



सत्यमेव जयते

GOVERNMENT OF INDIA
CENTRAL PUBLIC WORKS DEPARTMENT

GENERAL SPECIFICATIONS
FOR ELECTRICAL WORKS

PART-IV
SUB STATIONS

2013



PUBLISHED UNDER THE AUTHORITY
OF
DIRECTOR GENERAL, CPWD, NEW DELHI

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FOREWORD

These revised General Specifications for Electrical Works Part-IV Sub Stations 2013 serve the need to design the bulk electric supply system in a building.

The earlier edition of these specifications released in 2007 catered to the major technological changes in the electrical system of sub-stations along with the introduction of various latest power equipments. The same needed a revision in the system engineering owing to the policy initiative taken by CPWD to make all buildings under its construction GRIHA compliant.

The revised specifications have therefore incorporated the changes in the maximum allowable losses of the distribution transformers, design of cable sizes etc. as per the provision contained in ECBC 2007 and as recommended by TERI, New Delhi.


Detailed deliberations were conducted between CPWD officers and TERI officials on various aspects of energy efficiency in the building. As a result of these discussions, TERI presented its recommendations to CPWD. These revised specifications were drafted by Shri Mukesh Vij, CE (E), Shri S.K. Chawla, CE (E) and Shri C.K. Varma, CE (E) on the recommendations of TERI (*The Energy and Resources Institute*) to make these specifications ECBC (*Energy Conservation Building Code*) and GRIHA (*Green Rating for Integrated Habital Assessment*) compliant.

I acknowledge the efforts put in by members of the Specification Committee under the chairmanship of Sh R.K. Singhal, Spl. DG (NR) in reviewing and finalizing these specifications. I acknowledge the untiring efforts of the Team of TERI official too in their recommendations for the required updates. I also acknowledge the efforts of Sh. S.S. Garg, SE (E) TAS, Member Secretary and his team of officers for contributing towards making the publication available in a short period of time.

Suggestions for modifications as well as errors and omissions may be sent to SE (E) TAS, office of the Chief Engineer (E) CSQ, CPWD, Vidyut Bhawan, New Delhi.

In case of any discrepancy between English and Hindi Versions, the English version shall be held valid.

Place : New Delhi
Dated : 26.02.2013


(Ashok Khurana)
Director General
CPWD, New Delhi



राकेश कुमार सिंघल
विशेष महानिदेशक (उत्तरी क्षेत्र)
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PREFACE

The General Specifications for Electrical Works Part – IV Sub-Station– 2013 is revised edition of the earlier edition of these specifications released in 2007. Due to policy initiative taken by CPWD to make all buildings under its construction GHIRA compliant, the revision is needed to serve the purpose to design the Bulk Electric supply system in a building.

As per the provisions contained in ECBC-2007 and as recommended by TERI, New Delhi, these revised specifications include the maximum allowable losses of distribution transformer and design of cable sizes from the point of view of energy conservation.

I am grateful to Shri Ashok Khurana, Director General, CPWD for reposing trust in me to undertake this work and express my deep appreciation to Sh. Mukesh Vij, CE(E), Sh. Chawla CE(E) and Sh. C.K. Varma, CE(E), for drafting these specifications in the light of recommendations of TERI.

I acknowledge the efforts put in by members of the specification committee, in making the present specification technically update & user friendly. I acknowledge the active support of TERI officials whose recommendation have paved the way for this revision.

I also express my deep appreciation to Sh. S.S. Garg, SE(E) TAS, CSQ, Sh. R.R. Madaan, EE(E) TAS, Sh. V.K. Yadav, AE(E) TAS, Sh. P.P. Singh, AE(E) TAS, who made their sincere efforts to update and making the publication available in very short time.

Errors or omissions, and suggestions for improvement, if any, may kindly be brought to the notice of the Superintending Engineer (E) TAS, Office of the Chief Engineer (E) CSQ, CPWD, New Delhi -01

Place : New Delhi
Dated : 26.02.2013

(R.K. Singhal)

Spl. Director General (NR), CPWD
and Chairman, Specifications Committee(E&M)

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REFERENCES OF AMENDMENTS

<i>Sl. No.</i>	<i>Reference under which issued</i>	<i>Chapter No.</i>	<i>Item No.</i>	<i>Page</i>

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SECTION 1

GENERAL

1.1 SCOPE

These general specifications cover the details of Sub Station Equipments (Transformers, HT Panels, Bus Trunkings/ Rising Mains and other related items) to be supplied, the inspection as may be necessary before dispatch, delivery at site, installations, testing, commissioning, putting into operation and handing over in working condition of the equipment for sub-stations for working voltage of 11000/433 volts. The general specifications are subject to revision from time to time. The tender specifications for a particular job shall clearly indicate the applicable version of these specifications.

(Where Licensee is supplying power at 33 KV/ 6.6 KV etc. Voltages, sub-station equipments of suitable specification and capacity shall be provided).

These specifications do not cover sub-station installation in mines, quarries and installation of similar nature, having hazardous atmosphere.

These however do not bind the NIT approving authority from incorporating better and new, technologically superior, products judiciously.

1.1.1 Related Documents

These technical specification shall be read in conjunction with the standard conditions of the contract with correction slips, as are relevant for commercial aspects, as well as schedules and drawing and requirements under these specifications.

In the event of any discrepancy between these specifications and inter connected documents, the technical requirements as per the contract specifications shall be followed and deemed to be having overriding value.

1.2 DEFINITIONS

The definitions of terms are in accordance with relevant Indian standards.

Extra Low Voltage (ELV) : Not exceeding 50 Volts

Low Voltage (LV) : Normally exceeding 50 Volts but not exceeding 250 Volts.

Medium Voltage (MV) : Normally exceeding 250 V but not exceeding 650 V.

High Voltage (HV) : Normally exceeding 650 V but not exceeding 33 KV.

Extra High Voltage (EHV) : Normally exceeding 33 KV.

(Source: NBC, 2005, Part-8, Section 2.1.75 to 2.1.79)

1.3 SYSTEM ENGINEERING

1.3.1 General

A sub-station installation is a combination of a number of major equipments like Transformers, High Voltage Panel, Medium Voltage (MV) Panels, Inter-connecting Cables, Bus Ducts, Protection and Metering etc. individually engineered in each case depending upon the requirements, size and capacity of sub-station and in coordination with the licensee of the area concerned. **Generally supply at 230/415 or 433 Volts subject to verification for loads up to 100 KVA, 11 KV for loads up to 5 MVA and 33/ 66 KV for loads more than 5 MVA. While selecting the Transformer(s) for a substation it will be desirable to provide at least one standby Transformer, so that a certain amount of redundancy is built in the system.**

It may also be necessary to install capacitor banks/other modern systems to improve power factor, simultaneously controlling the Harmonics, for economy consideration as well as to comply with the requirements of local utility.

Metering aspects as well as protection arrangements will also depend upon the Licensee's requirements.

1.3.2 Items of Work

A sub-station installation work shall generally comprise of supply, installation, testing and commissioning of the following:

- (a) High Voltage Panels.
- (b) Step down Transformers, complete with associated auxiliaries as specified.
- (c) High voltage cable for inter-connection between the H.V. panel and transformers including terminations.
- (d) M.V. Panel(s).
- (e) L.T. cable, for upto 400 KVA Transformers and Bus trunking for higher than 400 KVA transformers, inter-connection between transformer's M.V. terminals and the M.V. Panel as specified.
- (f) Power factor improvement capacitors/ Power Conditioner Savers.
- (g) Earthing system.
- (h) Safety Equipments.
- (i) Emergency M.V. Panel if required.
- (j) Miscellaneous items.

1.4 CONFORMITY WITH STATUTORY ACTS, RULES, REGULATIONS, STANDARDS AND SAFETY CODES

1.4.1 Indian Electricity Act and Rules

All electrical works in connection with installation of electric sub-stations shall be carried out in accordance with the provisions of Indian Electricity Act, 2003 and the

Indian Electricity Rules, 1956 amended upto date. Wherever I.E. rule numbers have been indicated, they are based on I.E. Rules, 1956 amended upto date.

1.4.2 CPWD Specifications

The electrical works shall also conform to CPWD General Specifications for Electrical Works Part I (Internal) 2013 and Part II (External) 1994 as amended upto date wherever relevant and applicable.

1.4.3 Indian Standards

The sub-station equipments and their installation shall conform to relevant Indian standards.

1.4.4 Other Acts and Rules

The installation shall also comply with the following:-

- (i) Factories Act wherever applicable.
- (ii) Any other Act or Rules in force.

1.4.5 Safety Codes and Labour Regulations

In respect of all labour employed directly or indirectly on the work, the tenderer, here in after called the contractor, at his own expense will arrange for the safety provision outlined in section 9 of these specifications to comply with the statutory regulations, ISI recommendations and CPWD codes.

In case of default, the department shall be at liberty to make arrangements and provide facilities as aforesaid and recover the cost from the contractor.

The contractor shall provide necessary barriers warning signals and other safety measures to avoid accidents. He shall also indemnify CPWD against claims for compensation arising out of negligence in this respect.

Nothing in these specifications shall be construed to relieve the contractor of his responsibility for the design, manufacture and installation of the equipment with all accessories in accordance with applicable statutory regulations and safety codes in force from the safety angle.

1.5 INFORMATIONS AND DRAWINGS TO BE SUPPLIED BY THE DEPTT.

1.5.1 Specification Drawing

The tender specifications shall indicate, for a particular job, the reference drawings to help the contractor to work out the tender. The drawings shall also indicate the schematic of main connections and shall form part of the specifications. All the drawings specified and issued with the tender are for purpose of tendering only and shall be deemed to be specification drawings.

1.5.2 Schedule of Work

The department shall supply a schematic diagram and a schedule of work as per format in Appendix II detailing the equipments; materials required type and anticipated quantity/ numbers in respect of each item.

1.6 WORKS TO BE ARRANGED BY THE DEPARTMENT

Unless otherwise mentioned in the tender specifications the following works shall be carried out by the department.

- (i) Construction of sub-station building. The contractor should select such equipment for installation as can be properly installed in the spaces shown in specification drawings. While no guarantee can be given minor modification required by the contractor if mentioned in the tender or intimated immediately after the receipt of tender shall be carried out if structurally possible.
- (ii) Cable trench, entry pipe for cable, manholes for drawing of cables, manhole covers etc. as per requirements.
- (iii) Construction of necessary soak pits, drainage arrangement for soak pit etc., if required.
- (iv) Provision of storage space at site during the contract period free of cost.

1.7 WORKS TO BE DONE BY THE CONTRACTOR

In addition to supply, installation, testing and commissioning of all equipments as per schedule of work in accordance with 1.5.2 the following work shall be deemed to be included within the scope of work, to be executed by the contractor.

- (i) All minor building works, such as equipments foundation if required cutting and making good holes, grouting of channels belts as required. Cutting and making good damages etc.
- (ii) Provision of supports / clamps for equipments, cables etc. wherever required.
- (iii) Small wiring, inter-connection etc. inclusive of all materials and accessories, necessary to comply with the regulations as well as proper and trouble free operation of the equipment.
- (iv) Closing of the cable entry points in sub-station against seepage of water, rodents etc.
- (v) Tools and tackles required for handling and installation.
- (vi) Necessary testing equipments for commissioning.
- (vii) Watch and Ward of materials and/or installation and equipments till their handing over to the department.

1.8 SITE CONDITIONS

All the equipments and their installation shall be suitable for the environmental conditions encountered at the location as indicated in Appendix II.

1.9 INSPECTION OF SITE AND COLLECTION OF DATA

The contractor shall be deemed to have examined the tender documents, detailed specification, data etc. and to have visited the site or ascertained all relevant details for offering suitable equipments/ installation.

1.10 INTER CHANGEABILITY

All similar equipments, materials, removable parts of similar equipments etc. shall be inter-changeable with each other.

1.11 INTERFERENCE WITH COMMUNICATION EQUIPMENT

Suppressors or other protection devices shall be provided, if required as per schedule of quantities, wherever the sub-station installation is likely to interfere during the operation with any other electric or electronic equipment.

1.12 EXTENT OF WORK

The scope of work shall consist of cost of all materials, labour i/c supervision, installation, calibration, adjustments as required for commissioning of the sub-station. The term complete installation shall mean, not only, major item of the plant and the equipments covered by these specifications, but also, incidental sundry components necessary for complete execution and satisfactory performance of installation with all labour charges, whether or not specifically mentioned in the tender documents, which shall be provided by the contractor at no extra cost.

1.13 COMPLETENESS OF TENDER

All fittings, unit assemblies accessories, hardware foundation bolts, terminals blocks for connections, cable glands and miscellaneous materials and accessories of items of work which are useful and necessary for efficient assembly and working of the equipment shall be deemed to have been included within the scope of the work in the tender and within the overall details for complete item whether they have been specifically mentioned or not.

1.14 DATA MANUALS AND DRAWINGS TO BE FURNISHED BY CONTRACTOR

1.14.1 After Award of Work

The contractor shall submit the following drawing within a fortnight of the award of the work or as specified in tender document which shall prevail, for approval by the department.

- (i) General arrangement or location drawing of the equipment complete with dimensions and clearances.
- (ii) General arrangement drawing of H.V. Panel, Transformers, M.V. panels, Earthing, Cable route etc. including details of grouting of channels / bolts of various equipments.
- (iii) All panels' schematics & wiring diagram including control wiring.
- (iv) Bar chart indicating general programme for supply, installation, testing and commissioning and handing over.
- (v) Any other drawing or data that may be necessary for the job.

1.14.2 Before Commencement of Installation

The contractor shall also furnish 3 copies of detailed installation, operation and maintenance manuals of manufacturers for all items of equipment together with all relevant data sheet, spare parts catalogues, repairs, assembly and adjustment procedure etc., in triplicate.

1.15 QUALITY OF MATERIALS AND WORKMANSHIP

All parts of equipment shall be of such design, size and material so as to function satisfactorily under all rated conditions of loading and operation. All components of the equipment shall have adequate factors of safety. Materials/components which are not conforming to standards laid down by Bureau of Indian Standards (BIS) shall be got approved from the department before use on the work.

The entire work of fabrication, assembly and installation shall conform to sound engineering practice and on the basis of "fail safe" design. The mechanical parts subject to wear and tear shall be of easily replaceable type.

The construction shall be such as to facilitate ease of operation, inspection, maintenance and repairs. All apparatus shall also be designed to ensure satisfactory operation under working conditions as specified.

1.16 INSPECTION, TESTING AT MANUFACTURERS WORKS

The contractor will be required to furnish such facilities as will be necessary for inspection of the equipment before dispatch at the manufacturer's works and also for witnessing such tests, at the works, if so required by the department. The contractor shall furnish information for this purpose and will also give sufficient notice regarding the dates proposed for such test to Inspection agency.

1.17 TEST CERTIFICATE

Copies of all documents for routine, acceptance and type test certificates of the equipment carried out at the manufacturers premise shall be furnished to the department alongwith supply of the equipment.

1.18 DISPATCH OF MATERIALS AND STORAGE

The contractor shall commence work as soon as the drawings submitted by him are approved. The contractor should dispatch all materials to site in consultation with the department where suitable storage accommodation may be made available to him temporarily. For this purpose the programme of dispatches of materials shall be framed keeping in view the building progress so that suitable storage accommodation could be made available to the contractor. Safe custody of all machinery and equipment supplied by the contractor shall be his own responsibility till the final taking over by the CPWD.

1.19 COORDINATION WITH OTHER AGENCIES

The contractor shall coordinate his work and cooperate with other agencies by exchange of all technical information like details of foundation if required, weight, over all dimensions, clearance and other technical data required for successful and proper completion of his portion of the work in relation to the work of others without

any reservation. No remuneration should be claimed from the department for such technical cooperation. Care shall be taken not to damage the water proofing done in the case of substations constructed below ground level. If any unreasonable hindrance is caused to other agencies and any completed portion of the works has to be dismantled and redone for want of the cooperation and coordination by the contractor during the course of work, such expenditure incurred will be recovered from the contractor during the course of work, if the restoration work to the original condition of specification of the dismantled portion of the work was not under taken by the contractor.

1.20 CARE OF BUILDINGS

Care shall be taken, while handling/ installing the equipment to avoid damage to the building. On completion of the installation, the contractor shall arrange to repair all damages to the building caused during plant installation so as to bring to the original condition. He shall also arrange to remove all unwanted waste materials from substation room and other areas used by him.

1.21 PAINTING AND PROTECTION

All damages to painting during transport and installation shall be set right to the satisfaction of the department before handing over. All structural frame work for support of various items of equipment shall be given the final coat of paint of approved shade at site after erection is complete.

Additional protection measures against corrosion shall be provided when installed in special environment.

1.22 TRAINING OF DEPARTMENTAL PERSONNEL

The operation and maintenance staff of the CPWD shall be associated with the contractor's personnel during the installation, testing and commissioning of the equipments.

1.23 COMPLETION DRAWING

Three sets of completion drawings comprising the following shall be submitted by the contractor while handing over the installation:

- (a) Equipments layout drawing(s) giving complete details of the entire equipments.
- (b) Electrical drawings for the entire electrical equipments showing cable sizes, equipment capacities, switch-gear's ratings, control components, control wiring etc.
- (c) Schematic diagram of the entire sub-station installation.

1.24 FINAL INSPECTION AND TESTING

When the installation is complete, the contractor shall arrange for inspection and testing of the installation. Test results obtained shall be recorded. The installation shall not be accepted until it complies with the requirement of these Specifications. The Sub Station installation shall be got inspected by the contractor from local licensee and/or CEA and their clearance taken before energizing the Sub Station. All the observations/ deficiencies pointed out by the inspecting authorities shall be complied with by the contractor on priority.

The department shall render all help and pay mandatory charges to CEA and local licensee, if any, in this regard.

1.25 DATE OF ACCEPTANCE

The contractor shall operate the sub station for a period of fifteen days after it is energized. The date of taking over of the sub station shall be reckoned after its trouble free operation during the running in period.

1.26 GUARANTEE

The contractor shall guarantee the entire sub-station installation as per specifications. All equipments shall be guaranteed for one year from the date of acceptance against unsatisfactory performance or break down due to defective design, manufacture and installation. The installation shall be covered by the conditions that whole installation or any part there of found defective within one year from the date of taking over shall be replaced or repaired by the contractor free of charge as decided by the department. The warranty shall cover the following:-

- (a) Quality, strength and performance of materials used.
- (b) Safe mechanical and electrical stress on all parts under all specified conditions of operation.
- (c) Satisfactory operation during the maintenance period.
- (d) Performance figures and other particulars as specified by the tenderer under schedule of guaranteed technical particulars.

1.27 AFTER SALES SERVICES

The contractor shall ensure adequate and prompt after sales services in the form of maintenance personnel and spares as and when required with a view to minimizing the break down period. Particular attention shall be given to ensure that all spares are easily available during the normal life of installation.

SECTION 2

HIGH VOLTAGE PANEL

2.1 SCOPE

These specifications cover the detailed requirements for supply, installation, testing and commissioning of High Voltage Panels.

2.2 TYPE OF PANELS

- (a) Vacuum circuit breaker.
- (b) Gas filled Circuit Breaker: These breakers are new in the market and are being used for 33 KV and above in power distribution. These may be used on selective basis based on their availability, serviceability and cost.
- (c) Gas insulated compact Switchgears with Vacuum Circuit Breakers. These are recently introduced and may be used in cases of space crunches judiciously.

However the discussions shall be limited to only Vacuum Circuit Breakers.

VACUUM CIRCUIT BREAKER

2.3 H.V. PANEL

2.3.1 The Panel board shall be of indoor type, having the incoming sectionalisation and outgoing switch gears as per IS 13118 : 1991 of VCB, IEC 62271-100 for Breakers and -200 for Panels/ IS 3427 of switch board. The degree of enclosure protection shall be IP-4X.

Detailed requirements shall be in accordance with the schedule of works at Appendix II.

2.3.2 Rating

All panels assembled to form a board shall be suitable for the nominal operation voltage and rupturing capacity as specified. They should be rated as specified with a minimum of 630 Amps. and suitable for operation on 11 KV, 3 phase 50 Hz system. Type test certificate for the breaking capacity of the panel shall be supplied. A circuit breaker for a given duty in service is best selected by considering the individual rated values required by load conditions and fault condition.

2.3.3 Type

The HV Panel Board shall be metal clad, indoor, floor mounting, free standing type. It shall be totally enclosed dust, damp and vermin proof.

2.3.4 **General Construction**

Separately earthed compartments shall be provided for circuit breakers, bus bars, relay & instruments, CT&PT and cable boxes, fully and effectively segregating these from one another so that fault in any one compartment do not cause damage to equipment(s) in other compartment(s).

The housing shall be of bolted construction to ensure compact and rigid structure, presenting a neat and pleasing appearance. The sheet steel used should not be less than 2 mm thick.

The panels shall be bolted together to form a continuous flush front switch gear suitable for front operation of board and for extension at both ends.

2.3.5 **General Design Aspects**

The HV panel board shall be designed such that the switchgear, instruments, relays, bus bars, small wiring etc. are arranged and mounted with due consideration for the following:-

- (i) Facility for inspection, maintenance and repairs of testing terminals and terminal boards for ease of external connection.
- (ii) Minimum noise and vibrations.
 - Risk of accidental short circuits and open circuits.
 - Secured and vibration proof connections for power and control circuits.
- (iii) Risk of accidental contact and danger to personnel due to live connections.
- (iv) Mountings at approachable height.

2.4 **CIRCUIT BREAKER**

2.4.1 **General Arrangements**

The circuit breaker panels shall be complete with the following:

- (a) Racking in / Racking out mechanism.
- (b) Isolating plugs and sockets.
- (c) Mechanical inter-locks and safety shutters.
- (d) Mechanical ON/OFF indicator.
- (e) Minimum of 4 NO and 4 NC Auxiliary contacts directly operated by the circuit breaker. Additional NO & NC contacts can be provided with auxiliary contractors.
- (f) Anti condensation space heaters suitable for operation on 240V, 1 ϕ 50 Hz A.C. for each panel wherever specified.
- (g) Suitable tripping arrangement.
- (h) Mechanical counter to assess the total number of operations of the breaker (if asked for specifically).

2.4.2 **Type**

The circuit breaker shall be of horizontal/ vertical isolation, horizontal draw out pattern.

2.4.3 **Breaker Truck**

The breaker carriage shall be fabricated from steel, providing a sturdy vehicle for the circuit breaker and its operating and tripping mechanism. The carriage shall be mounted on wheels, moving on guides, designed to align correctly and allow easy movement of the circuit breaker and for removing the carriage for inspection and maintenance purposes. Vacuum interrupters shall be hermetically sealed and shall be designed for minimum contact erosion, fast recovery of dielectric strength, maintenance free vacuum interrupter, suitable for auto-reclosing. The drive mechanism shall preferably be provided with facility for pad locking at any position namely, "Service", "Test" and "Fully Isolated". It should be possible for testing the circuit breaker for its operation without energizing the power circuit in the "Testing" position. The contacts shall be made only after the breaker is inserted into service position. Interlocking should prevent contacts from being disconnected if circuit breaker is tried to be moved from service position.

2.4.4 **General Features**

Single break contacts are provided in sealed vacuum interrupter.

2.4.5 **Rating**

The circuit breakers shall be continuously rated as specified with a minimum rated current of 630 Amps. with voltage rating and breaking capacity as specified.

2.4.6 **Operating Mechanism**

The operating mechanism shall be one of the following as specified:-

Manually operated spring charged / motor wound spring charged with both mechanical and electrical release for closing. The operating mechanism shall be trip free.

2.4.7 External auxiliary supply shall be made available for charging motors & heaters operation.

2.5 **BUS BAR SECTION**

2.5.1 **General Requirement**

The switch board shall be **single bus bar pattern** with air insulated encapsulated bus bars housed in a separate compartment, segregated from other compartments.

Material

The bus bars shall be of high conductivity electrolytic copper rated as specified with a minimum rated current of 630 Amps. The bus bars shall be sized for carrying the rated and short circuit current without over-heating. Maximum bus bar temperature shall not exceed 95 degree C.

2.6 CURRENT TRANSFORMER

2.6.1 General Requirements

Accommodation shall be provided in the circuit breaker panel to mount one set of three numbers dual core dual ratio CTs for metering and protection purposes. Access to the CTs for cleaning, testing or changing shall be from the front, back or top of the panel.

2.6.2 Rating

Dual core & dual ratio CTs of suitable burden (but not less than 15 VA) shall be preferred with 5 Amps secondary. The ratio shall normally be one of the following as specified:

- (a) 400/200/5/5
- (b) 300/150/5/5
- (c) 200/100/5/5
- (d) 100/50/5/5
- (e) such other as required

Note: CT ratio shall be compatible with the loading pattern on HV side.

The CTs shall conform to relevant Indian Standards. The design and construction shall be robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitably to a terminal block which will be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5 P 10 of IS 2705- Part III-1992.

The metering CTs shall conform to the metering ratio and accuracy class 0.5 of IS 2705-1992 for incomer and class 1 for outgoing panels.

2.7 VOLTAGE TRANSFORMER

2.7.1 General Requirements

A voltage transformer of burden not less than 100 VA and of proper ratio as specified shall be provided at the incoming panel.

The accuracy class for the VT shall be class 0.5 as per IS 3156 Parts I to III for incomer and class 1 for outgoing panels.

The transformer shall be of cast epoxy resin construction. It shall be fixed/withdrawable type. HRC fuses/ MCBs shall be provided on both HV and LV sides.

2.8 PROTECTION AND TRIPPING ARRANGEMENT

2.8.1 Protection

The Relays shall be microprocessor based numerical relays with O/L, E/F and S/C protection Tripping relay shall be used for tripping signal to the Shunt Trip Coil of Circuit Breaker operating on 24 V/ 30 V D C supply / Power pack / 110 V VT supply.

Note: - 24V/ 30V DC shall be provided through 2 No. SMF batteries of 12/ 15 volts of minimum 26 AH capacity with a battery charger as per recommendation of the manufacturer both for protection as well as indications.

Alternatively Power Pack converters fed through PT/ 230V externally could be provided with 2 Nos., 12/ 15 volt, 7 AH SMF batteries (Power pack with condenser/ capacitor backup are also available which do not need batteries, these should not be used) for tripping. In cases where tripping is fed through PT, VA burden of PT shall be suitably increased (say 200 VA) as recommended by the manufacturer depending upon the number of panels and connected controls. In addition external 24 volt / 30 volt DC supply shall be provided for indications etc. through 2 No. SMF batteries of 12/ 15 volts of minimum 26 AH capacity with a battery charger as per recommendation of the manufacturer.

2.8.2 **Relays**

Over current Relays shall have adjustable setting for current from 50% to 200% and earth fault from 10% to 40% or 20% to 80%. These should be of manual reset type. All relays shall have a LED indicator which will indicate operation for each function. It shall be possible to reset it only by manual operation. The number and types of relays shall be as specified.

2.9 **SMALL WIRING**

The small wiring shall be carried out with minimum 1.5 sq. mm FRLS/ HFFR insulated copper conductor cables. CT wiring shall be done with minimum 2.5 sq mm wires with colour code: RYB, Gray for auxiliary DC circuits and Black for auxiliary AC circuits. The wiring shall be securely fixed and neatly arranged to enable easy tracing of wires. Identification tags shall be fitted to all wire terminals to render identification easy and to facilitate checking in accordance with IS 375. Necessary terminal blocks and cable entries shall be provided for RTD relay wiring, power supply etc.

2.10 **METERING INSTRUMENT, PANEL ACCESSORIES (DIGITAL)**

2.10.1 **Metering**

Energy metering shall be done either on the incomers or on the feeders as specified in Appendix II.

2.10.2 **Voltage Selection Scheme**

Where a bus coupler is incorporated and only one incomer feeder (out of two available) is intended to be operated at a time, a VT Transfer Relay shall be incorporated to provide necessary potential for metering. This will be necessary when energy metering is done on individual feeders or where VT supply is used for trip circuits. Alternatively PTs shall be provided on both the bus sections (incomers) with individual metering on each incomer.

2.10.3 **Instrument Panels**

The instrument panel shall form part of the housing. Relays, meters and instruments shall be mounted as per general arrangement drawings to be submitted by the tenderer. They shall be preferably of flush mounting type at a maximum height of 1800 mm.

2.10.4 Instrumentation

- (a) A voltmeter of class 1.5 accuracy as per IS 1248 shall be provided at each incomer panel, with selector switch. The instrument shall be calibrated for the ranges specified.
- (b) Energy meters of class 1.0 conforming to IS 722 (Part IX) and power factor meter of class of accuracy of 2 shall be provided, if specified.
- (c) Ammeter of specified range of class 1.5 accuracy as per IS 1248 shall be provided at both incomer and outgoing panels alongwith necessary selector switches.
- (d) The panel assembly shall also take care of the following requirements:
 - (i) Lamp indication shall be provided to indicate ON/ OFF (by red green respectively) of switch gear.
 - (ii) Panel illuminating lamp.
 - (iii) Mechanical indication for spring charged status. If possible an indicating lamp could be provided.
 - (iv) Lamp indicating tripping at fault status.
 - (v) Healthy trip supply shall be indicated by clear lamp.
 - (vi) Separate fuses/ MCBs shall be provided for lamps, heaters, voltmeters and other instrumentation etc. on each panel.
 - (vii) Anti-condensation space heaters shall be provided, and shall be suitable for operation on 240 V, 1 phase, 50 Hz A.C. for each panel if specified.
 - (viii) Where there is more than one incomer and bus sections, these shall be castle key interlocked as per interlocking scheme as specified.

2.11 CABLE BOXES

Cable boxes shall be situated in a compartment at the rear / side of the housing as specified.

2.12 CABLE ENTRY

Provision for top (bus ducts preferred for top entry) / bottom or such other side entry shall be made as per requirement with sufficient head room for cable termination. 3 mm thick removable gland plate shall be provided for cable termination.

2.13 EARTHING

The earthing of the breaker body and moving portion shall be so arranged that the earthing of the non-current carrying structure to the frame earth bar is completed well before the main circuit breaker plugs enter the fixed house sockets.

The entire panel board shall have a common tinned copper earth bar of suitable section with 2 earth terminals for effectively earthing metallic portion of the panels. The frame earthing of panel shall be in accordance with Section 7 of this specifications.

2.14 INSTALLATION

The installation work shall cover assembly of panels lining up, grouting the units etc. In the case of multi panels switch boards after connecting up the bus bar all joint shall be insulated with HV insulation tape or with approved insulation compound. A common earth bar shall be run preferably at the back of the switch board connecting all the sections for connecting the earth system. All protection, indications & metering connections and wirings shall be completed.

Where trip supply battery is installed the unit shall be commissioned, completing initial charging of the batteries. All relay instruments and meters shall be mounted and connected with appropriate wiring. Calibration checks of units as necessary and required by the licensee like CTs, VTs Energy Meters etc. shall be completed before pre-commission checks are undertaken.

2.15 TESTING AND COMMISSIONING

Procedure for testing and commissioning of relay shall be in general accordance with good practice.

Commissioning checks and tests shall include in addition to checking of all small wiring connections, relays calibration and setting tests by secondary injection method and primary injection method. Primary injection test will be preferred for operation of relay through CTs. Before panel board is commissioned, provision of the safety namely fire extinguishers, rubber mats and danger board shall be ensured. In addition all routine megger tests shall be performed. Checks and test shall include following:

- (a) Operation checks and lubrication of all moving parts.
- (b) Interlock function checks.
- (c) Continuity checks of wiring, fuses etc. as required.
- (d) Insulation tests.
- (e) Trip test and protection gear tests.
- (f) The complete panel shall be tested with 5000 V megger for insulation between poles and poles to earth. Insulation test of secondary of CTs and VT to earth shall be conducted using 500 V megger.
- (g) Any other tests as may be required by the Licensee / Inspector shall be conducted.
- (h) Where specified, the entire switch board shall withstand high voltage test after installation.
- (i) Any other test required by the consignee/ inspecting officer.

SECTION 3

TRANSFORMERS

3.1 SCOPE

This section covers the detailed requirements regarding supply, installation, testing, commissioning and handing over of transformers required for the sub-station.

Conventionally oil cooled transformers were being used for electrical sub-station. However due to presence of oil for cooling of transformers, an inherent fire risk is involved in the use of oil cooled transformers.

After repeated fire accidents due to burning of oil in oil cooled transformers, I.E. Rules have been amended to provide for use of only dry type transformers where a sub-station is planned inside the main building while oil cooled transformers can continue to be used if the sub-station is located in an independent building.

There are two types of dry type transformers viz. vacuum pressure impregnated (VPI) dry type transformers and cast resin dry type transformers. This section provide for use of both the type of dry type transformers where individual capacity of transformer does not exceed 400 KVA. Only cast resin dry type transformers shall be used for higher capacity.

3.2 OIL COOLED TRASFORMERS

Oil filled transformers may be used only in sub-stations located in separate single or two storied service buildings outside the main building structure and there shall at least be 6 meter clear distance between the adjoining buildings and sub-station such that fire tender is able to pass between the two structures. (NBC-2005 Part-8, Section 2 clause 4.2.1 j).

3.2.1 General Construction

The oil filled transformers shall comply with the following Indian Standards as amended upto date:

- (i) IS 2026 - Part I to V - power transformers.
- (ii) IS 335 - Transformer oil.
- (iii) IS 10028 (Part II & III) - Installation and Maintenance of Transformers.
- (iv) IS 2099 - Bushings.

- (v) IS 2705 - Current Transformers.
- (vi) IS 6600 - Guide for loading of oil immersed transformers.

3.2.2 Insulation Oil

Insulation oil shall conform to IS 335. Transformer oil to be supplied with initial fill of filtered oil.

3.2.3 General Requirements

The transformer shall be indoor or outdoor type as specified. Unless otherwise specified the transformer in addition shall have thermal and dynamic ability to withstand external short-circuit as per clause 9 of IS 2026 (Part I) : 1977.

3.2.4 Capacity and Rating

The KVA ratings for three phase transformers are given below: -

<u>100</u>	<u>250</u>	<u>630</u>	<u>1600</u>
125	315	800	& higher
160	<u>400</u>	<u>1000</u>	
200	500	<u>1250</u>	

Continuous rating specified shall be irrespective of tapping position.

TEMPERATURE RISE

The reference ambient temperatures assumed for the purpose of this specification are as follows: -

- (a) Maximum ambient air temperature 50°C.
- (b) Maximum daily average ambient air temperature 40°C.
- (c) Maximum yearly weighted average ambient temperature 32°C.
- (d) Minimum yearly weighted average ambient temperature (-)5°C.

The temperature rise at the above conditions and at the altitude not exceeding 1000 meters shall be as follows: -

By resistance method 55°C (maximum temperature being 95°C).

By thermometer 50°C.

If the site conditions indicated for a particular job is more severe than the refereed ambient temperature mentioned above, the temperature rise shall be suitably scaled down such that the hot spot temperature shall not exceed the values for the reference conditions.

3.2.5 Tap Changing Device

Tap changing device shall be provided on H.V side, circuit type, externally hand operated with necessary indications for tap position and locking arrangement at any

of the tapping positions. It shall be designed for bi-directional operation and shall be of self-positioning type and shall have the following steps: -

$\pm 2.5\%$ $\pm 5\%$ -7.5% -10% (if required)

Note: Tap changing device shall normally be off load type. However NIT approving authority may use on load type Tap Changing Devices judiciously.

3.2.6 Voltage Ratio

Unless otherwise specified, the transformer shall be suitable for a voltage ratio of 11 KV/433 V.

VECTOR GROUP

In case of step down transformers, the winding connections shall conform to vector group dy. 11 unless otherwise specified.

In case of step up transformer the vector group unless otherwise specified shall be star/ delta.

3.2.7 Cooling

Unless otherwise specified, the transformer shall be oil immersed natural air-cooled type (ONAN).

3.2.8 Accessories

The transformer shall be a single tank type with termination on bushings or cable end box as specified both on HV and MV side. The MV side shall be suitable to receive bus bar trunking or MV cable inter-connection suitable for full load current of the transformer.

FITTINGS

The transformer shall be complete with the following fittings: -

- (a) Oil conservator with oil level indicator, minimum level marking and drain plug for all transformers of capacity 50 KVA and above.
- (b) Off circuit type tap changer with position indicator and locking arrangement for all transformers.
- (c) Thermometer pocket with plug for all transformers of capacity 100 KVA and above.
- (d) 100 mm dial type /stem type thermometer with metal guard Dial type thermometer may have max. temperature indicator and resetting device for all transformers of capacity 250 KVA and above.
- (e) Lifting lugs for all transformers.
- (f) Bi-directional /Unidirectional Rollers to be specified.
- (g) Rating diagram and terminal marking plate for all transformers.
- (h) Explosion vent for all transformers of capacity 400 KVA and above.

- (i) Additional Neutral separately brought out on a bushing for earthing for all transformers.
- (j) Earth terminals (2 Nos.) for body earthing for all transformers.
- (k) Valves for filtration, drainage and filling etc. with necessary plugs for all transformers.
- (l) Radiator assembly for all transformers.
- (m) Silica gel breather for all transformers.
- (n) Air release plug for all transformers.
- (o) First filling of oil to IS 335:1993 including make-up fill during installation for all transformers.
- (p) Facility to connect up Buchholtz relay for all transformers of capacity 800 KVA and above.
- (q) Inspection covers on tank cover for access to terminal connections for all transformers.
- (r) Bushing terminations or cable box terminations as specified.
- (s) Necessary hardware, clamps, lugs etc. for termination on HV/MV etc. for all transformers.

3.2.9 **Explosion Vent**

Explosion vent or pressure relief device shall be provided of sufficient size for rapid release of any pressure that may be generated within the tank and which might result in damage to the equipment. The device shall operate at a static pressure less than the hydraulic test pressure for transformer tank. Means shall be provided to prevent the ingress of moisture and of such a design to prevent gas accumulation.

3.2.10 **Accommodation for Auxiliary Apparatus**

Where specified, such as, for restricted earth fault protection, facilities shall be provided for the mounting of a neutral current transformer.

RATING AND DIAGRAM PLATES

The following plates shall be fixed to Transformer in a visible position.

- (a) A rating plate of weather proof material bearing the data specified in the appropriate clauses of IS 2026:1977.
- (b) A diagram plate showing the internal connection and also the voltage vector relationship of the several windings in accordance with IS 2026:1977 and a plan view of the transformer giving the correct physical relationship of the terminals.

3.2.11 **Joints and Gaskets**

All gaskets used for making oil tight joints shall be of proven material such as granulated cork bonded with synthetic rubber gaskets or synthetic rubber or such other good material.

GAS AND OIL ACTUATED (BUCHHOLTZ) RELAYS

Buchholtz Relay shall be provided for transformers of capacity 800 KVA and above. The design of the relay mounting arrangements, the associated pipe work shall be such that mal-operation of the relays shall not take place under normal service. The pipe work shall be so arranged that all gas arising from the transformer shall pass through the gas and oil-actuated relay. The oil circuit through the relay shall not form a delivery path in parallel with any circulating oil pipe, nor shall it be tied into or connected through the pressure relief vent. Sharp bends in the pipe work shall be avoided.

All wiring connections, terminal boards, fuses and links etc. connected with gas actuated relays shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resistant insulation and the bared ends of stranded wire shall be sealed together to prevent seepage of oil entering connection boxes used for cables or wiring.

3.2.12 Cable Box

Cable box shall not be mounted on the tank covers. It shall be feasible to remove the tank covers for inspection during maintenance etc. without recourse to breaking the joints or disturbing the cables already terminated. Necessary removable links in oil approachable through inspection cover in tank cover etc. after lowering oil shall be provided for test purpose.

3.2.13 Parallel Operation

For parallel operation of transformers, the transformers shall have the same percentage impedance, same voltage ratio, same vector group, phase sequence etc.

3.2.14 Tests

3.2.14.1 Tests at Works :

All routine and other tests prescribed by IS 2026 shall be carried out at the manufacturer's works before dispatch of the transformer in the presence of inspecting officer if required. Copies of the test certificates shall be furnished to the department. In addition to the prescribed routine tests, temperature rise test shall be invariably done on one transformer of each design. A copy of the impulse test certificate done on the same type/ design of the transformer shall be furnished in accordance with IS for purpose of record. If no impulse test was done in an earlier unit of the same design and capacity, one transformer will be subjected to impulse test in consultation with the Inspector at the firm's cost.

Copies of the certificates for pressure test, test for bushings, and type test for short circuit shall be supplied to the Department.

3.2.14.2 Tests at Site :

In addition to tests at manufacturer's premises, all relevant pre-commissioning checks and tests conforming to IS code of practice No. 10028 (Part II & III) shall be done before energization. The following tests are to be particularly done before cable jointing or connecting up the bus bar trunking:

- (a) Insulation test between HV to earth and HV to MV with 5000 volts Megger.
- (b) Insulation test between MV to earth with 500 volts Megger.
- (c) Di-electric strength Test on oil.
- (d) Buchholtz relay operation by simulation test when fitted.

All test results are to be recorded and reports should be submitted to the department.

3.2.15 **Installation and Commissioning**

- 3.2.15.1 The transformer shall be installed in accordance with IS 10028 (Part II & III)-Code of practice for Installation and maintenance of transformer. Necessary support channels shall be grouted in the flooring.
- 3.2.15.2 The transformer shall be moved to its location and shall be correctly positioned. Transformer wheels shall be either locked or provided with wheel stoppers. All parts of the transformers which are supplied loose, such as conservator, radiator banks, Buchholtz relay, dial thermometer, bushing etc. shall be fitted on the transformer. Transformer oil supplied in drums shall be topped up into the transformer after duly testing/filtering upto the correct level required.
- 3.2.15.3 Wiring of devices such as Buchholtz relay, dial thermometer etc. shall be carried out as per drawings, Earthing of neutral and body of the transformer shall be done in accordance with section (7) of these specifications.
- 3.2.15.4 Drying out of transformer winding will be necessary when the di-electric strength of the oil is lower than the minimum value as per IS10028 or the transformer has not been energized within 6 months of leaving the works or where the radiator assembly is done at site. The transformer shall be dried out by one of the methods specified in IS 10028. Drying out with centrifugal or vacuum type filters will, however, be preferred. The contractor shall carry out the process of drying without interruption and shall maintain a log sheet indicating time, oil temperature and insulation resistance.
- 3.2.15.5 After complete drying out of the transformer, oil sample shall be collected by the contractor and shall be tested for di-electric strength as specified in IS 335:1993 with approved test kit.
- 3.2.15.6 All devices such as dial type thermometers, Buchholtz relays and main alarm and trip contacts shall be checked for satisfactory operation.
- 3.2.15.7 All tests specified in 3.2.14 of these specifications shall be carried out by the contractor in the presence of inspecting officer/consignee free of cost.

3.2.16 **Maximum Allowable Power Transformer Losses**

Power transformers of the proper ratings and design must be selected to satisfy the minimum acceptable efficiency at 50% and full load rating. In addition, the transformer must be selected such that it minimizes the total of its initial cost in addition to the present value of the cost of its total lost energy while serving its estimated loads during its respective life span.

Total losses for oil filled transformers should conform as per the following table:

<i>Maximum allowable losses for oil filled distribution transformer with highest voltage for equipment 36 kV, at 50% and 100% of the load</i>		
<i>Transformer Capacity (kVA)</i>	<i>Maximum Allowable losses at 50% kVA or load</i>	<i>Maximum Allowable losses at full load/Rated kVA</i>
100	1.04%	1.80%
160	0.96%	1.38%
200	0.93%	1.35%
250	0.89%	1.27%
400	0.79%	1.12%
500	0.75%	1.05%
630	0.70%	0.99%
1000	0.70%	0.98%
1600	0.65%	0.98%
2000	0.64%	0.98%

3.2.17 **Guaranteed Technical Data**

Guaranteed technical particulars shall be supplied vide Schedule 'C' of Appendix III.

3.3 **DRY TYPE DISTRIBUTION TRANSFORMERS**

3.3.1 **General Construction**

3.3.1.1 The Transformers shall comply with the following Indian Standards as amended upto date:

- (i) IS 11171 : 1985 - Dry type power transformers.
- (ii) IS 10028 (Part II & III) - Installation and Maintenance of Transformers.
- (iii) IS 2099 - Bushing
- (iv) IS 2705 - Current Transformers.

3.3.1.2 **Constructional Features**

All the MS parts shall be either Hot dipped galvanized or cold galvanized to make them corrosion free. The core shall be made up of high grade low loss cold rolled grain oriented silicon steel. Both low & high voltage windings shall be made of copper conductor. The class of winding insulation shall correspond to class 'F'. The construction of the windings of the transformer shall be such that no creepage path is found even in dusty & corrosive ambient conditions. The core coil assembly shall be housed in a prefabricated enclosure. The enclosure shall be fabricated with mild steel CRCA sheets with adequate provision for ventilation. The enclosures shall under go the seven tank process. Finally the external and internal surfaces of the enclosure shall be powder coated with the required paint shade.

3.3.2 **General Requirements**

The transformer shall be indoor or outdoor type as specified. Unless otherwise specified

the transformer in addition shall have thermal and dynamic ability to withstand external short-circuit as per clause 9 of IS 2026 (Part I): 1977 and clause 5 of IS 11171: 1985.

3.3.3 **Capacity and Rating**

The KVA ratings for three phase transformers are given below: -

<u>250</u>	<u>630</u>	<u>1600</u>
315	800	& higher
400	<u>1000</u>	
<u>500</u>	<u>1250</u>	

Continuous rating specified shall be irrespective of tapping position.

3.3.4 Indoor transformers shall be suitable for IP-23 protection; out door transformers shall confirm to IP-33 protection.

3.3.5 **Temperature Rise**

The reference ambient temperatures assumed for the purpose of this specification are as follows:-

- (a) Maximum ambient air temperature 50°C.
- (b) Maximum daily average ambient air temperature 40°C.
- (c) Maximum yearly weighted average ambient temperature 32°C.
- (d) Minimum yearly weighted average ambient temperature (-) 5°C.
- (e) Class of insulation F

The temperature rise limit at the above conditions and at the altitude not exceeding 1000 meters shall be as specified.

If the site conditions indicated for a particular job is more severe than the referred ambient temperature mentioned above, the temperature rise above ambient shall be suitably scaled down such that the hot spot temperature shall not exceed the values for the reference conditions 90°C (F class insulation).

3.3.6 **(A) Tap Changing Device**

Preferred tapping range is +5% to -7.5% in 2.5 percent steps by means of off load tap changing links or tap switch. The device shall be provided on HV for HV Voltage to keep LV Voltage constant.

(B) Terminal Markings Connections

Relevant provisions of IS 2026 (Part-IV): 1977 shall be applicable.

3.3.7 **Voltage Ratio**

Unless otherwise specified, the transformer shall be suitable for a voltage ratio of 11 KV/ 433 V.

3.3.8 **Vector Group**

In case of step down transformers, the winding connections shall conform to vector group Dy 11 unless otherwise specified.

In case of step up transformer the vector group unless otherwise specified shall be star / delta.

3.3.9 **Cooling**

Unless otherwise specified the transformer cooling shall be air and naturally cooled (AN).

3.3.10 **Accessories**

The transformer shall be with enclosure or without enclosure with HV and MV terminations as specified both on HV and MV side. The MV side shall be suitable to receive bus bar trunking or MV cable inter-connection suitable for full load current of the transformer.

3.3.11 **Fittings**

The transformer shall be complete with the following fittings: -

- (a) Off load type tap changing link or tap switch.
- (b) RTD temperature controller.
- (c) Lifting lugs for all transformers.
- (d) Bi-directional / Unidirectional Rollers to be specified.
- (e) Rating diagram and terminal marking plate for all transformers.
- (f) Additional Neutral separately brought out on a bushing for earthing for all transformers.
- (g) Earth terminals (2 Nos.) for body earthing for all transformers.
- (h) Necessary hardware, clamps, lugs etc. for termination on HV/MV etc. for all transformers.

3.3.12 **Rating Plates**

A rating plate of weather proof material bearing the data specified in clause-8 of IS 11171: 1985.

3.3.13 **Joints and Gaskets**

All gaskets used for making gas tight joints shall be of proven material.

3.3.14 **Parallel Operation**

For parallel operation of transformers, the transformers shall have the same percentage impedance, same voltage ratio, same vector group, phase sequence etc.

Where ever more than one Transformer is to be installed in the same Sub-Station, capacity of each Transformer shall preferably be same.

3.3.15 **Tests**

3.3.15.1 **Tests at Works**

All routine and other tests prescribed in IS 11171 : 1985 shall be carried out at the manufacturer's works before the dispatch of the transformer in the presence of inspecting officer. Copies of the test certificates shall be furnished to the department. In addition to the prescribed routine tests, temperature rise test shall be invariably done on one transformer of each design. A copy of the impulse test certificate done on the same type/design of the transformer shall be furnished in accordance with IS 11171 : 1985 for purpose of record. If no impulse test was done in an earlier unit of the same design and type, one transformer will be subjected to impulse test in consultation with the Inspector at the firm's cost. Copies of the certificates of type test for short circuit shall be supplied to the Department.

3.3.15.2 **Tests at Site**

In addition to tests at manufacturer's premises, all relevant pre-commissioning checks and tests conforming to IS code of practice No. 10028 shall be done before energization. The following tests are to be particularly done before cable jointing or connecting up the bus bar trunking.

- (a) Insulation test between HV to earth and HV to MV with a 5000 volts Megger.
- (b) Insulation test between MV to earth with 500 volts Megger.
- (c) All test results are to be recorded and reports should be submitted to the department.

3.3.16 **Installation and Commissioning**

3.3.16.1 The transformer shall be installed in accordance with IS 10028-Code of practice for Installation and maintenance of transformer. Necessary support channels shall be grouted in the flooring.

3.3.16.2 The transformer shall be moved to its location and shall be correctly positioned. Transformer wheels shall be either locked or provided with wheel stoppers.

3.3.16.3 Wiring of devices shall be carried out as per drawings; Earthing of neutral and body of the transformer shall be done in accordance with section (7) of these specifications.

3.3.16.4 All devices shall be checked for satisfactory operation.

3.3.16.5 All tests specified in 3.2.14 of these specifications shall be carried out by the contractor in the presence of inspecting officer/ consignee free of cost.

3.3.17 **Maximum Allowable Power Transformer Losses**

Power transformers of the proper ratings and design must be selected to satisfy the minimum acceptable efficiency at 50% and full load rating. In addition, the transformer must be selected such that it minimizes the total of its initial cost in addition to the present value of the cost of its total lost energy while serving its estimated loads during its respective life span.

Total losses for dry type distribution transformers should conform as per the following table:

<i>Maximum allowable losses for dry type distribution transformer with highest voltage for equipment 24 kV, at 50% and 100% of the load</i>		
<i>Transformer Capacity (kVA)</i>	<i>Maximum Allowable losses at 50% kVA or load</i>	<i>Maximum Allowable losses at full load/Rated kVA</i>
100	1.88%	2.44%
160	1.61%	2.07%
200	1.50%	1.90%
250	1.36%	1.73%
400	1.19%	1.51%
500	1.12%	1.45%
630	1.06%	1.40%
1000	0.90%	1.20%
1600	0.79%	1.05%
2000	0.75%	1.00%

SECTION 4

M.V. PANELS

4.1 SCOPE

This Section covers the detailed requirements of medium voltage switch panel for 433 V, 3 phase 50 Hz 4 wire system. These shall be branded and/or assembled/ fabricated from a factory of repute. All switchgears shall be fully rated at an ambient of 40°C.

4.2 TYPE OF PANEL

The medium voltage switch board panel shall comprise of any one of the following types of switchgears or combination thereof as specified.

- (a) Air Circuit breakers draw out or fixed type.
- (b) Switch Disconnecter Fuse Units fixed type, MCCBs of suitable Ics ratings. MCCBs shall invariably be Current Limiting type. Features like Double Break, Positive Isolation functions shall be preferred.

The Panel shall be indoor type having incoming sectionalization and outgoing switchgears as specified. The design shall be cubical type. The degree of enclosure protection shall be IP 42 as per IS 13947 (Part-I).

4.3 M.V PANEL

4.3.1 General Construction

The switchboard shall be floor mounted free standing totally enclosed and extensible type. The switch board shall be dust & vermin proof and shall be suitable for the climate conditions as specified. The design shall include all provisions for safety of operation and maintenance personnel. The general construction shall conform to IS 8623:1993 for factory assembled switch board.

4.3.2 Cubical Type Panels

- 4.3.2.1 Cubical type panels shall be fabricated out of sheet steel not less than 2.0 mm thick. Wherever necessary, such sheet steel members shall be stiffened by angle iron frame work. General construction shall employ the principle of compartmentalization and segregation for each circuit. Unless otherwise approved, incomer and bus section panels or sections shall be separate and independent and shall not be mixed with sections required for feeders. Each section of the rear accessible type panel shall have hinged access doors at the rear. Overall height of the panel shall not exceed 2.4 meters. Operating levers, handle etc. of highest unit shall not be higher than 1.7 meters. Multi-tier mounting of feeder is permissible. The general arrangement for multi-

tier construction shall be such that the horizontal tiers formed present a pleasing and aesthetic look. The general arrangement shall be approved before fabrication. Cable entries for various feeders shall be either from top or bottom. Through cable alleys located in between two circuit sections, either in the rear or in the front of the panel. All cable terminations shall be through gland plates. There shall be separate gland plate for each cable entry so that there will not be dislocation of already wired circuits when new feeders are added. Cable entry plates shall therefore be sectionalized. The construction shall include necessary cable supports for clamping the cable in the cable alley or rear cable chamber.

Cubicle panels with more than 1000 Amps bus shall be made of tested structural modular sections.

4.3.2.2 ***Bus Bar and Connections***

The bus bars shall be of Copper of high conductivity electrolytic quality and of adequate section. Current density for copper shall not exceed 160 amps/sq. cm. The bus bar system may comprise of a system of main horizontal bus bars and ancillary vertical bus bars run in bus bar alleys on either side of which the circuit could be arranged with front access cable entries. In the case of rear access, horizontal bus system shall run suitably either at the top or bottom. All connections to individual circuits from the bus bar shall preferably be solid connections; however flexible connections shall also be permitted as per recommendations of the Panel Manufacturer. All bus bars and connections shall be suitably sleeved / insulated in approved manner.

4.3.2.3 ***Incomer / Termination***

Incomer termination shall be suitable for receiving bus trunking / underground cables. Cable terminations shall invariably be through terminal blocks (Polyamide or superior) or brought out solid terminals.

4.3.2.4 ***Instruments***

All voltmeters and ammeters shall be flush mounted of size minimum 96 mm conforming to class 1.5 of IS 1248 for accuracy. All voltmeters shall be protected with MCB.

4.3.2.5 ***Indicating Lamps***

On all the incomers of M.V panels, ON/OFF indicating LED lamps shall be provided and shall be suitable for operation on AC supply. Phase indicating LED lamps shall be associated with necessary ON/OFF toggle switch.

4.3.2.6 ***Small Wiring***

All small wiring for Controls, Indication etc. shall be with suitable FRLS/ HFFR (halogen free fire retardant) copper conductor cables. Wiring shall be suitably protected within switch board. Runs of wires shall be neatly bunched, suitably supported and clamped. Means shall be provided for easy identifications of the wires. Where wires are drawn through steel conduits, the works shall conform to CPWD General Specifications for Electrical Works (Part I- Internal), 2013 and IS 732 as the case may be. Identification ferrules shall be used at both ends of the wires. All control wiring meant for external connections are to be brought out of terminal board.

OPERATIONAL REQUIREMENTS

The indoor type MV panel shall conform to the following: -

- (a) The panel shall comprise of incomers, outgoing feeders and bus coupler as specified. The incomer shall be either a double break / contact repulsion MCCB or an Air Circuit Breaker. The bus coupler shall be either a circuit breaker or a double break / contact repulsion MCCB or switch disconnecter fuse unit as specified. The outgoing feeders shall be circuit breakers/ MCCBs as specified.
- (b) Bus bars for phase and neutral shall have a rating as specified in the format of Appendix II.
- (c) The entire switch panel shall be cubical type generally conforming to IS 8623:1993 for factory assembled switch board.
- (d) The incomer panel shall be suitable for receiving bus trunking or MV cable of size specified either from top or from bottom.
- (e) All incoming AIR CIRCUIT BREAKER/ MCCB shall have suitable adjustable tripping current and the time delay settings.
- (f) The entire panel shall have a common earth bar of size as specified with two terminals for earth connections.

4.5 RATING AND REQUIREMENTS

4.5.1 Air Circuit Breaker

All Air Circuit Breakers shall be 3/4 pole with minimum 50 KA breaking capacity (35 MVA at 433V) conforming to IS 13947 (Part-II). Rated current shall be as per capacities specified. The equipment shall be complete with the following: -

- (a) Necessary circuit breaker carriage with 3 position (isolate, test, service) draw-out mechanism.
- (b) Necessary isolating plugs and sockets.
- (c) Necessary mechanism interlock and automatic safe shutters gear with arrangement for pad locking.
- (d) Necessary independent manual spring mechanism with mechanical On/Off indication as well as electrical On/Off indication.
- (e) Necessary bus bars with bolted type neutral links.
- (f) ACB shall be provided with microprocessor based releases having built in over load, short circuit & earth fault protection. Microprocessor release shall be EMI (Electro Magnetic Induction)/ EMC (Electro Magnetic Compatible) certified.
- (g) Necessary set of auxiliary switches.
- (h) Necessary set of CTs with ratios as specified.

- (i) Necessary identification, metering requirements as specified i/c. ON/ OFF indication lamps, selector switches, fuses, ammeter, voltmeter etc.
- (j) In case of 4 pole breaker neutral shall be fully rated with adjustable settings from 50% to 100% of I_n .
- (k) ACB terminals shall be suitable/ suitably brought out for direct aluminum termination as per IS 13947 Part-II.

Note: Wherever fixed type circuit breakers are required, it shall be clearly specified in Appendix II. Also refer Appendix V for further guidelines.

4.5.2 **Switch Disconnecter Fuse Units /MCCB**

4.5.2.1 **Switch Disconnecter Fuse Units**

All SDF units for feeders or outgoing circuits shall be suitable for a Breaking capacity of 80 KA (57 MVA 433V) capacity at 433V 3 phase 50 Hz AC system conforming to IS 4064. The number of units and rated current shall be as per detailed requirements specified. Switch Disconnecter Fuse unit shall be double break front operated type. The units shall be complete with following: -

- (a) Necessary HRC cartridge fuses conforming to IS 9224 (Part-II).
- (b) Necessary operating mechanism quick break make type.
- (c) Necessary set of CTs together with an ammeter and selector switch as specified.
- (d) Necessary interconnections to bus bars.
- (e) Necessary neutral link inside the SDF unit.
- (f) All SDF units shall be AC23A utilization category.

4.5.2.2 **MCCB**

All MCCBs shall be current limiting type with features of load line reversibility and suitable for Horizontal/ Vertical mounting without any derating. Beyond 300 Amps capacity MCCBs shall have positive isolation and preferably double break / contact repulsion & double insulation features.

The MCCBs shall invariably be used with terminal spreaders.

4.6 **TEST AT MANUFACTURERS WORK**

All routine tests shall be carried out and test certificates produced to the department.

4.7 **INSTALLATION**

The installation work shall cover assembly of various sections of the panels lining up, grouting the units etc. In the case of multiple panel switch boards after connecting up the bus bars etc., all joints shall be insulated with necessary insulation tape or approved insulation compound. A common earth bar as per section 7 of these specifications shall be run inside at the back of switch panel connecting all the sections for connection to

frame earth system. All protection and other small wirings for indication etc. shall be completed before calibration and commissioning checks are commenced. All relays, meters etc. shall be mounted and connected with appropriate wiring.

TESTING AND COMMISSIONING

Commissioning checks and tests shall include all wiring checks and checking up of connections. Relay adjustment/setting shall be done before commissioning in addition to routine Megger tests. Checks and tests shall include the following: -

- (a) Operation checks and lubrication of all moving parts.
- (b) Interlock function checks.
- (c) Continuity checks of wiring, fuses etc. as required.
- (d) Insulation test: When measured with 500 V Megger the insulation resistance shall not be less than 100 mega ohms.
- (e) Trip tests and protection gear test.

SECTION 5

CABLE WORKS

5.1 SCOPE

This section covers supply, laying and jointing as required and testing and energizing all cable work.

5.2 SPECIFICATION OF CABLE

5.2.1 11 KV grade XLPE insulated PVC sheathed armoured Aluminum/ Copper cable shall be 3 core earthed of sizes as specified. The cable shall conform to IS 1554, Part II

5.2.2 1.1 KV grade XLPE insulated PVC sheathed armoured Aluminum / Copper cable shall be 3 ½ /4 core of sizes as specified. The cable shall conform to IS 1554 Part I.

5.2.3 All control wires shall be 650 V grade copper conductor Halogen free fire retardant or FRLS PVC insulated, conforming to IS 1554-Part I. The minimum size of the control wires shall be 1.5 sq. mm.

5.3 INSTALLATION

Cable shall be laid in ground, trenches, cable trays and on walls as specified. Installation shall include all supports and clamps as required. The complete work shall be in accordance to CPWD General Specifications for Electrical Works - Part II (External) 1994 amended upto date. As far as possible cables shall not be fixed on walls directly but laid on cable trays.

5.4 JOINTING FOR 11 KV GRADE CABLE GLANDS

Jointing work shall be carried out only by licensed experienced cable jointer and shall be in accordance to CPWD General Specifications for Electrical Works - Part II (External) 1994 amended upto date.

5.5 EARTHING FOR 11 KV GRADE CABLE GLANDS

All HV cable glands shall be connected to the earth with 2 Nos. 38.6 mm copper or equivalent G.I. conductors.

5.6 Selection shall be made as per tables given under Table V of CPWD General Specifications for Electrical Works Part-II (External) - 1994 amended upto date.

5.7 TESTING

Testing of the complete cable installation shall be as per clause 2.8.2 and 2.8.3 of CPWD General Specifications for Electrical Works - Part II (External) 1994 amended upto date.

5.8 POWER DISTRIBUTION SYSTEM LOSSES

The power cabling shall be adequately sized as to maintain the distribution losses not to exceed 1% of the total power usage. Record of design calculation for the losses shall be maintained.

The cables be designed as per the voltage drop regulations at peak load, and the losses be calculated on the basis of the assessed load during the day, week and year and should not be limited to the peak load.

SECTION 6

BUS TRUNKING

Scope

This section covers manufacture, supply installation, testing and commissioning of enclosed type bus ducts indoor type for connection between the Transformer and MV panels. Bus Trunking shall be used for all sub-stations of capacity 500 KVA and more. These may be used even for smaller sub-stations judiciously.

A : CONVENTIONAL BUS TRUNKING

- 6.1** Provisions for such works in this regard given under GENERAL SPECIFICATIONS FOR ELECTRICAL WORKS PART-1 INTERNAL 2013 amended up to date should be referred to.

B : COMPACT BUS TRUNKING

6.2 SCOPE

This section deals with two types of compact BUS TRUNKINGS available commercially: (1) Air Insulated and (2) Sandwich insulated. These are described as given below:

(1) AIR INSULATED COMPACT BUS TRUNKING / RISING MAINS

6.3 SCOPE

The Bus Trunking/ Rising Mains are suitable for distributing 3 phase, 50 hz, 415/ 450 volts A.C. supply. These are available with Aluminum as well as Copper Conductors.

6.4 STANDARD FOR COMPLIANCE

IS 8623 : 1993 Part I & II.

6.5 CONSTRUCTION

Enclosure will be manufactured from CRCA sheet steel powder coated to shade RAL 7032 (or such other specified) or GI. Enclosure will be rectangular in shape. Busbars will be placed over insulators (Class F) located every 250 mm (Such other suitable length) along its length. On front face of the enclosure, tap off points for inserting plug in boxes will be provided at regular interval (500 mm or so). Each plug in point will have provision for closing with shutter assembly, which is integral part of enclosure, when not occupied by plug in box.

Bus bars will be aluminum conductor 63401 / WP grade aluminum alloy or copper conductor ETP grade with 99.9% pure copper, with radicalised edges. For ease in

handling, length of largest section will be restricted to 3 Mtrs nominally (floor to floor height). Neutral cross section unless specified for reduced cross section will be same as phase cross section unless specified for reduced cross section. Bus bars will not be drilled and so placed in insulators that when placed vertically they do not slide out of enclosure.

Joints between bus bars of one section to adjacent section will be through Uniblock Joint assembly operated by single bolt or clamped connections located in an insulated housing operated by single screw. Uniblock joint system will be removable and inserted as a separate sub-assembly to isolate adjacent sections without disturbing or moving bus bars.

Fire barriers of two hours rating will be provided at each floor crossing as per UL 1479 or as per IEC 60439 and test certificate provided.

The enclosure will have protection degree IP-54 as per IEC.

6.6 PLUG IN BOXES

These are required for Rising Mains. Plug in boxes will be of draw out type. Contacts will be of silver plated copper and spring loaded. Earth connection will be the first to make and last to break during insertion and withdrawal. Plug in box will be made from 1.6 mm CRCA sheet steel powder coated or GI. Inside the plug in boxes MCCB or SFU with fuses will be located as per requirements. The operating handle will be interlocked with plug in box cover so that MCCB can be operated only with suitable cover in closed position. If required the plug in box will be interlocked with bus bar trunking so that it could be inserted or removed with the plug in box lid opened. MCCB/SFU will be of 4 pole type unless otherwise specified in BOQ. Short circuit breaking capacity of MCCB in PIB should preferably be same as short circuit withstand for one second of bus bar trunking .

6.7 END FEED UNIT

The End feed unit will be manufactured from 1.6 mm thick sheet steel with powder coating to shade RAL 7032 or of GI. Inside the End feed unit MCCB of required rating and specifications or SF unit with HRC fuses will be located. End feed units at top will be connected to Bus bars of Rising Mains through solid connections. Terminals at the bottom will be provided to accept cable connections as required. The operating handle of MCCB/ SFU will be interlocked so that the door can be opened only when MCCB or SFU are in off position. The current rating of MCCB should correspond with current rating of bus bar trunking and short circuit breaking capacity with one second short circuit withstand of bus bar trunking .

6.8 BRACKETS

Mounting Brackets, which can be shifted anywhere on Bus Bar Trunking should be provided to fix bus bar trunking on to assembly grouted in wall where these brackets rest.

6.9 EARTH STRIP

Earth strip of copper or aluminum are to be provided, one on each side all along the Rising Mains of size dependent on short circuit withstand for one second of Rising

Mains specified as per derivation given below (IEC 60439/I). Earth strip should be firmly fixed to the body of Rising Main at regular intervals.

$$SP = \frac{\sqrt{I^2 t}}{K}$$

SP is cross sectional area in sqmm (total for both strips).

I = Rms value of A.C. fault current in amperes.

t = Operation time of operating / disconnecting device which may be taken as one second.

K = Factor depending on material of conductor. For aluminum it is 116, for copper it is 176.

6.10 SHORT CIRCUIT WITHSTAND

Bus bars offered should be tested for short circuit withstand specified. Generally specified in KA RMS for one second.

6.11 Bus bar system should be designed for an ambient temperature of 40 deg. C and temperature rise restricted to 45 deg. C max.

6.12 Other technical parameters to be met are:

- Max operating voltage : 1000 Volts.
- Insulation voltage : 1000 Volts.

6.13 Expansion joints will be provided after length of 30 Mtrs. for aluminum conductor bus trunking and after 40 Mtrs. for copper conductor bus trunking.

(2) SANDWICH INSULATED BUS TRUNKING AND RISING MAINS

6.14 SUPPLY VOLTAGE

For 3 phase, 4 wire, 50 cycles AC supply, operation voltage 415/440 volts.

6.15 STANDARD FOR COMPLIANCE

IS 8623: 1993 / I & II and IEC 60439 / I & II.

6.16 CONSTRUCTION

The enclosure will be made from 16 SWG GI/ CRCA sheet steel powder coated to shade RAL 7032 (or such other shade). Bus bars would be in 'Sandwich' construction and the conductors will be individually insulated with 4 layers of insulation film. Inner layer will be of glass MICA and outer layer of polyester material Class 'F'. Alternatively extrusion of Class 'F' material in form of epoxy insulation may be provided. No drilling of bus bars is permitted. Aluminium conductors will be of 19501 grade and copper conductor of 99.9% purity and ETP grade with radialised edges. Length of section will be limited to max. 3 Mtrs. Bus bars of one section will be connected to bus bars of adjacent section by uniblock joint system removable as separate sub-assembly, so that it can be inserted or removed without disturbing the adjacent sections.

Installation: Normally manufacturer's recommendations should be followed.

For installation as Rising Mains / Vertical installation, at each floor, a set consisting of two Spring Hangers will be provided for fixing it on channels grouted in wall. At the start of run, Hangers without springs may be used for rigid support. In addition Horizontal supports will be provided (2 Nos. per floor) to hold bus bars in position. On Rising Mains, on front face of the bus bar trunking tap off points will be provided for inserting plug in boxes. Number of tap off points at each floor will be as per requirement given in BOQ but minimum distance between tap off points may be kept around 500 mm. Each Tap off opening will be closed by insulated shutters forming part of BBT, when not occupied by Plug in Boxes. Neutral cross section will be same as phase cross section.

Enclosure will be tested for protection degree IP – 54.

Necessary Vertical / Horizontal bends / Tees will be provided as required by layout.

Bus bars trunking will be rigidly fixed to the side walls or suspended from ceiling by supports as per requirement detailed in the layout.

At the termination either on the transformer side or on generator end or on switchgear panel, bus duct will be provided with flange ends, adopter box and copper flexible (preferably multispeed types) to connect bus bars of bus duct to bus bars of switchgear panel or transformer terminals or generator terminals.

All the components like Busbar ducting, Bends, hanger ends, Adopter Boxes etc. will be made from CRCA or GI sheets. Two earth strips of copper or aluminum of size as mentioned in IEC 60439, dependent on short circuit withstand capacity required will be provided throughout the length.

Expansion units are to be installed after every uninterrupted run of 50 Mtrs. for composite expansion of complete Bus trunking run.

6.17 TECHNICAL PARAMETERS FOR COMPLIANCE

1. Bus trunking will be designed to withstand short circuit current for one second.
2. Bus bar system should be designed for an ambient temperature of 40 deg. C and temperature rise restricted to 55 deg. C max. above ambient on conductors above ambient.

Temperature rise of the enclosure 40 deg. C maximum. Temperature rise at terminals 70 deg. C max.

3. Maximum operating voltage = 1000 Volts. (600 Volts).
4. Insulation voltage = 1000 Volts.
5. Bus trunking will be suitably chosen to give permissible voltage drop.
6. Rated impulse withstand voltage 12 KV at 1000 V (600 Volts).

6.21 PLUG IN BOXES

Plug in Boxes will be of draw out type. Contacts will be of silver plated copper and

spring loaded. Earth connection will be the first to make and last to break during insertion and withdrawal. Plug in Box will be made from 1.6 mm CRCA sheet steel powder coated or GI. Inside the plug in Boxes MCCB or SFU with fuses will be located as per requirements. The operation handle will be interlocked with plug in Box cover so that MCCB can be operated only with suitable cover in closed position. If required the plug in Box will be interlocked with Bus bar trunking so that it can not be inserted or removed with the plug in Box lid opened. MCCB / SFU will be of 4 pole type unless otherwise specified in BOQ. Short circuit breaking capacity of MCCB in PIB should preferably be same as short circuit withstand for one second of Bus Bar Trunking.

6.22 LIST OF TEST TO BE CARRIED OUT

Type Tests : Copies of the following certificates should be submitted.

1. Verification of Temperature Rise limits.
2. Verification of dielectric properties.
3. Verification of short circuit strength.
4. Verification of degree of protection.

6.23 ROUTINE TESTS

1. Verification of insulation resistance.
2. Inspection of assembly, interlocks, locks etc.
3. Check on wiring if provided.
4. Dielectric test.

Note:- Refer Appendix VI for additional guidelines.

SECTION 7

EARTHING SYSTEM

7.1 SCOPE

This section covers the general requirements of the earthing system for Sub-station installation. G.I. plate earthing with G.I. strip for sub-stations of 500 KVA capacity and copper plate earthing for sub-stations of higher capacity shall preferably be used.

7.2 SYSTEMS

Earthing system shall comprise earth electrodes in accordance with clause 8.2.1 of General Specifications for Electrical Works (Part I-Internal), 2013. For every additional transformer 2 more separate and distinct earth electrodes shall be provided for neutral earthing. The body earthing for transformers, HV & MV panels shall be done to a common earth bus connected to two separate and distinct earth electrodes.

Note: For a single transformer Sub-station, the total number of earth electrodes shall be 4 (2 for neutral and 2 for connection to a common earth bus for body earthing). For a two transformer Sub-station total number of earth electrodes shall be 6 (4 for neutral earthing, two each for two transformers, and 2 for connection to a common earth bus for body earthing).

7.3 ELECTRODES

The earth electrodes shall be as per CPWD General Specifications for Electrical Works (Part I-Internal), 2013.

7.4 LOCATION OF EARTH ELECTRODES

Normally an earth electrode shall not be situated less than 1.5 m from any building. Care shall be taken that the excavation of earth electrode may not affect the column footings or foundation of the building. In such cases electrodes may be farther away from the building.

The location of the electrode earth will be a place where the soil has reasonable chance of remaining moist. As far as possible, entrances, pavements and road ways, are to be definitely avoided for locating the earth electrode.

7.5 WATERING ARRANGEMENT

Method of watering arrangement shall comply with CPWD general specifications.

7.6 SIZE OF EARTH LEAD

The recommended sizes of copper earth bus lead in case of Sub-stations shall be in accordance with clause 8.2.2 of General Specifications for Electrical Works (Part I-Internal), 2013 amended upto date. The minimum size of earth lead shall be 25 mm x 5 mm copper or equivalent GI strip.

7.7 INSTALLATION

All joints shall be riveted and sweated. Joints in the earth bar shall be bolted and the joints faces tinned. Where the diameter of the bolt for connecting earth bar to apparatus exceeds one quarter of the width of the earth bar, the connection to the bolt shall be made with a wider piece of flange of copper jointed to earth bar. These shall be tinned at the point of connection to equipment and special care taken to ensure a permanent low resistance contact to iron or steel. All steel bolts, nuts, washers etc. shall be cadmium plated, main earth bars shall be spaced sufficiently on the surface to which they are fixed such as walls or the side trenches to allow for ease of connections. Copper earthing shall not be fixed by ferrous fittings. The earthing shall suitably be protected from mechanical injury by galvanized pipe wherever it passes through wall and floor. The portion within ground shall be buried at least 60 cm deep. The earthing lead shall be securely bolted and soldered to plate or pipe as the case may be. In the case of plate earthing the lead shall be connected by means of a cable socket with two bolts and nuts. All washers shall be of the same materials as the plate or pipe. All iron bolts, nuts and washers shall be galvanized.

7.8 TESTING

After installation, the tests as specified in CPWD General Specifications for Electrical Work (Part I-Internal), 2013 shall be carried out and results recorded.

SECTION 8

POWER FACTOR IMPROVEMENT

8.1 SCOPE

This section covers the specification for supply, installation, testing and commissioning of 433 volts, 3 phase, 50 Hz capacitor banks and other such devices.

8.2 REQUIREMENTS

Capacities of the capacitor banks/ RLC panels shall be indicated in the format vide Appendix II.

8.3 CONSTRUCTION

8.3.1 The capacitor banks shall generally conform to IS 13341: 1992, 13340: 1993.

8.3.2 The capacitor units shall be indoor type, air-cooled with low viscosity impregnated paper dielectric hermitically sealed. The impregnation used shall be non- inflammable, non-oxidizing, lower freezing point type synthetic compound. Each individual cell shall be provided with pressure sensitive disconnectors / devices.

8.3.3 Main connections from the active element shall be brought out through porcelain bushing. Care shall be taken to solder the bushing to the cover to ensure perfect hermetic sealing.

8.3.4 Capacitor units shall be provided with externally mounted discharge resistors to reduce the residual voltage to less than 50 Volts in one minute of switching off.

8.3.5 Individual unit shall be provided with HRC fuses/ adequate capacity of MCBs/ MCCBs, contactors (capacitor duty) bus bars and terminal chambers to make bank of required KVAR. Terminal chamber shall be suitable for bottom/top cable entry. Two earth terminals shall be provided to each capacitor bank.

8.4 TESTS AT MANUFACTURER'S WORK

All routine and type tests as per IS 2834 relevant to capacitor banks as amended upto date shall be carried out at manufacturer's works and test certificates shall be furnished to the department.

8.5 INSTALLATION

Capacitor banks shall be installed at least 30 cm away from the walls on suitable metal frame work of welded construction. The earth terminals provided on the body of capacitor bank shall be bonded to the main capacitor panel earth bus with 2 Nos. 8 SWG copper or 6 SWG GI earth wires.

8.6 TESTS AT SITE

Insulation resistance with 500 V DC Megger shall be carried out and test results recorded.

8.7 POWER CONDITIONER SAVERS

Recently RLC circuit operated power factor improvement panels (power correction & saver system) are available in the market. These are more suitable for installations with electronic equipments (computers, servers, medical equipments, electronic ballasts etc.). Capacitor banks are prone to introduce additional harmonics at such installations and therefore their use should be restricted at such installations.

The equipments are called power conditioner savers. These are waveform correction and power factor improvement devices using Rapid Instruction Semi Conductor (RISC) micro controllers / capacitor duty contactor switching.

These work on principle of using low loss continuously variable reactance & adjustable phase wise capacitance to provide optimum impedance to the circuit for transfer efficiently.

Technical Features:

1. A micro controller & RISC processor.
2. Intelligent switching operation, fast response, high break relays (imported).
3. Polarity reversal indication.
4. Phase wise dynamically reactive compensation.
5. Operating power factor 0.6 – 0.99 Lag.

These devices may save upto 30% energy & provide pure near true, quality power.

SECTION 9

SAFETY REQUIREMENTS

9.1 SCOPE

This section covers the requirements of items to be provided in the sub-station for compliance with statutory regulations, safety and operational needs.

9.2 REQUIREMENTS

Safety provisions shall be generally in conformity with appendices (A) and (C) of CPWD General Specifications of Electrical Works (Part I-Internal), 2013. In particular following items shall be provided:

(a) *Insulation Mats*

Insulation mats conforming to IS 15652: 2006 shall be provided in front of main switch boards as well as other control equipments as specified.

(b) *First Aid Charts and First Aid Box*

Charts (one in English, one in Hindi, one in Regional language), displaying methods of giving artificial respiration to a recipient of electrical shock shall be prominently provided at appropriate place. Standard first aid boxes containing materials as prescribed by St. John Ambulance brigade or Indian Red Cross should be provided in each sub-station.

(c) *Danger Plate*

Danger Plates shall be provided on HV and MV equipments. MV danger notice plate shall be 200 mm x 150 mm made of mild steel at least 2 mm thick vitreous enameled white on both sides and with the descriptions in signal red colour on front side as required. Notice plates of other suitable materials such as stainless steel, brass or such other permanent nature material shall also be accepted with the description engraved in signal red colour.

(d) *Fire Extinguishers*

Portable CO₂ conforming to IS 2878: 1976/ chemical conforming to IS 2171: 1976 extinguishers, HCFC Blend A (P-IV) shall be installed in the sub-station at suitable places. Other extinguishers recommended for electric fires may also be used.

(e) *Fire Buckets*

Fire buckets conforming to IS 2546: 1974 shall be installed with the suitable stand for storage of water and sand.

(f) *Tool Box*

A Standard tool box containing necessary tools required for operation and maintenance shall be provided in the sub-station.

(g) *Caution Board*

Necessary number of caution boards such as “Man on Line” ‘Don’t Switch on’ etc. shall be available in the sub-station.

(h) *Key Board*

A keyboard of required size shall be provided at a proper place containing castle keys, and all other keys of sub-station and allied areas.

SECTION 10

UNITISED / COMPACT SUB-STATION

10.1 SCOPE

These sub-stations shall be used for locations covering long distances & wide areas where standby transformers are not installed. Their use shall normally be restricted to 250 KVA. They shall be preferred where ring main high voltage distribution is planned in open space.

10.2 Compact Sub-station shall consist of **11 KV SF6 Insulated compact switchgear with VCB as protection to Transformer, Transformer and L.T. Switchgear** with all connection accessories, fitting & auxiliary equipment in a pre-fabricated enclosure to supply Low-voltage energy from high-voltage system as detailed in this specification. The complete unit shall be installed on a sub-station plinth (base) as **Outdoor sub-station** 11 KV Load Break Cable Switches control incoming – outgoing feeder cables of the 11 KV ring/ radial distribution system. The Vacuum Circuit Breaker shall be used to control and isolate the Distribution transformer. The transformer's L.T. side shall be connected to L.T. Switchgear. The connection cables to consumer shall be taken out from the L.T. switchgear(s).

The pre-fabricated compact sub-station shall be designed for

- (a) Compactness,
- (b) Fast installation,
- (c) Maintenance free operation,
- (d) Safety for worker/ operator & public.

10.3 OUTDOOR ENCLOSURE

10.3.1 The enclosure shall be made of Galvanized Sheet Steel or such other material tropicalised to meet Indian weather condition.

10.3.2 The base of the enclosure shall ensure rigidity for easy transport & installation.

10.3.3 The structure of the substation shall be capable of supporting the gross weight of all the equipment & the roof of the sub-station compartment shall be designed to support adequate loads.

10.3.4 There shall be proper / adequate ventilation inside the enclosure so that hot air inside enclosure is directed out by help of duct. Louvers apertures shall be provided so that there is circulation of natural air inside the enclosure.

10.3.5 The complete design shall be modular in design i.e. small sheets shall be joined together to make a big sheet. This helps in avoiding skewing, bending, bending of the single sheets on doors and sides due to its own load under service. The doors shall be provided with proper interlocking arrangement for safety of operator.

10.3.6 **Public Nuisance Protection**

There shall be no bolting arrangement on the doors and sides (periphery) so that there is no access of water, dust inside. This also ensures that unit is well protected from outside from public nuisance owing to its being located in a crowded and compact places. Hinges and locks on the door shall be so designed that they are either not accessible to public from outside or can not be tampered with.

10.3.7 **Interconnection**

The connection of HT switchgear to Transformer shall be with the help of suitable size of cables, from Transformer to LT switchgear with the help of suitable size of Copper/ Aluminum bus bars. The interconnection inside the unit shall be the responsibility of the supplier.

10.3.8 **Internal Fault**

Failure within the unitised sub-station due either to a defect, an exceptional service condition or mal-operation may initiate an internal arc. Such event may lead to the risk of injury, if persons are present. It is desirable that the unit shall be tested for Internal Arc fault test as per latest IEC 61330.

10.3.9 **Covers & Door**

Covers & doors are part of the enclosure. When they are closed, they shall provide the degree of protection specified for the enclosure. Additional wire mesh may be used with proper Danger board for safety of the operator. All covers, doors or roof shall be provided with locking facility or it shall not be possible to open or remove them before doors used for normal operation have been opened. The doors shall open outward at an angle of at least 90° & be equipped with a device able to maintain them in an open position. The top cover shall be slightly inclined so that there is no accumulation of water during rainy season or otherwise. Proper padlocking facility shall be provided for doors of each compartment.

10.3.10 **Earthing**

All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of the installation, by way of flexible jumpers/strips & lug arrangement. The continuity of the earth system shall be ensured taking into account the thermal & mechanical stresses

caused by the current it may have to carry. The components to be connected to the earth system shall include:

- (a) The enclosure of sub-station,
- (b) The enclosure of high voltage switchgear & control gear from the terminal provided for the purpose,
- (c) The metal screen & the high voltage cable earth conductor,
- (d) The transformer tank or metal frame of transformer,
- (e) The frame &/ or enclosure of low voltage switchgear.

10.3.11 **Internal Illumination**

There shall be arrangement for internal lighting activated by associated switch on doors for HV, Transformer & LV compartments separately.

10.3.12 **Labels**

Labels for warning, manufacturer's operating instructions etc. & those according to local standards & regulations shall be pasted/ provided inside and shall be durable & clearly legible.

10.3.13 **Painting and Fabrication Process**

- (a) The paints shall be carefully selected to withstand tropical heat & rain. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling. For this purpose poly-urethane (or such other suitable) paint shall be used.
- (b) Special care shall be taken by the manufacturer to ensure against rusting of nuts, bolts and fittings during operation. All bushings and current carrying parts shall be cleaned properly after final painting.
- (c) The fabrication process shall ensure that there are no sharp edges on the GI sheets used. For modular structure the two smaller units shall be joined together by Clinching Technology so that there is no piercing of the material being joined. This type of joint shall ensure robust mechanical strength to the complete structure so made.

10.4 **11 KV SWITCHGEAR (Gas Insulated Compact Switchgear)**

10.4.1 Extensible SF6 Insulated Compact Switchgear as required shall consist of following items:

10.4.2 **Load Break Cable Switch**

Load Break Cable Switch with integral earth switch both having full making capacity shall be used for Incoming and Outgoing cables if used in a ring. Suitable arc proof tested

cable covers shall be provided for each cable switch. The cable covers accessible from front shall be mechanically interlocked to its corresponding earth switch shall be mechanically interlocked to its corresponding cable switch for safety of the operator.

10.4.3 **Vacuum Circuit Breaker**

Vacuum Circuit Breaker shall be used for distribution network of HT switchgear. Vacuum Circuit Breaker complete with operating mechanism, self-powered microprocessor based protection relay with associated Current Transformers shall be used for control and protection of Transformer. The VCB being fixed type shall be provided with an Isolator in series for isolation purpose for maintenance. An integral cable earthing switch with full making capacity shall be provided. The arc proof cable covers accessible from front shall be mechanically interlocked to the earthing switch, which in turn shall be interlocked to the isolator for safety of the operator.

10.4.4 The above Load Break Cable Switches, vacuum circuit breakers, Bus bars should be mounted inside a robotically welded sealed for life, stainless steel tank of 3 mm thick sheet metal. The operating mechanism of the switches and breakers shall be outside the SF6 tank and accessible from front. The tank should be filled with SF6 gas at adequate pressure. The degree of protection for gas tank should be IP67. There shall be provision for filling the SF6 gas at site. Moreover the Stainless Steel Gas Tank shall confirm to the sealed pressure system as per IEC and ensure the gas leakage upto 0.1% per year as per IEC.

10.4.5 The VCB is required to control distribution Transformer and relay settings and Current Transformers shall be selected accordingly.

10.4.6 **General Finish**

Totally enclosed, metal enclosed, vermin and dust proof suitable for tropical climate use as detailed in the specification.

10.4.7 **Ratings**

The bus bars shall have continuous rating of 630 Amps. The isolator shall have a continuous rating of 630 Amps. VCB breaker shall have a continuous rating of 200 Amps in accordance with relevant IS/ IEC standard.

10.4.8 **Breaking & Making Capacity**

The Load Break Cable Switches shall be capable for breaking rated full load current. The same along with its earthing switch shall also be suitable for full making capacity of the system as specified. The complete switchgear shall be suitable for breaking capacity of 21 KA symmetrical at 11000 volts three phase.

10.4.9 **Busbar**

Switchgear shall be complete with all connection bus bars etc. Copper bus bars continuous rating shall be 630 Amps. The bus bars should be fully encapsulated by SF6 gas inside the steel tank.

10.4.10 Protection

The Circuit Breaker shall be fitted with microprocessor based self-powered relay inside the front cover to avoid any tampering. The same shall be used in conjunction with suitable Current Transformer and Tripping Coil for fault tripping of the Circuit Breakers.

10.4.11 Cable Termination

Each Cable compartment shall be provided with three bushings of adequate sizes to terminate the incoming and outgoing 11 KV 3 Core cables. There shall be enough height (Minimum 450 mm) from the base to the mounted switchgear so that the cables can be bent and taken vertically up to the bushings. The Cable termination shall be done by Heat Shrinkable Termination method so that adequate clearances shall be maintained between phases for Termination. Access to all the cables should be possible from the front of panel. Cable Termination boots shall be supplied by the switchgear manufacturer.

10.4.12 Locking Arrangement

Suitable padlocking arrangements shall be provided as stated below:

- (a) CB manual operating handle in the "OFF" position.
- (b) Each feeder panel operation handles in 'Closed', 'Open' or 'Earth' position.
- (c) Each isolator operating handle in 'Closed', 'Open' or 'Earth' position.

10.4.13 Ratings

		<i>Extensible radial compact switchgear with VCB</i>
Switchgear Data		
(a)	Service	Outdoor but inside Enclosure
(b)	Type	Metal Enclosed
(c)	Number of phases	3
(d)	Voltage	11000 V
(e)	Rated Frequency	50 Hz
(f)	Rated Current	630 Amp (isolator)
(g)	Short Circuit rating	
	(I) Breaking	21 KA rms for Breaker
	(II) Short time withstand for 3 Sec.	21 KA
	(III) Rated S/C making	52.5 KA peak for Breaker

		<i>Extensible radial compact switchgear with VCB</i>
(h)	Short duration power freq.	28 Kv
(i)	Insulation Level	75 Kv peak
(j)	System earthing	Solidly earthed at substation
	Breaker	For load
(a)	Type VCB in SF6 tank	
(b)	Rated voltage	11 KV
(c)	Breaking current	
	(l) Load breaking	21 KA rms.
(d)	Making current	52.5 KA peak
(e)	Rated current	630 Amps.
(f)	No. of poles	3
(g)	Operating mechanism	Trip free & free handle type with mechanically operated indication & pad locking.
	Isolators	Loop-in & Loop out.
(a)	Type	Load breaking and fault making in SF6 tank
(b)	Rated current	630 Amps.
(c)	Rated breaking capacity	630 Amps.
(d)	Fault making capacity	52.5 KA peak
(e)	No. of poles	3
(f)	Operating mechanism	Operating handle with ON, OFF, Earth positions with arrangement for padlocking in each position.
	Bus bars	
(a)	Material	Copper
(b)	Type	SF6 insulated
(c)	Rated Current	630 Amps

10.4.14 **Testing**

Each type of 11 KV Switchgear shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards i.e. IS 9920, IS 3427, IS 13118, IEC 265, IEC 298 during manufacturing and on completion.

10.4.15 **Routine Test**

The tests shall include but not necessarily limited to the following:

- (a) Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of the equipment.
- (b) All wiring and current carrying part shall be given appropriate High Voltage test.

APPENDIX I

LIST OF INDIAN STANDARDS

I : ELECTRO-TECHNICAL VOCABULARY

- | | | |
|-----|--|-------------------------------|
| (1) | Fundamental definition | IS 1885 (Part-I) : 1961 |
| (2) | Secondary cells and batteries (Superceding IS 1147 : 1957) | IS 1885 (Part-VIII) : 1986 |
| (3) | Electrical power system protection | IS 1885 (Part-X) : 1993 |
| (4) | Electrical Measurement | IS 1885 (Part-XI) : 1966 |
| (5) | Switchgear and control gear (First revision) | IS 1885 (Part-XVII) : 1979 |
| (6) | Overhead transmission and distribution of electrical energy | IS 1885 (Part-XXX) : 1971 |
| (7) | Cables, conductor and accessories for Electrical supply (Superseding IS 1591 : 1960) | IS 1885 (Part-XXXII) : 1993 |
| (8) | Transformers (First revision) | IS 1885 (Part-XXXVIII) : 1993 |

II : GRAPHICAL SYMBOLS USED IN ELECTRO TECHNOLOGY

- | | | |
|-----|---|---------------------------|
| (1) | Guide for preparation of diagrams, charts & tables for electro technology. Defenitions and classification [Superceding IS 2032 (Part-I) : 1962] | IS 8270 (Part-I) : 1976 |
| (2) | Item designation | IS 8270 (Part-II) : 1976 |
| (3) | General requirements for diagrams | IS 8270 (Part-III) : 1977 |
| (4) | Circuit diagrams | IS 8270 (Part-IV) : 1977 |
| (5) | Inter connection diagrams and table | IS 8270 (Part-V) : 1976 |

III : CONDUCTOR AND POWER CABLES

- | | | |
|-----|---|---------------------------|
| (1) | PVC insulated cable for working voltages and including 1100 volts (Second revision) [Superceding IS 3035 (Part I) : 1965] | IS 694 : 1990 |
| (2) | (i) PVC insulated (Heavy duty) working dielectric cables for voltage upto & i/c. 1100 volts (Second revision) | IS 1554 (Part-I) : 1988 |
| | (ii) For working voltage from 3.3 KV upto and including 11 KV | IS: 1554 (Part II) : 1988 |

- | | | |
|-----|---|--|
| (3) | (i) Recommended current ratings for cables:
Paper insulated lead sheathed cables. | IS 3961 (Part I) : 1967 |
| | (ii) PVC insulated and PVC sheathed heavy duty cables | IS 3961 (Part II) :1967 |
| (4) | Application guide for non-linear resistor type Surge arrester for alternating current system (First revision) | IS 15086 (Part-5). |
| (5) | Recommended short circuit ratings of high voltage PVC cable | IS 5819 : 1970 |
| (6) | Conductors for insulated electric cables and flexible cords | IS 8130 : 1984 |
| (7) | Busbar trunking system (Air insulated & sandwich insulated type) | IS 8623 Part I & II : 1993,
IEC 60439 Part I & II |

IV : ELECTRICAL INSTALLATION CODE OF PRACTICES

- | | | |
|-----|---|----------------------------|
| (1) | Installation and maintenance of transformers | IS 10028 (Part - II & III) |
| (2) | Insulation oil in service, maintenance and supervision code of practice for | IS 1866 : 2000 |
| (3) | Earthing | IS 3043 : 1987 |
| (4) | Guide for short circuit calculations | IS 13234 |
| (5) | Electrical wiring installation (system voltage not exceeding 650 volts) | IS 732 : 1989 |
| (6) | Paper insulated power cables (Upto and including 33 KV (first revision) | IS 1255 : 1983 |

V : SWITCH GEAR AND CONTROL GEAR

- | | | |
|-----|--|---------------------|
| (1) | Degree of protection provided by the (enclosure for low voltage switchgear and control gear) | IS 13947 (Part-I) |
| (2) | HRC cartridge fuse links upto 650 volts. | IS 9224 (Part-II) |
| (3) | (i) Circuit breaker AC requirements & tests for voltages not exceeding 1000 Volts a.c or 1200 volts d.c. | IS 13947 (Part -II) |
| | (ii) General and definition. Section 2-Voltages above 1000 volt a.c. | IS 13118 : 1991 |
| | (iii) Type tests & Routine test for voltage above 1000 Volt a.c. | IS 13118 : 1991 |
| (4) | Heavy duty air break switches and composite units of air break switches & fuses for voltages not exceeding 1000 volts. | IS 4064 |
| (5) | General requirements for switch gear, control gear for voltage not exceeding 1000 volts. | IS 13947 (Part-I) |

- | | | |
|------|--|------------------------------|
| (6) | (i) Factory built assemblies of switch gear and control gear for voltages upto & including 1000 V AC or 1200 V DC. | IS 8623 : 1993 |
| | (ii) Particular requirements for bus bar trunking system (Bus ways) | IS 8623 (Part II) : 1993 |
| (7) | High Voltage alternating current circuit breakers | IS 13118 : 1991
IEC 60056 |
| (8) | High Voltage Switches –Part I : Switches for Rated Voltages Above 1 Kv and less than 52 Kv | IS 9920 : 2002 |
| (9) | A.C. Metal Enclosed Switchgear and Control gear for Rated Voltages Above 1 KV and up to and Including 52 KV | IS 3427 : 1997 |
| (10) | Electrical Measuring Instruments and their Accessories | IS 1248 |

VI : TRANSFORMERS AND REACTORS

- | | | |
|-----|--|---------------------------|
| (1) | Dry type power transformer | IS 11171 : 1985 |
| (2) | Power Transformer | |
| | (i) General | IS 2026 (Part-I) : 1977 |
| | (ii) Temperature rise | IS 2026 (Part-II) : 1977 |
| | (iii) Insulation level and di-electric tests | IS 2026 (Part-III) : 1981 |
| (3) | Distribution transformers | IS 1180 : 1989 |
| (4) | Gas operated relays | IS 3637 : 1966 |
| (5) | Power transformers fittings and accessories | IS 3639 : 1966 |
| (6) | Guide for loading of oil immersed transformers | IS 6600 : 1972 |
| (7) | (i) Current transformers Part I to III | IS 2705 : 1992 |
| | (ii) Voltage transformers Part I to III | IS 3156 : 1992 |
| (8) | Outdoor type three-phase distribution transformers | IS 2099 : 1986 |

VII : CHEMECALS

- | | | |
|-----|--|-------------------------------|
| (1) | Colours for ready mixed paints and enamels | IS 5 : 1994 (Third revision) |
| (2) | Ready mixed paint brushing zinc chrome priming | IS 104 : 1979 (IInd revision) |
| (3) | Enamel, synthetic exterior (a) under coating (b) finishing | IS 2932 : 2003 (Ist revision) |

VIII : INSULATING LIQUIDS

- | | | |
|-----|--|----------------|
| (1) | Specific resistance (resistivity) or electrical insulating liquids, methods of tests for | IS 6103 : 1971 |
|-----|--|----------------|

- | | | |
|-----|---|-----------------|
| (2) | Electric strength of insulating oils, methods for determination of | IS 6792 : 1992 |
| (3) | New insulation oils for transformers and switchgears (2nd revision) | IS 335 : 1993 |
| (4) | Insulating Mats | IS 15625 : 2006 |

IX: SAFETY EQUIPMENTS

- | | | |
|-----|---|-----------------|
| (1) | CO ₂ based Fire Extinguisher | IS 2878 : 1976 |
| (2) | Chemical based Fire Extinguishers | IS 2171 : 1976 |
| (3) | HCFC Blend- A Extinguishing System | IS 15505 : 2004 |
| (4) | Insulating Mats | IS 15625 : 2006 |

APPENDIX II

MODEL NIT (FOR SUB STATION)

(Note: The NIT approving authority may make changes in the Model NIT depending upon the contingency of work)

NIT – PART – I
TECHNICAL-CUM-COMMERCIAL BID
(No prices to be quoted)

INDEX

<i>S. No.</i>	<i>Item</i>	<i>Page No.</i>	<i>Remarks</i>
1.	NIT CPWD 6		To be attached by NIT approving authority
2.	Press Notification		
3.	CPWD 7/8 Schedule alongwith upto date correction slips		To be attached by NIT approving authority
4.	Commercial and Additional Conditions		
5.	Table of Mile Stone(s)		
6.	Technical Specifications, certificate of deviations		
7.	Schedule of Work		
8.	Technical particulars		
9.	Acceptable makes		
10.	Schematic Diagram & LOP of Sub-station		To be attached by NIT approving authority

Certified that this NIT Part I (Technical-cum-Commercial Bid) contain to.....pages

Note: Commercial and additional conditions shall be amended as per latest provisions of e-tendering.

PRESS NOTIFICATION

To be Attached by NIT Approving Authority

As per CPWD Works Manual

COMMERCIAL AND ADDITIONAL CONDITIONS

1.0 GENERAL

1.1 This specification covers manufacture, testing as may be necessary before dispatch, delivery at site, all preparatory work, assembly and installation, commissioning putting into operation of sub-station equipments consisting of HT panels, transformers, bus ducts, LT panels, HT cabling etc. and final testing of sub-station equipments at

1.2 **Location:**

The sub-station equipments will be installed in the newly constructed sub-station building in the

1.3 The work shall be executed as per CPWD General Specifications for Electrical Works Part-I, II & IV, as amended up to date, relevant I.E. Rules, BIS/IEC and as per directions of Engineer-in-charge. These additional specifications/ conditions are to be read in conjunction with above and in case of variations, specifications given in these additional conditions shall apply. However, nothing extra shall be paid on account of these additional specifications and conditions, as the same are to be read along with schedule of quantities for the work.

1.4 The tenderer should in his own interest visit the site and get familiarize with the site conditions before tendering.

1.5 No T&P shall be issued by the Department and nothing extra shall be paid on account of this.

2.0 COMMERCIAL CONDITIONS

2.1 **Type of Contract**

The work be awarded by this tender shall be treated as indivisible works contract.

2.2 **Submission and Opening of Tenders:**

2.2.1 The tender is in two parts:

- (a) Part-I Technical-cum-Unpriced Commercial Bid
- (b) Part-II Price Bid

2.2.2 The tender shall be submitted duly completed in two separate sealed envelopes as below:

2.2.2.1 *Envelope – A*

This envelope shall be superscribed as “**Technical and Unpriced Commercial Bid**” on top and name of work. This envelope should contain:

- (i) The terms and conditions and technical specifications of this tender as purchased from CPWD including the schedule of work (without indication of the price) and tender documents duly stamped and signed on form CPWD-7/8

in token of acceptance of tender conditions without making any changes.

- (ii) Make and model of all equipments offered along with technical catalogues/ pamphlets showing complete specification of the equipment.

2.2.2.2 *Envelope – B*

The envelope shall be superscribed as “**Price Bid**” and name of work and shall contain the price bid document exactly in the same format as the schedule of quantities given in the tender documents but with rates filled up both in figures and words and the amounts in figures.

- 2.2.3 The tenderers are advised not to deviate from the technical specifications/items, commercial terms and conditions of NIT like terms of payment, guarantee, arbitration clause, escalation etc.
- 2.2.4 Envelope ‘A’ containing technical-cum-unpriced commercial bid only shall be opened on the due date and time in the presence of tenderers or their authorized representatives who wish to remain present.
- 2.2.5 Scrutiny/ evaluation of the technical-cum-commercial bid shall be done by the department. In case it is found that the technical-cum-commercial bid of a tenderer is not in line with NIT specifications/requirements and / or contains too many deviations, the department reserves the right to reject the technical bid of such firms(s) without making any reference to the tenderer(s).
- 2.2.6 Necessary clarifications required by the department shall have to be furnished by the tenderer within the time given by the department for the same. The tenderer will have to depute his representative to discuss with the officer(s) of the department as and when so desired. In case, in the opinion of the department a tenderer is taking undue long time in furnishing the desired clarifications. His bid will be rejected without making any reference.
- 2.2.7 After obtaining clarifications from all the tenderers, the department will intimate the tenderers whose technical-cum-commercial bids are acceptable.
- 2.2.8 The price bids of only those tenderers shall be opened whose technical bids are found to be technically acceptable. The time and date of opening of price bid shall be fixed after the technical-cum-unpriced commercial bid is accepted and intimated to them by post / fax.
- 2.2.9 The department reserves the right to reject any or all the price bids and call for fresh price bids / tenders as the case may be without assigning any reason.

3.0 TERMS OF PAYMENTS

The following percentage of contract rates for the various items included in the contract shall be payable against the stage of work shown herein.

- 3.1 85% after initial inspection and delivery at site in good condition on pro-rata basis.
- 3.2 10% after completion of installation in all respects.
- 3.3 Balance 5% will be paid after testing, commissioning & handing over to the department for beneficial use.

3.4 **Security Deposit**

Security Deposit shall be deducted from each running bill and the final bill to the extent of 10% of the gross amount payable subject to a maximum amount of 5% of the tendered value. The earnest money deposited shall be adjusted against this security deposit. The security deposit shall be released on the expiry of guarantee period stipulated in the contract. Bank guarantee will not be accepted as security deposit.

3.5 **Performance Guarantee**

The successful tenderer shall submit an irrevocable performance guarantee of 5% of the tendered amount in addition to other deposits mentioned elsewhere in the contract for his proper performance of the contract agreement within 15 days of issue of letter of acceptance of tender. This guarantee shall be in the form of Demand draft/Pay order or irrevocable bank guarantee bond of any scheduled bank or the State Bank of India in the specified format or in the form of Government security, fixed deposit receipt pledged in favour of Executive Engineer or as specified in the letter of acceptance of tender. The performance guarantee shall be initially valid up to stipulated date of completion plus 60 day beyond. This bank guarantee shall be kept valid till the recording of completion certificate for the work by the competent authority.

3.6 Income Tax, VAT, work contract tax, labour cess & other statutory deduction etc. shall be made at source as per the prevalent laws. The deductions of security deposit, income- tax, works contract tax etc. shall be done after calculation of the above due payments as per clauses 3.1 to 3.3 and net payment shall be reduced accordingly.

4.0 **RATES**

4.1 The rates quoted by the tenderer, shall be firm and inclusive of all taxes (including works contract tax, VAT, labour cess & service tax), duties levies, octroi etc. and all charges for packing, forwarding, insurance, freight and delivery, installation, testing, commissioning etc. at site including temporary construction of storage, risks, over head charges, general liabilities /obligations and clearance from CEA. However, the fee for the CEA inspections shall be borne by the department.

4.2 The department will not issue Octroi exemption certificate.

4.3 The contractor has to carry out maintenance as per manufacturer's standards for a period of 12 months from the date of handing over. Nothing extra shall be paid on this account.

5.0 **COMPLETENESS OF TENDER**

All sundry equipment, fittings, unit assemblies, accessories, hardware items, foundation bolts, termination lugs for electrical connections, and all other items which are useful and necessary for efficient assembly and installation of equipment and components of the work shall be deemed to have been included in the tender irrespective of the fact whether such items are specifically mentioned in the tender documents or not.

6.0 **STORAGE AND CUSTODY OF MATERIALS**

The transformer rooms & HT panel rooms, if available, may be used for storage of sundry materials and erection equipments or else the agency has to make his own arrangements. No separate storage accommodation shall be provided by

the department. Watch and ward of the stores and their safe custody shall be the responsibility of the contractor till the final taking over of the installation by the department.

7.0 CARE OF THE BUILDING

Care shall be taken by the contractor while handling and installing the various equipments and components of the work to avoid damage to the building. He shall be responsible for repairing all damages and restoring the same to their original finish at his cost. He shall also remove at his cost all unwanted and waste materials arising out of the installation from the site of work.

8.0 COMPLETION PERIOD

The completion period indicated in the tender documents is for the entire work of planning, designing, approval of drawings etc., arrangement of materials & equipments, delivery at site including transportation, installation, testing, commissioning and handing over of the entire system to the satisfaction of the Engineer-in-charge.

9.0 GUARANTEE

9.1 All equipments shall be guaranteed for a period of 12 months, from the date of taking over the installation by the department, against unsatisfactory performance and/or break down due to defective design, workmanship or material. The equipments or components, or any part thereof, so found defective during guarantee period shall be forthwith repaired or replaced free of cost, to the satisfaction of the Engineer-in-charge. In case it is felt by the department that undue delay is being caused by the contractor in doing this, the same will be got done by the department at the risk and cost of the contractor. The decision of the Engineer-in-charge in this regard shall be final & binding on the contractor.

9.2 The tenderer shall guarantee among other things, the following :

- (a) Quality, strength and performance of the materials used as per manufacturers' standards.
- (b) Safe mechanical and electrical stress on all parts under all specified conditions of operation.
- (c) Satisfactory operation during the maintenance period.

10.0 POWER SUPPLY

A temporary three phase power supply of 15 KW shall be provided during execution of work, at single point inside the campus. Further arrangements for tapping power connection from this point shall be made by the contractor. Electricity shall be provided free of cost.

11.0 WATER SUPPLY

Water supply shall be made available by the department at one point in campus free of cost.

12.0 ACCEPTABLE MAKES OF VARIOUS EQUIPMENTS

The acceptable makes of various equipments/ components/accessories have been indicated in "Acceptable Makes" at page No..... The tenderer shall work out the cost of the offer on this basis. Alternate makes are not acceptable.

13.0 DATA MANUAL AND DRAWINGS TO BE FURNISHED BY THE TENDERER

13.1 *With Tender*

The tenderer shall furnish alongwith the tender, detailed technical literature, pamphlets and performance data for appraisal and evaluation of the offer.

13.2 *After Award of Work*

The successful tenderer would be required to submit the following drawings within 15 days of award of work for approval before commencement of installation.

- (a) General arrangement drawing of the equipments like HT panels transformers, bus duct, LT panel etc. in the sub-station building, with complete dimensions for LT Panel & Bus Duct. The tenderer shall also give dimensions, details of LT Panels and Bus Duct got tested at CPRI successfully for fault withstand capacity of 31 MVA for 1 Sec.
- (b) Details of foundations for the equipments and the weights of assembled equipments.
- (c) Cable/bus duct layout between HT panel boards, transformers & LT panel etc.
- (d) Any other drawings necessary for the job.

14.0 The successful tenderer should furnish well in advance three copies of detailed instructions and manuals of manufacturers for all items of equipments regarding installation, adjustments operation and maintenance including preventive maintenance & trouble shooting together with all relevant data sheets, spare parts catalogue etc. all in triplicate.

15.0 EXTENT OF WORK

15.1 The work shall comprise of entire labour including supervision and all materials necessary to make a complete installation and such tests and adjustments and commissioning, as may be required by the department. The term complete installation shall not only mean major items of the plant and equipments covered by the specifications but all incidental sundry components necessary for complete execution and satisfactory performance of installation with all layout charts whether or not those have been mentioned in details in the tender document in connection with this contract as this is a turnkey job.

15.2 The overhead bus duct as per schedule is to connect..... Nos..... KVA transformers to main LT panel. Similarly HT cable is to be laid inside the proposed sub-station in open duct between HT panel board and..... Nos. transformers. The HT cable shall be brought at site after taking correct measurements since no joint shall be permissible in between HT panel & transformer.

15.3 In addition to supply, installation, testing and commissioning of sub-station equipments, following works shall be deemed to be included within the scope of work to be executed by the tenderer as this is a trunk job:

- (a) Minor building works necessary for installation of equipments, foundation, making of opening in walls or in floors and restoring them to their original condition / finish and necessary grouting etc. as required.
- (b) All supports for over head bus ducts, cables and MS channels for erection of panels & transformers etc. as are necessary.
- (c) Testing of PTs/ CTs for metering & protection purpose & relay calibration & setting.
- (d) Getting CEA inspection done & obtaining approval for energizing the installation. However, necessary fees for inspection shall be borne by the Department.

16.0 EXCLUSION AND WORK TO BE DONE BY OTHER AGENCIES

The following shall be excluded from the scope of the work :

- (a) Major dismantling of any existing building work.
- (b) Electricity supply in sub-station building.

17.0 INSPECTION AND TESTING

17.1 All major equipments i.e. HT panel, transformers, bus duct, LT panel etc. shall be offered for initial inspection at manufacturers works. The contractor will intimate the date of testing of equipments at the manufacturer's works before dispatch. The successful tenderer shall give advance notice of minimum two weeks regarding the dates proposed for such tests to the department's representative to facilitate his presence during testing. The Engineer-in-charge may witness such testing. The cost of the Engineer's visit to the factory will be borne by the department. Equipments will be inspected at the manufacturer/Authorised dealers premises, before dispatch to the site by the contractor if so desired by the Engineer-in-charge.

17.2 Copies of all documents of routine and type test certificates of the equipment, carried out at the manufacturers premises shall be furnished to the Engineer-in-charge and consignee.

17.3 After completion of the work in all respects the contractor shall offer the installation for testing and operation.

18.0 VALIDITY

Tenders shall be valid for acceptance for a period ofdays from the date of opening.

19.0 COMPLIANCE WITH REGULATIONS AND INDIAN STANDARDS

19.1 All works shall be carried out in accordance with relevant regulation, both statutory and those specified by the Indian Standards related to the works covered by this specification. In particular, the equipment and installation will comply with the following:

- (i) Factories Act.
- (ii) Indian Electricity Rules.
- (iii) B.I.S. & other standards as applicable.
- (iv) Workmen's Compensation Act.
- (v) Statutory norms prescribed by local bodies like CEA, Power Supply Co., etc.

19.2 After completion of the installation, the same shall be offered for inspection by the representatives of the Central Electricity Authority. The contractor will extend all help including test facilities to the representatives of CEA. The observations of CEA will be attended by the contractor. The installation will be commissioned only after getting clearance from CEA.

19.3 Nothing in this specification shall be construed to relieve the successful tenderer of his responsibility for the design, manufacture and installation of the equipment with all accessories in accordance with currently applicable statutory regulations and safety codes.

19.4 Successful tenderer shall arrange for compliance with statutory provisions of safety regulations and departmental requirements of safety codes in respect of labour employed on the work by the tenderer. Failure to provide such safety requirement would make the tender liable for penalty of Rs.-/- for each default. In addition, the department will be at liberty to make arrangement for the safety requirements at the cost of tenderer and recover the cost thereof from him.

20.0 INDEMNITY

The successful tenderer shall at all times indemnify the department, consequent on this works contract. The successful tenderer shall be liable, in accordance with the Indian Law and Regulations for any accident occurring due to any cause and the contractor shall be responsible for any accident or damage incurred or claims arising there from during the period of erection, construction and putting into operation the equipments and ancillary equipments under the supervision of the successful tenderer in so far as the latter is responsible. The successful tenderer shall also provide all insurance including third party insurance as may be necessary to cover the risk. No extra payment would be made to the successful tenderer on account of the above.

21.0 ERECTION TOOLS

No tools and tackles either for unloading or for shifting the equipments for erection purposes would be made available by the department. The successful tenderer shall make his own arrangement for all these facilities.

22.0 COOPERATION WITH OTHER AGENCIES

The successful tenderer shall co-ordinate with other contractors and agencies engaged in the construction of buildings, if any, and exchange freely all technical information so as to make the execution of this work/contract smooth. No remuneration should be claimed from the department for such technical cooperation. If any unreasonable hindrance is caused to other agencies and any completed portion of the work has to

be dismantled and re-done for want of cooperation and coordination by the tenderer during the course of work, such expenditure incurred will be recovered from the successful tenderer if the restoration work to the original condition or specification of the dismantled portion of the work was not undertaken by the tenderer himself.

23.0 The work will be carried out with least disturbance during shifting & shut down taken in consultation with the client department.

24.0 MOBILIZATION ADVANCE

No mobilization advance shall be paid for this work.

25.0 INSURANCE AND STORAGE

All consignments are to be duly insured upto the destination from warehouse at the cost of the contractor. The insurance covers shall be valid till the equipment is handed over duly installed, tested and commissioned.

26.0 VERIFICATION OF CORRECTNESS OF EQUIPMENT AT DESTINATION

The contractor shall have to produce all the relevant records to certify that the genuine equipments from the manufacturers has been supplied and erected.

27.0 PAINTING

This shall include cost of painting of the entire installation. The major equipments like HT panel, transformers, LT panel, bus duct, cable trays etc. shall be factory final finish painted. The agency shall be required to do only touching to the damages caused to the painting during transportation, handling & installation at site, if there is no major damage to the painting. However hangers, supports etc. of bus trunking & cable tray etc. shall be painted with required shade including painting with two coats of anticorrosive primer paint at site.

28.0 TRAINING

The scope of works includes the on job technical training of two persons of department at site. Nothing extra shall be payable on this account.

29.0 MAINTENANCE

29.1 Sufficient trained and experienced staff shall be made available to meet any exigency of work during the guarantee period of one year from the handing over of the installation.

29.2 The maintenance, routine as well as preventive, for one year from the date of taking over the installation as per manufacturers recommendation shall be carried out on quarterly basis.

30.0 INTERPRETING SPECIFICATIONS

In interpreting the specifications, the following order of decreasing importance shall be followed in case of contradictions:

- (a) Schedule of quantities
- (b) Technical specifications

- (c) Drawing (if any)
- (d) General specifications
- (e) Relevant BIS or other international code in case BIS code is not available.

31.0 PRE-BID CONFERENCE

It is proposed to hold a pre-bid conference with the prospective tenderers to enable them to seek clarification on the technical specification and in tender documents that they may consider necessary for submission of tenders (technical bid & price bid). All clarifications sought for will be finalized during the pre-bid conference and confirmatory minutes for the pre-bid conference will be circulated among all tenderers who have been issued the tender documents irrespective of the fact they have attended the pre-bid conference or not. The date and time of pre-bid conference will be informed to the tenderers at the time of issue of the tenders. It is upto the prospective tenderers to take part in the pre-bid conference. Non-attendance of pre-bid conference does not debar the prospective tenderer from participating & submission of tender. No separate pre-bid conference will be conducted for the firms who do not attend the pre-bid conference on the date & time fixed for the purpose.

TABLE OF MILESTONE(S)

S. No	Description of Milestone (Physical)	Time allowed (From date of Start)		Amount to be withheld in case of non achievement
		Day of Start**	Day of Completion	
1.	Approval of Drawings	.....	.....	Rs.
2.	Supply and Installation of transformers	.....	.....	Rs.
3.	Supply and Installation of HT panel	.....	.....	Rs.
4.	Supply and Installation of LT Panels	.....	.....	Rs.
5.	Supply and Installation of Bus Trunking	.....	.....	Rs.
6.	Supply & Installation of Cables & other remaining items	.....	.....	Rs.
7.	Earthing	.....	.....	Rs.
8.	Testing & Commissioning of entire installation	.....	.....	Rs.

****Note :** The day of start can be even earlier than that indicated here.

TECHNICAL SPECIFICATIONS

- The work shall be carried out as per CPWD General Specifications for Electrical Works (Part IV : Sub-Station), 2013 as amended upto date and CPWD General Specifications for Electrical Works Part I & II, as amended upto date, relevant IE rules, and as per directions of Engineer-in-charge.

Note: Any deviations from CPWD General Specifications for Electrical Works (Part IV : Sub-Station), 2013 may be given by the NIT approving authority. In case there is no deviation, no deviations should be mentioned below this note.

CERTIFICATES

- I. Certified that all departure from the specifications have been brought down in the forwarding letter to this tender.
- II. Except for the departures brought down in the forwarding letter the tender complies with the tender specifications in all respect.
- III. The rates quoted are Net and inclusive of all duties, levies and taxes without any conditions. We understand that any condition in the price bid shall make the tender liable for cancellation.

(CONTRACTOR'S SIGNATURE)

SCHEDULE OF WORK

(Price not to be quoted)

With List of departure and certificate of no departure

Abstract of Cost

NAME OF WORK : TO BE FILLED IN BY NIT APPROVING AUTHORITY

Sub Head – I (Equipments)

Note : Amount not to be filled in

Sub Head – II (Cabling)

Sub Head – III (Earthing)

Sub Head – IV (Safety Equipment)

Total

.....

SCHEDULE OF WORK (Continued)

Prices should be net inclusive of all taxes, duties & without any conditions

Name of Work : ~~To be filled in by NIT approving authority~~

S.No.	Description of Item	Qty.	Rate	Unit	Amount
	Sub Head-I : Equipments-HT Panel Board, Transformers & H.T. Cable				
1	<p>Supplying, installation, testing & commissioning of indoor type floor mounted metal clad, 11 KV VCB panel with .....No. VCBs, totally enclosed & fully interlocked, horizontal drawout, horizontal/ vertical isolation type breaker as per IS 13118, as amended up to date and additional specifications, having capacities as mentioned below, single break, trip free mechanism, manually charged and auto/manually closing breaker suitable for use on 11 KV, 3 Phase, 50 Hz A.C. supply with short circuit fault level of 350 MVA, complete with self contained, fully interlocked, rack in and rack out mechanism, air insulated but encapsulated copper bus bars of.....Amps capacity, breaker featured with mechanical ON/OFF indicator with hand trip device, spring release coil, shunt trip coil and auxiliary switch of 4 NO+4NC and equipped with following switchgears and accessories i/c connections suitable for 3x .....*sq. mm. XLPE 11 KV cable (cable entry from *bottom/ top/side) end termination with heat shrinkable jointing material etc. as required. (Note- Cost of end termination not included in this item)</p> <p>A. (a) Incoming – ½* No.....Amp. VCB</p> <p>(b) ½* No. – 11 KV / 110 Volts PT Class 0.5 accuracy and 100 VA burden with 1 No. Voltmeter (0-15KV), analog/digital* type, selector switch for voltmeter and protection fuses/MCB for HT metering upto 12 KV on incomer.</p> <p>(c) ½* No. – (0-300 A) dual scale Ammeter, analog/digital* type, selector switches for ammeters.</p>				
		Note : Rate/Amount columns on each page of schedule of work to be crossed by NIT approving authority.			

S.No.	Description of Item	Qty.	Rate	Unit	Amount
	(d) ½* No. – Microprocessor based numerical relay with O/L, E/F and S/C protection.				
	(e) ½* No. – Set of dual core dual ratio 3 CTs 300/150/5/5 A of 15 VA burden and accuracy Class – 0.5 for metering and class 5P10 for protection.				
B.	(a) Outgoing – Nos. ....A VCB				
	(b) ....Nos. – (0-100 A) Ammeters, dual scale analog/digital* type & selector switches for Ammeters.				
	(c) Nos. – Microprocessor based numerical relays with O/L, E/F & S/C protections.				
	(d) Nos. – Set of dual core dual ratio 3 CTs 100/ 50/5/5 A of 15 VA burden and accuracy Class-1.0 for metering and class 5P10 for protection.				
C.	Bus coupler.....No.....A VCB (in case there is only one incomer, bus coupler should be deleted from the item).				
	Note : 1. Fill up the capacities of HT Bus Bars as per the requirements (should not be less than 630 Amps.)				Sets
	2. *One of the alternatives to be deleted.				
2.	Supplying, installation, testing & commissioning of power pack with 220 Volt AC input & 24 Volt DC continuous output suitable for closing/tripping/indication of... Nos. HT panel boards with 2 Nos. 12 Volts each maintenance free batteries of 100 (suitable) AH each, charging unit, capacitor bank for emergency delivering for trip system complete with suitable capacity of Ammeter & Voltmeter i/c connections with 2.5 sq. mm FRLS insulated copper conductor cable etc. as required.				Job
3.	Supplying, installation, testing and commissioning of .....KVA, 11/0433 KV, 3 Phase, 50 Hz, Dyn 11, indoor ONAN type, copper wound transformer with OFF load tap changing arrangement on HV side in steps of +/- 2.5% & -7.5%, having cable end boxes on				

S.No.	Description of Item	Qty.	Rate	Unit	Amount
	<p>HV side suitable for 3x.....sqmm XLPE cable of 11 KV grade and .....Amp. bus trunking arrangement on LV side complete with all accessories i/c first filling of filtered dehydrated oil and confirming to IS 2026 (Part 1 to Part 5) & as per specification attached complete in all respects as required at site.</p> <p style="text-align: center;">Or</p> <p>SITC of Cast Rasin Dry Type .....KVA 11/0.433 KV, 3 Phase, 50 Hz, Dyn 11 vector group, copper wound, class F insulation associated with winding temperature indicator/controller actuated by means of resistance temperature detector embedded in LV windings, indoor type Transformer with Approximately 5% impedance, tapping for off load operation on HV side in steps of +/-2.5%, +/-5% - 7.5%, having cable end boxes on HV side suitable for 3x .....sqmm XLPE cable of 11 KV grade and .....Amp. bus trunking arrangement on LV side with neutral brought out separately including supplying and laying of copper conductor multicore control cable from transformer to HT breaker for safety tripping, suitably mounted on M.S. Channel i/c supplying and grouting of suitable M.S. Channel with all accessories and confirming to IS 11171:1985 & as per specification attached complete in all respects as required at site.</p>				Each
4.	<p>Supplying, Installation, Testing & Commissioning of .....Amps. Pre-fabricated Air-insulated/ Sandwiched bus trunking suitable for 415 Volt 3 Phase 4 wire 50 Hz AC supply system (between transformer's LT side & incomer of LT Panel side) of copper/aluminium bus bars complete with bends, expansion joints, fir barriers, copper flexible end connections at both ends Earthing with 2 runs of copper earth of size 25 mm x 5 mm strips etc. i/c necessary supports etc. as per specifications attached as reqd.</p> <p>Note : The bus trunking shall be measured along the length of enclosure. The copper/aluminium strips which will go inside L.T. panels & end termination boxes of transformers shall not be taken into measurement of bus trunking quantity).</p>				Per Metre

S.No.	Description of Item	Qty.	Rate	Unit	Amount
5.	<p>Supplying, installation, testing & commissioning of cubical type LT panel suitable for 415 V, 3 Phase, 4 Wire 50 Hz AC supply system having front surface area .....sq.mtr (Approx.) fabricated in compartmentalized (preferably) design from CRCA sheet steel of 2 mm thick for frame work and covers, 3 mm thick for gland, plates i/c cleaning & finishing complete with 7 tank process for powder coating in approved shade, having .....Amp capacity extensible type TPN aluminium alloy bus bars of high conductivity, DMC / SMC bus bars of high conductivity, DMC/ SMC bus bar supports, with short circuit withstand capacity of 31 MVA for 1 Sec., bottom base channel of MS section not less than 100 mm x 50 mm x 5 mm thick, fabrication shall be done in transportable sections, entire panel shall have a common copper earth bar of size 25 mm x 5 mm at the rear with 2 Nos. earth stud, solid connections from main bus bar to switch gears with required size of Al. bus bars and control wiring with .....sq. mm. PVC insulated copper conductor S/C cable, cable alleys, cable gland plates in two half, i/c providing following switch gears :-</p> <p>(I) Incoming :</p> <p>_____ Nos..... Amps each four pole MCCB/ horizontal drawout type air circuit breaker of fault breaking capacity 50 KA (Ics=Icu upto 433 V manually operated, fitted with interlocked door, automatic safety shutters, mechanical ON/OFF and service/test/isolated position indicators and frame earthing contact, conforming to IS 1397- 2 : 1993 as amended up-to-date complete with following accessories for each ACB/MCCB (delete whatever is not applicable for MCCB.)</p> <p>(a) Independent manual spring closing mechanism- 1 No.</p> <p>(b) Microprocessor release (EMI & EMC certified) for over current, earth fault & short circuit protection- 1 set.</p> <p>(c) Analog 96 mm square flush pattern / Digital* type Voltmeter (0-500 V), with selector switch & back up HRC fuses/ MCBs-1 set.</p>				

Note : NIT approving authority should avoid using O/G MCCBs of rating less than 200 A (rating 100) Amps in the main panel. Smaller loads S/S building/ Pumps/street light should be put on a separate DB/Feeder Pillar fed from main panel.

S.No.	Description of Item	Qty.	Rate	Unit	Amount
	<p>(d) Analog 96 mm. square flush pattern/ Digital* type Ammeter (0-....Amp), with selector switch and one set of 3 nos. CT's of ratio...../5A Class I accuracy and 15 VA burden- 1set. (Ratio to be filled up).</p> <p>(e) 3 Nos. Phase indication LED lamps with 2 Amp back up HRC fuse, breaker 'ON' indicating light with 2 A HRC fuse, test terminal block set, fuses, circuits as per standard practice, auxiliary contacts for positive interlocking of the breakers as required.</p> <p>(f) Shunt trip coil 220 V A.C.</p> <p>(II) Bus Couplers :</p> <p>.....Nos. ....Amps horizontal four pole MCCB/drawout type, air circuit breakers of fault breaking capacity 50 KA (Ics=Icu upto 433 V) manually operated, with interlocked door, automatic safety shutters, mechanical ON/OFF and service/test/isolated position indicators and frame earthing contact conforming to IS 13947-2 : 1993 as amended upto date complete with following accessories for each ACB:</p> <p>(a) Independent manual spring closing mechanism- 1 No.</p> <p>(b) Breaker 'ON' indicating light with back up 2 A HRC fuse test terminal block, fuses, circuits contactors for positive electrical interlocking of breakers, etc. as required- 1 set.</p> <p>(III) Bus Bars :</p> <p>TPN aluminium bus bars of minimum of ....Amps capacity with heat shrinkable coloured sleeves and i/c DMC/SMC bus bar cross section, size supports & their spacing etc. for withstanding fault level of 31 MVA for 1 Sec.</p> <p>(IV) Interlocking :</p> <p>Electrical through advance contacts in MCCB/ ACB's (incomers & bus couplers) and mechanical (castel key) interlocking should be</p>			Amps	

S.No.	Description of Item	Qty.	Rate	Unit	Amount
	provided to ensure that only one supply is available at a time on each section of bus and to eliminate any possibility of accidentally approaching two supplies at one bus section.				
	(V) Outgoing :				
(1)	(a) Nos. ....Amp 4 Pole MCCB (Ics = kA upto 433 V)/SFU with HRC fuse (BC : 80 kA)	Amps			
	(b) CT's of ratio ...../_Amps .....Nos. ....Set (1 set of 3 Nos.)				
	(c) Analog 96 mmsq/Digital* type ammeter (0-.....Amp) with selector switch set.				
(2)	(a) —— Nos. .Amp 4 Pole MCCB (Ics = _ kA upto 433 V)/SFU with HRC fuse (BC : 80 kA)	Amps		Job	
	(b) CT's of ratio ...../_Amps set (1 set of 3 Nos.)				
	(c) Analog 96 mm sq./Digital* type ammeter (0_.....Amp) with selector switch set.				
Total of Sub Head I					
Sub Head-II : Cabling					
1.	Supplying of Unearthed/earthed armoured, aluminium conductor XLPE power cable of 11 KV grade confirming to IS 7098 (Part II) amended upto date as per the following size:				
	(a) 3x_____ sqmm			Mtr.	
	(b) 3x_____ sqmm			Mtr.	
2.	Laying of 1 No. XLPE insulated power cable of grade exceeding 1.1 KV but not exceeding 11 KV of size exceeding .....sqmm but not exceeding .....sqmm direct in ground i/c excavation, sand cushioning & protective covering and refilling the trench etc. as required.			Mtr.	
3.	Laying of 1 No. XLPE insulated power cable of grade exceeding 1.1 KV but not exceeding 11 KV of size not exceeding .....sqmm in the existing masonry open duct as required.			Mtr.	

S.No.	Description of Item	Qty.	Rate	Unit	Amount
4.	Laying of 1 No. XLPE insulated power cable of 1.1 KV grade of size exceeding .....sqmm but not exceeding .....sqmm direct in ground i/c excavation, sand cushioning, protective covering and refilling the trench etc. as required.			Mtr.	
5.	Laying of 1 no. PVC insulated and PVC sheathed/ XLPE power cable of 1.1 KV grade of size not exceeding .....sqmm direct in ground i/c excavation, sand cushioning & protective covering and refilling the trench etc. as required.			Mtr.	
6.	Laying of 1 No. Additional PVC insulated and PVC sheathed / XLPE power cable of 1.1 KV grade of size exceeding .....sqmm but not exceeding .....sqmm direct in ground in the same trench in one tier horizontal formaton i/c excavation, sand cushioning & protective covering and refilling the trench etc. as required.			Mtr.	
7.	Laying of 1 No. PVC insulated and PVC sheathed/ XLPE power cable of 1.1 KV grade of size exceeding sqmm but not exceeding..... sqmm in the exsting masonry open duct as required.			Mtr.	
8.	Excavation of the trench in hard rock not exceeding .....mtrs in width and lift up to.....mtr i/c getting out the excavated soil and disposal of excavated soil as directed within a reach of .....mtrs.			Cu.Mtr.	
9.	Supplying and making end termination with brass compression gland and Al. lugs for following size of PVC insulated and PVC sheathed/XLPE Al. conductor cable of 1.1 KV grade as required. a. 3.5x.....sq. mm b. 3.5 x .....sq.mm			Set Set	
10.	Supplying and making straight through joint with cast resin compound i/c ferrule and other jointing material for following sizes of PVC insulated and PVC sheathed /XLPE Al. Conductor cable of 1.1 KV grade as required. a. 3.5 x.....sq.mm b. 3.5 x.....sq.mm			Each Each	

S.No.	Description of Item	Qty.	Rate	Unit	Amount
11.	Supplying and making straight through cable jointing with heat shrinkable jointing kit complete with all accessories i/c ferrules suitable for the following size of 3 core PILCDSTA Al. conductor cable of 11 KV grade as required. a. ....sq.mm			Each	
12.	Supplying and making indoor cable end termination with heat shrinkable jointing kit complete with all accessories i/c lugs suitable for following sizes of 3 core XLPE Al. Conductor cable of 11 KV grade as required. a. ....sq.m			Each	
13.	Supplying and making straight through cable jointing with heat shrinkable jointing kit complete with all accessories i/c ferrules suitable for the following size of 3 core XLPE Al. conductor cable of 11 KV grade as required . a. ....sq.m			Each	
14.	Supplying of .....Sand and filling in the existing sub-station trench/Open masonry duct as required.			Cu.Mtr	
Total of Sub Head II					
Sub Head – III : Earthing					
1.	Earthing with coper Earth Plate 600 mm x 600 mm x 3 mm thick i/c accessories and providing masonry enclosure with cover plate having locking arrangement and watering pipe etc. (but without charcoal or coke and salt) complete as required.			Set	
2.	Extra for using charcoal / coke and salt for GI or copper plate earthing electrode as required.			Set	
3.	Earthing with GI earth place 600 mm x 600 mm x 6 mm thick i/c accessories and providing masonry enclosure with cover plate having locking arrangement and watering pipe etc. (but without charcoal or coke and salt) complete as required.			Set	
4.	Supplying and laying 65 mm dia GI pipe medium class ISI marked in ground from earth electrode to building entry as required.			Mtr.	

S.No.	Description of Item	Qty.	Rate	Unit	Amount
5.	Providing and fixing earth bus of 50 mm x 5 mm copper strip on surface for connection etc. as required.			Mtr.	
6.	Providing and fixing 25 mm x 5 mm GI/Copper strip in 40 mm dia GI pipe from earth electrode as required.			Mtr.	
7.	Providing and fixing 25 mm x 5 mm GI/Copper strip on surface or in recess for connection etc. as required.			Mtr.	
8.	Riveting sweating & soldering of copper strip with another copper strip or any other metallic object as required.			No.	
Total of Sub Head III					
Sub Head – IV : Safety Equipment					
1	Providing & fixing danger plates made of mild steel at least 2 mm thick & vitreous enameled white on both sides & with inscriptions in signal red colour on front side as read. (a) High Voltage – size 250 mm x 200 mm (b) Medium Voltage – size 200 mm x 150 mm			Each Each	
2.	Providing and fixing carbon dioxide (CO ₂) type fire extinguishers conforming to IS 2878 : 1976 and cylinders fully charged of following capacity. (a) 4.5 KG			Each	
3.	Supply and fixing of foam fire extinguishers, Portable type 9 lit capacity hanged on wall with bracket complete as required.			Each	
4.	Supply and fixing safety instruction chart in word duly framed with 5 mm thick glass as required. (approx. front area 1.20 sq. mt.)			Each	
5.	Providing of set of 4 Nos. 9.5 Litre capacity GI bucket painted in post office red colour with prior coat of red oxide paint and written with white paint 'FIRE' and mounted on MS angle iron frame with bracket of appropriate size & capacity i/c filling sand etc.			Set	
6.	Providing First Aid Box as approved by St. John Ambulance Brigade/Indian Red Cross conforming to IS 2217 : 1963.			Each	

<i>S.No.</i>	<i>Description of Item</i>	<i>Qty.</i>	<i>Rate</i>	<i>Unit</i>	<i>Amount</i>
7.	Supply & fixing shock treatment chart duly mounted on a wooden frame with 5 mm thick glass as reqd. (approximate front area 1.20 sq. metre)			Each	
8.	Providing of rubber mat 1 mtr. wide and 12 mm thick to withstand 15 KV dielectric strength as per IS 5424 : 1969			Mtr.	
9.	Providing of rubber mat 1 mtr. wide and 12 mm thick to withstand 3.3 KV dielectric strength as per IS 5424 : 1969			Mtr.	
Total of Sub Head IV					

* Strike out whichever is not applicable

Technical Particulars

Sl. No.	Details of Particulars	Remarks
	Transformers:	
1.1	Make	
1.2	Type	
	(a) Type of winding	
	(b) Type of enclosure	
1.3	Output in KVA (continuous rating)	
1.4	Frequency	
1.5	Voltage between phases (HV on no-load)	
1.6	Voltage between phases (L V on no-load)	
1.7	Impedance at normal voltage ratio at 75 deg. C	
1.8	Efficiency at unity power factor	
	(a) Full Load	
	(b) $\frac{3}{4}$ load	
	(c) $\frac{1}{2}$ load	
1.9	Iron losses at normal voltage ratio	
1.10	Copper losses at normal voltage ratio, at full load	
1.11	Regulation at unity power factor at 75 deg. C	
1.12	Reactance at normal voltage and ratio	
1.13	Resistance of HV winding at 75 deg. C	
1.14	Regulation at 0.8 PF at 75 deg. C	
1.15	Resistance of MV winding at 75 deg. C	
1.16	Over Load : The transformers are capable of carrying overload as follows :	
	Percentage Load	When starting Cold (in hours)
	(a) 25%	After Running continuously (in hours)
	(b) 50%	
	(c) 100%	

- 1.17 Over all dimensions of the transformer.
- 1.18 CPRI Type test certificates be enclosed for all type tests applicable as per I.S.

L.T. Panel :

- 2.1 Make
- 2.2 Thickness of the sheet metal
- 2.3 Size of the bus bars
- 2.4 Material of bus bars – copper/aluminum
- 2.5 Bus bar insulation
- 2.6 Over all dimension
- 2.7 Degree of protection

Bus Trunking :

- 3.1 Name of manufacturer
- 3.2 CPRI certificate No. & validity
- 3.3 Thickness of the sheet metal
- 3.4 Size of the bus bars
- 3.5 Material of bus bars - copper / aluminium
- 3.6 Bus bar insulation
- 3.7 General arrangement indication spacing of bus bars insulators.
- 3.8 No. of flexible/ expansion joints
- 3.9 Details of flexible joints

HT Panel:

- 4.1 Make
- 4.2 Type
- 4.3 Rated current Amps.
- 4.4 Over all dimensions & weight.
- 4.5 Breaking currentKA.....MVA at 11000 Volts.

ACCEPTABLE MAKES

<i>Item</i>	<i>Makes</i>
Transformer	
H.T. Panels	
Bus Duct	
Air Circuit Breaker	
Contactors	
MCCB	
SDFU	
Selector Switches	
Voltmeter/Ammeter	
Multi function meter	
Pilot Lams	
Push Buttons	
End joints	
LT Current Transformer	
11 KV XLPE Cables	
11 KV Cable Jointing Kit	
LT Cable	
PVC Insulated Copper Conductor Armoured	
Control Cable, 1100 V grade	
Cable Lugs	
Cable Glands	
Control Fuses	
Fire Extinguisher	

- Note:** 1. The acceptable reputed makes to equipments to be given by the NIT approving authority.
2. In case the quantity of a item is more than one, same make shall be supplied.

NIT – PART – II
PRICE BID

INDEX

<i>S.No.</i>	<i>Description</i>	<i>Page No.</i>
1.	Abstract of Cost	
2.	Schedule of Work	

Certified that this NIT Part-II (Price Bid) contains pages

CERTIFICATE – The rates quoted are net inclusive of all rate, rent and taxes except service tax without any conditions. We understand that any condition in the price bid shall make the tender liable for cancellation.

(CONTRACTOR'S SIGNATURE)

SCHEDULE OF WORK

Abstract of Cost

NAME OF WORK : TO BE FILLED IN BY NIT APPROVING AUTHORITY

Sub Head – I (Equipments)

Note : Amount not to be filled in.

Sub Head – II (Cabling)

Sub Head – III (Earthing)

Sub Head – IV (Safety Equipment)

Total

.....

SCHEDULE OF WORK

Prices should be net inclusive of all taxes, duties & without any conditions

Name of Work :

S.No.	Description of Item	Qty.	Rate	Unit	Amount
	Sub Head-I : Equipments-HT Panel Board, Transformers & H.T. Cable				
1	<p>Supplying, installation, testing & commissioning of indoor type floor mounted metal clad, 11 KV VCB panel with .....No. VCBs, totally enclosed & fully interlocked, horizontal drawout, horizontal/ vertical isolation type breaker as per IS 13118, as amended up to date and additional specifications, having capacities as mentioned below, single break, trip free mechanism, manually charged and auto/manually closing breaker suitable for use on 11 KV, 3 Phase, 50 Hz A.C. supply with short circuit fault level of 350 MVA, complete with self contained, fully interlocked, rack in and rack out mechanism, air insulated but encapsulated copper bus bars of.....Amps capacity, breaker featured with mechanical ON/OFF indicator with hand trip device, spring release coil, shunt trip coil and auxiliary switch of 4 NO+4NC and equipped with following switchgears and accessories i/c connections suitable for 3x .....*sq. mm. XLPE 11 KV cable (cable entry from *bottom/ top/side) end termination with heat shrinkable jointing material etc. as required. (Note- Cost of end termination not included in this item)</p> <p>A. (a) Incoming – ½* No.....Amp. VCB</p> <p>(b) ½* No. – 11 KV / 110 Volts PT Class 0.5 accuracy and 100 VA burden with 1 No. Voltmeter (0-15KV), analog/digital* type, selector switch for voltmeter and protection fuses/MCB for HT metering upto 12 KV on incomer.</p> <p>(c) ½* No. – (0-300 A) dual scale Ammeter, analog/digital* type, selector switches for ammeters.</p>				

S.No.	Description of Item	Qty.	Rate	Unit	Amount
	(d) ½* No. – Microprocessor based numerical relay with O/L, E/F and S/C protection.				
	(e) ½* No. – Set of dual core dual ratio 3 CTs 300/150/5/5 A of 15 VA burden and accuracy Class – 0.5 for metering and class 5P10 for protection.				
B.	(a) Outgoing – Nos. ....A VCB				
	(b) ....Nos. – (0-100 A) Ammeters, dual scale analog/digital* type & selector switches for Ammeters.				
	(c) Nos. – Microprocessor based numerical relays with O/L, E/F & S/C protections.				
	(d) Nos. – Set of dual core dual ratio 3 CTs 100/50/5/5 A of 15 VA burden and accuracy Class-1.0 for metering and class 5P10 for protection.				
C.	Bus coupler.....No.....A VCB (in case there is only one incomer, bus coupler should be deleted from the item).				
	Note : 1. Fill up the capacities of HT Bus Bars as per the requirements (should not be less than 630 Amps.)				Sets
	2. *One of the alternatives to be deleted.				
2.	Supplying, installation, testing & commissioning of power pack with 220 Volt AC input & 24 Volt DC continuous output suitable for closing/tripping/indication of... Nos. HT panel boards with 2 Nos. 12 Volts each maintenance free batteries of 100 (suitable) AH each, charging unit, capacitor bank for emergency delivering for trip system complete with suitable capacity of Ammeter & Voltmeter i/c connections with 2.5 sq. mm FRLS insulated copper conductor cable etc. as required.				Job
3.	Supplying, installation, testing and commissioning of .....KVA, 11/0433 KV, 3 Phase, 50 Hz, Dyn 11, indoor ONAN type, copper wound transformer with OFF load tap changing arrangement on HV side in steps of +/- 2.5% & -7.5%, having cable end boxes on				

S.No.	Description of Item	Qty.	Rate	Unit	Amount
	<p>HV side suitable for 3x.....sqmm XLPE cable of 11 KV grade and .....Amp. bus trunking arrangement on LV side complete with all accessories i/c first filling of filtered dehydrated oil and confirming to IS 2026 (Part 1 to Part 5) & as per specification attached complete in all respects as required at site.</p> <p style="text-align: center;">Or</p> <p>SITC of Cast Rasin Dry Type .....KVA 11/0.433 KV, 3 Phase, 50 Hz, Dyn 11 vector group, copper wound, class F insulation associated with winding temperature indicator/controller actuated by means of resistance temperature detector embedded in LV windings, indoor type Transformer with Approximately 5% impedance, tapping for off load operation on HV side in steps of +/-2.5%, +/-5% - 7.5%, having cable end boxes on HV side suitable for 3x .....sqmm XLPE cable of 11 KV grade and .....Amp. bus trunking arrangement on LV side with neutral brought out separately including supplying and laying of copper conductor multicore control cable from transformer to HT breaker for safety tripping, suitably mounted on M.S. Channel i/c supplying and grouting of suitable M.S. Channel with all accessories and confirming to IS 11171:1985 & as per specification attached complete in all respects as required at site.</p>				Each
4.	<p>Supplying, Installation, Testing & Commissioning of .....Amps. Pre-fabricated Air-insulated/ Sandwiched bus trunking suitable for 415 Volt 3 Phase 4 wire 50 Hz AC supply system (between transformer's LT side & incomer of LT Panel side) of copper/aluminium bus bars complete with bends, expansion joints, fir barriers, copper flexible end connections at both ends Earthing with 2 runs of copper earth of size 25 mm x 5 mm strips etc. i/c necessary supports etc. as per specifications attached as reqd.</p> <p>Note : The bus trunking shall be measured along the length of enclosure. The copper/aluminium strips which will go inside L.T. panels & end termination boxes of transformers shall not be taken into measurement of bus trunking quantity).</p>				Per Metre

S.No.	Description of Item	Qty.	Rate	Unit	Amount
5.	<p>Supplying, installation, testing & commissioning of cubical type LT panel suitable for 415 V, 3 Phase, 4 Wire 50 Hz AC supply system having front surface area .....sq.mtr (Approx.) fabricated in compartmentalized (preferably) design from CRCA sheet steel of 2 mm thick for frame work and covers, 3 mm thick for gland, plates i/c cleaning & finishing complete with 7 tank process for powder coating in approved shade, having .....Amp capacity extensible type TPN aluminium alloy bus bars of high conductivity, DMC / SMC bus bars of high conductivity, DMC/ SMC bus bar supports, with short circuit withstand capacity of 31 MVA for 1 Sec., bottom base channel of MS section not less than 100 mm x 50 mm x 5 mm thick, fabrication shall be done in transportable sections, entire panel shall have a common copper earth bar of size 25 mm x 5 mm at the rear with 2 Nos. earth stud, solid connections from main bus bar to switch gears with required size of Al. bus bars and control wiring with sq. mm. PVC insulated copper conductor S/C cable, cable alleys, cable gland plates in two half, i/c providing following switch gears :-</p> <p>(I) Incoming :</p> <p>_____ Nos..... Amps each four pole MCCB/ horizontal drawout type air circuit breaker of fault breaking capacity 50 KA (Ics=Icu upto 433 V manually operated, fitted with interlocked door, automatic safety shutters, mechanical ON/ OFF and service/test/isolated position indicators and frame earthing contact, conforming to IS 1397- 2 : 1993 as amended up-to-date complete with following accessories for each ACB/MCCB (delete whatever is not applicable for MCCB.)</p> <p>(a) Independent manual spring closing mechanism- 1 No.</p> <p>(b) Microprocessor release (EMI & EMC certified) for over current, earth fault & short circuit protection- 1 set.</p> <p>(c) Analog 96 mm square flush pattern / Digital* type Voltmeter (0-500 V), with selector switch & back up HRC fuses/MCBs-1 set.</p>				Per Metre

S.No.	Description of Item	Qty.	Rate	Unit	Amount
	<p>(d) Analog 96 mm. square flush pattern/ Digital* type Ammeter (0-....Amp), with selector switch and one set of 3 nos. CT's of ratio...../5A Class I accuracy and 15 VA burden- 1set. (Ratio to be filled up).</p> <p>(e) 3 Nos. Phase indication LED lamps with 2 Amp back up HRC fuse, breaker 'ON' indicating light with 2 A HRC fuse, test terminal block set, fuses, circuits as per standard practice, auxiliary contacts for positive interlocking of the breakers as required.</p> <p>(f) Shunt trip coil 220 V A.C.</p> <p>(II) Bus Couplers :</p> <p>.....Nos. ....Amps horizontal four pole MCCB/drawout type, air circuit breakers of fault breaking capacity 50 KA (Ics=Icu upto 433 V) manually operated, with interlocked door, automatic safety shutters, mechanical ON/OFF and service/test/isolated position indicators and frame earthing contact conforming to IS 13947-2 : 1993 as amended upto date complete with following accessories for each ACB:</p> <p>(a) Independent manual spring closing mechanism- 1 No.</p> <p>(b) Breaker 'ON' indicating light with back up 2 A HRC fuse test terminal block, fuses, circuits contactors for positive electrical interlocking of breakers, etc. as required- 1 set.</p> <p>(III) Bus Bars :</p> <p>TPN aluminium bus bars of minimum of ....Amps capacity with heat shrinkable coloured sleeves and i/c DMC/SMC bus bar cross section, size supports & their spacing etc. for withstanding fault level of 31 MVA for 1 Sec.</p> <p>(IV) Interlocking :</p> <p>Electrical through advance contacts in MCCB/ ACB's (incomers & bus couplers) and mechanical (castel key) interlocking should be</p>			Amps	

S.No.	Description of Item	Qty.	Rate	Unit	Amount
	provided to ensure that only one supply is available at a time on each section of bus and to eliminate any possibility of accidentally approaching two supplies at one bus section.				
	(V) Outgoing :				
(1)	(a) Nos. ....Amp 4 Pole MCCB (Ics = kA upto 433 V)/SFU with HRC fuse (BC : 80 kA)	Amps			
	(b) CT's of ratio ...../_Amps .....Nos. ....Set (1 set of 3 Nos.)				
	(c) Analog 96 mmsq/Digital* type ammeter (0-.....Amp) with selector switch set.				
(2)	(a) _____ Nos. .Amp 4 Pole MCCB (Ics = _ kA upto 433 V)/SFU with HRC fuse (BC : 80 kA)	Amps			
	(b) CT's of ratio ...../_Amps set (1 set of 3 Nos.)				
	(c) Analog 96 mm sq./Digital* type ammeter (0_.....Amp) with selector switch set.			Job	
Total of Sub Head I					
Sub Head-II : Cabling					
1.	Supplying of Unearthed/earthed armoured, aluminium conductor XLPE power cable of 11 KV grade confirming to IS 7098 (Part II) amended upto date as per the following size: (a) 3x_____ sqmm (b) 3x_____ sqmm			Mtr.	
2.	Laying of 1 No. XLPE insulated power cable of grade exceeding 1.1 KV but not exceeding 11 KV of size exceeding .....sqmm but not exceeding .....sqmm direct in ground i/c excavation, sand cushioning & protective covering and refilling the trench etc. as required.			Mtr.	
3.	Laying of 1 No. XLPE insulated power cable of grade exceeding 1.1 KV but not exceeding 11 KV of size not exceeding .....sqmm in the existing masonry open duct as required.			Mtr.	

S.No.	Description of Item	Qty.	Rate	Unit	Amount
4.	Laying of 1 No. XLPE insulated power cable of 1.1 KV grade of size exceeding .....sqmm but not exceeding .....sqmm direct in ground i/c excavation, sand cushioning, protective covering and refilling the trench etc. as required.			Mtr.	
5.	Laying of 1 no. PVC insulated and PVC sheathed/ XLPE power cable of 1.1 KV grade of size not exceeding .....sqmm direct in ground i/c excavation, sand cushioning & protective covering and refilling the trench etc. as required.			Mtr.	
6.	Laying of 1 No. Additional PVC insulated and PVC sheathed / XLPE power cable of 1.1 KV grade of size exceeding .....sqmm but not exceeding .....sqmm direct in ground in the same trench in one tier horizontal formaton i/c excavation, sand cushioning & protective covering and refilling the trench etc. as required.			Mtr.	
7.	Laying of 1 No. PVC insulated and PVC sheathed/ XLPE power cable of 1.1 KV grade of size exceeding sqmm but not exceeding..... sqmm in the exsting masonry open duct as required.			Mtr.	
8.	Excavation of the trench in hard rock not exceeding .....mtrs in width and lift up to.....mtr i/c getting out the excavated soil and disposal of excavated soil as directed within a reach of .....mtrs.			Cu.Mtr.	
9.	Supplying and making end termination with brass compression gland and Al. lugs for following size of PVC insulated and PVC sheathed/XLPE Al. conductor cable of 1.1 KV grade as required. a. 3.5x.....sq. mm b. 3.5 x .....sq.mm			Set Set	
10.	Supplying and making straight through joint with cast resin compound i/c ferrule and other jointing material for following sizes of PVC insulated and PVC sheathed /XLPE Al. Conductor cable of 1.1 KV grade as required. a. 3.5 x.....sq.mm b. 3.5 x.....sq.mm			Each Each	

S.No.	Description of Item	Qty.	Rate	Unit	Amount
11.	Supplying and making straight through cable jointing with heat shrinkable jointing kit complete with all accessories i/c ferrules suitable for the following size of 3 core PILCDSTA Al. conductor cable of 11 KV grade as required. a. ....sq.mm			Each	
12.	Supplying and making indoor cable end termination with heat shrinkable jointing kit complete with all accessories i/c lugs suitable for following sizes of 3 core XLPE Al. Conductor cable of 11 KV grade as required. a. ....sq.m			Each	
13.	Supplying and making straight through cable jointing with heat shrinkable jointing kit complete with all accessories i/c ferrules suitable for the following size of 3 core XLPE Al. conductor cable of 11 KV grade as required. a. ....sq.m			Each	
14.	Supplying of .....Sand and filling in the existing sub-station trench/Open masonry duct as required.			Cu.Mtr	
Total of Sub Head II					
Sub Head – III : Earthing					
1.	Earthing with coper Earth Plate 600 mm x 600 mm x 3 mm thick i/c accessories and providing masonry enclosure with cover plate having locking arrangement and watering pipe etc. (but without charcoal or coke and salt) complete as required.			Set	
2.	Extra for using charcoal / coke and salt for GI or copper plate earthing electrode as required.			Set	
3.	Earthing with GI earth place 600 mm x 600 mm x 6 mm thick i/c accessories and providing masonry enclosure with cover plate having locking arrangement and watering pipe etc. (but without charcoal or coke and salt) complete as required.			Set	
4.	Supplying and laying 65 mm dia GI pipe medium class ISI marked in ground from earth electrode to building entry as required.			Mtr.	

S.No.	Description of Item	Qty.	Rate	Unit	Amount
5.	Providing and fixing earth bus of 50 mm x 5 mm copper strip on surface for connection etc. as required.			Mtr.	
6.	Providing and fixing 25 mm x 5 mm GI/Copper strip in 40 mm dia GI pipe from earth electrode as required.			Mtr.	
7.	Providing and fixing 25 mm x 5 mm GI/Copper strip on surface or in recess for connection etc. as required.			Mtr.	
8.	Riveting sweating & soldering of copper strip with another copper strip or any other metallic object as required.			No.	
Total of Sub Head III					
Sub Head – IV : Safety Equipment					
1	Providing & fixing danger plates made of mild steel at least 2 mm thick & vitreous enameled white on both sides & with inscriptions in signal red colour on front side as read. (a) High Voltage – size 250 mm x 200 mm (b) Medium Voltage – size 200 mm x 150 mm			Each Each	
2.	Providing and fixing carbon dioxide (CO ₂) type fire extinguishers confirming to IS 2878 : 1976 and cylinders fully charged of following capacity. (a) 4.5 KG			Each	
3.	Supply and fixing of foam fire extinguishers, Portable type 9 lit capacity hanged on wall with bracket complete as required.			Each	
4.	Supply and fixing safety instruction chart in word duly framed with 5 mm thick glass as required. (approx. front area 1.20 sq. mt.)			Each	
5.	Providing of set of 4 Nos. 9.5 Litre capacity GI bucket painted in post office red colour with prior coat of red oxide paint and written with white paint 'FIRE' and mounted on MS angle iron frame with bracket of appropriate size & capacity i/c filling sand etc.			Set	
6.	Providing First Aid Box as approved by St. John Ambulance Brigade/Indian Red Cross conforming to IS 2217 : 1963.			Each	

<i>S.No.</i>	<i>Description of Item</i>	<i>Qty.</i>	<i>Rate</i>	<i>Unit</i>	<i>Amount</i>
7.	Supply & fixing shock treatment chart duly mounted on a wooden frame with 5 mm thick glass as reqd. (approximate front area 1.20 sq. metre)			Each	
8.	Providing of rubber mat 1 mtr. wide and 12 mm thick to withstand 15 KV dielectric strength as per IS 5424 : 1969			Mtr.	
9.	Providing of rubber mat 1 mtr. wide and 12 mm thick to withstand 3.3 KV dielectric strength as per IS 5424 : 1969			Mtr.	
Total of Sub Head IV					

* Strike out whichever is not applicable

APPENDIX III

COMPACT BUS TRUNKING TECHNICAL PARAMETER

Technical Data : CBA (Aluminium Bus Trunking)

The Table

PARAMETER	UNIT									
Trunking Type		CBA	CBA	CBA	CBA	CBA	CBA	CBA	CBA	
		160	250	400	500	630	800	1000	1250	
Overall Dimensions	mm	147x60	147x75	147x95	147x115	147x135	147x190	147x230	147x270	
Rated Current	A	160	250	400	500	630	800	1000	1250	
Insulation Voltage	v	1000	1000	1000	1000	1000	1000	1000	1000	
Peak Short Circuit Current	kA	17	30	52	73	84	105	105	105	
RMS Short Circuit Current (1 Sec.)	kA	10	15	25	35	40	50	50	50	
Conductor Material		Al	Al	Al	Al	Al	Al	Al	Al	
No. of Conductors per phase/ Neutral		1	1	1	1	1	2	2	2	
Phase Cross Section	mm ²	90	180	300	420	540	600	840	1080	
Neutral Cross Section	mm ²	90	180	180	300	420	360	600	840	
PE Enclosure (CU equivalent)	mm ²	84	102	110	1.18	126	164	184	204	
Trunking Weight) (3P+N)	Kg/m	7.2	9.6	11.6	13.5	15.5	18.9	23.2	27.4	
Degree of Protection (IEC 529)	IP	52	52	52	52	52	52	52	52	
Reactance at 50 Hz X	m Ω/m	0.14	0.095	0.074	0.06	0.052	0.038	0.03	0.025	
Resistance at 20 ° C. R	m Ω/m	0.348	0.174	0.1040	0.0750	0.058	0.0520	0.037	0.029	
Impedance at 20 ° C. Z	m Ω/m	0.375	0.198	0.128	0.096	0.078	0.065	0.048	0.038	
Resistance at Thermal Condition	m Ω/m	0.411	0.205	0.12	0.088	0.068	0.062	0.044	0.034	
Impedance at Thermal Condition	m Ω /m	0.434	0.226	0.144	0.107	0.086	0.072	0.053	0.042	
Voltage drop L-1 for COS Φ with nominal load concentrated at the end	at 0.7	mV/mA	0.671	0.367	0.241	0.181	0.147	0.122	0.09	0.072
	at 0.8	mV/mA	0.715	0.383	0.248	0.184	0.149	0.125	0.092	0.073
	at 0.9	mV/mA	0.746	0.392	0.248	0.183	0.146	0.125	0.091	0.072
	at 1.0	mV/mA	0.711	0.356	0.213	0.152	0.119	0.107	0.076	0.059

Note : The above table is only for guidelines shall vary from manufacturer to manufacturer.

APPENDIX III

COMPACT BUS TRUNKING TECHNICAL PARAMETER

Technical Data : CBA (Copper Bus Trunking)

PARAMETER	UNIT													
Trunking Type		CBC	CBC	CBC	CBC	CBC	CBC	CBC	CBC	CBC	CBC	CBC	CBC	
		125	250	315	400	500	630	800	1000	1250	1500	1750	2000	
Overall Dimensions	mm	147x60	147x60	147x75	147x75	147x95	147x95	147x115	147x135	147x190	147x230	147x230	147x270	
Rated Current	A	125	250	315	400	500	630	800	1000	1250	1500	1750	2000	
Insulation Voltage	V	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	
Peak Short Circuit Current	kA	7.5	30	40	52	73	84	105	105	105	105	143	143	
RMS Short Circuit Current (1 Sec.)	kA	5	15	20	25	35	40	50	50	50	50	65	65	
Conductor Material		Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	
No. of Conductors per phase / Neutral		1	1	1	1	1	1	1	1	2	2	2	2	
Phase Cross Section	mm ²	28	90	120	180	240	300	420	540	600	720	840	1080	
Neutral Cross Section	mm ²	28	90	120	180	180	180	300	420	360	600	600	840	
PE Cross Section Cu Conductor	mm ²	36*	36*	36*	36*	75**	75**	75**	75**	75**	75**	75**	75**	
PE Enclosure (CU equivalent)	mm ²	84	84	102	102	110	110	118	126	164	184	184	204	
Trunking Weight (3P+N)	Kg/m	7.5	9.6	12.0	13.8	17.5	19.2	24.2	29.3	33.4	40.6	44.0	54.3	
Degree of Protection (IEC 529)	IP	52	52	52	52	52	52	52	52	52	52	52	52	
Reactance at 50 Hz X	mΩ/m	0.155	0.122	0.11	0.092	0.079	0.069	0.057	0.05	0.033	0.03	0.027	0.024	
Resistance at 20°C. R	mΩ/m	0.635	0.197	0.1480	0.0990	0.074	0.0590	0.042	0.033	0.03	0.025	0.0210	0.016	
Impedance at 20°C.Z	mΩ/m	0.653	0.232	0.184	0.135	0.108	0.091	0.071	0.06	0.044	0.039	0.034	0.029	
Resistance at Thermal Condition	mΩ/m	0.818	0.254	0.191	0.127	0.095	0.076	0.055	0.042	0.038	0.032	0.027	0.021	
Impedance at Thermal Condition	mΩ/m	0.832	0.282	0.22	0.157	0.124	0.0103	0.079	0.066	0.05	0.044	0.038	0.032	
Voltage drop L-1 at 0.7 for COS Φ with nominal load concentrated at the end	at 0.7	mV/mA	1.183	0.0456	0.367	0.268	0.213	0.178	0.137	0.113	0.087	0.076	0.066	0.055
	at 0.8	mV/mA	1.294	0.479	0.379	0.272	0.214	0.177	0.135	0.111	0.087	0.075	0.066	0.054
	at 0.9	mV/mA	1.392	0.489	0.381	0.268	0.208	0.171	0.128	0.104	0.084	0.072	0.063	0.051
	at 1.0	mV/mA	1.417	0.441	0.331	0.22	0.165	0.132	0.094	0.073	0.066	0.055	0.047	0.037

* Inside of Enclosure ** Outside of Enclosure

Note : The above table is only for guidelines shall vary from manufacturer to manufacturer.

APPENDIX III

COMPACT BUS TRUNKING TECHNICAL PARAMETER

Technical Parameters

Technical Data : SBC (Copper Sandwich Insulated Bus Trunking)
 Compliance of Standards IEC 60439 - Part 1 & 2/IS 8623 - Part 1 & 2
 Rated Operational Voltage (Ue) 1000V AC
 Rated Insulation Voltage (Ui) 1000V AC
 Rated Impulse Withstand Voltage U_{imp} 12kV (1.2/50μs)
 Rated frequency 50 Hz
 Insulation Busbars fully insulated with class F (155°C) material
 Enclosure material CRCA/G.I. OF THICKNESS 1.6 mm (16 SWG)
 System 3Φ4 wire, full neutral

PARAMETER	UNIT	1-Tier								2-Tier				
		SBC 50N1	SBC 70N1	SBC 100N1	SBC 125N1	SBC 150N1	SBC 175N1	SBC 200N1	SBC 230N1	SBC 125N2	SBC 150N2	SBC 175N2	SBC 200N2	SBC 230N2
Production Code														
Rated current (in) at 40° C ambient Max.	A	800	1000	1250	1500	1750	2000	2250	2500	3000	3600	4000	4500	5000
Busbar Size (Copper) 3 phase & Neutral	mm	6x50	6x70	6x100	6x125	6x150	6x175	6x200	6x230	6x125	6x150	6x175	6x200	6x230
No. of conductors per phase/Neutral	Nos.	1	1	1	1	1	1	1	1	2	2	2	2	2
Rated short time current for 1 second (I _{cw})	kArms	50	50	65	65	75	75	100	100	120	120	120	180	180
Rate peak short time current (I _{pk})	kA	105	105	143	143	165	165	220	220	264	264	264	396	398
Resistance @+20°C (R ₂₀)	mΩ/m	0.0616	0.0431	0.0304	0.0243	0.0202	0.0173	0.0151	0.0131	0.0121	0.0101	0.0086	0.0076	0.0066
Resistance at thermal conditions @	mΩ/m	0.077	0.055	0.04	0.033	0.028	0.024	0.021	0.019	0.016	0.014	0.012	0.011	0.01
Reactance @ 50Hz (X)	mΩ/m	0.038	0.03	0.022	0.018	0.016	0.014	0.012	0.01	0.009	0.008	0.007	0.006	0.005
Impedance at thermal conditions (Z)	mΩ/m	0.0859	0.0626	0.0457	0.0376	0.0322	0.0278	0.0242	0.0215	0.0184	0.0161	0.0139	0.0125	0.0112
Composite Voltage Drop at full load concentrated at the end. These values will become half if load is distributed along the run	P.F.0.7 mV/m/A	0.1404	0.1038	0.0757	0.0623	0.0537	0.0464	0.0403	0.0354	0.0305	0.0269	0.0232	0.0208	0.0183
	P.F.0.8 mV/m/A	0.1462	0.1074	0.0783	0.0644	0.0554	0.0478	0.0416	0.0367	0.0315	0.0277	0.0239	0.0215	0.0191
	P.F.0.9 mV/m/A	0.1487	0.1084	0.0790	0.0650	0.0557	0.0480	0.0418	0.0372	0.0317	0.0279	0.0240	0.0217	0.0194
	P.F.1.0 mV/m/A	0.1334	0.0953	0.0693	0.0572	0.0485	0.0416	0.0364	0.0329	0.0277	0.0242	0.0208	0.0191	0.0173
Overall dimension of Bus bar Trunking (Without Internal Earthing)	147xH (mm)	95	115	145	170	195	220	245	275	340	390	440	490	550
Weight of Busbar Trunking (Without Internal Earthing)	Kg/m	22	28	35	42	48	54	60	67	84	96	108	120	134
Overall Dimension of busbar trunking (Without Internal Earthing)	150xH (mm)	95	115	145	170	195	220	245	275	340	390	440	490	550
Weight of Bus bar Trunking (with 50% Internal Earthing)	Kg/m	25	31	39	47	53	60	67	74	94	106	120	134	148

Note : The above table is only for guidelines shall vary from manufacturer to manufacturer.

APPENDIX IV

TABLE A
Sub-station Area

<i>Sub-station with Transformer capacity of</i>	<i>Total transformer room area reqd.</i>	<i>Total sub-station area reqd. i/c H.V.M.V. Panels transformers but without generators.</i>	<i>Suggested min. face width.</i>
2x500 KVA	36.00 sqm.	130.0 sqm.	14.5 m.
3x500 KVA	54.00 sqm.	172.00 sqm.	19.0 m.
2x800 KVA	39.00 sqm.	135.00 sqm.	14.5 m.
3X800 KVA	58.00 sqm.	181.00 sqm.	19.0 m.
2X1000 KVA	39.00 sqm.	149.00 sqm.	1 4.5 m.
3X1000 KVA	58.00 sqm.	197.00 sqm.	19.0 m.

The clear height required for S/S equipment shall be a minimum of 3.6 M.

APPENDIX IV

TABLE B
Additional Area for One Generator

<i>Capacity</i>					<i>Area.</i>
25 KW	.	.	.	.	56 sqm.
48 KW	.	.	.	.	56 sqm.
100 KW	.	.	.	.	65 sqm.
150 KW	.	.	.	.	72 sqm.
248 KW	.	.	.	.	100 sqm.

The height required for the generating set room for DG sets beyond 160 KVA shall be a minimum of 4.57 meters clear from the soffit of the beam.

REFERENCE : NBC-2005, Part-8, Section-2, Annexure C & D.

APPENDIX IV

TABLE C Co-ordination Table of Rated Values for Circuit Breakers

Rated Voltage V (kv)	Rated short-circuit breaking current I_{ka}	Rated Normal Current							
		I_n (A)							
3.6	10 16 25 40	400	630		1250 1250 1250	1600 1600		2500 2500	4000
7.2	8 12.5 16 25 40	400 400	630 630 630		1250 1250 1250 1250	1600 1600 1600		2500 2500	4000
12	8 12.5 16 25 40 50	400 400	630 630 630		1250 1250 1250 1250 1250	1600 1600 1600		2500 2500 2500	4000 4000
17.5	8 12.5 16 25 40	400	630 630 630		1250 1250 1250 1250 1250	1600		2500	
24	8 12.5 16 25 40	400	630 630 630		1250 1250 1250 1250	1600 1600		2500 2500	4000
36	8 12.5 16 25 40		630 630 630		1250 1250 1250	1600 1600 1600		2500 2500	4000
52	8 12.5 20			800	1250 1250	1600	2000		
72.5	12.5 16 20 31.5			800 800	1250 1250 1250 1250	1600 1600	2000 2000		

APPENDIX IV

TABLE D

Permissible Deflection of Oil Tanks

<i>Horizontal Length of Flat Plate (in mm)</i>	<i>Permanent Deflection (in mm)</i>
Upto and including 750	5
750 to 1250	6.5
1251 to 1750	8
1751 to 2000	9.5
2001 to 2250	11
2251 to 2500	12.5
2501 to 3000	16
Above 3000	19

APPENDIX IV

TABLE E

Width of Steel Enclosure for Conventional Bus Trunking

<i>Max. Width of the Enclosure*</i>	<i>Thickness of Sheet*</i>
150 mm or Smaller	1.6 mm
Over 150 mm but not over 270 mm	2.00 mm
Over 270 mm but not over 750 mm	2.6 mm
Over 750 mm	3.00 mm

***Note :** Size of compact bus trunking (air insulated/sandwich) shall be as per manufacturers recommendation conforming to relevant International/Indian Standards.

APPENDIX IV

TABLE F

Permissible Maximum Short Circuit Current Ratings for XLPE

CONDUCTOR AREA Sq. mm	SHORT CIRCUIT RATINGS FOR ONE SECOND DURATION	
	COPPER CONDUCTORS	ALUMINIUM CONDUCTORS
	A	B
16	2570	1730
25	3970	2670
35	5500	3690
50	7800	5220
70	10850	7400
95	14600	9740
120	18400	12200
150	23000	15200
185	28200	18700
240	36400	24200
300	45300	30100
400	60200	39900
500	74800	49800
630	92700	62000
800	–	78800
1000	–	97800

Initial conductor temperature – 90 Deg. C.

Final conductor temperature – 250 Deg. C.

For durations other than one second the short circuit current may be calculated from the following formula-

$$I_{sc} = \frac{I}{\sqrt{t}}$$

Where I_{sc} – Short circuit current during time t, amperes

I – Short circuit current during the time one second as given in above table.

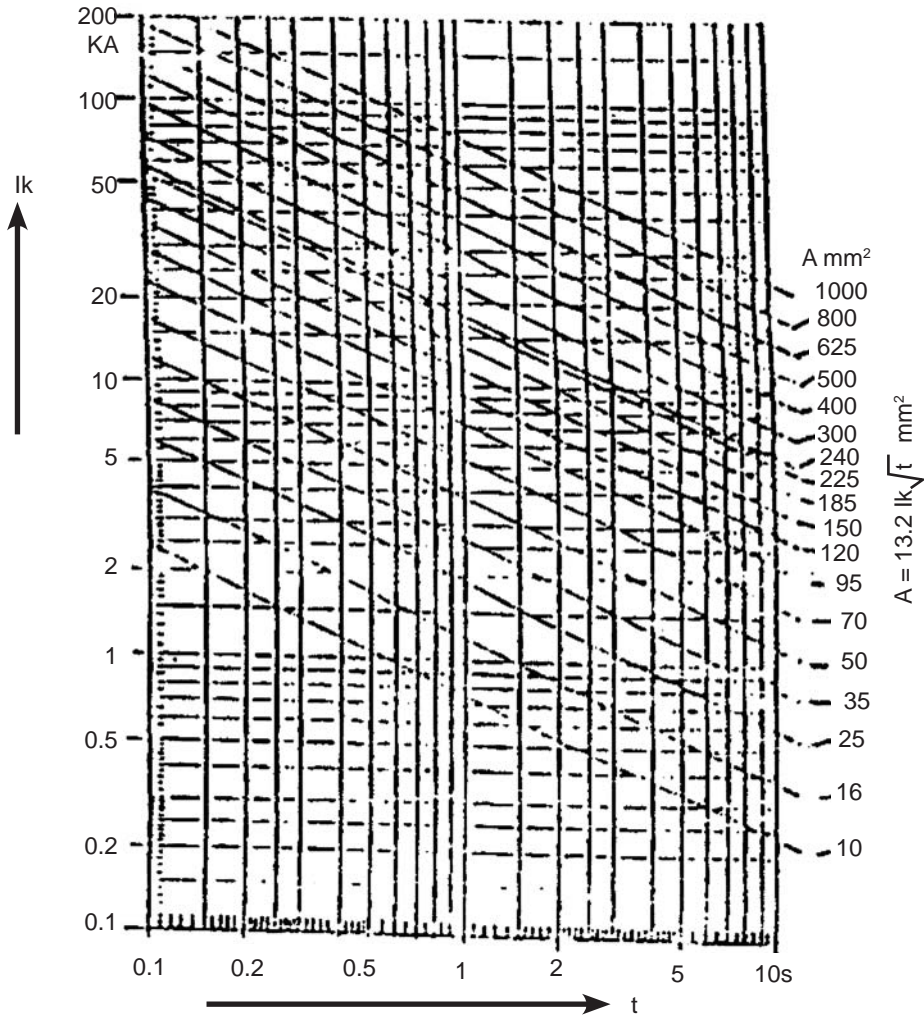
t – Short circuit current duration, seconds.

Note: For large currents the force between the conductors must be considered especially when single core cable are used.

APPENDIX IV

TABLE G

Short Circuit Ratings for PVC Insulated, PVC Sheathed Power Cables



Thermally Admissible Short Circuit Current for Cables 650/1100 V to 6350/11000 V grade cables.

For Full Load Conductor Temperature

Cond. Temp. prior to Short Circuit — 70°C

and

Max. S.C. Conductor Temperature — 160°C

IK — Short Circuit Current in KA rms

T — Duration of Short Circuit in seconds

A — Area of Aluminium Conductor in mm²

APPENDIX V

SPECIFICATIONS TO BE WATCHED FOR ACBs / MCCBs/ COMPACT SUB-STATION / COMPACT BUS TRUNKING

LT SWITCHGEAR

Preferred Specification/Selection of Air Circuit Breaker and Moulded Case Circuit Breakers;

These should be confirmed entering into the agreements:-

(I) MCCBs: MCCBs should preferably be used for loads below 800 Amperes.

- (1) Upto 160 A MCCBs shall be of > 20 Ka (Ics=Icu) at 433 V Short CKt. Current rating and should be Thermal Magnetic.
- (2) From 200 A- 250 A MCCBs shall be of > 35 Ka (Ics= Icu) at 433 V Short Ckt. Current rating and should be Thermal Magnetic.
- (3) From 200 A-250 A MCCBs shall be of > 50 Ka (Ics=Icu) at 433 V Short Ckt. Current rating and should be microprocessor based having over load and short circuit protection. If used as incomer should also have earth fault protection & time delay. Earth leakage modules are not acceptable.

Note: Rated operational voltage = 690 V; Rated Insulation Voltage (Ui) = 690 V are additional features. These should have Rated Impulse Voltage (Uimp) 8KV for all frame sizes.

Electrical/Mechanical : Following Endurance values are available for MCCBs of some of the reputed manufacturers which are higher than BIS/IES provisions.

S. No.		BIS E/M End. Requirement	C&S	L&T	Schneider	ABB
		IS13947-2, Clause 7.2.4.2	GB range	DX range	Simpact	T. Max
1.	upto 160 A	8500/1500	10000/5000	20000/6000	15000/6000	25000/8000
2.	200-250 A	7000/1000	10000/5000	20000/3500	15000/6000	25000/8000
3.	300 A	7000/1000	1000/5000	20000/1250	15000/6000	20000/6000
	<i>Micro Processor</i>		<i>Susol MP</i>	<i>D Sine MP</i>	<i>NS MP</i>	<i>T. Max</i>
4.	400 A	4000/1000	20000/6000	INA	15000/6000	20000/7000
5.	630 A	2500/500	20000/6000	INA	15000/4000	20000/5000
6.	800 A	2500/500	10000/3000	INA	10000/4000	

Information is from catalogues of competitors

MCCBs for sub-station panels should have double break, positive isolation current limiting, load line reversibility & horizontal-cum-vertical mounting features.

Frame Size

MCCB are available in the following Frame Sizes:

(a)	Upto 160 A. Rating	160 A Frame
(b)	From 160 A. to 250 A.	250 A Frame
(c)	From 250 A . to 400 A.	400 A Frame
(d)	From 400 A. to 630 A.	630 A Frame
(e)	From 800 A. to higher	Different frame size

For Thermal Magnetic protection the O/L adjustment should be 80% - 100% and for S/C it should be 5 to 10 times. For Microprocessor-based release the adjustment should be 50% - 100% and S/C for 4 to 10 times.

(II) ACBs: From 800 A onwards ACBs shall normally (MCCBs should be used judiciously for such loads) be used. These should have 50 Ka ($I_{cu}=I_{cs}$) Short Ckt. Current rating with microprocessor based overload, short circuit and earth fault protection at 415 volts, 50 Hz.

Electrical/ Mechanical Endurance: Endurance values are available for ACBs of reputed manufacturers which are many times higher than BIS/IES standards. These are given in Annexure enclosed.

The air circuit-breakers (ACBs) used in low-voltage installations shall be designed, built and tested in compliance with the standards of the IEC 947-2 & EN 60947/ IS 19947 (Part-II) : 1993

- The ACBs shall be suitable for service from -5°C to $+70^{\circ}\text{C}$.
- Rated operational voltage U_e should be 415/690 V.

Note : C&S & LT are manufacturing MCCBs/ACBs of 415 & 690 V; AB, Siemens, MG manufacture MCCBs of rated voltage of only 690 volts.

- The rated insulation voltage shall be equal to or greater than 1000 V.
- The rated impulse withstand voltage shall be equal to 8 KV and upto 12 KV if required on demand.

Setting range of protection release :

- (a) Overload protection shall have adjustable setting from 50% to 100% of the ACB's rating.
- (b) Current in steps of 10% and adjustable time setting from 3-18 m sec. For generator application lower settings may be used.
- (c) Short circuit protection shall have adjustable current setting from 400% to 100% of rated current.
- (d) The short circuit setting and adjustable time delay setting for fault discrimination from 50-500 m sec.

- (e) E/F protection if specified will have adjustable current setting from 20% to 100% of ACB's rated current and adjustable time setting from 100-400 m sec.
- (f) The ACB release shall be self-powered, requiring no external power supply. For it to operate, it is sufficient for one phase to be loaded at 20% of the rated current of the current transformer.

- Note :**
- (1) With judicious application of mind MCCBs may be used for greater than 800 Amp. capacity also both for incoming as well as outgoing sections.
 - (2) Wherever MCCBs are used as incomer these shall be provided with earth fault protection.
 - (3) Power loss in breakers should also be watched for selection.
 - (4) Utilization category
 - (5) Releases are also available with LCD display which display all three phase current & neutral current. These releases will also display maintenance data like no. of operations, contact wear & fault history (10 trips). To protect the load and cables from repetitive over temperature protection. In case of BMS connectivity through RS 485 port, the release shall enable the user full control over the breaker and also to get the protection data.

APPENDIX V

ANNEXURE

ACB Endurance Comparison																				
Rating (A)	BIS		GE-Spectronic S		L&T-C Power		L&T-U Power		Schneider-Enerpact		Schneider-Master Pact		Siemens (SENTRON-3WL)		ABB-Emax		C&S - AH			
	Mech	Elec.	Mech-anical	Electrical (@415V AC)	Mean time between maintenance	Mechanical	Electrical (@415V AC)	Mech-anical	Electrical (@415V AC)	Mech-anical	Electrical (@415V AC)	Mechanical	Electrical (@415V AC)	Mechanical	Electrical (@415V AC)	Mechanical	Electrical (@415V AC)	Mechanical	Electrical (@415V AC)	
800A	2500	500	20000	20000	2000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000
1000A	2500	500	20000	20000	2000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000
1250A	2500	500	20000	20000	2000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000
1600A	2500	500	20000	20000	2000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000
2000A	2500	500	20000	20000	1500	20000	20000	15000	5000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000
2500A	2500	500	20000	20000	1500	20000	20000	15000	5000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000
3200A	1500	500	10000	10000	1500	10000	10000	10000	5000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
4000A	1500	500	10000	10000	1500	10000	10000	10000	5000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
5000A	1500	500	NA	NA		5000	5000	5000	2500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6300A	1500	500	NA	NA		5000	5000	5000	2500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Remarks				To guarantee this no. of operations, it is necessary to check the spark arrestors & arc chutes at the maintenance periods as given above and replace when necessary.	Arcing contacts need to be replaced depending upon the wear.	To guarantee electrical life with maintenance arcing contacts have to be replaced	Without Maintenance	Maintenance requires replacement of main contacts, arc chute & connecting rod springs	Maintenance means replace main contact elements and arc chutes											

TYPE/ROUTINE TEST ON COMPACT SUB-STATION

TYPE TESTS FOR THE COMPACT SUB-STATION

The offered compact sub-station should be fully type tested as per the IEC- 1330 Routine tests: The routine tests shall be made on each complete prefabricated sub-station.

- (a) Voltage tests on auxiliary circuit
- (b) Functional test.
- (c) Verification of complete wiring.

Test Certificates:

Test report for the test mentioned under Type tests clause shall be submitted along with offer. Certified reports of all the tests carried out at the works shall be furnished in three (3) copies of approval of the owner.

Compact Bus bar Trunking System Air Insulated/ Sandwich Specifications:

Distribution Application upto 5000 A.

General : Busbar Trunking shall be 415 V, 3- Phase, 4-wire with 50% capacity integral earth bus.

Short Circuit Rating and Tests: The short circuit rating of the bus bar trunking shall be determined according to IEC 60439. This rating must be based upon actual tests at the rated short circuit current.

Basic Construction:

(a) Housing:

- (i) The busbar trunking housing shall be constructed of cold gauge steel and aluminium to reduce hysteresis and eddy current losses and shall be provided with a suitable protective finish (of ANSI 49 gray epoxy paint).
- (ii) The bus bar trunking housing shall be totally enclosed non-ventilated for protection against mechanical damage and dust accumulation.
- (iii) The totally enclosed housing shall be manufactured by the bus bar trunking manufacturer. Modifications of bus bar trunking to make it totally enclosed by other than the bus bar trunking manufacturer voids the manufacturer's warranty. Bus bar trunking so modified is unacceptable without the written consent of the manufacturer.

(b) Joint:

- (i) The busbar trunking joint shall be of on-bolt type which utilizes a high strength steel bolt 9s and Belleville washers to maintain proper pressure over a large contact surface area.
- (ii) The bolt shall be torque indicating and at earth potential.
- (iii) The bolt shall be two-headed design to indicate when proper torque has been applied and require only a standard long handle wrench to be properly activated.

- (iv) Access shall be required to only one side of the bus bar trunking for tightening joint bolts.
- (v) One bus bar trunking 800 A and above, it shall be possible to remove any joint connection assemble to allow electrical isolation or physical removal of a busbar trunking length without disturbing adjacent bus bar trunking lengths.

(c) Bus bars:

- (i) Bus bar joints shall be tin plated or silver flashed or Nickel plated.
- (ii) Each bus bar shall be insulated with Calls B rated 130° C vendor certified polyester film.
- (iii) The temperature rise at any point in the bus bar trunking shall not exceed 55°C rise above ambient temperature when operating at rated load current.
- (iv) Both feeder and plug-in bus bar trunking (800 A and above) shall be of sand with construction, meaning no air gap shall exist between bus bars except at plug-in openings.

(d) Plug-in Opening :

- (i) On plug-in busbar trunking there shall be suitable dead front, covered type plug-in openings as per site requirement.
 - (ii) All openings shall be usable simultaneously.
 - (iii) Bus bar trunking shall be installed so that plugs are side mounted to permit practical use of all openings.
 - (iv) It shall be possible to inspect the plug-in opening and bus bars prior to the installation of the plug-in units.
- As requirement is for a Compact bus bar system, clearance and creepage distances are to be kept to minimum i.e. clearance in vicinity of 15 mm and creepage distances corresponding to pollution degree 3 and material group III a i.e 16 mm.

For guidance, the overall cross section should be limited to following dimensions and not vary more than ± 10%

Aluminum Bus Bar

<i>Current rating (Amp.)</i>	160	250	400	500	630	800	1000	1250
<i>Dimensions (mm)</i>								
<i>Width</i>	150	150	150	150	150	150	150	150
<i>Depth</i>	60	75	100	120	140	200	230	280

Copper Bus Bar

<i>Current rating (Amp.)</i>	125	250	315	400	500	630	800	1000	1250	1500	1750	2000
<i>Dimensions (mm)</i>												
<i>Width</i>	150	150	150	150	150	150	150	150	150	150	150	150
<i>Depth</i>	60	60	75	75	95	95	115	135	190	230	130	270

- Temperature rise of the enclosure and terminals are to be restricted to 40 Deg C and 70 Deg. C respectively.

Support of Bus bar Trunking:

- (A) Hanger spacing shall be noted on layout drawing and shall not exceed manufacturer's recommendations.
- (B) Indoor Feeder and plug-in bus bar trunking shall be approved for hanger spacing of upto 3 metres for horizontally or vertically mounted runs.

Voltage Drop:

- (a) The voltage drop (input voltage minus output voltage) specified shall be based on the bus bar trunking operating at full rated current and at stabilised operating temperature.
- (b) The three-phase, line-to-line voltage drop shall not exceed 3.1 volts per hundred feet at 40% power factor concentrated load which may exist during motor starting.
- (c) The line-to-line voltage drop shall not exceed 4.0 volts per hundred feet at the load power factor which produces maximum voltage drop in the bus bar trunking.

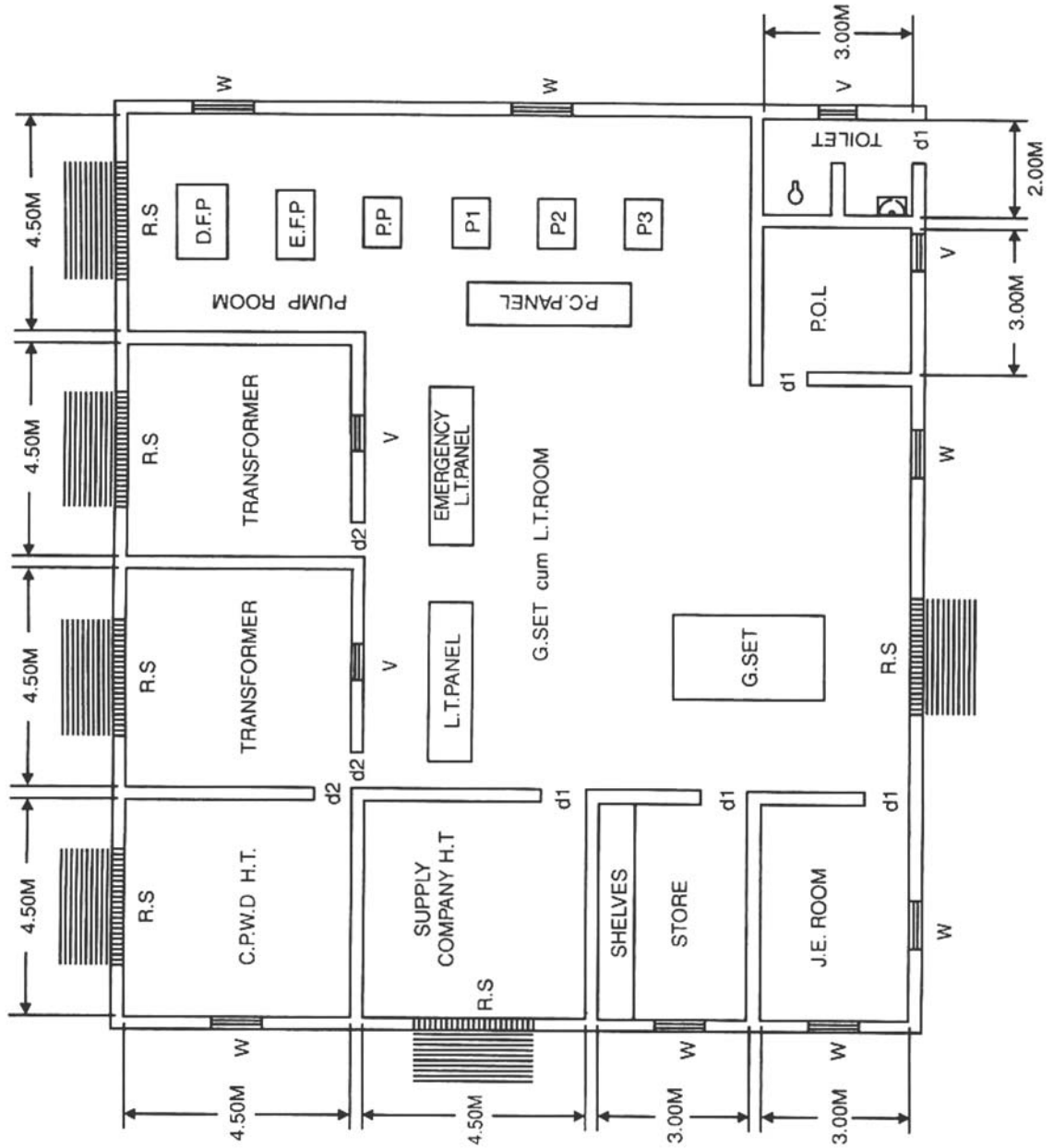
Plug-in Units:

- (A) Plug-in Units (Circuit breaker type or fusible switch type) shall be operated with visible blade quick-make and quick-break mechanism.
- (B) Plug-in Units which cannot be operated directly from the floor shall be equipped with suitable means for hookstick operation.

Plug-in Unit Safety Devices:

- (A) Plug-in unit enclosures shall make positive earth connection with the earth bus before the jaws make contact with the phase bars. The earthing method shall be such that it cuts through painted surfaces to make the positive earth connection.
- (B) The Plug-in units shall be equipped with internal barriers to prevent accidental contact of tape and conductors with live parts on the line side of the protective device during time of wire protective device during time of wire pulling.
- (C) Covers of all plug-in units must have interlocks to prevent the cover from being opened when the switch is in the ON position.
- (D) The rising mains shall have neutral of 100% capacity as of phases.
- (E) IP protection shall be IP 54.
- (F) The joints shall be silver (or such other system) for high reliability.

ANNEXURE I
ELECTRIC SUB-STATION CUM FIRE PUMP HOUSE
(WHERE SUB-STATION IS A SEPARATE BUILDING)



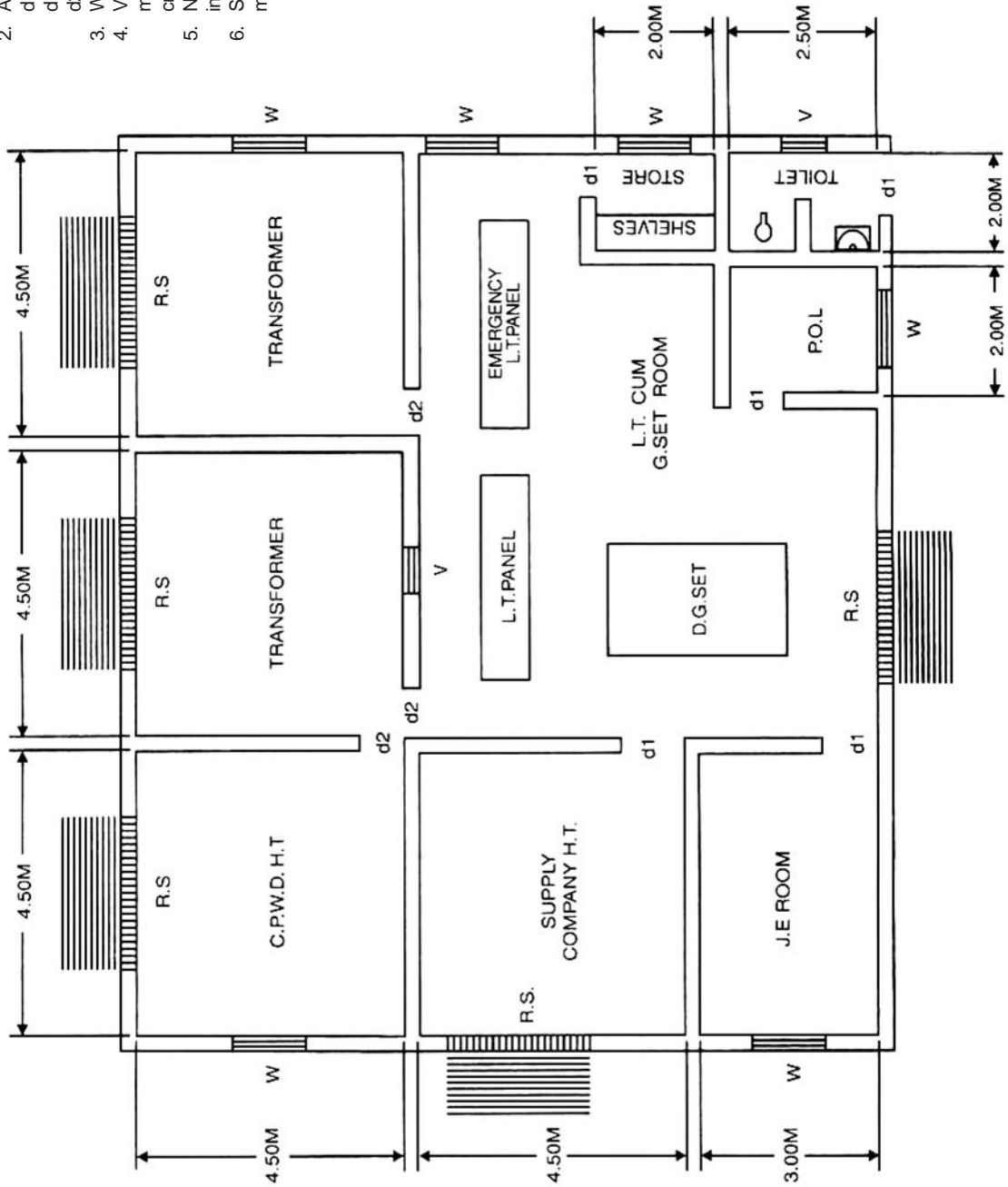
Note :

1. Floor to ceiling height - 4.5 m
1. Floor level - 30 cm above ground level.
2. Motorable concrete approach road all-round.
3. Partition walls - 30 cm thick brick.
4. Heavy-duty steel ladder with side railing upto sub-station roof for roof drainage maintenance.
5. 1 m wide chajja projection all around.
6. Underground water tank as near as possible to pump room.
7. Rolling shutter 2.5 m wide - 3 m height as per Annexure X and with ventilation grills.
8. All doors of steel for fire protection.
9. d 1 - 1 m wide - 2 m height
10. d 2 - .75 m wide - 1.8 m height
9. W - window - normal size with grill.
10. V - ventilator. Size 75 cm wide - 50 cm height made of steel frame with heavy wire mesh. 50 cm below ceiling.
11. D.F.P. - Diesel fire pump.
- E.F.P. - Electrical fire pump
- P.P. - Jockey pump.
- P1, P2, P3 - Water supply pumps.
12. Cable entry pipes - Executive Eng. will give location and details.
13. Cable trenches - Executive Eng. will give details.
14. Projection boundary wall with gate - if sub-station is a protected premise, suitable boundary walls with gates to be provided.
15. Store shelves - .75 m deep. RCC, 1 m, 2 m, 3 m above ground level.

Note :

1. Transformer/HT Panel shall be 'Dry' type when sub-station is housed with main building. (It is not a separate building away from main building).
2. Room with wall enclosure, in case of 'Dry' transformer, is not essential.

ANNEXURE II ELECTRICAL SUB-STATION BUILDING



Note :

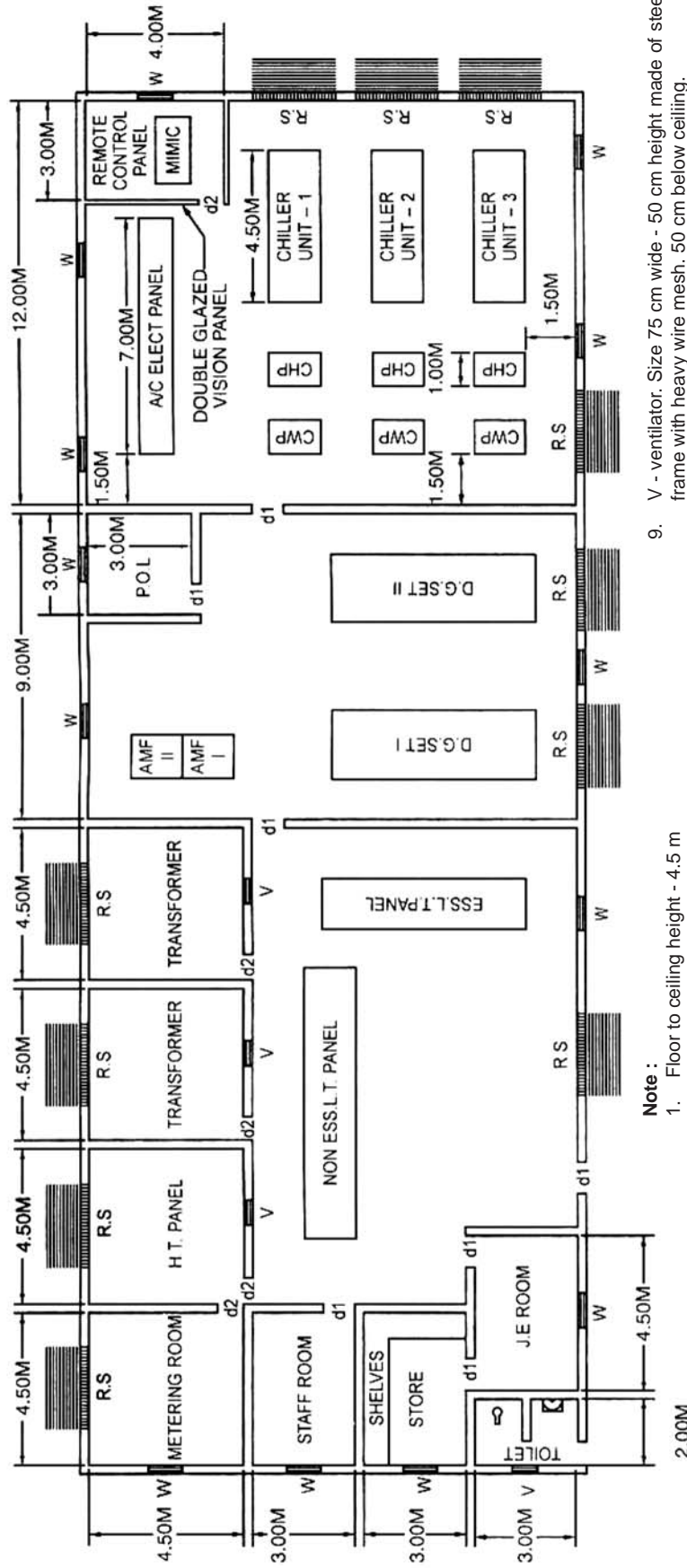
1. Rolling shutter 2.5 m wide - 3 m height as per Annexure X and with ventilation grills.
2. All doors of steel for fire protection.
 d - 1.22 m wide - 2.1 m height double leaf
 d1 - 1 m wide - 2 m height
 d2 - .75 m wide - 1.8 m height
3. W - window - normal size with grill.
4. V - ventilator. Size 75 cm wide - 50 cm height made of steel frame with heavy wire mesh. 50 cm below ceiling.
5. No toilet is required where sub-station is located in the main building itself.
6. Store shelves - .75 cm deep. RCC, 1 m, 2 m, 3 m above ground level.

Note :

1. Transformer/HT Panel shall be 'Dry' type when sub-station is housed with main building. (It is not a separate building away from main building).
2. Room with wall enclosure, in case of 'Dry' transformer, is not essential.

ANNEXURE III

TYPICAL LAYOUT OF D.G. SETS, SUB-STATION EQUIPMENT AND A.C. PLANT ROOM 2*100 KVA TRANSFORMER 2*500 KVA D.G. SET 300 TR*3 A.C. PLANT



Note :

1. Floor to ceiling height - 4.5 m
Floor level - 30 cm above ground level.
2. Motorable concrete approach road all-round.
3. Partition walls - 30 cm thick brick.
4. Heavy-duty steel ladder with side railing upto sub-station roof for roof drainage maintenance.
5. 1 m wide chajja projection all around.
6. Rolling shutter 2.5 m wide - 3 m height as per Annexure X and with ventilation grills.
7. All doors of steel for fire protection.
d1 - 1 m wide - 2 m height
d2 - .75 m wide - 1.8 m height
8. W - window - normal size with grill.

Note :

1. Decide cooling tower location.
2. Transformer/HT Panel shall be 'Dry' type when sub-station is housed with main building (It is not a separate building away from main building).
3. Room with wall enclosure, in case of 'Dry' transformer, is not essential.

9. V - ventilator. Size 75 cm wide - 50 cm height made of steel frame with heavy wire mesh. 50 cm below ceiling.
10. C.H.P. - Chiller water pump
C.W.P. - Condenser water pump
A.M.F. - Automatic main failure panel
11. Cable entry pipes - Executive Eng. will give location and details.
12. Cable trenches - Executive Eng. will give details.
13. Projection boundary wall with gate - if sub-station is a protected premise, suitable boundary walls with gates to be provided.
14. Store shelves - .75 m deep, RCC, 1 m, 2 m, 3 m above ground level.

ANNEXURE IV

LOCATION AND REQUIREMENTS

General :

General guidelines regarding the locations and layout of sub-station are given below:

Location:

The following points shall be considered while deciding the sub-station location.

- (a) Accessibility to source of supply.
- (b) Overall economy in distribution.
- (c) Proximity to Air-conditioning equipments and other concentrated loads like computer servers etc.
- (d) Ease of bringing in and removing equipment.
- (e) Fire safety requirements.
- (f) Accessibility to licensee.
- (g) Future expansion.

The electric sub-station shall be located in a separate building in accordance to I.E. Rules 68 (I) and 64 (I) (a) (b). If this is not possible due to site conditions, the sub-station be located on the ground floor. As far as possible sub-station shall not be installed in a basement, for such situations special provisions like mechanical ventilation, wherever required, cable ducting, cable trays, top/bottom entry of HV/LV cable, hooks on Transformer(s) & HV panels, adequate fire detection and fire fighting arrangement, adequate drainage, effective measures to prevent flooding etc. shall be provided. Adequate precautions shall also be taken for water proofing to prevent seepage of water. A ramp shall also be provided with a slope, not steeper than 1 in 7, for easy movement of equipments to and from sub-station. For sub stations of capacity more than 3000 KVA, particularly when DG set(s) is also installed inside the sub-station building, suitable provision for Over Head Crane shall be made.

SUB-STATION BUILDING REQUIREMENTS

General:

The electrical sub-station should be well ventilated and generally accommodate the following equipments:-

- (a) H.V. switchgear and metering arrangement as per requirements of licensee in accordance with Rule 64 (I) (a) of I.E. Rules.
- (b) Consumer's H.V. panel boards.
- (c) Transformers.
- (d) M.V. Panels in accordance with rule 64 (I) (b) of I.E. rules amended upto date.

- (e) Cable trenches/Cable trays/ Bus ducts.
- (f) Inter connecting cables and auxiliary equipments.
- (g) Room for staff amenities such as rest room, toilets, water cooler, wash basin etc.

Area for Sub-stations:

The minimum sub-station and transformer room area required for different capacities are tabulated in Table A & B Appendix IV for general guidance. Actual area will however depend upon the particular layout and site constraints.

Typical layouts of a sub-station building / area is attached as Annexure I, II, & III.

Fire Regulations:

The installations shall be carried out in conformity with the local fire regulations and rules there under wherever they are in force. At other places NBC guidelines shall be followed.

ANNEXURE V

ABSTRACTS FROM IS 13947 FOR SWITCHGEARS

SCOPE:

This annexure contains information about BIS provisions for Environmental Conditions, Pollution Degree, Condition Different from Normal, Degree of Protection and Operating Cycle for information of users. These has been taken from IS 13947 Part-I : 1993.

IS 1347 (Part I) : 1993

IEC Pub 947- I (1988)

If necessary, the instructions for the transport, installation and operation of the equipment shall indicate the measures that are of particular importance for the proper and correct installation, commissioning and operation of the equipment.

These documents shall indicate the recommended extent and frequency of maintenance, if any.

Note:- All equipment covered by this standard is not necessarily designed to be maintained.

6. Normal Service, Mounting and Transport Conditions

6.1 Normal Service Conditions

Equipment complying with this standard shall be capable of operating under the following standard conditions:

Note: For non-standard conditions in service, see Appendix B. These may require agreement between manufacturer and user.

6.1.1 Ambient air temperature

The ambient air temperature does not exceed +40°C and its average over a period of 24h does not exceed +35°C

The lower limit of the ambient air temperature is – 5°C

Ambient air temperature is that existing in the vicinity of the equipment if supplied without enclosure, or in the vicinity of the enclosure if supplied with an enclosure.

Notes: 1. Equipment intended to be used in ambient air temperature above +40°C (e.g. in forges, boiler rooms, tropical countries) or below – 5°C (e.g. - 25°C, as required by IEC Publication 439-1 for outdoor installed low-voltage switchgear and controlgear assemblies) should be designed or used according to the relevant product standard, where applicable, or according to agreement between manufacturer and user. Information given in the manufacturer's catalogue may take the place of such an agreement.

2. Standard reference air temperature for certain types of equipment, e.g. circuit-breakers or overload relays for starters, is indicated in the relevant product standard.

6.1.2 *Altitude*

The altitude of the site of installation does not exceed 2000m.

Note: For equipment to be used at higher altitudes, it is necessary to take into account the reduction of the dielectric strength and the cooling effect of the air. Electrical equipment intended to operate in these conditions shall be designed or used in accordance with an agreement between manufacturer and user.

6.1.3 *Atmospheric conditions*

6.1.3.1 *Humidity*

The relative humidity of the air does not exceed 50% at a maximum temperature of +40°C. Higher relative humidities may be permitted at lower temperatures, e.g. 90% at +20°C. Special measures may be necessary in cases of occasional condensation due to variations in temperature.

Note: Pollution degrees, as stated in sub-clause 6.1.3.2, define the environmental conditions more precisely.

6.1.3.2 *Pollution degree*

The pollution degree (see sub-clause 2.5.58) refers to the environmental conditions for which the equipment is intended.

Note: The micro-environment of the creepage distance or clearance and not the environment of the equipment determines the effect on the insulation. The micro-environment might be better or worse than the environment of the equipment. It includes all factors influencing the insulation, such as climatic and electromagnetic conditions, generation of pollution, etc.

For equipment intended for use within an enclosure or provided with an integral enclosure, the pollution degree of the environment in the enclosure is applicable.

For the purpose of evaluating clearances and creepage distances, the following four degrees of pollution of the micro-environment are established (clearances and creepage distances according to the different pollution degrees are given in Tables XIII and XV):

Pollution degree 1 : No pollution or only dry, non-conductive pollution occurs.

Pollution degree 2: Normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation may be expected.

Pollution degree 3: Conductive pollution occurs, or dry, non-conductive pollution occurs which becomes conductive due to condensation.

Pollution degree 4: The pollution generates persistent conductivity caused, for instance, by conductive dust or by rain or snow.

Standard Pollution Degree of Industrial Applications: Unless otherwise stated by the relevant product standard, equipment for industrial applications is generally for use in pollution degree 3 environment. However, other pollution degrees may be considered to apply depending upon particular applications or the micro- environment.

Note : The pollution degree of the micro-environment for the equipment may be influenced by installation in an enclosure.

Standard Pollution Degree of Household and Similar Applications: Unless otherwise stated by the relevant product standard, equipment for household and similar applications is generally for use in pollution degree 2 environment.

6.1.4 *Shock and vibrations*

Standard conditions of shock and vibration to which the equipment can be submitted are under consideration.

6.2 ***Conditions during Transport and Storage***

A special agreement shall be made between user and manufacturer if the conditions during transport and storage, e.g. temperature and humidity, differ from those defined in sub-clause 6.1, except that, unless otherwise specified, the following temperature range applies during transport and storage : between -25°C and + 55°C and, for short periods not exceeding 24 hours, up to +70°C.

APPENDIX - B**SUITABILITY OF THE EQUIPMENT WHEN CONDITIONS FOR OPERATION IN SERVICE DIFFER FROM THE NORMAL CONDITIONS**

If the conditions for operation in service and the application differ from those given in this standard, the user shall state the deviations from the standard conditions and consult the manufacturer on the suitability of the equipment for use under such conditions.

B1. Examples of conditions differing from normal**B 1.1 *Ambient air temperature***

The expected range of ambient air temperature can be lower than -5°C or higher than +40°C.

B1.2 *Altitude*

The altitude of the place of installation is more than 2,000 m.

B1.3 *Atmospheric conditions*

The atmosphere in which the equipment is to be installed may have a relative humidity greater than the values specified in sub-clause 6.1.3 or contain an abnormal amount of dust, acids, corrosive gases, etc.

The equipment is to be installed near the sea.

B1.4 *Conditions of installation*

The equipment may be fitted to a moving device, or its support may assume a sloping position either permanently or temporarily (equipment fitted aboard ships), or it may be exposed in service to abnormal shocks or vibrations.

B2. Connections with other apparatus

The user shall inform the manufacturer of the type and dimensions of electrical connections with other apparatus in order to enable him to provide enclosures and terminals meeting the conditions of installation and temperature-rise prescribed by this standard and/or the relevant product standard and also to enable him to provide space, where necessary, to spread out conductors within the enclosure.

B3. Auxiliary contacts

The user shall specify the number and type of auxiliary contacts to be supplied to satisfy requirements such as signaling, interlocking, and similar functions.

B4. Special applications

The user shall indicate to the manufacturer if the equipment could be used for special applications not covered by this standard and/or the relevant product standard.

First characteristic numeral and suffix	Degree of Protection		Test conditions, see Sub-clause
	Short description	Definition (see Clause C3)	
1	Protected against solid objects greater than 50 mm	Excludes solid objects exceeding 50 mm in diameter and protects against contact with live and moving parts by a large body surface such as a hand (but not against deliberate access)	C7.1
2L	Protected against solid objects and against contact by standard test finger.	Excludes solid objects exceeding 12.5 mm in diameter and protects against contact with live and moving parts by a standard test finger or similar objects not exceeding 80 mm in length	C1.2
3	Protected against solid objects greater than 2.5 mm	Excludes solid objects exceeding 2.5 mm in diameter or thickness	C.7.3.1
3L	Protected against solid objects greater than 12.5 mm and against contact by 2.5 mm probe.	Excludes solid objects exceeding 12.5 mm in diameter and protects against contact with live and moving parts by a 2.5 mm diameter test probe not exceeding 100 mm in length	C.7.3.2
4	Protected against solid objects greater than 1.0 mm	Excludes solid objects exceeding 1.0 mm in diameter or thickness	C.7.4.1
4L	Protected against solid objects greater than 12.5 mm and against contact by 1.0 mm probe.	Excludes solid objects exceeding 12.5 mm in diameter and protects against contact with live and moving parts by a 1.0 mm diameter test probe not exceeding 100 mm in length	C.7.4.2
5	Dust protected	Prevents ingress of dust in quantitative and locations that would interfere with the intended operation of the equipment	C.7.5
6	Dust tight	Prevents ingress of dust	C.7.6

Note: The short description given in column 2 should not be used to specify the form of protection. It should only be used as a brief description.

C4. Degrees of protection – second characteristic numeral

The second characteristic numeral indicates the degree of protection enclosed equipment with respect to harmful ingress of water.

Table CII gives, in column 3, details of the type of protection provided by the enclosure for each of the degrees of protection represented by the second characteristic numeral.

Compliance of an enclosure with a stated degree of protection implies that the enclosure will also comply with all lower degree of protection in Table CII. In consequence, the tests establishing these degrees of protection need not necessarily be carried out.

TABLE CII
Degrees of Protection indicated by the Second Characteristic Numeral

First characteristic numeral and suffix	Degree of Protection		Test conditions, see Sub-clause
	Short description	Definition (see Clause C3)	
1	Protected against dripping water	Dripping water (vertically falling drops) shall have no harmful effect.	C8.1
2	Protected against dripping water when tilted up to 15°	Vertically dripping water shall have no harmful effect when the enclosure is tilted at any angle up to 15° from its normal position.	C8.2
3	Protected against spraying water	Water falling as a spray at an angle up to 60° from the vertical shall have no harmful effect.	C8.3
4	Protected against splashing water	Water splashed against the enclosure from any direction shall have no harmful effect.	C8.4
5	Projected against water jets	Water projected by a nozzle against the enclosure from any direction shall have no harmful effect.	C8.5
6	Protected against heavy seas.	Water from heavy seas or water projected in powerful jets shall not enter the enclosure in harmful quantities.	C8.6
7	Protected against the effects of immersion	Ingress of water in a harmful quantity shall not be possible when the enclosure is immersed in water under standard conditions of pressure and time.	C8.7
8	Protected against submersion	No ingress of water	C8.8

Note : The short description given in column 2 should not be used to specify the form of protection. It should only be used as a brief description.

C5. Marking

The requirements for marking are specified in the relevant product standard, where applicable.

C6. General requirements for test

The test in this appendix are type tests.

All tests shall be made with the equipment in an unenergized state.

The samples of equipment for each test shall be in a clean and new condition with all parts fitted and assembled as stated by the manufacturer for normal use.

Additional requirements, if any, may be given in the relevant product standard, concerning, for example :

- Number of samples,
- Mounting and installation of samples.

ANNEXURE V

OPERATING CYCLE

IS 13947 (Part-2) : 1993
IEC Pub 947-2 (1989)

7.2.4 Ability to make and break under no load. Normal load overload conditions.

7.2.4.1 Overload Performance

This requirement applies to circuit-breakers of rated current up to and including 630 A. The circuit-breaker shall be capable of carrying out the number of operating cycles with current in the main circuit exceeding its rated current, under the test conditions according to sub-clause 8.3.3.4.

Each operating cycle consists of a making operation followed by a breaking operation.

7.2.4.2 Operational Performance Capability

Sub-clause 7.2.4.2 of Part I applies with the following additions :

The Circuit-breaker shall be capable of meeting the requirements of Table VIII.

- For the test of operational performance without current in the main circuit under the test conditions specified in sub-clause 8.3.3.3.3.
- For the test of operational performance with current in the main circuit under the test condition specified in sub-clause 8.3.3.3.4.

Each operating cycle consists of, either a closing operation followed by an opening operation (test of operational performance without current) or a making operation followed by a breaking operation (test of operational performance with current).

TABLE VIII
Number of Operating Cycles

1	2	3	4	5
Rated current (A)	Number of operating cycles per hour*	Number of operating cycles		
		Without current	With current**	Total
$I_n \leq 100$	120	8500	1500	10000
$100 < I_n \leq 315$	120	7000	1000	8000
$315 < I_n \leq 630$	60	4000	1000	5000
$630 < I_n \leq 2500$	20	2500	500	3000
$2500 < I_n$	10	1500	500	2000

* Column 2 gives the minimum operating rate. This rate may be increased with the consent of the manufacturer. In this case the rate used shall be stated in the test report.

** During each operating cycle the circuit-breaker shall remain closed for sufficient time to ensure that the full current is established but not exceeding 2s.

7.2.4.3 Ability to make and break under short-circuit conditions

Sub-clause 7.2.5 of Part-1 applies with the following amplifications :

ANNEXURE VI

A FEW DEFINITIONS FOR SWITCHGEAR SAFETY GASES

(I) SHORT CIRCUIT BREAKING CAPACITIES

Ref. : IS 13947 Part – II

Rated Short Circuit Breaking Capacity (Icn) : The rated short circuit breaking capacity of an equipment is the value of short circuit current assigned to it by the manufacturer, which the equipment can satisfactorily break under specified conditions. For AC it is expressed as RMS value (in KA rms) of Symmetrical component of current.

Short circuit breaking capacities are classified into two types :

- (a) **Rated Ultimate Short Circuit Breaking Capacity (Icu)** : A breaking capacity for which the prescribed condition according to a specified test sequence (given below) do not include capability of circuit breaker to carry its rated current continuously.

O (open)-t (time > 3 minutes) – CO (close open)

Implication of Icu rating :

- Must clear 2 Short Circuit Shots.
- Must pass dielectric strength test.
- Over Load Characteristics to be maintained.
- May not be able to carry full load current.
- Needs immediate replacement.

- (b) **Rated Service Short Circuit Breaking Capacity (Ics)** : A breaking capacity for which the prescribed condition according to a specified test sequence (given below) include capability of circuit breaker to carry its rated current continuously.

O (open)-t (time > 3 minutes) – CO (close open)-t (>3 minutes) – CO (close open)

Implication of Icu rating

- Must clear 3 Short Circuit Shots.
- Must pass dielectric strength test.
- Over Load Characteristics to be maintained.
- May not be able to carry full load current without excessive temperature rise.
- Can be used till next replacement.
- May not clear any more short circuit faults but should be capable of performing normal operations.

- (c) **Icw : Rated Short Circuit withstand capacity** : To bear fault level current for upto (0.05,01,0.25,0.5,1) sec. Used for Cat. B where time based discrimination is required.

- (d) **I_{cm}** : Rated short circuit making capacity for rated voltage, frequency and specified power factor = <2.2 times I_{cs} normally.

Utilization Categories :

Circuit breakers are used as:

1. **Category – A** : Circuit breakers not specially intended for selectivity under short circuit. For immediate isolation. No intended time delay can be incorporated.
2. **Category – B** : Can withhold fault for some pre-decided time. Circuit breaker specially intended for selectivity under short circuit condition i.e. within preset time delay.

Discrimination :

1. Current Based : Upstream breaker 2.5 times
2. Time Based : Upstream delayed
3. Energy Based :
4. Logical Based :

All microprocessor based releases should withstand Electro Magnetic Interference (EMI) & should be Electro Magnetic Compatible (EMC).

All the releases/ accessories like UV/ Shunt shall be continuously rated.

The MCCB shall have double insulation with class-2 front facia i.e. no live part shall be exposed on opening the front cover for accessory mounting.

(II) CURRENT TRANSFORMERS

Categories of CT are : Metering CTs and Protection CTs

1. **Metering CTs** : Used in conjunction with ammeter, watt meter, KVA meter, KVAH meter.
2. **Protection CTs** : Used in conjunction with over current/ short circuit protection, earth fault protection, differential protection of feeders, transformer etc.

Indoor CT's mounted with medium voltage switchgear are generally epoxy resin encapsulated design.

Current transformer may be bar type or wound type. For low primary current of below 100 Amp. the CT is of wound type.

Nominal Ratio : Nominal ratio (Rated Primary winding current : rated secondary winding current). Nominal ratio of CT should be selected on the basis of current in the primary circuit. The primary value shall be selected from standard values and should be so selected that it is suitable for all normal over current relay higher rated primary current may be selected.

Referring values of rated primary currents : 0.5-1-2.5-5-10-12.5-15-20-25-30-40-50-60-75-100-125-150-200-250-300-400-500-600-750-800-1000-1250-3000-4000-5000-6000-7500-10000 Amps.

Standard secondary current is 5 Amp.

Class for accuracy : Accuracy is measured in percentage. Class-I accuracy means, an accuracy with tolerates of +/- 1%.

Measuring Current Transformer :

- (i) Instantaneous over current relay : class 15P
- (ii) Relays : Class 10 P where discrimination is important. Class 15P where discrimination is not important. Class 5P where accuracy, phase fault stability and accurate time grading is desired.

Burden : Impedence of secondary circuit expressed in ohms and power factor. It is also expressed in volt-amperes at rated secondary current at specified power factor. Rated burden of CT shall be selected from standard values. For selection, load connected on secondary.

Like measuring instrument, protective relays and resistance load of pilot wire shall be calculated.

The Rated burden of CT shall be near the calculated total burden but not less than the same. Reference value of rated output: 2.5-5-7.5-10-15-30-100 VA and above.

	<i>Fluorocarbons</i>	<i>CO₂</i>	<i>Powder</i>	<i>Foams</i>	<i>Water</i>
Class A Fires	***	*	**	**	**
Class B Fires	***	**	***	*	**
Electrical Fires	***	***	*	*	*
Range	**	*	***	***	***
Screened Fires	***	***	*	*	*
Secondary Damages	***	***	*	*	*

* Not recommended

** Recommended

*** Highly recommended