

3.1 GENERAL

The Works covered by the Specification shall be designed, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India. The Equipment(s) shall also conform to the general requirements detailed in the following standards, which shall form an integral part of the Specification, in addition to meeting the specific requirements called for elsewhere in the Specification.

The Contractor shall note that the standards mentioned herein are not mutually exclusive or complete in themselves, but are intended to complement each other, with minimum repetition, to define the requirements of the Specification.

When specific requirements stipulated in the Specification exceed or change those required by the applicable standards, the stipulations of the Specification shall take precedence.

Unless specifically agreed to by the Employer prior to Award of Contract, the Work shall be in accordance with the standards indicated and the requirements of the Specification. The Contractor shall be held responsible for any deviation.

In case of conflict between the various standards, the decision of Employer shall be binding & final.

Wherever the IS code is mentioned below or elsewhere in the technical specification, the relevant IEC shall be applicable in place of IS code.

3.2 STANDARDS

All equipment and materials, unless otherwise specifically required in the Specification, shall conform to latest revisions of the standards listed in the Specification, in force 15 days before the **originally scheduled** deadline for submission of bid for this project.

Generally the standards listed below are applicable in accordance with the specific requirements of the technical section covering particular alternating current equipment or materials. Direct current equipment or materials shall also follow the general requirements of the standards listed below, in addition to the specific requirements included in the Specification.

3.2.1 GENERAL STANDARDS

IS-5	Colours for Ready Mixed Paints and Enamels
IS-335	Insulating oil for Transformers and Switchgears.
IS-2071	Methods of High Voltage Testing
IS-12063	Classification of degrees of Protection Provided by Enclosures for Electrical Equipment
IS-2165	Insulation Co-ordination
IS-3043	Code of Practice for Earthing
IS-3637	Gas Operated Relays
IS-6103	Method of Test for Specific Resistance (Resistivity) of Electrical Insulating Liquids
IS-6104	Method of Test for Interfacial Tension of Oil against Water by the Ring Method

IS-6262	Method of Test for Power Factor and Dielectric Constant of Electrical Insulating Liquids
IS-6792	Method for Determination of Electric Strength of Insulating Oils
IS-8263	Method for Radio Interference Tests on High Voltage Insulators
IS-8269	Methods for Switching Impulse Tests on High Voltage Insulators
IEC-60060/IS 2071 : Part 1	High Voltage Test Techniques
IEC-60117/IS 8270	Graphical Symbols
IEC-60156/IS 6792	Method for the Determination of the Electric Strength of Insulating Oils
IS/IEC-60270	High Voltage Test Techniques
IEC-60296	Specification for Unused Mineral Insulating Oils for Transformers and Switchgear
IEC-60376/IS 13072	Specification and Acceptance of New Sulphur Hexafluoride
IEC-60437/IS 8263	Radio Interference Test on High Voltage Insulators
IEC-60506	Switching Impulse Tests on High Voltage Insulators
IEC-60507/IS 8704	Artificial Pollution Tests on High Voltage Insulators to be used on AC Systems
IEC-60694	Common Clauses for High Voltage Switchgear & Control gear Standards.
IEC-60815/IS 16683	Guide of the Selection of Insulators in respect of Polluted Conditions.
IEC-60865/IS 13235	Short Circuit Currents
IEC- 61803/IS 15597	Determination of losses in HVDC converter stations
ASTM-D1275	Standard Test Method for Corrosive Sulphur in Electrical Insulating Oils

DIN 51353	Testing of Insulating Oils, Detection of Corrosive Sulphur, Silver Strip Method
IEC 60919-1/IS 14902-1	Performance of high-voltage direct current (HVDC) systems with line-commutated converters - Part 1: Steady-state conditions
IEC 60919-2/IS 14902-2	Performance of high-voltage direct current (HVDC) systems with line-commutated converters - Part 2: Faults and switching
IEC 60919-3/IS 14902-3	Performance of high-voltage direct current (HVDC) systems with line-commutated converters - Part 3: Dynamic conditions
IS/IEC 62305-Part 1	Protection against lightning - Part 1: General principles
IS/IEC 62305-Part 2	Protection against lightning - Part 2: Risk management
IS/IEC 62305-Part 3	Protection against lightning - Part 3: Physical damage to structures and life hazard
IS/IEC 62305-Part 4	Protection against lightning - Part 4: Electrical and electronic systems within structures

3.2.2 BUSHINGS

IS 2099	High voltage porcelain Bushings for Alternating Voltages above 1000 V
IS/IEC 60137	Bushings for Alternating Voltages above 1000V Surge arresters - Metal-oxide surge arresters without gaps for HVDC converter stations
IEC-61462	Composite Insulators
IEC/IEEE 65700	Bushings for DC applications

3.2.3 CURRENT TRANSFORMERS, VOLTAGE TRANSFORMERS AND COUPLING CAPACITOR VOLTAGE TRANSFORMERS

IS-2705	Current Transformers
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IS-3156		Voltage Transformers
IS-4379		Identification of the contents of Industrial Gas Cylinder
IS 9348		Coupling capacitor and capacitor dividers
IEC-61869-5 16227 Part 5	/IS	Voltage Transformers
IEC-60358		Coupling Capacitors and Capacitor Dividers
IEC-61869-4/IS 16227 Part 5		Instrument Transformers Partial Discharge Measurements
IEC-60481		Coupling Devices for power Line Carrier Systems
IEC 61869-6/IS 16227 Part 5		Instrument transformers – Additional general requirements for low-power instrument transformers
IEC 61869-11		Instrument transformers - Part 11: Additional requirements for low power passive voltage transformers
IEC 61869-14		Additional Requirements For Current Transformers For DC Applications
IEC 61869-15		Instrument transformers - Part 15: Additional requirements for voltage transformers for DC applications

3.2.4 SURGE ARRESTERS

IS-3070		Lightning arresters for alternating current systems: Metal oxide lightning arresters without gaps
IEC-99-4/ 10586 Part 4	IS	Metal oxide surge arresters without gaps
IS/IEC-60071Part 1 to 4		Insulation Co-ordination
IEC-60071-5		Insulation co-ordination - part 5: procedures for high-voltage direct current (HVDC) converter stations
IEC 60099-9/ 10586 Part 9	IS	Surge arresters - Metal-oxide surge arresters without gaps for HVDC converter stations

3.2.5 CUBICLES AND PANELS & OTHER RELATED EQUIPMENT

IS-722, IS-1248, IS-3231, IEC-68.2.2	Electrical relays for power system protection Basic environmental testing procedures Part 2: Tests: B : Dry heat
IS/IEC-60529	Degrees of Protection provided by enclosures
IEC-60158	Low Voltage Control Gear Contractor
IS-8623	Specification for Switchgear & Control Assemblies

3.2.6 CAPACITORS

IEC-60871/IS 13925	Shunt Capacitors
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3.2.7 TELECOMMUNICATIONS AND LINE TRAPS

IS-8792	Line Traps
IS-8793	Methods of Test for Line Traps

IS-8997	Coupling Devices for PLC Systems
IS-8998	Methods of Tests for Coupling Devices for PLC systems.
IEC-60353	Line Traps
IEC-60481	Coupling Devices for Power Line Carrier Systems
IEC-60495	Single sideboard power line carrier terminals
IEC-60663	Planning of (single Side-Band) Power Line Carrier Systems
CIGRE	Tele-Protection
CCIR	International Radio Consultative Committee
CCITT	International Telegraph & Telephone Consultative Committee
EIA	Electronic Industries Association

3.2.8 CONVERTERS

IEC-60700-1/ 14911-1	IS Testing of Semiconductor Valves for High Voltage dc Power Transmission
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3.2.9 PROTECTION AND CONTROL EQUIPMENT

IEC-60051	Recommendations for Direct Acting Indicating Electrical Measuring Instruments and their Accessories.
IEC-60255	Electric Relays

IEC-60297	Dimensions of mechanical structures of the 482.6 mm (19inches) series
IS-9606	Dimension of Panels and racks(482.6 mm system)
IEC-60337	Control Switches (low voltage switching devices for control and auxiliary circuits, including contactor relays)
IEC-60359/ IS 9176	Expression of the Functional Performance of Electronic Measuring Equipment
IEC-60387	Symbols for Alternating- Current and Electricity Meters
IEC-60447	Standard Directions of Movement for Actuators which control the Operation of Electrical Apparatus
IEC-60521	Class 0.5, 1 and 2 Alternating Current Watt-hour Meters
IS 13010	AC Watthour Indian Standard Meters, Class Specification 0.5, 1 and 2
IEC-60547	Modular Plug-in Unit and Standard 19-Inch rack Mounting Unit Based on NIM Standard (for electronic nuclear instruments)
IS/IEC - 61850	Communication networks and Systems in Substations.

3.2.10 MOTORS

IS-325	Three Phase Induction Motors
IEC-60034	Rotating Electrical Machines

3.2.11 MATERIAL AND WORKMANSHIP STANDARDS

IS-1363	Hexagon head bolts, screws and nuts of product grade C
IS-1364	Hexagon head bolts, screws and nuts of products grades A and B

IS-3138	Hexagonal Bolts and Nuts (M42 to M150)
ISO-898	Fasteners: Bolts, Screws and Studs
ASTM	Specification and Tests for Materials

3.2.12 CLAMPS & CONNECTORS

IS-5561	Electric Power connectors
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3.2.13 BUS HARDWARE AND INSULATORS

IS-2121	Fittings for Aluminium and steel cored Aluminium conductors for overhead lines
IS-731	Porcelain Insulators for Overhead Power Lines with nominal voltages greater than 1000 V

IS-2486	Insulator fittings for Overhead Power Lines with nominal voltages greater than 1000 V
IEC-60120	Dimensions of Ball and Socket Couplings of String Insulator Units
IS/IEC-60168	Tests on Indoor and Outdoor Post Insulators for Systems with Nominal Voltage Greater than 1000 V
IEC-60233	Tests on Hollow Insulators for use in Electrical Equipment
IS/IEC-60273	Characteristics of Indoor and Outdoor Post Insulators and Post Insulator Units for Systems with Nominal Voltage Greater than 1000 V
IEC-60305	Characteristics of String Insulator Units of the Cap and Pin Type
IS/IEC-60372	Locking Devices for Ball and Socket Couplings of String Insulator Units.
IS/IEC-60383	Tests on Insulators of Ceramic Material or Glass for Overhead Lines With a Nominal Voltage greater than 1000 V
IEC-60433	Characteristics of String Insulator Units of the Long Rod Type
IEC-60471	Dimensions of Clevis and Tongue Coupling of String Insulator Units

3.2.14 STRAIN AND RIGID BUS-CONDUCTOR

IS-2678	Dimensions for Wrought Aluminium and Aluminium Alloys, plates and hot rolled steel
IS-5082	Wrought Aluminium and Aluminium Alloy Bars, Rods, Tubes and Sections for Electrical Purposes

3.2.20 BATTERIES AND BATTERY CHARGERS

IEC-60086	Primary Batteries.
IEC-60086-2	Primary Batteries, Specification sheets.
IEEE-484	Recommended Practice for Installation Design and

Installation of Large Lead Storage Batteries for
Generating Stations and Substations.

IEEE-485

Sizing Large Lead Storage Batteries for
Generating Stations and Substations.

3.2.15 WIRES AND CABLES

IEC-60434

Rubber insulated cables with copper(part 1)
conductors

IS-694

PVC insulated cables for working voltages upto and
including 1100 Volts

IS-1255	Code of Practice for Installation and maintenance of Power Cables, upto and including 33 kV rating
IS-1554	PVC insulated (heavy duty) electric (Part 1) cables for working voltage upto and including 1000V
IS-2982	Copper conductors in insulated cables and cords
IS-3961	Recommended current ratings for cables
IS-3975	Mild steel wires, strips and tapes for armouring of cables
IS-5831	PVC insulation and sheath of electric cables
IS-6380	Elastomeric Insulation and sheath of electric cables
IS-7098	Cross-linked polyethylene insulated PVC sheathed (Part 1) cables for working voltage upto and including 1000V
IS-7098	Cross-linked polyethylene insulated PVC sheathed (Part 2) cables for working voltage from 3.3KV upto and including 33KV
IS-8130	Conductors for Insulated electrical cables and flexible cords
IEC-60096	Radio Frequency Cables
IEC-60183	Guide to the Selection of High Voltage Cables
IEC-60189	Low Frequency cables and wires with PVC Insulation and PVC Sheath
IEC-60227	Polyvinyl Chloride Insulated Cables of Rated Voltages up to and Including 450/750 V
IEC-60228	Conductors of Insulated Cables
IEC-60230	Impulse Test on Cables and their Accessories
IEC-60287	Calculation of the Continuous Current rating of Cables (100% Load Factor)
IEC-60304	Standard Colours for Insulation for Low-Frequency Cables and Wires

IEC-60330	Methods of Test for PVC Insulation and Sheath of Electrical Cables
IEC-60331	Fire - Resisting Characteristics of Electric Cables
IEC-60332	Tests on Electric Cables under Fire conditions
IEC-60502	Extruded solid dielectric insulated power cables for rated voltages from 1 kV upto 30 kV
IEC-60540	Tests methods for insulators & sheaths of electric cables & cords (electrometric & thermoplastic)
IEC-7541	Tests on gases evolved during combustion of electrical cables

3.2.16 GALVANIZING

IS-209	Zinc
IS-2633	Methods of Testing Uniformity of coating of Zinc coated articles
ASTM-A-153	Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware
ASTM-A-239	Test Method for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles by the Preece Test (Copper Sulphated Dip)
ASTM-A-121-77	Zinc - coated (Galvanized)Steel Barbed Wire

3.2.17 FIRE PROTECTION

TAC	Fire Protection Manual Issued by Tariff Advisory Committee (TAC) of India
NFPA	National Fire Protection Association
NBFU	National Board of Fire Underwriters

3.2.18 PAINTING

IS-6005	Code of practice for phosphating of Iron & Steel
ANSI-Z551	Gray Finishes for Industrial Apparatus and Equipment
SSPC	Steel Structure Painting Council

Compliance with Various CEA Regulations:

Construction standards

Central Electricity Authority (Technical standards for construction of electrical plants and electric lines) Regulations, 2010

Safety Standards for Construction and O&M

Central Electricity Authority (Safety Requirements for construction, operation and maintenance of electrical plants and electric lines) Regulations, 2011

Central Electricity Authority (Measures relating to Safety and electricity supply) Regulations, 2010

Connectivity standards

Technical standards for connectivity to the grid (Amendment) Regulation 2013

Technical standards for connectivity to the distributed generation sources

Technical standards for connectivity to the grid regulation , 2007

Operation Standards

Central Electricity Authority (Grid Standards) Regulations, 2010

Metering Regulations

Central Electricity Authority (Installations and operation of meters) (Amendment) Regulations, 2010

Central Electricity Authority (Installations and operation of meters) Regulations, 2006

- These CEA regulations are available in the website

www.cea.nic.in and compliance of these CEA regulations is mandatory.

3.3 MATERIALS AND WORKMANSHIP

3.3.1 GENERAL REQUIREMENTS

Where the Specification does not contain references to workmanship, it is understood that the equipment shall be new, of the best quality and in accordance with the purpose for which they are intended.

In cases where the equipment, materials or components are indicated in the specification as "similar" to any special standard, the Employer shall decide upon the question of similarity. When required by the Specification, or when required by the Employer the Contractor shall submit for approval, all the information concerning materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.

The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expense. Each component shall be designed to be consistent with its duty and suitable factors of safety shall be used throughout the design.

All joints and fastenings shall be so devised, constructed and documented that the component parts shall be accurately positioned to fulfil their required function. In general, screw threads shall be standard metric threads. The use of other thread forms shall only be permitted when prior approval has been obtained from the Employer.

Whenever possible, all similar parts of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall be interchangeable with, and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. All equipment of the same type and rating shall be physically and electrically interchangeable.

All materials and equipment shall be installed strictly in accordance with the manufacturer's recommendation(s). All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary. The spare equipment(s) shall also be installed at designated locations and tested for healthiness.

The Contractor shall apply oil and grease of the proper specification as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary in readiness for applying the lubricant required for operation. The Contractor shall apply all operational lubricants to the equipment installed by him. All insulating oil, lubricating material, grease and other consumables used in the Works/ Equipment shall be purchased in India unless the Contractor has any special requirement for the specific application for a type of oil or grease not available in India. If such is the case he shall declare in the proposal where such oil or grease or other consumables is available. In case possible he shall identify equivalent Indian makes and inform the Employer of the name of at least two Indian suppliers before handing over of the Works to the Employer. All consumables required upto operational acceptance shall be the part of supply scope of the Contractor.

The Works covered by the Specification, unless otherwise specifically required in the individual technical sections of each equipment or material, shall conform to the general requirements listed hereinafter.

3.3.2 COLOUR SCHEMES

The Contractor shall propose a colour scheme for the station for the approval of the Employer. The decision of the Employer shall be final. The scheme shall include:

- Finishing colour of Indoor equipment
- Finishing colour of all cubicles
- Finishing colour of various auxiliary system equipment including piping

3.3.3 CLAMPS & CONNECTORS

i) All power clamps and connectors shall conform to IS: 5561/ IEC standard and shall be made of materials listed below:

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|----|--|---|
| a) | For connecting ACSR conductors | Aluminium alloy casting, conforming to designation A6 of IS: 617 /IEC Standard and shall be tested for all tests as per IS: 617/IEC Standard |
| b) | For connecting equipment terminals made of copper with ACSR conductors | Bimetallic connectors made from aluminium alloy casting, conforming to designation A6 of IS 617/ IEC Standard with 2mm thick Bimetallic liner/Bimetallic strips and shall be tested as per IS: 617 /IEC Standard. |
| c) | For connecting G.I. Shield wire | Galvanised mild steel |
| d) | (i) Bolts, nuts & Plain washers. | Electro galvanised for sizes below M12, for others hot dip galvanised |
| | (ii) Spring washers for items 'a' to 'c' | Electro-galvanised mild steel suitable for at least service condition-3 as per IS:1573 |

ii) Equipment shall be supplied with the necessary terminals and connectors, as required by the ultimate design for the particular installation. The conductor terminations of equipment shall be either expansion, sliding or rigid type. The requirements regarding external corona and RIV as specified for any equipment shall include its terminal fittings and the equipment shall be factory tested with the connectors in position. In case the connector is not available then equivalent connector may be used. If corona rings are required to meet these requirements they shall be considered as part of that equipment and included in the scope of Work.

iii) Where copper to aluminium connections are required, bi-metallic clamps shall be used, which have been properly designed to ensure that any deterioration of the

connection is kept to a minimum and restricted to parts which are not current carrying or subjected to stress. The design details of joint shall be furnished to the Employer.

iv) Low voltage connectors, grounding connectors and accessories for grounding all equipment as specified are also included in the scope of Work.

v) No current carrying part of any clamp shall be less than 10 mm thick. All ferrous parts shall be hot dip galvanised. Copper alloy liner of minimum 2mm thickness shall be cast integral with aluminium body for Bi-metallic clamps. When copper alloy is not cast integral with aluminium body, a bimetallic washer or strip shall be used to meet the functional requirement.

vi) All casting shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

vii) Flexible connectors, braids or laminated straps made for the terminal clamps for bus posts shall be suitable for both expansion or through (fixed/sliding) type connection of IPS Aluminium tube as required. In both the cases the clamp height (top of the mounting pad to centre line of the tube) should be same.

viii) Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified ambient temperature. The rated current for which the clamp/connector is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.

ix) All current carrying parts shall be designed and manufactured to have minimum contact resistance.

x) TESTS

The following is the list of type tests.

- a) Temperature rise test (maximum temperature rise allowed is 35°C over maximum ambient temperature of the HVDC station location)
- b) Short time current test
- c) Dry corona and RIV test
- d) Resistance test and tensile test

3.3.4 NAME PLATES AND MARKINGS

- 1) All equipment mounted on front and rear side as well as equipment mounted inside the panels shall be provided with individual nameplates with equipment designation engraved. Also on the top of each panel on front as well as rear side, large and bold nameplates shall be provided for circuit/ feeder designation.
- 2) All front mounted equipment shall also be provided at the rear with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate easy tracing of the wiring.
- 3) All relays and other devices shall be clearly marked with manufacturer's name, manufacturer's type, serial number and electrical rating data.

- 4) Name Plates shall be made of non-rusting metal. Nameplates shall be black with white engraving lettering.

All the panels shall be provided with nameplate mounted inside the panel. Stainless steel nameplates shall be installed on all apparatus and on all major equipment components. For indoor cubicles, nameplates made of aluminium shall also be acceptable. Name plates shall be white with black engraved lettering and shall carry all the applicable information specified in the applicable items of the Standards, together with any other relevant information which may be required. For groups of smaller items for which this is not possible e.g. switch bays etc. a common nameplate with the title and special instructions on it shall be provided. No scratching, corrections or changes shall be allowed on nameplates.

All equipment mounted on front and rear sides as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved. Also on the top of each panel on front as well as rear sides large name plates with bold size lettering shall be provided for circuit / feeder / cubicle / box designation.

All front mounted equipment shall also be provided at the rear with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate tracing of the wiring. The nameplates shall be mounted directly by the side of the respective equipment and shall not be hidden by the equipment wiring.

The nameplate inscription and size of nameplates and letters shall be submitted to the Employer for approval.

The nameplates of the apparatus shall include, at least, the information listed below, together with any other relevant information specified in the applicable standards:

- a) A concise descriptive title of the equipment
- b) Rating and circuit diagram reference numbers
- c) Manufacturer's name, trade-mark, model type, serial number
- d) Instruction book number
- e) Year of manufacture
- f) Total weight (for capacitor racks indicate weight, for capacitors indicate quantity of liquid)
- g) Special instructions, if any, about storage, transportation, handling etc.

Each measuring instrument and meter shall be prominently marked with the quantity measured e.g. kV, A, MW etc. All relays and other devices shall be clearly marked with manufacturer's name, manufacturer's type, serial number and electrical rating data.

Danger plates and plates for phase colours shall be provided as per requirement. The Contractor shall devise a system to designate equipment and sub-systems. The nameplates/ labels displaying these designations shall be installed at appropriate locations. Wherever motion/ flow of fluids are involved, plates/ marks showing direction of motion/ flow shall also be provided.

3.4 PROVISIONS FOR EXPOSURE TO HOT AND HUMID CLIMATE

Outdoor equipment supplied under the Specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favourable to the growth of fungi and mildew. The indoor equipment located in non air-conditioned areas shall also be of the same type.

3.4.1 Space Heaters

The heaters shall be suitable for continuous operation at 240 V ac supply voltage & shall be connected to the supply through a fuse.

Control cubicles installed in air-conditioned area need not be provided with space heaters. These cubicles shall, however, have space heaters in case of storage of cubicles for long duration.

One or more heaters shall be provided, with thermostats or hygrostat, to prevent condensation in any compartment. The heaters shall be suitable to maintain the compartment temperature at approximately 10 deg. C, above the outside air temperature.

3.4.2 Fungistatic Varnish

Besides the space heaters, special moisture and fungus resistant varnish shall be applied to parts, which may be subject or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. Alternative fungal growth prevention methods may be offered for approval by the Employer. The varnish shall not be applied to any surface or part where the treatment shall interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

3.4.3 Ventilation Openings

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass or galvanized steel to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

3.4.4 Tropicalisation

The service building and bay kiosk shall be air-conditioned whereas the valve halls shall have ventilation system with positive pressure. All equipments shall, however, be suitable for installation in a tropical monsoon area having hot, humid climate and dry & dusty seasons with ambient conditions as specified. All control wiring, equipment and accessories shall be protected against fungus growth, condensation, vermin and other harmful effects due to a tropical environment.

3.4.5 Degree of Protection

Unless otherwise specified the degree of protection shall at least be IP 55 as per IS-2147 for outdoor equipment & IP 42 for indoor equipment. IP 41 may also be acceptable for indoor equipments if the layout is arranged such that there is no possibility at all of any liquid entering the area. For equipments with sensitive electronics, design of the boxes and Degree of protection shall be IP 66 and appropriate measures shall be taken to ensure that no mal-operation occurs due to extreme variations of temperature and humidity in the tropical climate. Suitable measures shall be taken in the design of outdoor equipment such that ingress of air inside the boxes does not cause high relative humidity which may lead to failure of electronic components. The Degree of protection test on boxes shall be done with all cables, accessories etc installed as per actual site conditions.

3.5 PAINTING AND FINISHING OF METAL SURFACES

All sheet steel work shall be phosphated in accordance with the IS: 6005 "Code of practice for phosphating iron and steel"/ IEC Standards.

Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water rinsing with a slightly alkaline hot water and drying.

After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.

The phosphate coating shall be sealed with application of two coats of ready mixed, stoved type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after in-spection of first coat of painting. The exterior colour of paint shall be of a slightly different shade to enable inspection of the painting.

A small quantity of finished paint shall be supplied for minor touching up required at site after installation of the panels.

In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc., the procedure shall be submitted along with the Bids for Employer's review & approval. The Contractor shall use procedures for painting ap-proved by the Employer during detailed Engineering.

Contractor's standard practice shall be acceptable to the Employer subject to approval during detailed engineering and meeting all functional requirements of the TS.

3.5.1 HOT DIP GALVANIZING

The minimum weight of the zinc coating shall be 900 gm/ sq.m (considering costal area) and minimum thickness of coating shall be 85 microns for all items thicker than 6 mm. For items less than 6 mm, requirements of coating thickness shall be as per relevant ASTM. For surfaces, which shall be embedded in concrete, the zinc coating shall be 900-gm/ sq.m.

The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, which is loosely attached to the steel globules, spiky deposits, blistered surfaces, flaking or peeling off, etc. The presence of any of these defects noticed on visual inspection shall render the material liable to rejection.

After galvanizing, no drilling or welding shall be performed on the galvanized parts of the equipment except the nuts may be rethreaded after galvanizing. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

The galvanized steel shall be subjected to six one-minute dips in copper sulphate solution as per IS 2633/ IEC Standards.

Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should be performed as per relevant IS/IEC Standards.

- Coating thickness
- Uniformity of zinc
- Adhesion test
- Mass of zinc coating

3.6 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR EQUIPMENT

All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IS-5039/IS-8623, IEC-60439 Standards as applicable, and the clauses given below:

1. Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of CRCA or aluminum enclosure and shall be dust, water and vermin proof. CRCA used shall be at least 2.0 mm thick cold rolled or 2.5 mm hot rolled or alternately 1.6 mm thick stainless steel can also be used. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In case of aluminum enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation.

2. The enclosures of the control cabinets, junction boxes, terminal boxes & marshalling boxes located outdoor shall provide a degree of protection of not less than IP 55 as per IS-13947: Part I/ IEC Standards. One control cabinet, junction box, terminal box & marshalling box of each type shall be tested for the same.
3. Cabinets/boxes shall be freestanding floor-mounting type, wall mounting type, or pedestal mounting type as required. Equipments such as telephone exchange, Public address systems etc shall be kept inside cubicles.
4. Cabinets/ boxes shall be provided with double-hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of the gasket shall be such that it does not get damaged / cracked during the operation of the equipment.
5. All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM/Neoprene gaskets. The gasket shall be tested in accordance with approved Quality Plan. Ventilating louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass. Alternative screen materials may be offered for approval by the Employer.
6. All boxes/cabinets shall be designed for the entry of cables from the bottom by means of weatherproof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. A suitable horizontal cable gland plate positioned at least 150 mm above the base of the marshalling kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland plate. The gland shall project at least 25mm above gland plate to prevent entry of moisture in cable crutch. Gland plate shall have provision for some future glands to be provided later, if required. The glands shall be dust proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS: 6121 and shall be nickel-plated.

Boxes / cabinets to be located inside a building in a non air-conditioned area may be designed for the entry of cables from the bottom or from the top.

7. Earthing

The provision for earthing shall be generally as per requirements given in Clause 3.7.2.1.

8. Tests

- a) The Marshalling Kiosks shall be subject to routine tests as per IS: 5039
- b) The following routine tests shall also be conducted:
 - i) Check for wiring
 - ii) Visual and dimension check

Marshalling kiosk shall be provided with danger plate and a diagram showing the numbering/ connection/ ferruling by pasting the same on the inside of the door.

Marshalling kiosk shall also be provided with incoming MCB and one 15 Amp interlocked switched socket in addition to the MCB required.

3.7 INDOOR CONTROL CUBICLES

The control panel, cubicles and desks shall be in accordance with the relevant IEC standards and shall be installed in air-conditioned space. Indoor electronic cubicles shall not generally require fans for cooling in order to operate successfully and correctly at the maximum ambient temperature. However, if it is absolutely necessary to install fans etc. in cubicles for cooling then these shall be driven by the same dc supply as used for control, and necessary redundancy, failure alarm etc. shall be incorporated. Louvers in the doors and side panels shall be permitted, if required.

The control and relay panels shall be suitable for numerical relays of modular type mounted in standard 19 inch racks located on the vertical front panel with rear doors for access or located on the front doors for front access type panels. Panels Cubicles shall be completely metal enclosed and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP 32 in accordance with IS-13947:Part I/IEC Standards for cubicles located in air-conditioned areas. IP 31 may also be acceptable for these areas if the layout is arranged such that there is no possibility at all of any liquid entering the area. However, for ventilation reasons the cubicles may be provided with a ventilation hood at the top with a protection class of IP21.

Panels shall be free standing, floor mounting type and shall comprise structural frames enclosed completely with specially selected smooth finished, cold rolled sheet steel of thickness not less than 2.5 mm for weight bearing members of the cubicles such as base frame, front sheet and door frames, and 1.5 mm for sides, door top and bottom portions. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration and rigidity during transportation and installation. The cubicles shall be provided with lifting lugs.

All doors, removable covers and plates shall be gasketed all around with neoprene gaskets. Ventilation louvers, if provided, shall have screens and filters. The screens shall be made of either brass or GI wire mesh with a graduation of 1 mm or less. Design, material selection and workmanship shall be such as to result in a neat appearance, inside and outside with no welds rivets or bolt heads apparent from outside, with all exterior surfaces true and smooth. All cubicles located in any room shall be matched in appearance.

The Contractor along with anchor bolts and necessary hardware for mounting the cubicles shall furnish metal sills in the form of metal channels properly drilled. Panels shall have an additional rolled channel plinth at the bottom with a smooth bearing surface. The panels shall be fixed on channels with intervening layers of anti-vibration strips made of shock absorbing material, which shall be supplied by the Contractor. Contractor's standard practice for control panels shall be acceptable to the Employer subject to approval during detailed engineering and meeting all functional requirements of the TS.

3.7.1 MOUNTING

All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush. No equipment shall be mounted on the doors.

Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices and are readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible.

The Contractor shall carry out cut out, mounting and wiring of the free issue items supplied by others, which are to be mounted in his panel in accordance with the corresponding equipment manufacturer's drawings. Cut outs if any, provided for future mounting of equipment shall be properly blanked off with blanking plate.

The centre lines of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel. The centre lines of relays, meters and recorders shall be not less than 450mm from the bottom of the panel

The centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Like wise the top lines of all meters, relays and recorders etc. shall be matched.

No equipment shall be mounted on the doors.

At existing station, panels shall be matched with other panels in the control room in respect of dimensions, colour, appearance and arrangement of equipment in order to have better aesthetic look.

All the equipment connections and cabling shall be designed and arranged to minimize the risk of fire and damage which may be caused by fire.

3.7.2 EARTHING

- 1) All panels shall be equipped with an earth bus securely fixed. Location of earth bus shall ensure no radiation interference for earth systems under various switching conditions of isolators and breakers. The material and the sizes of the bus bar shall be at least 25 X 6 sq. mm perforated copper with threaded holes at a gap of 50mm with a provision of bolts and nuts for connection with cable armours and mounted equipment etc for effective earthing. When several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply of Contractor. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.
- 2) Provision shall be made on each bus bar of the end panels for connecting Substation earthing grid. Necessary terminal clamps and connectors for this purpose shall be included in the scope of supply of Contractor.
- 3) All metallic cases of relays, instruments and other panel mounted equipment including gland plate, shall be connected to the earth bus by copper wires of size not less than 2.5 sq. mm. The colour code of earthing wires shall be green.
- 4) Looping of earth connections, which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. Earthing may be done in such a manner that no circulating current shall flow in the panel.

- 5) VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel. Such earthing shall be made through links so that earthing may be removed from one group without disturbing continuity of earthing system for other groups.
- 6) An electrostatic discharge point shall be provided in each panel connected to earth bus via 1 Mega Ohm resistor.

3.7.3 INSTRUMENTS, METERS AND RECORDERS

For HVDC station and associated AC yards only digital displays and systems shall be provided. The requirements in this section are applicable to auxiliary systems only. All instruments, meters and recorders shall be enclosed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. They shall be calibrated to read directly the primary quantities. They shall be accurately adjusted and calibrated at the factory and shall have means of calibration, checking and adjustment at site.

3.7.4 Miscellaneous

- 1) The Contractor shall submit all type and routine test certificates to the Employer for approval before dispatching the equipment. Control and relay panels shall also be subjected to the following tests:
 - i) Mechanical operation test
 - ii) Verification of degree of protection as per IS-13947:Part I/ IEC Standards
 - iii) High voltage test
 - iv) Electrical control, Interlock and sequential operation test
 - v) Verification of wiring as per approved schematic.
- 2) Plug Point: 240V, Single phase 50Hz, AC socket with switch suitable to accept 5 Amps and 15 Amps pin round Indian plug as applicable, shall be provided in the interior of each cubicle with ON-OFF switch.
- 3) Interior Lighting: Each panel shall be provided with a CFL lighting fixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch. Adequate lighting shall also be provided for the corridor in Duplex panels.
- 4) MCB's: Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breakers (MCB).
- 5) Space Heater: Panels wherever required shall be provided with a space heater rated for 240V single phase, 50 Hz Ac supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with thermostat and switch fuse /MCB unit.

3.7.5 TERMINAL BLOCKS AND WIRING

All internal wiring to be connected to external equipment shall terminate on terminal blocks. The Contractor has to supply new terminal box (if required) at its own cost.

Terminal blocks shall be 650 V grade and have 10 Amps. Continuous rating, moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Markings on the terminal blocks shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material.

Disconnecting type terminal blocks for current transformer and voltage transformer secondary leads shall be provided. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities.

At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

The terminal blocks shall be suitable for connecting the conductors of external cable on each side.

Terminal blocks shall be of (at least) 650V grade and have 10 amps continuous rating. These shall be moulded, complete with insulated barriers, stud type terminals, complete with washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud terminals with locking type. Other types of terminal and marking that have been approved by the Employer for use on previous projects may be offered. The terminal blocks shall be of reputed make subject to Employer's acceptance.

Terminal block design shall include a white fibre marking strip with clear plastic, /clip-on terminal covers. Markings on the terminal strips shall correspond to wire numbers on the wiring diagrams.

Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short-circuiting and earthing facilities.

The conducting part in contact with the cable shall preferably be tinned or silver-plated however; nickel-plated copper shall also be acceptable. Insulating barriers shall be provided between the terminal blocks.

Manufacturer's standard practice for internal wiring of cubicles shall be acceptable to the Employer. However all external cabling requirements shall be strictly as per TS.

The Contractor shall furnish all wire, conduits and terminals for the necessary inter-phase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets.

3.7.6 Cable sealing

Multi cable transit (MCT) system shall be used for all cable entry to the control room and switchyard panel room in switchyard. Location and type of MCT shall be submitted to employer for approval.

3.8 WELDING AND WELDERS' QUALIFICATIONS

All welding shall be in accordance with the corresponding standards of the American Welding Society or the American Society of Mechanical Engineers.

Other standards to determine the quality of welding processes and qualifications of welders may be considered, provided that sufficient information is first submitted for the approval of the Employer.

Prior to the start of fabrication, the Contractor shall submit to the Employer for approval, a description of each of the welding procedures which he proposes to adopt, together with certified copies of reports of the results from tests made in accordance with these procedures.

The Contractor shall be responsible for the quality of the work performed by his welding organization. All welding operators shall be assigned to the work, including for repair of castings, shall pass the required tests for qualification of welding procedures. The Employer reserves the right to witness the qualification tests for welding procedures and operators and the mechanical tests of the samples. If the Inspector so requires, the Contractor shall furnish to the Inspector certified copies of reports of the mechanical test results of the samples.

The Contractor shall bear all his own expenses in connection with the qualification tests. If the work of any operator at any time appears questionable, such operator shall be required to pass appropriate re-qualification tests as specified by the Inspector and at the expense of the Contractor.

Strict measures for quality control shall be exercised throughout the Equipment/Works. The Engineer may call for an adequate NDT test of the work of any operator, who, in his opinion, is not maintaining the required standard of workmanship. Should this NDT test prove defective, all work done by that operator, since his last test shall be tested at the Contractor's expense. If three or more of these tests prove defective, the operator shall be removed from the project.

A procedure for the repair of defects shall be submitted to the Employer for his approval prior to any repairs being made.

3.9 MICROCOMPUTER SUB SYSTEMS

3.9.1 HARDWARE

1. Computer Circuit Protection

All computer circuits shall be adequately protected from all external interferences such as induced current and voltages from other adjacent control panels or high power circuits, and voltage spikes that propagate in the system.

2. Programmer's Facilities

The following minimum facilities shall be provided for use in application software maintenance, program loading, program checking, program development and implementing changes.

- i) Program development systems including console, keyboard etc. with editors and compilers.
- ii) Interactive printers.

3.9.2 SOFTWARE

1. The provision of all the necessary software in an operational state shall be the responsibility of the Contractor. System performance shall be fully demonstrated during factory acceptance tests and during the final system acceptance tests.
2. The software provided shall be of modular design and shall accommodate the identified future system growth without need for software modification.
3. Programming, development/changes and the addition of new programs via test, maintenance and programmer's facilities shall be reduced to simple, easy to follow procedures. Protection against inadvertent damage or modification to on line programs shall be provided.
4. The software shall include but shall not necessarily be limited to the following:
 - Real time multiprogramming / multitasking / multi-user operating system.
 - Application Software.
 - Man machine software.
 - Error diagnostics/corruption detection software
 - Software design specifications, details of each software module, details of formats, logger formats etc., shall be submitted to the Employer for approval.
 - All software provided must be fully documented.

3.9.3 SOFTWARE PROTECTION/ SECURITY

Adequate protection systems shall be incorporated in the computer systems to prevent mutilation or corruption of the software due to any form of extraneous software interference or hardware/interface incompatibilities. Software supplied in DVDs shall be well protected against corruption or destruction due to any extrinsic software. Operating systems shall also be suitably well protected.

3.10 MOTORS

3.10.1 GENERAL

All motors shall conform to IEC 34 / IS Standard/IEC Standard and as specified herein:

1. Motors rated 0.5 kW and above, and reversing motors, shall be rated 415 V, three phase, grounded neutral;
2. Motors rated below 0.5 kW shall be rated 240 V one phase;
3. All motors shall be designed to operate at full load dynamic conditions with a voltage range of variation of +10%, 20% and a frequency range variation of +5%, 10%. Motors shall also be designed to operate at 125% of the rated

- speed without mechanical damage, and to start with 80% of their rated voltage;
4. All motors shall be designed and rated for continuous operation at maximum ambient temperature of the HVDC station. The class of insulation shall be at least one class higher than used for defining the temperature rise of the motor;
 5. Vertical motors rated 60 kW and above shall be provided with oil lubricated self cooled pivoted shoe type thrust bearing. Vertical motors below 60 kW shall be provided with re-greasable anti friction ball or roller bearings;
 6. All anti friction bearings shall be guaranteed to operate successfully for a minimum of 131,000 hours;
 7. All bearings shall be quiet operating and statically and dynamically balanced;
 8. All belts to be used shall be "V" type and designed for the maximum power to be transmitted and for the maximum speed. The selection of the "V" belt drive for any application shall also be based on the nature of the load and the type of the driving unit. Belts installed outdoors shall be suitably protected.

3.11 CONDUITS, PIPES AND ACCESSORIES

The Contractor shall supply and install all rigid conduits, mild steel pipes, flexible conduits, hume pipes etc. including all necessary sundry materials, such as tees, elbows, check-nuts, bushings, reducers, enlargers, wooden plugs, coupling caps, nipples, gland sealing fittings, pull boxes etc. The size of the conduit/pipe shall be selected to limit the fill to a maximum of 40%. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed in an approved manner to prevent damage to threaded portions and entrance of moisture and foreign materials.

PVC conduits shall be of high impact, heavy gauge (at least class 2) conduit conforming to BS 4607.

The outer surface of the steel conduits shall be coated with hot dip zinc and chromate conversion coatings. The inner surface shall have silicone epoxy ester coating for easy cable pulling. Mild steel pipes shall be hot dip galvanized. All rigid conduits/pipes shall be of a reputed make.

The hume pipes and accessories shall be of reinforced concrete conforming to class NP2 of IS 458. All tests on hume pipes shall be conducted as per IS 458.

Flexible conduits shall be of heat resistant lead coated steel, water leak, fire and rust proof.

3.12 SEISMIC FORCE CONSIDERATION

All structures shall be designed for seismic forces in accordance with IS 1893/IEC Standards.

The seismic design of electrical equipment shall be performed using estimated actual earth/ground motion, defined by a response spectrum, rather than the equivalent loads specified in typical Building Codes.

For brittle materials like glass, porcelain and glass fibre reinforced plastic the maximum calculated load should not exceed 2/3 of the guaranteed minimum rupture (breaking) strength (safety factor 1.5) as defined by the manufacturer/supplier of the material used. The minimum rupture value is defined as $(X - 2 \cdot \sigma)$, where X is the mean value and 'sigma' is the standard deviation. For load combinations in porcelain insulators and similar the following expressions shall be fulfilled:

$$\{F_t / (F_t)_b\} + \{M_b / (M_b)_b\} < 2/3$$

and

$$\{F_c / (F_c)_b\} + \{M_b / (M_b)_b\} < 2/3$$

Where:

F_t, F_c, M_b : calculated maximum tensile force; compressive force and bending respectively

$(F), (F), (M)_b$: corresponding guaranteed strength values

(For normal operating loads, a higher safety factor more than 1.5 shall be used, normally 2.0-2.5 depending on type of load as per recommendations of manufacturer). Factor regarding importance of structures (I), as defined in IS 1893/IEC Standards, shall not be taken less than 1.5.

3.14 SAFETY REQUIREMENTS

The requirements regarding provision of additional staircases and approachability as defined in the Fire Protection Manual, issued by the Regional Committees of the Tariff Advisory Committee shall be completely fulfilled. All other safety requirements shall be met as per the factories Act, TAC etc.

MICROCOMPUTER SUB-SYSTEMS

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ii) Interactive printers.

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1. The provision of all the necessary software in an operational state shall be the responsibility of the Contractor. System performance shall be fully demonstrated during factory acceptance tests and during the final system acceptance tests.

2. The software provided shall be of modular design and shall accommodate the identified future system growth without need for software modification.

3. Programming, development/changes and the addition of new programs via test, maintenance and programmer's facilities shall be reduced to simple, easy to follow procedures. Protection against inadvertent damage or modification to on-line programs shall be provided.

4. The software shall include but shall not necessarily be limited to the following:

- Real time multiprogramming / multitasking / multi-user operating system.
- Application Software.
- Man-machine software.
- Error diagnostics/corruption detection software
- Software design specifications, details of each software module, details of formats, logger formats etc., shall be submitted to the Employer for approval.
- All software provided must be fully documented.

3.15.3 SOFTWARE PROTECTION/ SECURITY

- Adequate protection systems shall be incorporated in the computer systems to prevent mutilation or corruption of the software due to any form of extraneous software interference or hardware/interface incompatibilities. Software supplied in CDs shall be well protected against corruption or destruction due to any extrinsic software. Operating systems shall also be suitably well protected.