15°C

X : Rate of change of temperature (1°C / min.)
Y : *Time taken by the chamber to attain temperature equilibrium*
R : *Recovery period – 1 to 2 hours*
⊠ : Functional check (Equipment should remain operational)
S : Standard check
TOL : Lowest Temperature at which equipment remains operational
TSL : Lowest Temperature at which standard guaranteed

3.1.1 Object

The objectives of this test are:

a) To determine the suitability of the equipment for use at specified low ambient temperature in accordance with a particular environmental category.
b) Whether or not the equipment can be switched ON and function during low temperature conditions; and
c) The influence of low temperature conditions, after a specified period of exposure on the operational performance of the equipment.

3.1.2 Test chamber

The construction of the test chamber used for the test shall comply with the requirements given in Section 4.

3.1.3 Initial examination and measurement

The equipment shall be visually examined, electrically tested and mechanically checked under standard atmospheric conditions as required by the relevant measurement standard. All the test results shall be recorded as per relevant equipment standard.

3.1.4 Conditioning and Intermediate Measurements

3.1.4.1 The equipment under test in unpacked `ready for use' condition and at the ambient temperature shall be introduced into the chamber which is at the same ambient temperature. At the beginning of the test, the equipment shall be in `switched off' condition.

3.1.4.2 The temperature within the chamber shall then be adjusted to the lower temperature at which, the equipment is required to remain operational and at which, no irreversible damage is to occur (as per Table 2.3). The rate of change of temperature shall not exceed 1º C per minute averaged over a period of not more than 5 minutes. The relative humidity shall not exceed 50% RH.

3.1.4.3 The equipment shall be exposed to the low temperature condition as in 3.1.4.2 within the tolerance given until temperature equilibrium is reached. The equipment shall then be switched ON and checked to ascertain whether it is capable of operating and shall then remain in an operating condition for a further period of atleast two hours. Any cooling or heating arrangement normally used with the equipment in actual service shall be used during this period of the test.

3.1.4.4 At the end of the two hour period and while still at this temperature, the equipment shall be checked to be functional (operational) - Functional Check. Any failure of operation shall be noted. The equipment shall then be switched OFF. The duration of functional check shall be as short as possible.

3.1.4.5 The temperature within the chamber shall then be adjusted to the temperature within the tolerance at which the equipment is required to meet the standards (as per Table 2.3). The rate of change of temperature shall not exceed 1º C per minute averaged

over a period of not more than 5 minutes. After it has reached equilibrium, the equipment shall be switched ON and then exposed at that temperature for a further period of at least two hours. Any cooling or heating normally used with the equipment in actual service shall be used during this period of test.

3.1.4.6 At the end of this period and while still at the low temperature, the equipment shall be electrically tested in accordance with the relevant standard-***Standard Check***. Any departure from the requirement of this standard shall be noted. The duration of standard check shall not be more than ***one hour***.

3.1.4.7 The temperature of the chamber, with the equipment energised, shall be gradually increased until it is within the limits of standard atmospheric conditions for testing. The equipment shall then be switched OFF.

3.1.5 Recovery

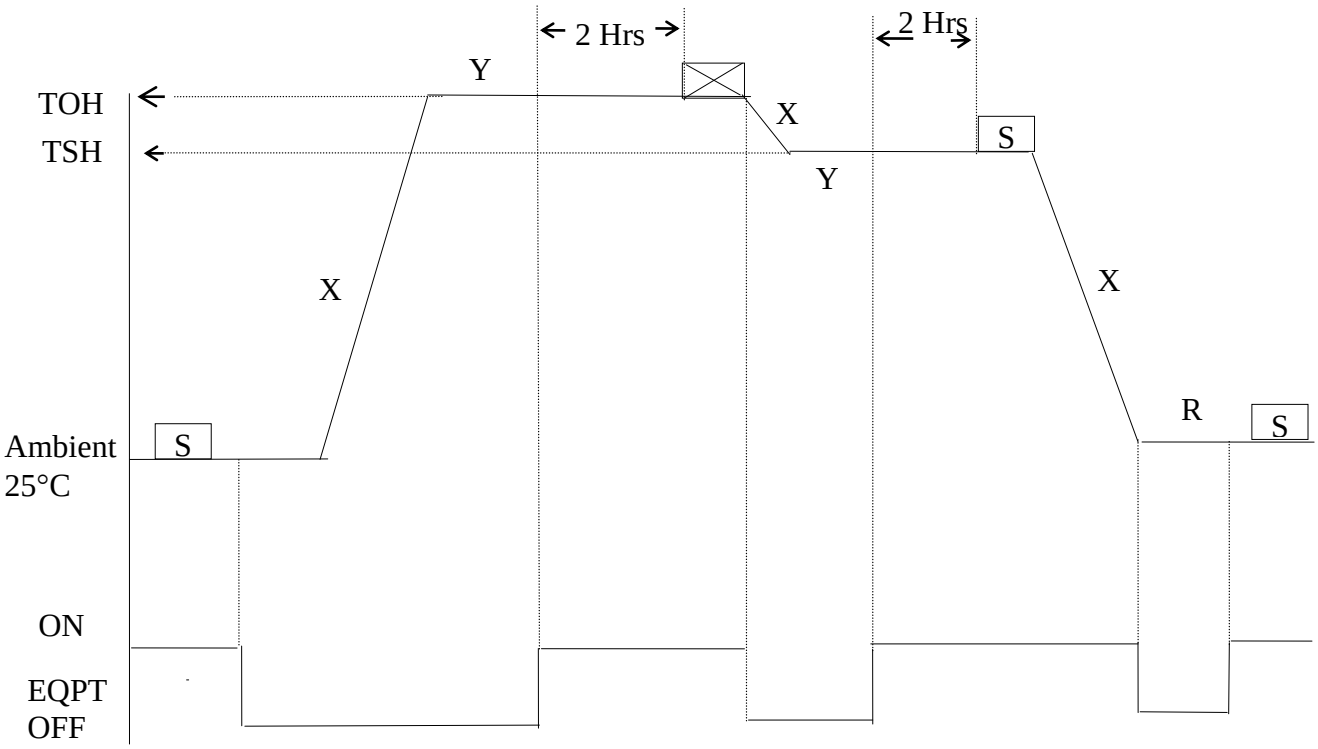
At the end of this period, the equipment shall be removed, if required, from the chamber and subjected to standard atmospheric conditions for recovery for a period of 1 to 2 hours.

3.1.6 Final examination and measurements

The equipment shall be visually examined, electrically tested and mechanically checked as required by the relevant standard- ***Standard Check***. The results of the measurements shall be compared with the result of initial measurements.

TEST NO. 2

HIGH TEMPERATURE (DRY HEAT) CYCLE



	CAT. A	CAT. B	CAT. C	CAT. D
TOH	35°C	55°C	40°C	60°C
TSH	30°C	50°C	35°C	55°C

X : Rate of change of temperature (1°C / min.)
Y : *Time taken by the chamber to attain temperature equilibrium*
R : *Recovery period – 1 to 2 hours*
⊠ : Functional check (Equipment should remain operational)
S : Standard check
TOH : Highest Temperature at which equipment remains operational
TSH : Highest Temperature at which standard guaranteed

3.2.1 Object

The object of this test is:

a) To determine the suitability of equipment for use under conditions of high ambient temperature in accordance with a particular environmental category.
b) Whether or not the equipment can be switched ON and function during the high temperature conditions and
c) The influence of high temperature conditions after a specified period of exposure on the operational performance of the equipment.

3.2.2 Test Chamber

The construction of the test chamber used for the test shall comply with the requirements given in Section 4.

3.2.3 Initial examination and measurement

The equipment shall be visually examined, electrically tested and mechanically checked under standard atmospheric conditions as required by the relevant measurement standard. All the test results shall be recorded as per relevant equipment standard.

3.2.4 Conditioning and Intermediate Measurements

3.2.4.1 The equipment under test is unpacked, 'ready for use' condition and at the ambient temperature shall be introduced into the chamber which is at the same ambient temperature. At the beginning of the test, the equipment shall be in `switched OFF' condition.

3.2.4.2 The temperature within the chamber shall then be adjusted to the higher temperature at which the equipment is required to remain operational and at which, no irreversible damage is to occur (as per table 2.3). The rate of change of temperature shall not exceed 1°C per minute averaged over a period of not more than 5 minutes. The relative humidity shall not exceed 50%.

3.2.4.3 The equipment shall be exposed to the high temperature condition as in 3.2.4.2 within the tolerances given until temperature equilibrium is reached. The equipment shall then be switched ON and checked to ascertain whether it is capable of operating and shall then remain in an operating condition for a further period of at least two hours. Any cooling or heating arrangement normally used with the equipment in actual service shall be used during this period of the test.

3.2.4.4 At the end of the two hour period and while still at this temperature, the equipment shall be checked to be functional (operational) – Functional Check. The duration of functional check shall be as short as possible. Any failure of operation shall be noted. The equipment shall then be switched OFF. The maximum surface temperature of components or materials in the equipment shall be measured and recorded, wherever possible.

3.2.4.5 The temperature within the chamber shall then be adjusted to the temperature within the tolerance at which the equipment is required to meet its standard (as per table 2.3). The rate of change of temperature shall not exceed 1°C/minute averaged over a period of not more than 5 minutes. After it has reached equilibrium, the equipment shall be switched ON and then exposed at that temperature for a further period of two hours to check that no derangement has occurred on account of hot "switch ON" or start up. Any cooling or heating arrangements normally used with the equipment in actual service shall be used during the period of test.

3.2.4.6 At the end of this period and while still at high temperature the equipment shall be electrically tested in accordance with the relevant standard – ***Standard Check***. Any departure from the requirement of this standard shall be noted.

3.2.4.7 The temperature of the chamber, with the equipment energized, shall be gradually lowered until it is within the limits of standard atmospheric conditions for testing. The equipment shall be then switched OFF.

3.2.5 Recovery

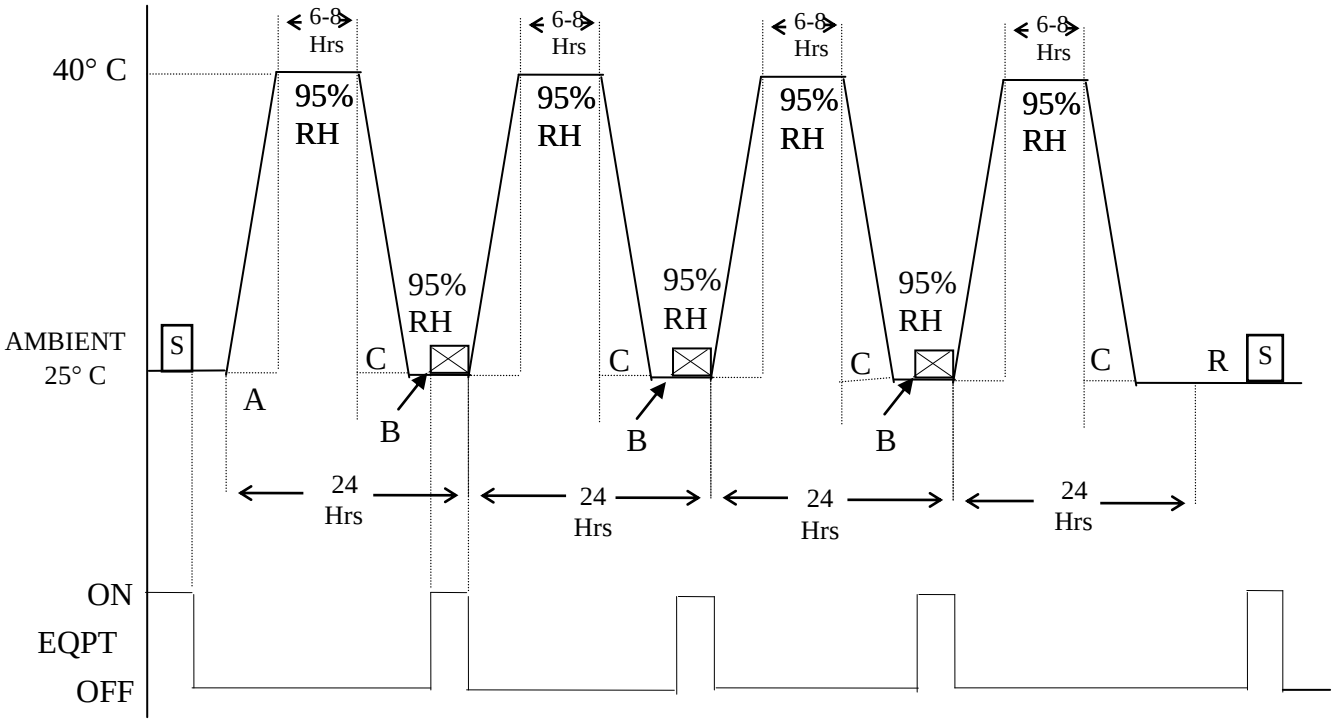
At the end of this period, the equipment shall be removed from the chamber, if required, and subjected to standard atmospheric conditions for recovery for a period of 1 to 2 hours.

3.2.6 Final examination and measurements.

The equipment shall be visually examined, electrically tested and mechanically checked as required by the relevant standard - ***Standard Check***. The results of the measurements shall be compared with the result of initial measurements.

TEST NO. 3

TROPICAL EXPOSURE (Damp Heat Cyclic)



A - 2 to 3 Hrs

B - 3 to 6 Hrs

R - Recovery period - 1 to 2 Hrs

C - 3 to 6 Hrs

⊠ - Functional check (Eqpt. should remain operational)

S - Standard check

3.3.1 OBJECT

To determine the suitability of equipment for use after storage conditions of high humidity when combined with cyclic temperature changes.

3.3.2 Test Chamber

The construction of the test chamber used for the test shall comply with the requirements given in Section 4.

3.3.3 Initial examination and measurements

The equipment shall be visually examined, electrically tested and mechanically checked under standard atmospheric conditions as required by the relevant standard. All the test results shall be recorded as per relevant equipment standard.

3.3.4 Conditioning and Intermediate Measurements

3.3.4.1 The equipment at ambient temperature shall be introduced into the chamber which is also at the ambient temperature in the unpacked, switched-off condition, assembled in its final form with all panels and covers in place and with sealing arrangements, where applicable intact, or as otherwise specified in the relevant standard. The mounting position will be prescribed in the standard. Where no specific mounting is prescribed, the thermal conduction of the mounting shall be low.

3.3.4.2 The temperature of the equipment under test shall be established at 25 ± 3 Deg. C by adjusting and maintaining the temperature of the test chamber to this value after the introduction of the equipment. The relative humidity during this phase shall be between 45% and 75% (standard testing conditions). Pre-heating of equipment should be done before injection of humidity. The relative humidity shall then be increased to not less than 95% within a period not exceeding one hour. Commencing the cycle from here, the temperature of the chamber shall be continuously raised to the appropriate upper limit prescribed for storage or 40 deg. C whichever is lower over a period of 2 to 3 hours. During this period, the relative humidity shall not be less than 93 ± 2% except during the last 15 minutes when it shall not be less than 90%.

3.3.4.3 The chamber shall be maintained at the above upper limit temperature within the prescribed tolerance for a duration of 6 to 8 hours. During this period, the relative humidity shall be 93 ± 2 % except for the first and last 15 minutes when it shall be between 90% and 100%. Condensation must not occur during the last 1/2 hour.

3.3.4.4 The temperature of the chamber shall then be lowered to 25 ± 3 deg.C within 3 to 6 hours. During the period of temperature fall, the relative humidity shall be not less than 95% except for the last 15 minutes when it shall not be less than 90%. The temperature shall be maintained at 25 ± 3 deg. C with relative humidity not less than 95% until the 24 hour cycle is completed. The equipment may be switched ON after 3 to 6 hours and checked for operation without irreversible damage (Functional Check).

3.3.4.5 The procedure in the paras 3.3.4.2, 3.3.4.3 & 3.3.4.4 will be repeated for the next 3 cycles, except that the stabilisation part and period which includes maximum one hour to raise relative humidity will not be required (para 3.3.4.2) as the same would exist when commencing the subsequent cycles.

3.3.5 Recovery

3.3.5.1 At the end of this, the equipment shall be subjected to atmospheric conditions for recovery for not less than 1 hour and not more than 2 hours. The equipment may be transferred to another chamber for recovery or may remain in the damp heat chamber. In the former case, the changeover time shall be as short as possible and shall not exceed 5 minutes. In the latter case, the relative humidity shall be reduced to between 73 & 77% in not more than 30 minutes after which the temperature shall be adjusted to within ± 2 deg. C of standard atmospheric temperature in not more than 30 minutes.

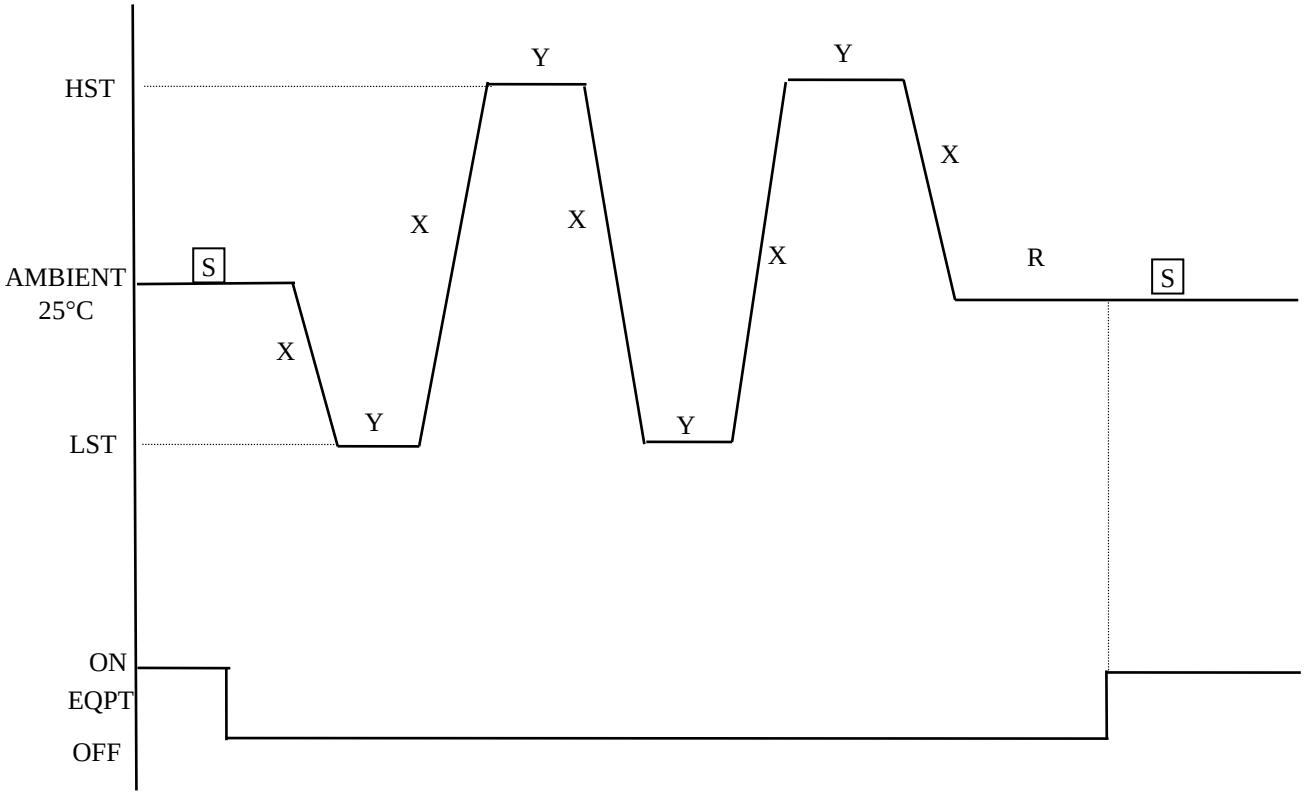
3.3.5.2 If the standard conditions given above are not appropriate, the equipment shall be subjected to standard recovery condition. Surface moisture, if any, may be removed by shaking or drying by means of an air jet at suitable temperature.

3.3.6 Final examination and measurements

At the end of the recovery period, the equipment shall be visually examined, electrically tested and mechanically checked under the standard atmospheric conditions as required by the relevant standard (***Standard Check***). The results of the measurements shall be compared with the results of the initial measurements. The parameters most sensitive to changes of relative humidity shall be measured first and the measurement of these parameters shall be completed preferably within 60 minutes of the end of recovery.

TEST NO. 4

RAPID TEMPERATURE CYCLING TEST



Temp	CAT A	CAT B	CAT C	CAT D	CAT E		
					I/D	U/G	O/D
LST	-5°C	-5°C	-5°C	-15°C	-5°C	-5°C	-15°C
HST	60°C	60°C	60°C	60°C	60°C	60°C	60°C

X : Rate of change of temperature 5° C/min in case of single chamber
Y : 3 Hrs
R : *Recovery period – 1 to 2 hours*
S : Standard check
LST : Lowest Storage Temperature
TSH : Highest Storage Temperature

3.4.1 Object

To determine the ability of equipment to withstand rapid changes of temperature in air, such as may occur during storage, transportation and subsequent use.

3.4.2 Test chambers

Ordinarily, two chambers shall be used for this test, a dry heat chamber and a cold chamber. The test chamber shall conform to the requirements given in Section 4. It shall, however, be permissible to employ single test chamber for both the hot and cold tests, provided that the changeover from low temperature to high temperature and vice versa can be performed at the rate of change of temperature required for the test and the required low and high temperature values can be maintained within a maximum tolerance of ±3 deg. C.

3.4.3 Initial Examination and Measurement

The equipment shall be visually examined, electrically tested and mechanically checked as required by the relevant standard. All the test results shall be recorded as per relevant equipment standard.

3.4.4 Conditioning

3.4.4.1 The equipment shall be subjected to the test in the unpacked and switched OFF condition.

3.4.4.2 The equipment under test, while being at the laboratory ambient conditions, shall be introduced into the cold chamber which is maintained at the minimum temperature specified for the environmental category of the equipment as per Table 2.3 and kept therein for a period of 3 hours.

3.4.4.3 The equipment shall then be transferred to the dry heat chamber maintained at the maximum temperature as specified for the environmental category as per Table 2.3. The transfer shall preferably take 2 to 3 minutes and in any case, not more than 15 minutes. Where a single test chamber is used, the rate of variation of temperature from the minimum to maximum value or back shall be such, as to attain the limit of values within the shortest possible time, taking into consideration, the capacity of the chamber and the thermal capacity of the equipment. A rate of variation of 5±1 Deg. C per minute averaged over a period of not more than 5 minutes will adequately meet the stipulation in the case of all equipment categories where a single test chamber is employed. The equipment shall be exposed to the dry heat for a period of 3 hours.

3.4.4.4 The procedure in paras 3.4.4.2 and 3.4.4.3 constitutes one cycle. The equipment shall be subjected to a second cycle of temperature change with no more than the 15 minutes interval allowed for the transfer from hot to cold chamber or cold to hot chamber (appropriate rate of variation of temperature being made in case of a single test chamber).

3.4.5 Recovery

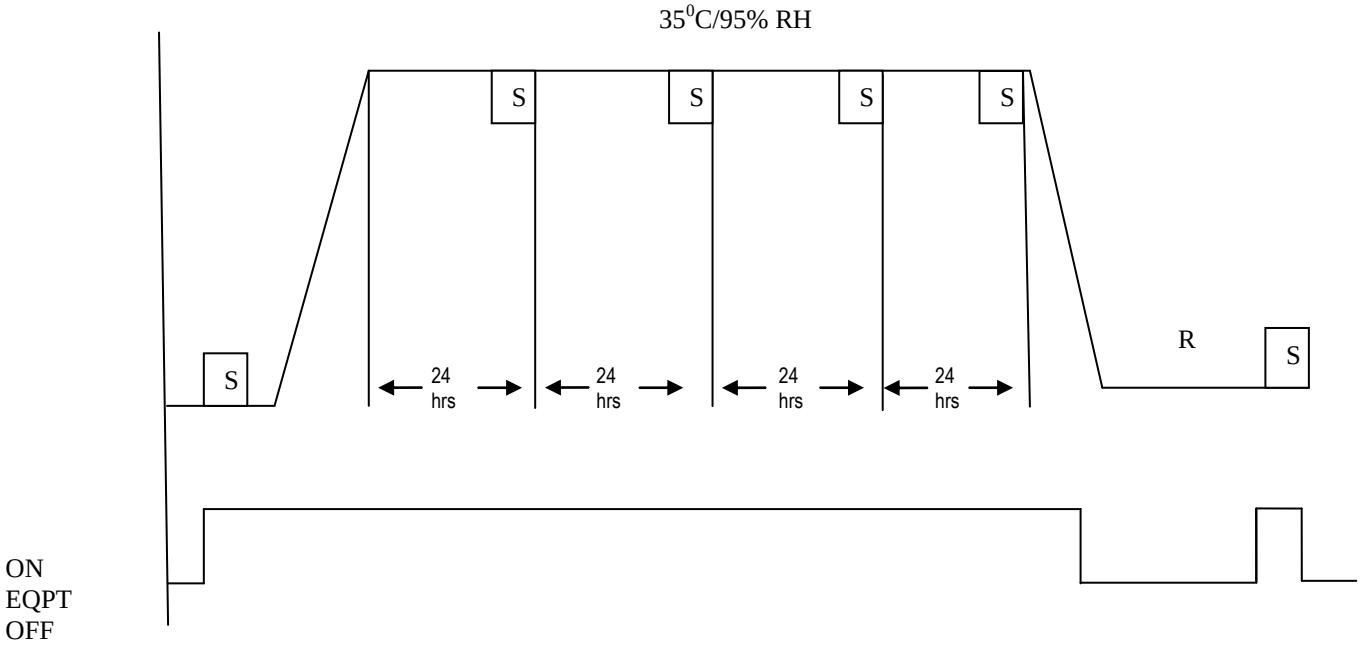
The equipment may be removed, if required, from the hot test chamber at the end of the conditioning period and is subjected to standard atmospheric conditions for recovery for a period of 1 to 2 hours.

3.4.6 Final examination and measurements

The equipment shall be visually examined, electrically tested and mechanically checked as required by the relevant standards (***Standard Check***) at the end of recovery period. The results shall be compared with the results of initial examination and measurements.

TEST NO. 5

DAMP HEAT (STEADY STATE)



S STANDARD CHECK

R Recovery period – 1 to 2hrs

3.5.1 Object

To determine the suitability of the equipment for use and storage under conditions of maximum relative humidity applicable to the environmental category of the equipment under test. The test is primarily intended to permit the observation of the effects of high humidity at constant temperature over a prescribed period.

3.5.2 Test Chamber

The construction of the test chamber used for the test shall comply with the requirements given in Section 4.

3.5.3 Initial requirements

The equipment shall be visually examined, electrically tested and mechanically checked as required by the relevant standard(standard check). All the test results shall be recorded as per relevant equipment standard.

3.5.4 Conditioning

3.5.4.1 Chamber

The chamber used for this test shall be capable of maintaining the following conditions in any region where the equipment is placed.

Temperature	:	35 ± 2 deg. C
Relative humidity	:	**95 + 0 or 95 - 2%** ***in the temperature range***

3.5.5 Procedure

3.5.5.1 The equipment shall be subjected to this test in its unpacked and normal operating and switched ON condition with the cover plates of the equipment kept in closed condition.

3.5.5.2 While at laboratory temperature the equipment shall be introduced into the chamber. At the time of introducing the equipment into the chamber, care shall be taken to avoid the formation of water droplets on the equipment by pre-heating the equipment to the chamber temperature, if necessary.

3.5.5.2.1 The temperature and relative humidity of the chamber shall then be adjusted to that specified in 4.5.4.1

3.5.5.2.2 After temperature equilibrium has been attained, these conditions shall be maintained for four days or any other period specified by the relevant equipment standard.

NOTE:

1. During this period of 4 days saturation of water vapour shall not occur in the chamber.

2. Any cooling or heating arrangement normally used with the equipment in actual service shall be used during this period of test.

3.5.5.2.3 During the above period of 4 days the equipment shall be tested for its guaranteed performance at appropriate intervals as required by the relevant equipment standard (***Standard Check***) except in the case of category A. Any departure from standard shall be noted.

3.5.5.2.4 For category A, the equipment will be subjected to conditions as in para 3.6.5.2.1 and 3.5.5.2.2. At the end of the 4 day period, the chamber conditions will be reduced gradually to 30 deg. C at 95% RH over a period of one hour and tested for performance as per standard (***Standard Check***). The temperature shall be maintained at 30°C for the required duration for checking of performance.

3.5.6 Recovery

3.5.6.1 At the end of the conditioning, the equipment shall be subjected to standard atmospheric conditions for recovery for not less than 1 hour and not more than 2 hours. The equipment may be transferred to another chamber for recovery or may remain in the damp heat chamber. In the former case, the changeover time shall be as short as possible and shall not exceed 5 minutes. In the latter case, the relative humidity shall be reduced to between 73 and 77% in not more than 30 minutes after which the temperature shall be adjusted to within ±2 deg. C of standard atmospheric temperature in not more than 30 minutes. The Equipment is switched OFF after the chamber reaches standard atmospheric temperature.

3.5.6.2 If the standard conditions given above are not appropriate, the equipment shall be subjected to standard recovery conditions. Surface moisture, if any, may be removed by shaking or drying by means of an air jet at suitable temperature.

3.5.7 Final measurements

At the end of the recovery period, the equipment shall be visually examined, electrically tested and mechanically checked as required by the relevant standard ***(Standard Check)***. The results of the measurements shall be compared with the results of the initial measurements. The parameters most sensitive to changes of relative humidity shall be measured first and the measurement of these parameters shall be completed within 60 minutes of the end of recovery.

TEST NO. 6

VIBRATION

3.6.1 Object

To determine the mechanical reliability of sub-assemblies in the form it is transported to withstand vibrations such as would be encountered during transportation and/or at the place of installation where it has to work adjacent to engine generators, heavy road traffic, etc.

3.6.2 Testing equipment

The characteristics required for the vibration generator and fixture when loaded for the conditioning process shall be as given in Section 4.

3.6.3 Mounting

The equipment under test in the unpacked and ready for use or packed and shipment condition or both, depending upon the application shall be mounted on the vibration apparatus, so as to simulate normal usage. Any connections to the equipment such as cables, wires, pipes, etc. shall be so arranged that they do not impose any restriction in executing the test.

In case of larger equipment which cannot be mounted as a whole, the equipment can be divided into parts as subracks, modules, etc. and mounted separately in packed or unpacked condition as per the application one by one or in sets depending upon packing methodology and vibration table characteristics.

3.6.4 Initial measurements

The equipment shall be visually examined, electrically tested and mechanically checked as required by the relevant standard (Standard Check). All tests shall be recorded as per relevant equipment standard.

Visual examination

Visual examination is generally made before and after the conditioning in each test and form a part of Initial and Final Measurements. During the visual examination of the equipment, defects in construction, the presence of foreign bodies, moisture, dust etc, corrosion of metal parts and any form of deterioration of materials and finishes, distortion or mechanical imperfections shall be noted.

3.6.5 Test severity

3.6.5.1 The frequency range and amplitude shall be as given in Table 3.1. The relevant standard shall prescribe the frequency.

Table 3.1

Frequency range and amplitude for vibration testing

Category of equipment	Frequency range	Amplitude
Equipment transported by vehicle, ship and or aircraft or ***has to work adjacent to engine generators, heavy road traffic, etc.***		
a) Up to and including 75 Kgs.	5 to 350 Hz	±6 mm constant displacement OR 15m/Sec^2 constant acceleration whichever is less.
b) Over 75 Kgs.	5 to 150 Hz	±6 mm constant displacement OR 15m/Sec^2 constant acceleration whichever is less.

NOTE: For equipment which have designated base, the vibration conditioning shall be applied only in a place normal to the base.

3.6.6 Conditioning

3.6.6.1 Endurance Test by Frequency Sweep

Frequency shall be varied at the rate of 1 (one) octave per minute from minimum to maximum frequency (as per table 3.1) and maximum to minimum constituting one full sweep. The total duration of the endurance shall be 6 (six) hours and this shall be conducted in all the three axes preferably with equal distribution.

3.6.6.2 Unless otherwise specified (see note under table 3.1), the equipment is to be vibrated in three mutually perpendicular directions.

3.6.6.3 The frequency is to be varied continuously (or in approved steps) from the lowest to the highest value over the specified range, at such rate that resonances can be easily detected. The rate of change of frequency will not normally exceed one octave in one minute. Resonances may be observed by stroboscope or other means. All frequencies at which assemblies are detected to resonate shall be noted.

3.6.6.4 At the end of the test, the equipment is to be examined for mechanical damage.

3.6.7 Final examination and measurements

The equipment shall be visually examined and shall be electrically tested and mechanically checked as required by the relevant equipment standard ***(Standard Check).***

TEST NO.7

SEALING TEST (GAS TIGHTNESS)/HIGH ALTITUDE TEST

3.7.1 Object

a. To determine the effectiveness of sealing of electronic equipment.

b. To determine the ability of equipment to withstand the atmospheric pressure at high altitudes during its operation.

3.7.2 Test Equipment

Besides the climatic test chamber constructed as per general requirements of Section 4, the following items will be required:

a) A vacuum pump capable of producing vacuum equivalent to an air pressure of atleast 25 kPa.
b) A sensitive pressure gauge with reading accuracy of 0.7 kPa or less.
c) A cylinder of dry air / nitrogen with pressure regulating arrangement.
d) Assorted nozzles, valves, connecting hoses, etc.
e) The chamber capable of maintaining air pressure equivalent to altitude in excess of 3000 metres.

3.7.3 Scheme of testing

3.7.3.1 The tests shall be according to the following, as required

a) Procedure-1: Sealing test -Vacuum and / or

b) Procedure-2: Sealing test - Pressure and / or

c) Procedure-3: High Altitude test

Procedure-1 shall be applied where equipment with sealed relays, crystals or pressure sensitive components is operated at altitudes in excess of 3000 metres. Procedure-2 shall be applicable in the case of any equipment which is pressurised with the requirement to retain pressure in normal operation.
Procedure-3 shall be applied where any Telecom equipment, without sealed relays/ crystals/pressure sensitive components or with no requirement of retaining pressure, is expected to operate at altitudes in excess of 3000 metres.

3.7.3.2 A suitable nozzle should be available or provided on the equipment for making connection to vacuum pump / dry gas cylinder pressure gauge etc.

3.7.4 Procedure 1: Sealing test (vacuum)

3.7.4.1 The equipment shall be subjected to this test in the unpacked, `switched off' condition.

3.7.4.2 The equipment nozzle shall be connected to a vacuum pump and a pressure gauge. The equipment temperature shall be stabilised at 20±2 deg. C.

3.7.4.3 The equipment shall be evacuated until a vacuum corresponding to air pressure equal to 25kPa is achieved. The equipment shall then be sealed off from the pump and allowed to stand for 30 minutes after which the reading on the pressure gauge shall be noted. For the equipment sealing to be deemed satisfactory, the air pressure reading at the end of 30 minutes shall not have fallen by more than 10 kPa.

3.7.5 Procedure 2: Sealing test (Pressure)

3.7.5.1 The equipment shall be subjected to this test in the unpacked, `switched off' condition.

3.7.5.2 The equipment shall be connected to a dry gas (air or nitrogen) cylinder and a sensitive pressure gauge. The test shall be conducted at the highest operating temperature and then at the lowest operating temperature of the equipment (as per table 2.3). The pressure within the equipment shall be adjusted accurately to double the specified operating value after stabilisation of the temperature and the time shall be noted. The pressurising dry gas source shall have been turned off when the specified pressure has been attained.

3.7.5.2 The rate of fall of internal pressure shall be determined from measurements with the pressure gauge at regular intervals. Generally the test shall be continued until the pressure has fallen by at least 1.4kPa. There shall be no noticeable fall in pressure in a period of 24 hours, making allowance for any temperature variation.

3.7.6 Procedure 3: High Altitude Test

3.7.6.1 Initial examination and measurement

The equipment shall be visually examined, electrically tested and mechanically checked under standard atmospheric conditions as required by the relevant equipment standard. All the test results shall be recorded as per relevant equipment standard.

3.7.6.2 Conditioning and Intermediate Measurements

3.7.6.2.1 The equipment under test in unpacked `ready for use' condition and at the ambient temperature shall be introduced into the chamber which is at the same ambient temperature. At the beginning of the test, the equipment shall be in `switched off' condition.

3.7.6.2.2 The pressure within the chamber shall then be adjusted to the atmospheric pressure equivalent to the altitude of above 3000 Mtrs as given in the table below or as called for in the relevant equipment standard. The temperature inside the chamber shall be stabilised at 25±2 deg. C.

Altitude	Pressure

Mtrs	ft	hPa	mm Hg	inHg	atm	PsiA	Kg/cm^2	KPa
3012	9882	700	525	20.67	0.691	--	--	--
3050	10000	696.81	522.7	20.58	0.688	10.1	0.738	69.64

3.7.6.2.3 The equipment shall be exposed to the pressure condition as in 3.7.6.2.2 until pressure equilibrium is reached. The equipment shall then be switched ON and checked to ascertain whether it is capable of operating and shall then remain in an operating condition for a minimum period of one hour. Any cooling or heating arrangement normally used with the equipment in actual service shall be used during this period of the test.

3.7.6.2.4 At the end of this period and while still at the pressure equivalent to 3000 Mtrs altitude, the equipment shall be electrically tested in accordance with the relevant standard (***Standard Check***). Any departure from the requirement of this standard shall be noted.

3.7.7 The pressure and temperature inside the chamber, with the equipment energized condition, shall be gradually adjusted until it is within the limits of standard atmospheric conditions (equal to outside atmospheric pressure and temperature). The equipment shall then be switched OFF.

3.7.8 Recovery

At the end of this period, the equipment shall be removed, if required, from the chamber and subjected to standard atmospheric conditions for recovery for a period of 1 to 2 hours.

3.7.9 Final examination and measurements

The equipment shall be visually examined, electrically tested and mechanically checked as required by the relevant standard (***Standard Check)***. The results of the measurements shall be compared with the result of initial measurements.

TEST NO. 8

WATER IMMERSION

3.8.1 OBJECT

To determine the water tightness of casing with telecom equipment when subjected to immersion in water under stated conditions of pressure and time.

3.8.2 Test chamber:

3.8.2.1 An immersion tank of sufficient dimensions to take in the equipment under test and to provide the specified head of water above the topmost point of the equipment shall be used, besides the source of supply of water required for test for the test.

3.8.2.2 In the immersion tank, a specific depth of water shall be measured above the topmost point of the equipment.

3.8.3 Test procedure

3.8.3.1 Pre-conditioning:
Pre-conditioning of the equipment and seals shall be carried out as required.

3.8.3.2 Initial measurements:

The equipment shall be visually examined and shall be electrically and mechanically checked as specified. All sealing features shall be checked to ascertain that they

have been correctly mounted. All the test results shall be recorded as per relevant equipment standard.

3.8.3.3 Conditioning:

The equipment shall be subjected to this test in its `unpacked' and `switched off' condition.

3.8.3.3.1 The water used for this test shall be at a temperature between 15°C & 35°C.

3.8.3.3.2 The equipment temperature shall be 5 to 10°C above the temperature of the water immediately before the start of the test.

3.8.3.3.3 The equipment shall be placed in the attitude specified and shall be completely immersed in the water. The depth of immersion from the top most point of the equipment shall be adjusted at the specified value. If no value of depth is specified, the depth can be taken as 1.5 mtrs.

3.8.3.3.4 The duration of immersion shall be 2 hrs. Unless otherwise specified, during immersion, the equipment under test shall not be in operating conditioning, but shall be in `switched off' condition.

3.8.3.3.5 At the end of the period of test, the equipment shall be removed from the immersion tank and its external surfaces shall be thoroughly dried by wiping or by applying a blast of air at room temperature, unless otherwise specified.

3.8.3.4 Recovery

The equipment shall then be allowed to remain under standard recovery conditions for a period of 2 hrs.

3.8.3.5 Final measurements

The equipment shall be visually examined, in its interior for any ingress of water and shall be electrically tested and mechanically checked as per relevant standard. The results of the measurements shall be compared with the results of the initial measurements.

TEST NO. 9

CORROSION - SALT

3.9.1 Object

To determine the suitability of equipment / sub assemblies / units for use or storage and / or transport in salt-laden atmosphere.

3.9.2 Test chamber

A salt-mist chamber constructed to meet the general requirements of 3.9.2.1 to 3.9.2.4 shall be used for the salt mist exposure. It shall be optional to use it or a separate humidity test chamber for the storage part of conditioning.

3.9.2.1 The salt mist chamber should be so constructed, that the spray is produced in the lower part of the chamber which is connected with an upper part in which the equipment is exposed. The chamber shall be constructed from non-corrosion materials so as not to be affected by the salt mist. (It shall not influence the corrosive effects of the salt mist). It shall be properly vented to prevent pressure build-up and allow uniform distribution of salt fog.

3.9.2.2 The spray shall be produced by one or more atomizer employing compressed air free from all impurities. The atomizers shall be so constructed that the solution used is efficiently atomized and the dripping of the solution from the spray nozzle is negligible. The quantity of solution sprayed per hour shall be approximately 1% of the volume of the chamber.

3.9.2.3 The ceiling, walls and other parts of the chamber shall be so constructed and the equipment under test so arranged, that no condensate can drip on the equipment or be allowed to be recirculated.

3.9.2.4 If used also for the storage part of the conditioning, the chamber shall be able to maintain a temperature of 35 ± 3 deg. C and RH 90% to 95% within its working space for the duration of the storage period.

3.9.3 Pre-conditioning

The equipment under test shall not have been put through any of the environmental tests and shall be given a minimum of handling, particularly on the significant surfaces and shall be prepared for test immediately before exposure. Unless otherwise specified, all surfaces shall be thoroughly cleaned of oil, grease, or temporary protective coating. The cleaning methods used shall not interfere with the effect of the salt mist on the test item nor introduce any secondary corrosion. Those portions of the item which come in contact with the support and cut edges and surfaces not required to be coated shall be protected with a suitable coating of wax or similar material impervious to moisture parts, finishes, materials and components. To aid in examination salt deposits, if any, may be removed with a wet soft brush.

3.9.4 Salt solution

The requisite volume of salt solution in distilled water shall consist of the prescribed quantities of the following salts within ± 10% tolerance per litre of solution with a view to simulate sea water.

a) Sodium Chloride	:	26.5 gms
b) Magnesium Sulphate	:	3.30 gms
c) Magnesium Chloride	:	2.40 gms
d) Sodium Bicarbonate	:	0.20 gms.
e) Calcium Chloride	:	1.10 gms
f) Sodium Bromide	:	0.28 gms
g) Potassium Chloride	:	0.73 gms

Fresh solution shall be used for each spray. Sufficient quantity of the solution shall be made to suit the capacity being used.

3.9.5 Initial measurements

The equipment shall be, visually examined, electrically tested and mechanically checked as required by the relevant standard.

3.9.6 Conditioning

The tests are designed to check the efficacy of the protective coatings and test shall be performed on specific mechanical parts and PCBs.

3.9.6.1 The equipment under test shall be subjected to this test in its unpacked and `switched off' condition. It shall be introduced into the salt mist chamber under laboratory atmospheric condition and positioned in the chamber in its normal operational attitude. It shall not be in contact with metal parts.

3.9.6.2 The equipment shall be exposed to the salt mist, with the spray operating for 2 (two) hours under laboratory atmospheric conditions.

3.9.6.3 The equipment shall then be stored at a temperature of 35 deg. C and RH of 90% (Damp heat) for a period of 22 hours. The removal of the equipment from the salt mist chamber to the humidity chamber, if used for storage, shall be carried out, so as to minimise the loss of salt solution from the equipment under test.

3.9.6.4 Exposure of the equipment to salt mist for 2 hours followed by storage under damp heat for 22 hours constitutes one cycle. The equipment shall be subjected to 3 (three) such cycles in continuous succession.

3.9.6.5 The equipment shall then be removed from the storage (salt mist or humidity) chamber and examined for evidence of corrosion and deterioration of metal.

3.9.7 Recovery

The equipment shall then be allowed to recover under laboratory atmospheric conditions for testing for a period of 2 to 4 hours.

3.9.8 Final measurements

The equipment shall then be visually examined, electrically and mechanically checked as required by the relevant standard. Any deviation in performance, observation shall be recorded.

TEST NO. 10

DROP TEST

3.10.1 OBJECT

To determine the ability of telecom equipment to withstand the shocks normally induced when it is dropped or roughly handled during its use.

3.10.2 Test Equipment

3.10.2.1 A drop test platform meeting the requirements of 3.10.2.2 and 3.10.2.3 shall be used for this test.

3.10.2.2 The drop test platform shall consist of a steel plate not less than 6.5mm thick which has been wet floated on and bolted down to a fully set concrete block atleast 460mm thick.

3.10.2.3 The surface dimensions of the steel plate prepared as in 3.10.2.2 shall be larger than the largest surface of the equipment under test.

3.10.3 Test procedure

3.10.3.1 Initial measurements

The equipment shall be visually examined, electrically tested and mechanically checked as required by the relevant standard. All the test results shall be recorded as specified.

3.10.3.2 Conditioning

3.10.3.2.1 The equipment shall be subjected to this test in its `unpacked' and `switched off' condition.

3.10.3.2.2 The equipment shall be placed on the test platform in the unpacked, ready-to-use condition and in its normal position of use with the covers, cable forms, etc. in place.

3.10.3.2.3 Using one edge as a pivot, the opposite edge of the equipment shall be lifted until one of the following conditions occurs (whichever occurs first).

a) The bottom surface of the equipment under test forms an angle of 45° with the horizontal test platform.

b) The lifted edge of the equipment has been raised 100mm above the horizontal test platform.

c) The lifted edge of the equipment is just below the point of perfect balance.

3.10.3.2.4 The equipment shall then be allowed to drop back freely to the horizontal test platform.

3.10.3.2.5 The procedure given in 3.10.3.2.3 & 3.10.3.2.4 shall be repeated using other practical edges of the same horizontal face of the equipment as pivot points for a total of four drops.

3.10.3.3 Final examination and measurements

The equipment shall be visually examined, electrically tested and mechanically checked as required by the standard immediately after completion of these tests. The results shall be compared with the results of initial examination.

TEST NO. 11

TOPPLE TEST

3.11.1 OBJECT

To determine the ability of telecom equipment to withstand the knocks and jolts likely to occur during repair work and rough handling in its use.

3.11.2 Test equipment

3.11.2.1 A topple test platform meeting the requirements of 3.11.2.2 and 3.11.2.3 shall be used for this test.

3.11.2.2 The topple test platform shall consist of a steel plate not less than 6.5mm thick which has been wet floated on and bolted down to a fully set concrete block atleast 460mm thick.

3.11.2.3 The surface dimensions of the steel plate prepared as in 3.11.2.2 shall be larger than the largest surface of the equipment under test.

3.11.3 Test procedure

3.11.3.1 Initial measurements

The equipment shall be visually examined, electrically tested and mechanically checked as required by the relevant standard. All the test results shall be recorded as per relevant equipment standard.

3.11.3.2 Conditioning

3.11.3.2.1 The equipment shall be subjected to this test in its `unpacked' and `switched OFF' condition.

3.11.3.2.2 The equipment shall be placed on the test platform in the unpacked, ready-to-use condition and in its normal position of use with the covers, cable forms etc. in place.

3.11.3.2.3 The equipment standing in its normal position, using one edge as a pivot, the opposite edge of the equipment shall be lifted until it reaches a position of instability. It is then allowed to fall over freely from this position on to an adjacent face. The equipment shall be subjected to one topple about each of the four bottom edge.

3.11.3.2.3 Final examination

The equipment shall then be visually examined and shall be electrically and mechanically checked as specified (Standard Check).

TEST NO. 12

FALL TEST

3.12.1 OBJECT

To determine the ability of the equipment to withstand the shocks normally induced when it falls from a height or roughly handled during its use.

3.12.2 Test equipment

3.12.2.1 A fall test platform meeting the requirements of 3.12.2.2 & 3.12.2.3 shall be used for this test.

3.12.2.2 The fall test platform shall consist of a steel plate not less than 6.5mm thick which has been wet floated on and bolted down to a fully set concrete block at least 460mm thick.

3.12.2.3 The surface dimensions of the steel plate prepared as in 3.12.2.2 shall be larger than the largest surface of the equipment under test.

3.12.3 Test procedure

3.12.3.1 Initial measurements

The equipment shall be visually examined, electrically tested and mechanically checked as required by the relevant standard. All the test results shall be recorded as per relevant equipment standard.

3.12.3.2 Conditioning

3.12.3.2.1 The equipment under test shall be subjected to this test in its `unpacked' and `switched OFF' condition.

3.12.3.2.2 The equipment shall be allowed to fall freely on the test platform from a height of 1000cms (1 metre).

3.12.3.2.3 The height of drop shall be measured from the point of the equipment, nearest to the surface of the steel plate when suspended prior to dropping.

3.12.3.2.4 The method of releasing the equipment to the fall test platform from the desired height shall be such as to allow free fall from the position of suspension, with a minimum of disturbance at the moment of release.

4.12.3.2.5 Equipment shall be subjected to such fall test once on each of the four edges (sides) and once on base or topside of the equipment.

3.12.4 Final examination:

The equipment shall be visually inspected, electrically tested and mechanically checked as required by the relevant standard immediately after completion of this test(Standard Check). The test results shall be compared with the results of initial measurements.

TEST NO. 13

BUMP / ROADABILITY TEST

3.13.1 BUMP TEST

3.13.1.1 Object

To determine the ability of telecom equipment to withstand repeated bumps without malfunctioning and mechanical damage.

3.13.1.2 Test equipment

3.13.1.2.1 Characteristics of Bump Machine

A Bump machine shall be used for this test. When the bump machine and fixtures are loaded with the equipment and any other necessary load for the testing, the applied bumps shall, at the monitoring points, have the characteristics specified below.

a) Basic Pulse shape: The bump machine shall be capable of generating a pulse approximating to one half cycle of a sine wave. The nominal pulse shall have a peak acceleration of 400m/s^2 with a duration of 6 ms.
b) Repetition rate: The bump repetition rate shall be such that between impacts, the relative motion within the equipment shall be substantially zero and the value of acceleration at the monitoring point shall be within limits. A bump repetition rate of 1 to 3 bumps per second is usually adequate to reduce secondary bumps to a minimum.
c) Velocity change: The actual velocity change shall be within ±20 % of the value corresponding to the nominal pulse i.e., 1.50m/s.
d) Transverse motion: The positive or negative peak acceleration at the monitoring point perpendicular to the intended direction of bumps shall not exceed at any time 30% of the nominal value of the peak acceleration in the intended direction.

3.13.1.3 Test procedure

3.13.1.3.1 Initial measurement

The equipment shall be visually examined, shall be electrically and mechanically checked as specified.

3.13.1.3.2 Mounting

The units / cards of the equipment or full equipment may be packed in one or more packing cases depending upon the capacity of the bump machine. The packing shall be as per equipment packing standard which shall be followed normally while dispatching the equipment. No extra care shall be taken in packing the equipment for this test.

The packed cases then shall be mounted and fastened one by one on the bump machine and the test procedure completed for each packing case separately.

(In case of large equipment where heavy component such as transformers / coils / capacitors are mounted, the whole equipment may be subjected to roadability test as described in 4.13.2 below).

3.13.1.3.3 Conditioning

3.13.1.3.3.1 Where the attitude of the equipment when mounted and transported is known, and since bumps are generally of greatest significance in one direction (usually vertical), the specified number of bumps shall be applied in that direction and attitude only. However, where the attitude is unknown, the specified number of bumps should be applied in each of the directions specified. In this case, three mutually perpendicular directions are usually adequate.

3.13.1.3.3.2 The equipment shall be subjected to 1000 ± 10 bumps at a peak acceleration of 400 ± 40 m/s^2 (40 ± 4 g).

3.13.1.3.4 Final measurements

The equipment shall be visually examined for any mechanical damage and shall be electrically and mechanically checked as specified.

3.13.2 ROADABILITY TEST

3.13.2.1 OBJECT

To ensure that the system shelter assemblage shall be capable of withstanding the vibrations and other dynamic duresses normally induced during transportation.

3.13.2.2 TEST EQUIPMENT

Test track trials formulated to include movement over the types of terrain representative of more severe condition of deployment are more realistic than laboratory tests since they reproduce the combination of various environmental/dynamic duresses that occur in the field. The system shelter assemblage may consist of equipment mounted on platform of the wheeled vehicle or equipment mounted in a shelter which is then mounted on a platform of wheeled vehicle. The vehicle used shall have capability to be mobile on highways and unimproved cross country terrain.

3.13.2.3 TEST PROCEDURE

3.13.2.3.1 Initial measurement

The equipment shall be visually examined and checked electrically and mechanically checked as specified.

3.13.2.3.2 Mounting

The equipment packed in the normal way as it is transported may be loaded in the truck and fastened suitably.

3.13.2.3.3 Conditioning

The tyre pressure of the van or shelter transport vehicle shall be adjusted for tactical (off road) cross country service. The vehicle shall be checked for mobility. Requirements as given in clause 3, before subjecting the equipment for roadability test.

Procedure 1

The system shelter assemblage shall be driven for the following distances, over a section of track in following order at specified speed, to assess reliability of equipment mounted and mounting arrangements. This constitutes one cycle.

	Track	Distance	Speed
(a)	Belgian Pave	50km	16km/h
(b)	Corrugated	4 passes each on 5cm & 10cm crest height of 400m length	16 km/h
©	Steering pad	20 rounds (4.8km)	Maximum safe speed
(d)	High speed	100km	60km/h
(e)	Pot holes	4 passes (1.2km)	8km/h

Procedure 2

In the absence of suitable test as per Clause 4.3 (Procedure 1), the equipment shall be hauled for a distance of 40 kms on a cross country drive as per the details given below :

Natural / Virgin Terrains other than metalled roads, comprising of bullock card or animal tracks, slushy or sandy terrain such as river bed crossing, leveled or undulated boulder sections or hilly terrain for a distance of 20 km at a speed of 5 to 10 kmph.

Cross country fields with bunds of 20 to 25 cm high for a distance of 20 kms at a speed of 3 to 5 kmph.

Test severities

Test condition ‘A’ One cycle

Test condition ‘B’ Three cycles

NOTE : when this test is specified in the relevant equipment standard, the facilities regarding the test tracks to be used as per procedure 1 or alternative test tracks suggested in procedure 2 shall be mutually agreed to between the contracting parties.

3.13.2.3.4 Final measurements

The equipment shall be visually examined for any mechanical damage and shall be electrically and mechanically checked as specified. The test results can be compared with the results of initial measurements.

TEST NO. 14

RAIN TEST

3.14.1 Object

To determine the suitability of electronic and electrical equipment under conditions of rain.

3.14.2 Test chamber

A driving rain chamber with following standard if available can be used for this test.

3.14.2.1 The chamber shall be capable of spraying water under laboratory atmospheric conditions at a static pressure of 200 kPa ±15 % from eight shower heads. The static pressure shall be measured nearest to each shower head.

3.14.2.2 It shall be possible to direct the spray from four of these shower heads downwards, at an angle of 45°, at each of the four uppermost corners of the equipment under test

and from the remaining four shower heads, horizontally at the centre of the area of each of the four sides of the equipment without excessive overlap from the adjacent shower heads. It shall also be possible to locate the shower heads at such a distance that the intensity of water spray at the equipment under test shall be not less than the equivalent of the rainfall of 250 mm per hour.

Use of such shower head will result in water consumption of approximately 450 litres per hour at a static pressure of 200 kPa.

3.14.3 If driving rain chamber is not available, a setup with 2 to 3 shower heads may be used to direct water jets over the item under test at angle of 45°.

3.14.4 Test Procedure

3.14.4.1 Initial measurements

The equipment shall be visually examined and shall be electrically and mechanically checked as per relevant equipment standard.

3.14.4.2 Conditioning

The equipment shall be subjected to this test in its `unpacked' and `switched OFF' condition.

3.14.4.3 The equipment under test, shall be under normal atmospheric conditions and shall be suitably positioned in its normal operation attitude as specified.

3.14.4.4 Tap water at laboratory temperature shall be sprayed for one hour or any other period as specified.

3.14.4.5 Spray from the shower heads shall be directed from all sides of the equipment under test at an angle of 45° over the uppermost corners of the equipment.

3.14.4.6 At the conclusion of the period specified in 3.14.4.4, the equipment shall be removed from the chamber and if required, a performance check shall be carried out.

3.14.5 Recovery:

Unless otherwise specified, the external surfaces of the equipment shall be dried by wiping or by applying a blast of air at room temperature.

3.14.6 Final measurement:

The equipment shall then be visually examined and electrically and mechanically checked as specified.

TEST NO. 15

DUST TEST

3.15.1 OBJECT

To determine the suitability of telecom equipment for use and or storage in a dust laden environment.

3.15.2 Test Equipment

3.15.2.1 A dust chamber capable of circulating dust in its working space in such a manner as to produce specified dust concentration shall be used. The chamber shall also be capable of maintaining its working space at a temperature of 40 deg. ± 3 deg. C with relative humidity not exceeding 50%.

3.15.2.2 The dust used for the test shall be dry and particle size must satisfy that

a) 100% passes through 150micron IS sieve
b) 98 dust passes through 106 micron IS sieve and
c) 75 ± 2 % dust passes through 45 micron IS sieve.

IS : 460 (Part 1), 1978 specifies the wire cloth test sieves (second revision)

Chemical composition of the dust shall be 97 to 99 percent by weight of silicon dioxide, with trace of oxides of iron, aluminum, titanium and magnesium to make up the balance.

3.15.2.3 A suitable dust measuring device, such as in IS: 9000 (Part XII), 1981 for this test, shall be placed in the dust chamber to measure the dust concentration therein. The specified value of dust concentration is to be deemed to have been attained when, after circulation of the air for 5 minutes and allowing the dust to settle down, the amount of dust collected in the device is 25 ± 5 gms.

3.15.3 Pre-conditioning

It shall be permissible to change the gaskets in the equipment for this test after it has recovered from the sealing test.

3.15.4 Initial examination and measurements

The equipment shall be visually examined, electrically tested and mechanically checked as required by the relevant standard. All the test results shall be recorded as per relevant equipment standard.

3.15.5 Conditioning

3.15.5.1 The equipment in its unpacked, ready for use but `switched OFF' condition and at the ambient temperature shall be introduced into the chamber which is at the same

ambient temperature. Sufficient quantity of dust shall also be introduced into the chamber.

3.15.5.2 The temperature of the chamber shall then be raised to 40 deg. ± 3 deg. C with the relative humidity maintained at not more than 50%.

3.15.5.3 After temperature stability has been attained, the equipment shall then be subjected to a stream of dust-laden air for a period of one hour. The dust concentration during this period shall be maintained as specified in 3.15.2.3.

3.15.5.4 The equipment shall be switched `ON' and performance checks carried out 30 minutes after commencement of the agitation and circulation of dust.

3.15.5.5 The circulation of dust shall be discontinued at the end of one hour and the temperature of the chamber shall be restored to the laboratory atmospheric conditions.

3.15.6 Recovery

The equipment shall be removed from the chamber and allowed to recover under standard atmospheric condition for atleast 2 hours.

3.15.7 Final examination and measurements

The equipment shall be visually examined, noting any local accumulation of dust. After removal of the accumulated dust by brushing, wiping or shaking, electrical and mechanical checks are made and the results compared with the results of initial measurements. No air blast or vacuum cleaning shall be permitted for the removal of the accumulated dust.

SECTION - 4

STANDARDS OF CLIMATIC TEST CHAMBER(S) & VIBRATION GENERATOR

4.1 The climatic tests may be carried out either in one test chamber capable of achieving the required temperature and humidity conditions or in separate chambers for dry heat, damp heat and rapid temperature cycling tests. The standards of test chambers are given below:-

4.2 GENERAL STANDARDS

4.2.1 Volume of test chamber

The volume of test chamber shall be such that the bulk of the equipment under test shall not interfere with the control and maintenance of test conditions in the working space of the chamber and any heat dissipated from the equipment under test shall not appreciably influence the conditions in the chamber.

4.2.2 Control of temperature and relative humidity

Wet and dry bulb thermometers of mercury-in-glass type or thermocouples or equivalent sensors shall be used to control or determine the specified chamber temperature and relative humidity. These sensors shall be centrally located within the test chamber, wherever possible, or in the return air-stream and shall be baffled or otherwise protected against direct impingement of supply air and against radiation effects. The desired rate of change of temperature and relative humidity should be possible to be achieved if a single test chamber is employed for all climatic tests.

4.2.3 Stability and rate of change of temperature

Unless otherwise specified, the rate of change of temperature within the test chamber shall not exceed 1° C per minute, averaged over a period of not more than 5 minutes. The chamber shall be capable of maintaining within its working space, appropriate high and low temperature within ± 2° C. In the case of a single large chamber for all climatic tests, the temperature tolerance for equilibrium condition will be ± 3° C.

4.2.4 Uniformity of conditions in Test Chamber

Necessary measures shall be taken to ensure that conditions throughout the chamber are homogeneous and are as near as possible to those prevailing in the immediate vicinity of the temperature and relative humidity sensors. The high / low temperature conditions inside the chamber, should therefore be achieved only by circulating hot / cold air. The air in the chamber shall be continuously agitated, but not so vigorously as to cause undue cooling of the equipment under test.

4.2.5 Heat source in Test Chamber

The heat source of the test chamber shall be so located that the radiant heat does not fall directly on the equipment under test except where radiant heat is one of the test conditions.

4.3 Damp Heat Chamber

4.3.1 Damp heat chamber shall be capable of maintaining at any point in its working space a temperature with tolerance of ± 0.5°C, of any value up to 40±2°C with a relative humidity of not less than ~~90%~~ *91%*.

4.3.2 Condensed water shall be continuously drained from the chamber and shall not be used again until it has been purified.

4.3.3 When the relative humidity conditions in the chamber are obtained by using demineralised water, this shall have a resistivity of not less than 500 Ohm metres.

4.3.4 The temperature and relative humidity of the chamber shall be monitored by sensing devices suitably located in the working space.

4.3.5 In case of damp heat chambers employing steam injection, the air velocity at the point accessible to the wet bulb thermometer shall be not less than 3m/s.

4.3.6 Any condensed water from the walls and roof of the chamber shall not fall on the equipment.

4.4 CHARACTERISTICS OF THE VIBRATION GENERATOR

4.4.1 Basic motion shall be sinusoidal and such that all the fixing points of the equipment are moving substantially in phase and in straight parallel lines except as permitted by Cl.No. 4.4.2 below.

4.4.2 Transverse motion - Maximum vibration amplitude on the fixed points of the equipment in any direction normal to the intended one shall not exceed 25% of the specified amplitude.

4.4.3 Distortion - The total rms harmonic content of the acceleration, at the fixing point of the equipment, shall not exceed 25% of the acceleration corresponding to the specified amplitude at the fundamental drive frequency.

4.4.4 The vibration generator should be capable of continuously sweeping the frequency range of 5-350-5 Hz logarithmically or with a linear band approximation in a time of 15±1 minutes.

4.4.5 The vibration generator should be capable of continuously sweeping the frequency range of 5-55-5 Hz logarithmically or with a linear band approximation in a time of 5±1 minutes.

4.4.6 The time taken to sweep from the lowest to the highest frequency and vice versa shall be approximately equal.