



**ODISHA POWER TRANSMISSION CORPORATION LIMITED**

(A Govt. Of Odisha Undertaking)

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Website of OPTCL “[www.optcl.co.in](http://www.optcl.co.in)”

**COMMON DOCUMENT  
TECHNICAL SPECIFICATION  
VOLUME-II (SECTION-I)**

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# GENERAL

## GENERAL CLAUSES

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## **1. GENERAL CONDITIONS**

### **1.1 Responsibility of the Contractor**

The Contractor shall also be responsible for the complete design and engineering, overall co-ordination with internal and external agencies, project management, training of Employer's manpower, loading, unloading, storage at site, inventory management at site during construction, dismantling, re-erection of installations as per Engg Incharge advice, handling, moving to final destination, obtaining statutory authority's clearance for successful erection, and testing and commissioning of the substation.

### **1.2 Specific exclusions:**

The following items of work are specifically excluded from the Contractors scope of work unless otherwise specifically brought out..

I. Substation site selection

II. Land acquisition

### **1.3 Interfacial point for line termination at substation**

The line Contractor shall terminate the transmission line along with insulator hardware and other essential fittings at the substation gantry. The substation Contractor shall provide necessary anchoring plates in co-ordination with the transmission line contractor. The substation Contractor shall be responsible for providing the necessary electrical interconnection from the line conductor to the substation.

### **1.4 Limit of contract**

The scope of work shall also include all work incidental for successful operation and commissioning and handing over of works whether specifically mentioned or not. In general works are to be carried out by the Contractor in accordance with stipulations in Conditions of Contract.

### **1.5 Quantity variation**

The Employer reserves the right to order and delete such works which may be necessary for him within the quantity variation option laid down in the conditions of the contract. This shall include but not be limited to: the manufacture, supply, testing, and delivery to site, erection and commissioning as may be required in accordance with the Conditions of Contract at the prices stated in the Schedules.

The Employer shall be at liberty to order from the Contractor such quantities of the apparatus at any time before the expiration of the maintenance period of the scope of work, provided that such quantities do not exceed the limitation of the Contract Value as defined in the Conditions of Contract. Each separate order for Work at the Option of the Employer shall constitute a section for the purpose of payment and taking over.

The Employer shall also be at liberty to delete from the Contractor such quantities of the apparatus at any time before commencement of supply of works under the detailed scope of work.

### **1.6 Supply of non specified equipment/service during execution of contract.**

The Employer may require the Contractor to supply and install a number of items such as testing and measuring instruments, vehicles, repairing of existing equipment, removal and refurbishment of plant/equipment from one place to another etc., which in the opinion of the Engg Incharge are to the interest of the project execution. These items and services shall not be limited to proprietary goods provided for the project.

Such supplies and services shall be reimbursed against supply and service invoices for the materials or services actually supplied from the manufacturer or supplier of these items. The bidder shall quote on cost for these items for the earmarked funds in appropriate schedules which shall be considered in bid prices. However these costs shall be payable to the Contractor on pro rata basis for the actual amount spent for procurement and availing of the services.

For such items of supply the Contractor shall follow the fair principle of contracting procedure to the satisfaction of Engg Incharge.

## **2. GENERAL PARTICULARS OF SYSTEM**

### **System description**

The following are the general particulars governing the design and working of the complete system of which the Contract Works will eventually form a part:

Electrical energy is generated at a number of thermal and hydro power plants generally located in the North, Central and Southern areas of Orissa State. The system is three phase, 50Hz and power is transmitted at 400kV, 220kV and 132kV to the distribution system, via grid substations, which operate at 33kV, 11kV and 400V. The 400kV and 220kV networks tie into the OPTCL's 400kV and 220kV grid systems operated by OPTCL. The proposed works will increase the interconnection of, and will thus reinforce the 400kV and 220kV networks within Orissa State. The detailed technical parameters of the system are given in the schedules.

### **Substation description:**

OPTCL has adopted the philosophy of installing open terminal air insulated substations. The busbars for 400 KV rigid type and for 220 KV flexible strain type depending upon the choice of the designer considering the overall suitability and economy of the substation to be installed.

### **Layout arrangement**

The Contractor shall study the details of layout arrangements already indicated in the schedules details for the existing substations. The bay width and height of the conductors for these substations shall be achieved by the Contractor in case of extension substations. However the Contractor shall finalise the layout arrangements in case of new substations in line with this Specification with the approval of the Engg Incharge, which shall be meeting at least the basic minimum electrical clearances as specified in the schedules.

### **Location and site description**

Details of the sub-substation locations, their approach, geography and topography has been provided to the extent possible. The Bidder shall make necessary visit to the substation sites and fully appraise himself before bidding. Deviations on account of inadequate data for substation works shall not be acceptable and the Bid shall not be considered for evaluation in such cases.

### **Meteorological data**

Appropriate meteorological data is given in the schedules.

### **Soil data**

Detailed soil investigations in respect of various substations have not been made. However the general characteristics of the soil are given in the schedules. The Contractor shall investigate the properties of the substations and measure the soil resistivity as part of the scope of work.

### **Completeness and accuracy of information**

The Contractor shall note that the information provided above and in the relevant schedules may not be complete or fully accurate at the time of bidding. For his own interest the Contractor is advised to make site visits and fully satisfy himself regarding site conditions in all respects, and shall be fully responsible for the complete design and engineering of the substations.

### **3. DRAWINGS ATTACHED WITH TENDER DOCUMENT**

The various drawings and schedules provided are a part of the specification and for information purposes only. These are not necessarily binding on the part of the Contractor. Bids shall be prepared by the Bidder based on information provided in the drawings and schedules and that gathered by the Bidder himself.

### **4. GUARANTEES TECHNICAL PARTICULARS**

The Contract Works shall comply with the guaranteed technical particulars specified or quoted in the bid. All plant and apparatus supplied under this Contract shall be to the approval of the Engg Incharge .

All plant and equipment supplied under this contract must have been type tested, have been in manufacture and satisfactory service at identical ratings for at least two years. The bidder shall furnish in his bid the necessary supporting data in specified formats for consideration during bid evaluation. If during evaluation non compliance is identified the successful Contractor shall be bound to supply the equipment from manufacturers complying with the stipulated requirements / OPTCL approval renders.

The Contractor shall be responsible for any discrepancies, errors or omissions in the particulars and guarantees.

The Bidder for his own interest, shall establish the technical responsiveness of his bid, shall provide all data in appropriate technical data sheets, general/ technical information, literature, and pamphlets etc. along with the bid.

### **5. COMPLIANCE WITH SPECIFICATION**

All apparatus should comply with this Specification. Any departures from the requirements of this Specification shall be stated in the relevant Bid Proposal Schedules and will be considered-during Bid evaluation. Unless brought out clearly in the technical schedules, it will be presumed that the equipment is deemed to comply with the technical specification.

In the event of there being any inconsistency between the provisions of the conditions of contract and the provisions of this Specification in respect of commercial requirements, the provisions of the conditions of contract shall take precedence for commercial matters and the provisions of this Specification shall take precedence in respect of technical matters.

In case of inconsistency between technical specification & bid proposal sheet, quantities of various items as specified in the bid proposal sheet shall be considered for quoting however the work shall be executed as specified in the technical specification. Only brief description is given in the BPS & the work shall be executed in line with the requirement given in the TS.

The manufacturer and places of manufacture, testing and inspection of the various portions of the Contract Works shall be stated in the relevant Bid Proposal Schedules.

### **6. TEST AND MAINTENANCE EQUIPMENT**

The Contractor shall supply the type and quantity of test and maintenance equipment specified in the Schedules as part of the contract works.

### **7. SPARES**

#### **7.1 General**

The Contractor shall provide the mandatory spares detailed in the Schedules. Provide a list of recommended spare parts (optional spares) together with their individual prices, but that will not be considered for evaluation. The Employer may order all or any of the Optional spare parts listed at the time of contract award . Mandatory spares shall be supplied as part of the Works under this



specification. Additional spares(Mandatory) may be ordered at any time during the contract at the rates stated in the Price Schedule.

## **7.2 Mandatory spares**

The Employer has indicated the requirement of mandatory spares as a percentage of the population of main equipment together with proposed storage locations. The quantities shall be determined by the Contractor and indicated in the relevant Bid Price Schedules. These quantities shall be considered for evaluation of the bids.

## **7.3 Optional spares ( shall not be considered for evaluation purpose).**

The Contractor may recommend a list of optional spare parts together with the quantity and usage rates for their equipment in the relevant Bid Proposal Schedule. The Engg Incharge shall assess their requirement and place orders.

The spares shall include consumable items sufficient for a plant operational period of five years after commissioning, as well as essential replacement parts to cover the event of a break-down which would affect the availability or safety of the plant. Spares shall be available during the life of the equipment and the Contractor shall give 12 months notice of his, or any sub-contractor's, intention to cease manufacture of any component used in the equipment.

The Contractor shall ensure that sufficient spare parts and consumable items are available for his own use during commissioning of the plant. Spares ordered by the Employer shall not be used by the Contractor without the written consent of the Engg Incharge and any spares so used by the Contractor during the commissioning of the plant shall be replaced by the Contractor at the Contractor's expense.

Any spare apparatus, parts and tools shall be subject to the same specification, tests and conditions as similar material supplied under the Scope of Works of the Contract. They shall be strictly interchangeable and suitable for use in place of the corresponding parts supplied with the plant and must be suitably marked and numbered for identification and prepared for storage by greasing or painting to prevent deterioration.

All spare apparatus or materials containing electrical insulation shall be packed and delivered in cases suitable for storing such parts or material over a period of years without deterioration. Such cases shall have affixed to both the underside and top side of the lid a list detailing its contents. The case will remain the property of the Employer.

## **8.0 TRAINING**

The Contractor will be required to provide suitable training for selected staff both on site and at the Contractor's place of work. Details of the training considered appropriate shall be stated clearly, at the bidding stage, based on the number of trainees specified. The cost of training including all course fees shall be included.

The areas in which it is considered training should be provided, and duration of the training courses, are given in this section. Alternative arrangements, where considered appropriate, should be suggested.

Four categories of training are considered appropriate namely :

- I. Hardware maintenance.
- II. Operator familiarisation.
- III. Software management.
- IV. Installation and commissioning techniques.

## **8.1 Hardware maintenance**

Courses for hardware maintenance shall identify techniques for preventative physical maintenance and for identification, isolation and replacement of faulty components. This course shall take place before equipment is delivered to site.

An essential part of the hardware maintenance course shall include highlighting the philosophy of computer based preventive maintenance and identification of the various diagnostic/interrogation facilities available. The Contractor shall supply adequate documented instructions to enable a detailed interrogation and analysis process to be carried out using the diagnostic software facilities. All items of hardware to be supplied shall be covered by the course.

## **8.2 Operator familiarisation**

This course is intended to familiarise the operators with the system and its use in operating and controlling the PLCC network. The course shall ensure that the control room staff are completely familiar with all operational aspects of the equipment. The means of obtaining special data, report logs and all other facilities which would enable the operators to be fully conversant with the system, shall also be incorporated.

It is envisaged that it will be necessary for the Contractor to run operator familiarisation courses each of approximately one week in duration at site for the training of the Employer's staff.

## **8.3 Software management**

This course shall comprise two main areas and shall take place at the Contractor's works before equipment is delivered to site .

**I). A FORMAL COURSE ON THE SOFTWARE FOR EPAX ETC. DETAILING THE VARIOUS MODULES USED AND THEIR INTERACTION.**

**II). A PRACTICAL COURSE ON EDITING THE DATABASE (TO INCORPORATE EXTENSIONS TO THE POWER NETWORKS, INCLUSION OF ADDITIONAL ANALOGUE/DIGITAL SIGNALS FROM EXISTING EQUIPMENT, ETC.) AND GENERATING NEW LOGS, ALPHANUMERIC DISPLAYS, ETC.**

It is envisaged that the software management courses shall extend for a period of approximately six weeks.

### **II.A) Installation and commissioning techniques**

The Employer's staff will be present during the installation and commissioning period and it is essential that they be fully involved in any on-site corrections or modifications to hardware and software equipment.

It is envisaged that it will be necessary for the Contractor to run installation and commissioning techniques courses each of approximately one week in duration at site for the training of the Employer's staff.

### **II.B) Proposals for training and manning**

For each course recommended the following information shall be provided:

- I. Course name and identification.
- II. Short description of the curriculum.
- III. Level of competency required for each course.
- IV. Date and duration.
- V. Maximum number of staff that can attend.
- VI. Location.

## VII. Other important information.

The times at which the various training courses will take place shall be stated, and fully documented notes shall be available to the Employer not later than two months before the commencement of the course.

All training course notes and documentation shall be in the English language.

An estimate of the total number of the Employer's staff required to run, operate and service the works covered by this Specification shall be given if this is different to the numbers specified.

The prices of the training courses shall be detailed in full such that additions or deletions to personnel or courses can be calculated by the Employer without necessarily having to contact the Contractor. This is particularly important for the 'Software management' courses where prices for formal course days and practical course days shall be individually detailed.

### **9.0 ERECTION AT SITE AND ACCOMMODATION**

The Contractor shall provide, at his own cost and expense, all labour, plant and material necessary for unloading and erection at the Site and shall be entirely responsible for its efficient and correct operation.

The Contractor shall be responsible for arranging and providing all living accommodation services and amenities required by his employees. He shall also provide suitable office accommodation at each substation site for the sole use by the Engg Incharge (Divisional Engr.) **for new substations only**.

### **10 .0 SITE CONSTRUCTION SUPPLIES**

The Contractor shall provide at his own cost and expense, any site supplies of electrical energy which he may require for supplying power for heavy erection plant, welding plant or other tools and lighting and testing purposes.

All wiring for such tackle and for lighting from the point of supply shall be provided by the Contractor and all such installations shall comply with all appropriate statutory regulations to which the Employer is subject.

Wiring shall be of the best quality double insulated flexible cable, suitably fixed, protected and maintained. All necessary precautions shall be taken to ensure the safety of every person employed or working on the Site and this shall include routine inspection of all temporary installations and portable equipment.

The Engg Incharge or his authorised representative may require the disconnection or alteration of any parts which he may consider dangerous.

As soon as any part or the whole of the Contractor's installation is no longer required for the carrying out of the works, the Contractor shall disconnect and remove the same to the satisfaction of the Engg Incharge or his authorised representative.

The contractor shall be responsible for arranging construction water at his own cost.

How ever in case water is available at any substation site, Contractor may request Engg Incharge for availing water at one point, which shall be charged to the contractor at prevailing rates for supply of water by Govt. Dept. / Municipal Authorities.

In no case the work shall suffer on account of the Employer not making available the supply of water and electricity for construction purposes.

### **11.0 SUPERVISION AND CHECKING OF WORK ON SITE**

All work on site included in the Contract scope of works shall be supervised by a sufficient number of qualified representatives of the Contractor.

Before putting any plant or apparatus into operation the Contractor shall satisfy himself as to the correctness of all connections between the plant and apparatus supplied under this and other contracts. The Contractor shall advise the Engg Incharge in writing, giving the period of notice as specified in the General Conditions of Contract, when the plant or apparatus is ready for inspection or energisation.

## **12 .0 RESPONSIBILITY FOR THE RUNNING OF PLANT BY CONTRACTOR**

Until each Section of the Contract Works has been taken over or deemed to have been taken over under the Conditions of Contract, the Contractor shall be entirely responsible for the Contract Works, whether under construction, during tests, or in use for the Employer's service.

The Contractor shall instruct the Employer's operating staff in the recommended method of operation of the plant supplied. Such instruction shall commence prior to the commissioning of the plant and shall be followed by practical instruction for a period of up to one month after the plant is taken over by the Employer. During this one month period the Contractor shall provide an engineer, on each site that is taken over, to assist with operation of the plant and to provide on-site training of the Employer's operating staff. The training schedule and programme for each substation shall be submitted to the Engg Incharge for approval, three months prior to the substation's planned completion date.

If the Employer shall so require, the Contractor shall provide the services of a skilled engineer acquainted with the running of the plant for any period required by the Employer between commencing of use of any portion of the plant (whether taken over or not) and the expiry of the period of maintenance, the wages for such services being paid by the Employer to the Contractor, except in respect of the carrying out of any work already covered by the Contractor's obligations under this Contract.

When the Contractor ceases to be obliged to maintain a supervising engineer on the Site under the foregoing provisions of this clause, the Contractor shall, until the expiration of the period of maintenance, make such arrangements as to ensure the attendance on site within 24 hours of being called upon by the Engg Incharge of a competent supervising engineer for the purpose of carrying out any work of maintenance or repair for which the Contractor shall be liable. During such part or parts of the said period as the Engg Incharge shall deem it necessary the said representative shall be continuously available on the Site.

Any work which may be necessary for the Contractor to carry out in pursuance of his obligations under the Conditions of Contract shall be carried out with the minimum of interference to the normal operation of the substation. Work on the Site shall be carried out at such time and during such hours as the Engg Incharge may require.

## **13 .0 COMPLIANCE WITH REGULATIONS**

All apparatus and material supplied, and all work carried out shall comply in all respects with such of the requirements of all Regulations and Acts in force in the country of the Employer as are applicable to the Contract Works and with any other applicable regulations to which the Employer is subject.

The Contractor shall fully inform himself of the requirements of the local Laws, Regulations and rules in-force in the State of Orissa, especially with respect to local employment laws, licensing requirements, electrical safety rules and regulations, building regulations and planning procedures.

The Contractor shall be responsible for applying for all necessary licenses; including Electrical Contractors License, Workman's Permits and Certificates of Competency for Supervisors, and local government approvals required for the contract works and for the payment of all necessary fees associated with such licenses and approvals.

Correspondence with the Electrical Inspector shall be conducted through the Engg Incharge (Divisional Engr.), but the Contractor shall provide all necessary information, regarding the contract works, as may be required by the Electrical Inspector.

Additionally the Contractor shall also follow the minimum regulations on safety, employees welfare, industry etc. as stipulated under the relevant Clause of this section.

#### **14 .0 MAINTENANCE AND CLEARING OF SITE**

The placing of materials and plant near the erection site prior to their being erected and installed shall be done in a neat, tidy and safe manner. The Contractor shall at his own expense keep the site area allocated to him and also the erection area of the Contract Works reasonably clean and shall remove all waste material as it accumulates and as directed by the Engg Incharge from time to time.

#### **15 .0 INSURANCE**

##### **15.1 General**

In addition to the conditions covered under the Clause titled insurance in the Special Conditions of Contract, the following provisions will also apply to the portion of works to be done beyond the Suppliers own or his sub-Contractors manufacturing Works.

##### **15.2 Workmen's Compensation Insurance**

This insurance shall protect the Contractor against all claims applicable under the Workmen's Compensation Act, 1948 (Government of India). This policy shall also cover the Contractor against the claims for injury, disability, disease or death of his or his sub-contractor's employees, which for any reason are not covered under the Workman's Compensation Act, 1948. The liabilities shall not be less than;

- |     |                         |                             |
|-----|-------------------------|-----------------------------|
| I.  | Workmen's' Compensation | As per statutory provisions |
| II. | Employee's liability    | As per statutory provisions |

\* According to the Govt. rules.

##### **15.3 Comprehensive auto mobile insurance**

This insurance shall be in a such a form to protect the Contractor against all claims for injuries, disability, disease and death to members of public including the Employer's men and damage to the property of others arising from the use of motor vehicles during on or off the Site operations, irrespective of the ownership of such vehicles. The minimum liability covered shall be as herein indicated:

- |      |              |   |                               |
|------|--------------|---|-------------------------------|
| I.   | Fatal Injury | : | Rs. 100,000/- each person     |
| II.  | Property     | : | Rs. 200,000/- each occurrence |
| III. | Damage       | : | Rs. 100,000/- each occurrence |

\* As per latest prevailing Govt. rules.

##### **15.4 Comprehensive General Liability Insurance**

This insurance shall protect the Contractor against all claims arising from injuries, disabilities, disease or death of members or public or damage to property of others, due to any act or omission on the part of the Contractor, its agents, its employees, its representatives and sub-contractors or from riots, strikes and civil commotion.

The hazards to be covered will pertain to all works and areas where the Contractor, its sub-contractors, agents and employees have to perform work pursuant to the Contracts.

The above are only an illustrative list of insurance covers normally required and it will be the responsibility of the Contractor to maintain all necessary insurance coverage to the extent both in time and amount to take care of all its liabilities either direct or indirect, in pursuance of the Contract.

## **16.0 PROTECTION OF MONUMENTS AND REFERENCE POINTS**

The Contractor shall ensure that any finds such as relics, antiques, coins, fossils, etc. which he may come across during the course of performance of his works either during excavation or elsewhere, are properly protected and handed over to the Employer. Similarly, the Contractor shall ensure that the bench marks, reference points, etc. which are marked either with the help of Employer or by the Employer shall not be disturbed in any way during the performance of his works. If any work is to be performed which disturbs such reference points, the same shall be done only after these are transferred to other suitable locations under the direction of the Employer. The Contractor shall provide all necessary materials and assistance for such relocation of reference points etc.

## **17 .0 WORK AND SAFETY REGULATIONS**

The Contractor shall ensure safety of all the workmen, plant and equipment belonging to him or to others, working at the Site. The Contractor shall also provide for all safety notices and safety equipment required by the relevant legislation and deemed necessary by the Engg Incharge .

The Contractor will notify, well in advance to the Engg Incharge, his intention to bring to the Site any container filled with liquid or gaseous fuel, explosive or petroleum substance or such chemicals which may involve hazards. The Engg Incharge shall have the right to prescribe the conditions under which such a container is to be stored, handled and used during the performance of the works and the Contractor shall strictly adhere to and comply with such instructions. The Engg Incharge shall also have the right, at his sole discretion, to inspect any such container or such construction plant and equipment for which materials in the container is required to be used and if in his opinion, its use are not safe, he may forbid their use.

No claim due to such prohibition or towards additional safety provisions called for by him shall be entertained by the Employer.

Further, any such decision of the Engg Incharge shall not, in any way, absolve the Contractor of his responsibilities and in case use of such a container or entry thereof into the Site areas is forbidden by the Engg Incharge the Contractor shall use alternative methods with the approval of the Engg Incharge without any cost implication to the Employer or extension of work schedule.

Where it is necessary to provide and/or store petroleum products or petroleum mixtures and explosives, the Contractor shall be responsible for carrying out such provision and/or storage in accordance with the rules and regulations laid down in Petroleum Act 1934, Explosives Act 1948 and amendments thereof, and Petroleum and Carbide of Calcium Manual published by the Chief Inspector of Explosives of India. All such storage shall have prior approval of the Engg Incharge. In case, any approval is necessary from the Chief Inspector (Explosives) or any statutory authorities, the Contractor shall be responsible for obtaining the same.

All equipment used in construction and erection by Contractor shall meet Indian or International Standards and where such standards do not exist, the Contractor shall ensure these to be absolutely safe. All equipment shall be strictly operated and maintained by the Contractor in accordance with manufacturers operation manual and safety instructions and as per any existing Guidelines/Rules in this regard.

Periodical examinations and all tests for all lifting and hoisting equipment and tackle shall be carried out in accordance with the relevant provisions of Factories Act 1948, Indian Electricity (Supply) Act and associated Laws/Rules in force, from time to time. A register of such examinations and tests shall be properly maintained by the Contractor and will be promptly produced as and when desired by Engg Incharge.

The Contractor shall provide suitable safety equipment of prescribed standard to all employees and workmen according to the need, as may be directed by the Engg Incharge who will also have the right to examine such safety equipment to determine it's suitability, reliability, acceptability and adaptability.

Where explosives are to be used, the same shall be used under the direct control and supervision of an expert, experienced and qualified competent person, strictly in accordance with the Code of Practices/Rules framed under Indian Explosives Act pertaining to handling, storage and use of explosive.

Contractors employing more than 250 workmen whether temporary, casual, probationer, regular or permanent or on contract, shall employ at least one full time officer exclusively as Safety Officer to supervise safety aspects of the equipment and workmen. Such an officer will co-ordinate with the Project Safety officer of the Employer.

The name and address of the Safety Officer of the Contractor will be promptly informed in writing to the Engg Incharge with a copy to the Safety Officer-in-charge before he starts work or immediately after any change of the incumbent is made during currency of the Contract.

In case any accident occurs during the construction, erection or other associated activities undertaken by the Contractor, thereby causing any minor or major or fatal injury to his employees due to any reason whatsoever, it shall be the responsibility of the Contractor to promptly inform the same to the Engg Incharge and also to all the authorities envisaged under the applicable laws.

The Engg Incharge shall have the right at his sole discretion to stop the work, if in his opinion the work is being carried out in such a way as may cause accidents or endanger the safety of the persons and/or equipment. In such cases, the Contractor shall be informed in writing about the nature of hazards and possible injury/accident and he shall remove shortcomings immediately. The Contractor, after stopping the specific work, can if felt necessary appeal against the order of stoppage of work to the Engg Incharge within three days of such stoppage of work and the decision of the Engg Incharge in this respect shall be conclusive.

The Contractor shall not be entitled for any damages or compensation for stoppage of work due to safety reasons and the period of such stoppage of work will not be taken as an extension of time for completion of work, nor will it be the grounds for waiver of any part of suppliers liability for timely completion of the works.

The Contractor shall follow and comply with all Safety Rules, relevant provisions of applicable laws pertaining to the safety of workmen, employees, plant and equipment as may be prescribed from time to time without any demur, protest or contest or reservation. In case of any conflict between statutory requirement and Safety Rules referred above, the most stringent clause shall be applicable.

If the Contractor fails in providing safe working environment as per Safety Rules or continues the works even after being instructed to stop work by the Engg Incharge, the Contractor shall promptly pay to the Employer on demand, compensation at the rate of Rs. 5,000/- per day or part thereof till the instructions are complied with and so certified by the Employer. However, in case of accident taking place causing injury to any individual, the provision contained in subsequent paragraph as here below shall also apply in addition to the compensation mentioned in this paragraph.

If the Contractor does not take all safety precautions and comply with Safety Rules as prescribed by the Engg Incharge or as prescribed under the applicable law, to safeguard equipment, plant and personnel the Contractor shall be responsible for payment of compensation to the Employer as per the schedule given below.

If the Contractor does not prevent hazardous conditions which may cause injury to his own employees, employees of other Contractors, or the Employer or any other person at Site or adjacent thereto, the Contractor shall be responsible for payment of compensation to the Employer as per the following Schedule:

Fatal injury or accident causing death.	Rs. 100,000/- per person	Applicable for injury or death to any person whomsoever.
Major injuries or accident causing 25% or more permanent disability.	Rs. 20,000/- per person	Applicable for injury or death to any person whomsoever.

\* As per prevailing Govt. rules.

Permanent disability shall have the same meaning as indicated in Workmen's Compensation Act. The compensation mentioned above shall be in addition to the compensation payable to the workmen/employees under the relevant provisions of the Workmen's Compensation Act and rules framed thereunder or any other applicable law as applicable from time to time. In case the Employer is made to pay such compensation, the Contractor will reimburse the Employer such amount(s) in addition to the compensation indicated above.

## **18 .0 FOREIGN PERSONNEL**

If necessary for the execution of the works, the Contractor shall bring foreign supervisors for the execution of the Contract at his own cost. The Contractor shall submit to the Employer data on all personnel he proposes to bring into India for the performance of the works under the Contract, at least Sixty (60) days prior to their arrival in India. Such data shall include the name of each person, his present address, his assignment and responsibility in connection with the works, and a short resume of his qualifications and experience etc. in relation to the work to be performed by him.

Any person unsuitable and unacceptable to the Employer, shall not be brought to India. Any person brought to India, and found unsuitable or unacceptable to the Employer shall be immediately removed from Site and repatriated. If found necessary, he may be replaced by other personnel acceptable to the Employer.

No person brought to India by the Contractor for the works shall be repatriated without the consent of the Employer in writing, based on a written request from the Supplier for such repatriation giving reasons for such an action to the Employer. The Employer may give permission for such repatriation provided the Employer is satisfied that the progress of work will not suffer due to such repatriation.

The cost of passports, visas and all other travel expenses to and from India, shall be to the Contractor's account. The Employer will not provide any residential accommodation and/or furniture for any of the Contractor's personnel including foreign personnel. Contractor shall make his own arrangements for such facilities.

The Contractor and his expatriate personnel shall respect all Indian Acts, Laws, Rules and Regulations and shall not in any way, interfere with Indian political and religious affairs and shall conform to any other rules and regulations which the Government of India, and the Employer may establish on them. The Contractor's expatriate personnel shall work and live in close co-operation and co-ordination with their co-workers and the community and shall not engage themselves in any other employment either part-time or full-time nor shall they take part in any local politics.

The Employer shall assist the Contractor, to the extent possible, in obtaining necessary certificates and other information needed by the Government agencies.



**ODISHA POWER TRANSMISSION CORPORATION LIMITED**



**COMMON DOCUMENT**

**TECHNICAL SPECIFICATION**

**FOR**

**GENERAL TECHNICAL CLAUSES  
FOR DESIGN**

# GENERAL TECHNICAL CLAUSES

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## **1. GENERAL**

The following provisions shall supplement all the detailed technical specifications and requirements brought out in accompanying Technical Specifications. The Contractor's proposal shall be based upon the use of equipment and materials complying fully with the requirements specified herein. It is recognised that the Contractor may have standardised on the use of certain components, materials, processes or procedures different to those specified herein. Alternate proposals offering similar equipment based on the manufacturers standard practice will also be considered, provided such proposals meet the specified design standard and performance requirement and are acceptable to the Engg. Incharge.

## **2. DESIGN AND STANDARDISATION**

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

The Contract works shall be designed to facilitate inspection, cleaning and repairs, and for operation where continuity of supply is the first consideration. Apparatus shall be designed to ensure satisfactory operation in all atmospheric conditions prevailing at the Site(s) and during such sudden variation of load and voltage as may be met with under working conditions on the system, including those due to faulty synchronising and short circuit.

The design shall incorporate all reasonable precautions and provisions for the safety of those concerned in the operation and maintenance of the Contract Works and of associated works supplied under other contracts.

Where the Specification does not contain characteristics with reference to workmanship, equipment, materials and components of the covered equipment, it is understood that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.

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

The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expense. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements and shall be used throughout the design. All joints and fastenings shall be so devised, constructed and documented that the component parts shall be accurately positioned and restrained to fulfil their required function.

All outdoor apparatus and fittings shall be designed so that water cannot collect at any point. Grease lubricators shall be fitted with nipples and where necessary for accessibility, the nipples shall be placed at the end of extension piping.

All water and oil pipe flanges shall be to IS 6392/BS 4504 or other equivalent standard, as regards both dimensions and drilling, unless otherwise approved.

Cast iron shall not be used for chambers of oil filled apparatus or for any part of the equipment which is in tension or subject to impact stresses.

Kiosks, cubicles and similar enclosed compartments shall be adequately ventilated to restrict condensation. All contractor or relay coils and other parts shall be suitably protected against corrosion.

All apparatus shall be designed to obviate the risk of accidental short circuit due to animals, birds, insects, mites, rodents or micro-organisms.

Corresponding parts shall be interchangeable. Where required by the Engg. Incharge the Contractor shall demonstrate this quality.

### **3.0 QUALITY ASSURANCE**

#### **3.1. General**

To ensure that the supply and services under the scope of this Contract, whether manufactured or performed within the Contractor's works or at his Sub-Contractor's premises or at Site or at any other place of work are in accordance with the Specification, with the Regulations and with relevant Indian or otherwise Authorised Standards the Contractor shall adopt suitable Quality Assurance Programmes and Procedures to ensure that all activities are being controlled as necessary.

The quality assurance arrangements shall conform to the relevant requirements of ISO 9001 or ISO 9002 as appropriate.

The systems and procedures which the Contractor will use to ensure that the Works comply with the Contract requirements shall be defined in the Contractor's Quality Plan for the Works.

The Contractor shall operate systems which implement the following:

**Hold Point** "A stage in the material procurement or workmanship process beyond which work shall not proceed without the documented approval of designated individuals or organisations."

The Engg. Incharge written approval is required to authorise work to progress beyond the Hold Points indicated in approved Quality Plans.

**Notification Point** "A stage in material procurement or workmanship process for which advance notice of the activity is required to facilitate witness."

If the Engg. Incharge does not attend after receiving documented notification in accordance with the agreed procedures and with the correct period of notice then work may proceed.

#### **3.2. Quality assurance programme**

Unless the Contractor's Quality Assurance System has been audited and approved by the Engg. Incharge, a Quality Assurance Program for the Works shall be submitted to the Engg. Incharge for approval a minimum of one month prior to commencement of the works, or such other period as shall be agreed with the Engg. Incharge. The Quality Assurance Program shall give a description of the Quality System for the Works and shall, unless advised otherwise, include details of the following:

- The structure of the Contractor's organisation
- The duties and responsibilities assigned to staff ensuring quality of work
- The system for purchasing, taking delivery and verification of materials
- The system for ensuring quality of workmanship
- The system for the control of documentation
- The system for the retention of records
- The arrangements for the Contractor's internal auditing
- A list of the administration and work procedures required to achieve and verify the Contract's Quality requirements. These procedures shall be made readily available to the Engg. Incharge for inspection on request.

### **3.3. Quality plans**

The Contractor shall draw up for each section of the work Quality Plans which shall be submitted to the Engg. Incharge for approval at least two weeks prior to commencement of the particular section. Each Quality Plan shall set out the activities in a logical sequence and, unless advised otherwise, shall include the following:

- An outline of the proposed work and program sequence
- The structure of the Contractor's organisation for the Contract
- The duties and responsibilities assigned to staff ensuring quality of work for Contract
- Hold and Notification points
- Submission of engineering documents required by the Specification
- The inspection of materials and components on receipt
- Reference to the Contractor's work procedures appropriate to each activity
- Inspection during fabrication/construction
- Final inspection and test

### **3.4. Inspection and testing**

The prime responsibility for inspection and testing rests with the Contractor. The inspection or its waiver by the Engg. Incharge does not relieve the Contractor of any obligations or responsibilities to carry out the work in accordance with the Contract.

The inspection and testing shall be documented such that it is possible to verify that it was performed. Records of inspection shall include as a minimum the contract identity, operation/inspection, technique used, acceptance standard, acceptability, identity of inspector/tester and date of inspection/test.

### **3.5. Non-conforming product**

The Contractor shall retain responsibility for the disposition of non-conforming items.

### **3.6. Monitoring of quality arrangements**

During the course of the Contract the Engg. Incharge may monitor the implementation of the Quality Assurance arrangements. Monitoring will be by surveillance of the activities at work locations and/or by formal audits of the adherence of the Contractor to the systems and procedures which constitute his Quality Assurance arrangements. Corrective actions shall be agreed and implemented in respect of any deficiencies

The Contractor shall provide any facilities, including access, which may be required by the Engg. Incharge for monitoring activities.

The Engg. Incharge may participate on an agreed basis in the Contractor's monitoring of a sub-contractor's Quality Assurance arrangements.

### **3.7. Sub-contractors**

The Contractor shall ensure that the Quality Assurance requirements of this Specification are followed by any sub-contractor appointed by him under the Contract.

The Contractor shall assess the sub-contractor's Quality Assurance arrangements prior to his appointment to ensure its compliance with the appropriate ISO 9000 standard and the Specification.



Auditing of the sub-contractor's Quality Assurance arrangements shall be carried out by the Contractor and recorded in such a manner that demonstrates to the Engg. Incharge the extent of the audits and their effectiveness.

### **3.8. Method statement**

Prior to commencing work, the Contractor shall submit a method statement setting out full details of his method of working. This is a **Hold Point**.

Details of the Contractor's method of working shall also be submitted at the time of Bidding.

## **4.0 HEALTH, SAFETY AND ENVIRONMENT (HSE) PLAN**

### **4.1. General**

Within one month of award of contract the Contractor shall produce a HSE Plan for the contract and submit for the approval of the Engg. Incharge . The HSE Plan is described in the following sections.

The primary objective of the HSE Plan is for the contractor to demonstrate that he has the capability to carry out the contract work in a cost effective manner, giving due consideration to the Health, Safety and Environmental management of both his own employees, those of the Employer and anyone who may be affected by his activities.

### **4.2. Content of HSE Plan**

The general structure of the HSE Plan is outlined in 1.9.8.3. The HSE Plan will comprise two parts i.e.:

**Part : I :** Sections 1 to 5, covering general HSE management and controls.

The following would be attached as appendices, where appropriate:

- Organisation chart showing the proposed Contractors HSE organisational structure
- The CV's, duties and responsibilities of the following personnel:
  - (i) Contract Manager
  - (ii) Contractors Site Representatives
  - (iii) Safety Officer
  - (iv) Site Safety Officers

**Part : II :** Section 6, providing a summary of hazards and controls.

### **4.3. General structure of HSE Plan**

The HSE Plan shall conform to the following general structure:

1. Contractors Policy Statement
2. Health
  - 2.1 First Aid
  - 2.2 Primary health care
  - 2.3 Occupational health
3. Safety
  - 3.1 Objectives and targets
  - 3.2 Organisation and responsibilities
  - 3.3 HSE meetings

- 3.4 Motivation and communication
- 3.5 HSE training
- 3.6 Audits and inspections
- 3.7 Emergency response
- 3.8 Safety function
- 3.9 Accident investigating and reporting
- 3.10 Standards
- 3.11 Personal protective equipment
- 4. Environment
  - 4.1 Waste management
  - 4.2 Chemicals management
  - 4.3 Environmental impact
- 5. Critical areas
  - 5.1 Subcontractors
- 6. Summary of hazards and controls

#### **4.4. Section 6 of HSE Plan**

In addition to general hazards and their controls, the following hazards have been identified as specific to this contract and therefore the contractor should demonstrate that he is capable of providing the necessary controls for the work:

- Working within a Permit to Work system
- Working adjacent to live high voltage equipment
- Working adjacent to, and in the vicinity of, live high voltage overhead lines
- Working at elevation
- Lifting operations
- Use of explosives
- Use of heavy machinery including crane, pile rigs and concrete mixers
- Excavation works
- Work in confined spaces
- Working with insulating oil
- Working with compressed gas
- Rotating machinery

The Contractor should demonstrate his understanding of these hazards by either proposing specific controls for each of them or by giving supporting documentation which demonstrates that such controls already exist.

#### **4.5. Standards, Procedures and Guidelines**

The HSE Plan shall identify the Standards, Procedures and Guidelines that will be applicable to the project. These will include the Indian Electricity Rules and The OPTCL Operations Safety Manual - 1997 (Draft), and will be subject to the approval of the Engg. Incharge (Divisional Engr.).

#### **4.6. Supervision strategy**

The Contractor will provide supervisors with a minimum of five years experience of this type of work such that they are able to supervise the quality and standards of the work without intervention by the Employer. The role of the Employer will be to monitor and audit the quality of the work to ensure that it is of adequate standard and that it is being safely and successfully managed.

### **5. 0 PROGRESS REPORTING**

The Contractor shall submit for approval, within four weeks of the issue of letter of award, an outline of the design, engineering, material procurement, production, site mobilisation, man and machine deployment, delivery, erection, testing, commissioning, and handing over programme. Within a further period of 4 weeks the Contractor shall provide a detailed programme of all these activities in a form to be agreed by the Engg. Incharge . The Contractor shall submit monthly progress reports to the Engg. Incharge office not later than the fifth day of the following month. The reports shall show clearly and accurately the position of all activities associated with design, material procurement, manufacture, works tests, shipping, site erection, testing and commissioning with regard to the agreed contract programme.

In addition to the routine monthly progress report the Contractor shall also submit to the Engg. Incharge by the 25th day of every month, a man hour schedule for the following month, detailing the man hours scheduled for that month, skill-wise and area-wise.

The preferred format for presentation of programmes is MS Project version 4.0 or any latest. The programmes and monthly updates shall be submitted on CD.

The design aspect of the progress report shall include a comprehensive statement on drawing and calculations submitted for approval.

The position on material procurement shall give the date and details of orders placed and indicate the delivery date quoted by the manufacturer. If any delivery date has an adverse affect on the contract programme the Contractor shall state the remedial action taken to ensure that delays do not occur.

The position on manufacture shall indicate the arrival of material, the progress of manufacture and date at which the equipment will be ready for transport. Any events that may adversely affect completion in the manufacturers works shall also be reported.

All works tests executed shall be listed and the test-results shall be remarked upon. Any test failures shall be highlighted and the Contractor shall detail the necessary steps taken in order to avoid any adverse affect on the contract completion dates.

The despatch of each order shall be monitored on the progress report giving the date by which the equipment will be available for transport, the estimated time of arrival on site and the dates actually achieved.

The site works shall be segregated into civil, mechanical and electrical works for reporting purposes and each section of the site works shall be monitored giving the percentage completion and the estimated completion date in accordance with the contract programme. The number of men working on site, both labour and supervisory staff, shall be reported together with any incidents or events that may affect the progress of site works.

Any delays which may affect any milestone or final completion dates shall be detailed by the Contractor who shall state the action taken to effect contract completion in accordance with the contract programme.

The contractor shall provide two copies of the progress report to the Engg. Incharge (Divisional Engr.) office.

## **6. 0 STANDARDS**

Except where otherwise specified or implied, the Contract Works shall comply with the latest edition of the relevant Indian Standards, International Electrotechnical Commission (IEC) standards and any other standards mentioned in this Specification. The Contractor may submit for approval, equipment or materials conforming to technically equivalent National Standards. In such cases copies of the relevant Standards or part thereof, in the English language shall be submitted with the Tender. In case of conflict the order of precedence shall be (1) IEC, (2) IS and (3) other alternative standard.

Reference to a particular standard or recommendation in this Specification does not relieve the Contractor of the necessity of providing the Contract Works complying with other relevant standards or recommendations.

The list of standards provided in the schedules of this Specification is not to be considered exhaustive and the Contractor shall ensure that equipment supplied under this contract meets the requirements of the relevant standard whether or not it is mentioned therein.

## **7. 0 LANGUAGE AND SYSTEM OF UNITS**

The English language shall be used in all written communications between the Employer, the Engg. Incharge (Divisional Engr.) and the Contractor with respect to the services to be rendered and with respect to all documents and drawings procured or prepared by the Contractor pertaining to the work, unless otherwise agreed by the Employer.

It is required that danger plates, equipment designation labels or plates, instruction notices on plant and general substation notices be written in English, Hindi and Oriya. Control switch and lamp labels, indicator lamp and annunciator inscriptions shall be in English only.

The Contractor must furnish a schedule giving the English, Hindi and Oriya version of all labels, notices, etc., for approval.

The design features of all equipment shall be based on the SI system of units.

## **8. 0 CORRESPONDENCE, DRAWINGS, APPROVAL PROCEDURE AND SAMPLES**

### **8.1. Correspondence**

All correspondence shall be addressed to the Sr. G.M, TP, OPTCL / Sr. G.M, C.P.C, OPTCL

### **8.2. Drawings and samples**

A list of the drawings to be submitted by the Contractor with his Bid and a list of drawings and samples to be submitted after the Commencement Date, are to be given in the Schedules. The Contractor shall also provide free of charge any additional drawings and/or copies of any drawing required by the Engg. Incharge. All design drawings and calculations shall be submitted for approval not later than 180 days after commencement of the contract.

Within 30 days of contract commencement the Contractor shall submit, for approval by the Engg. Incharge a schedule of the drawings to be produced detailing which are to be submitted for "Approval" and which are to be submitted "For Information Only". The schedule shall also provide a programme of drawing submission, for approval by the Engg. Incharge that ensures that all drawings and calculations are submitted within the period specified above.

Details of the loads and fixing arrangements of the circuit breakers and transformers, supplied under a separate contract, shall be provided by the Engg. Incharge in order to enable the Contractor to design the foundations for these items of plant.

All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement,

and the dimensions, required for installation and interconnections with other equipment and materials, clearances and spaces required for installation and interconnections between various portions of equipment and any other information specifically requested in the specification.

The Contractor shall submit samples of materials for approval as required from time to time by the Engg. Incharge .

All dimensions marked on drawings shall be considered correct although measurement by scale may differ from general arrangement drawings. Detailed drawings shall be worked to where they differ from general arrangement drawings.

All detail drawings submitted for approval shall be to scale not less than 1 : 20. All important dimensions shall be given and the material of which each part is to be constructed shall be indicated on the drawings.

All documents, drawings and samples shall be submitted in accordance with the provisions of this Specification and shall become the property of the Employer.

All drawings and calculations, submitted to the Engg. Incharge shall be on international standard size paper, either A0, A1, A2, A3 or A4. All such drawings and calculations shall be provided with a contract title block and shall be assigned a unique project drawing number; the contract title block and project numbering system shall be agreed with the Engg. Incharge .

All drawings for approval shall have the OPTCL-LOGO and the name of the Employer.

Technical drawings must be shown, in such a form that the information necessary to construct an installation or part of an installation must be understandable by the technicians/skilled workmen responsible for construction and supervision. The drawings must therefore conform to following standards.

For presentation of design drawings and circuit documents IEC Publication 617 or equivalent standards for graphical symbols are to be followed.

Script sizes and thickness of scripts and lines be selected so that if reduced by two stages the alphanumeric characters and lines are still perfectly legible so as to microfilm them .

### **8.3. Approval procedure**

The Contractor shall submit all drawings and samples for approval in sufficient time to permit modifications to be made if such are deemed necessary, and the drawings and samples to be re-submitted without delaying the initial deliveries or completion of the Contract Works. The following schedule shall be adhered for submission, approval, re-submission and final distribution drawings/documents.

- Initial submission: All drawings, designs and documents requiring approval of Engg. Incharge - not later than 100 days from award of contract.
- Approval/comments of 1st submission: Within 30 days of receipt.
- Re-submission where required: Within 21 days of receipt including postal time both ways.
- Approval/comments of re-submission: Within 15 days of receipt.
- Submission of distribution copies: Within 15 days of approval.

Three copies of all drawings shall be submitted for approval and three copies for any subsequent revision. The Engg. Incharge reserves the right to request any additional information that may be considered necessary in order to fully review the drawings. Drawings for approval shall be submitted as paper prints and shall bear the approved contract references. Submittal should where possible be staggered to facilitate maintenance of the above schedule.

If the Engg. Incharge is satisfied with the drawing, one copy will be returned to the Contractor marked with "Approved" stamp. If the Engg. Incharge is not totally satisfied with the drawing, then "Approved subject to comment" status will be given to it and a comment sheet will be sent to the Contractor. If the drawing does not comply with the requirements of the specification then it will be given "Not Approved" status and a comment sheet will be sent to the Contractor. In both the latter cases the Contractor will have to modify the drawing, update the revision column and resubmit for final approval.

Following approval copies of final drawings will be required as given below.

- Reproducible on Tracing Films or Papers : 3 copies
- Hard Copies on paper (Blue print or Xerox) : 20 copies
- Computer CD ROM : 1 copy

Any drawing or document submitted for information only should be indicated as such by the Contractor. Drawings submitted for information only will not be returned to the Contractor unless the Engg. Incharge considers that such drawings do need to be approved, in which case they will be returned suitably stamped with comments.

Drawings, samples and models submitted by the Contractor and approved by the Engg. Incharge shall not be departed from without the instruction in writing of the Engg. Incharge .

The Contractor shall be responsible for any discrepancies or errors in or omissions from the drawings, whether such drawings have been approved or not by the Engg. Incharge . Approval given by the Engg. Incharge (Divisional Engr.)to any drawing or sample shall neither relieve the Contractor from his liability to complete the Contract Works in accordance with this Specification and the conditions of contract nor exonerate him from any of his guarantees.

If the Contractor needs approval of any drawing within a period of less than four weeks in order to avoid delay in the completion of the Contract Works, he shall advise the Engg. Incharge when submitting the drawings and provide an explanation of the document's late submission. The Engg. Incharge will endeavour to comply with the Contractors time scale, but this cannot be guaranteed.

#### **8.4. Final as-built drawings**

After completion of work on site all drawings shall be revised where necessary to show the equipment as installed and three copies submitted duly signed by site-in-charge. Following approval, two reproducible transparencies and twenty prints shall then be provided as required by the Engg. Incharge and shall be of sufficient detail to enable all parts to be identified. The contractor shall also submit, where possible, digitally stored copies of all as-built drawings on disc or CD-ROM in a format compatible with the Employer's drawing system.

#### **8.5. Operation and Maintenance Manuals**

Six months prior to the contractual completion date for each substation site the Contractor shall forward to the Engg. Incharge, two copies of the Operation and Maintenance Manual unique to the substation site being handed over.

After approval by the Engg. Incharge the Contractor shall deliver ten (10) copies of the complete manual .

The Taking Over Certificate will not be issued until the required number of approved copies of the manuals have been provided by the Contractor.

The manuals shall be as complete and as specific as possible and shall incorporate documentation that is specific to the materials and equipment used on the contract. Because the nature of the work varies from site to site the manuals will have to be tailored to the specific needs of each site.

All precautions and warnings relative to the safety of life and equipment shall be included in the manuals.

The manuals should also show exploded views wherever required.

## **9. 0 MASS AND SIZE OF PARTS AND QUANTITIES OF OIL**

The mass and dimensions of any item of equipment shall not exceed the figures stated in the Schedules.

Each item shall be labelled to indicate its mass, quantity of oil (if any) and any special handling instructions.

## **10. 0 GENERAL REQUIREMENTS**

### **10.1. Bolts and nuts**

All bolts, studs, screw threads, pipe threads, bolt heads and nuts shall comply with the appropriate national standards for metric threads, or the technical equivalent.

Except for small wiring, current carrying terminal bolts or studs, for mechanical reasons, shall not be less than 6 mm in diameter.

All nuts and pins shall be adequately locked.

Wherever possible bolts shall be fitted in such a manner that in the event of failure of locking resulting in the nuts working loose and falling off, the bolt will remain in position.

All bolts, nuts and washers placed in outdoor positions shall be treated to prevent corrosion, by hot dip galvanising or electro galvanising to service condition 4. Appropriate precautions shall be taken to prevent electrolytic action between dissimilar metals.

Where bolts are used on external horizontal surfaces where water can collect, methods of preventing the ingress of moisture to the threads shall be provided.

Each bolt or stud shall project at least one thread but not more than three threads through its nut, except when otherwise approved for terminal board studs or relay stems. If bolts and nuts are placed so that they are inaccessible by means of ordinary spanners, special spanners shall be provided.

The length of the screwed portion of the bolts shall be such that no screw thread may form part of a shear plane between members.

Taper washers shall be provided where necessary.

Protective washers of suitable material shall be provided front and back on the securing screws.

### **10.2. Galvanising.**

#### **10.2.1. General**

All machining, drilling, welding, engraving, scribing or other manufacturing activities which would damage the final surface treatment shall be completed before the specified surface treatment is carried out.

#### **10.2.2. Galvanising**

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use shall be hot dip galvanised. High tensile steel nuts, bolts and spring washers shall be electro galvanised to service condition 4. All steel conductors including those used for earthing and grounding (above ground level) shall also be galvanised according to IS 2629.

All galvanising shall be applied by the hot dip process and shall comply with IS 2629, IS 2633, IS 4759, IS 1367 or IS 6745.

All welds shall be de-scaled, all machining carried out and all parts shall be adequately cleaned prior to galvanising. The preparation for galvanising and the galvanising itself shall not adversely affect the mechanical properties of the coated material.

The threads of all galvanised bolts and screwed rods shall be cleared of spelter by spinning or brushing. A die shall not be used for cleaning the threads unless specially approved by the Engg. Incharge (Divisional Engr.). All nuts shall be galvanised with the exception of the threads which shall be oiled. Surfaces which are in contact with oil shall not be galvanised or cadmium plated.

Partial immersion of the work will not be permitted and the galvanising tank must therefore be sufficiently large to permit galvanising to be carried out by one immersion.

Galvanising of wires shall be applied by the hot dip process and shall meet the requirements of IS 2141.

The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum thickness of coating shall be 86 microns for all items thicker than 5 mm. For items of less than 5 mm thickness requirement of coating thickness shall be as per BS 729. For surface which shall be embedded in concrete, the zinc coating shall be a minimum of 800 gm/sq.m.

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

After galvanising no drilling or welding shall be performed on the galvanised parts of the equipment excepting that nuts may be threaded after galvanising. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanisation.

The galvanised steel shall be subjected to six one minute dips in copper sulphate solution as per IS 2633.

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

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

Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

### **10.3. Cleaning, painting and tropicalisation**

#### 10.3.1. General

All paints shall be applied in strict accordance with the paint manufacturer's instructions.

All painting shall be carried out on dry and clean surfaces and under suitable atmospheric and other conditions in accordance with the paint manufacturer's recommendations.

An alternative method of coating equipment such as with epoxy resin-based coating powders will be permitted, subject to the approval of the Engg. Incharge (Divisional Engr.), and such powders shall



comply with the requirements of IEC 455. The Contractor shall provide full details of the coating process to the Engg. Incharge (Divisional Engr.)for approval.

It is the responsibility of the Contractor to ensure that the quality of paints used shall withstand the tropical heat and extremes of weather conditions specified in the schedules. The paint shall not peel off, wrinkle, be removed by wind, storm and handling on site and the surface finish shall neither rust nor fade during the service life of the equipment.

The colours of paints for external and internal surfaces shall be in accordance with the approved colour schemes .

#### 10.3.2. Works painting processes

All steelworks, plant supporting steelworks and metalwork, except galvanised surfaces or where otherwise specified, shall be shot blasted to BS 7079 or the equivalent ISO standard. All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS 6005 “Code of Practice for phosphating iron and sheet steel”. All surfaces shall then be painted with one coat of epoxy zinc rich primer, two pack type, to a film thickness of 50 microns. This primer shall be applied preferably by airless spray and within twenty minutes but not exceeding one hour of shot blasting.

All rough surfaces of coatings shall be filled with an approved two pack filler and rubbed down to a smooth surface.

The interior surfaces of all steel tanks and oil filled chambers shall be shot blasted in accordance with BS 7079 or the equivalent ISO, and painted within a period of preferably twenty minutes, but not exceeding one hour with an oil resisting coating of a type and make to the approval of the Engg. Incharge (Divisional Engr.).

The interior surfaces of mechanism chambers, boxes and kiosks, after preparation, cleaning and priming as required above, shall be painted with one coat zinc chromate primer, one coat phenolic based undercoating, followed by one coat phenolic based finishing paint to a light or white colour. For equipment for outdoor use this shall be followed by a final coat of anti-condensation paint of a type and make to the approval of the Engg. Incharge (Divisional Engr.), to a light or white colour. A minimum overall paint film thickness of 150 microns shall be maintained throughout.

All steelworks and metalwork, except where otherwise specified, after preparation and priming as required above shall be painted with one coat metallic zinc primer and two coats of micaceous iron oxide paint followed by two coats of either phenolic based or enamel hard gloss finished coloured paint to the approval to an overall minimum paint film thickness of 150 microns.

Galvanised surfaces shall not be painted in the works.

All nuts, bolts, washers etc., which may be fitted after fabrication of the plant shall be painted as described above after fabrication.

The painted metal works shall be subjected to paint qualification test as per draft ANSI/IEEE-Std 37.21 -1985 clause 5.2.5.

#### 10.3.3. Site painting

After erection at site, the interior surfaces of mechanism chambers and kiosks shall be thoroughly examined, and any deteriorated or mechanically damaged surfaces of such shall be made good to the full Specification described above.

After installation/erection at site all surfaces of steelworks and metalwork shall be thoroughly washed down. Any deteriorated or otherwise faulty paint-work removed down to bare metal and made good to the full Specification described above, then painted one further coat of phenolic based undercoating and one coat phenolic based hard gloss finishing paint to provide an overall minimum paint film thickness of 200 microns.

Any nuts, bolts, washers, etc., which have been removed during site erection, or which may be required to be removed for maintenance purposes shall be restored to their original condition.

All paint work shall be left clean and perfect on completion of the works.

10.3.4 Colour Schemes The Contractor shall propose a colour scheme for the sub-station for the approval of Engg. Incharge (Divisional Engr.). The decision of Engg. Incharge (Divisional Engr.) shall be final. The scheme shall include:

- Finishing colour of indoor equipment
- Finishing colour of outdoor equipment
- Finish colour of all cubicles
- Finishing colour of various auxiliary system equipment including piping.
- Finishing colour of various building items.

All steel structures, plates etc. shall be painted with non-corrosive paint on a suitable primer. It may be noted that normally all Employer's electrical equipment in Employer's switchyard are painted with shade 631 of IS:5 and Employer will prefer to follow the same for this project also. All indoor cubicles shall be of same colour scheme and for other miscellaneous items colour scheme will be subject to the approval of the Engg. Incharge (Divisional Engr.).

Sl. No.	Equipment	Application Environment			
		Indoor		Outdoor	
		Colour	Code IS:5	Colour	Code IS:5
<b>400kV/220kV/132kV Class Equipment</b>					
1	Transformers	—	—	Light grey	631
2	Marshalling boxes, CTs, PT's, CVT's, surge counter casings, junction boxes etc.	Light Admiralty grey.	697	Light Admiralty grey.	697
3	Control and relay panels, PLCC cabinets etc.	Smoke grey	692	—	—
4	Porcelain parts i.e. insulators	Dark brown	412	Dark brown	412
5	All structures/ metallic parts exposed to atmosphere	Hot dip galvanised			
<b>33kV Class equipment</b>					
6	Switchgear cubicles	Smoke grey	692	Light grey	631
7	Control and relay panels	Smoke grey	692	—	—
	LT switchgear				
8	LT switchgear exterior	Smoke grey	692	Light grey	631
9	ACDB/ MCC	Smoke grey	692	Light grey	631
10	DCDB	Smoke grey	692	—	—
11	LT bus duct in side enclosure	Matt Paint		—	—
12	LT bus duct outside enclosure	Smoke grey	692	—	—
13	Motors	Smoke grey	692	Light grey	631
14	Diesel generator engine	Smoke grey	692	—	—
15	Diesel generator	Smoke grey	692	—	—
16	LT transformers	Smoke grey	692	Light grey	631
17	Battery charger	Smoke grey	692	—	—
18	Mimic diagram				
	400kV	Dark violet	796	—	—
	220kV	Golden yellow	356	—	—
		Sky blue			
	132kV	Signal red	101	—	—
	33kV	Canary yellow	537	—	—
	11kV	Middle brown	309	—	—
	415V		411	—	—
	Miscellaneous				
19	Control modules and console inserts	Smoke grey	692	Light grey	631
20	Lighting package equipment outside	Light grey	631	Light grey	631
21	Lighting package equipment inside	Glossy white		Glossy white	
22	Water pipes	sea green	217	sea green	217

23	Air pipes	Sky blue	101	Sky blue	101
24	Transformer oil pipes	Light brown	410	Light brown	410
25	Fire Installations	Fire red	536	Fire red	536
26	Insulating oil/ gas treatment plant	Gulf red	473	Gulf red	473

**Table 10.3.4. Recommended colour schemes**

#### **10.4. Provision for exposure to hot and humid climate**

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

##### 10.4.1. Anti-condensation Provisions:

Space heaters where provided shall be suitable for continuous operation at 240V supply voltage. On-off switch and fuse shall be provided.

One or more adequately rated permanently or thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimise deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature at approximately 10C, above the outside air temperature to prevent condensation. This shall be demonstrated by tests.

##### 10.4.2. Fungistatic treatment

Besides the space heaters, special moisture and fungus resistant varnish shall be applied to parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface or part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

##### 10.4.3. Ventilating specifications

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

#### **10.5. Labels and plates**

All apparatus shall be clearly labelled indicating, where necessary, its purpose and service positions. Each phase of alternating current and each pole of direct current equipment and connections shall be coloured in an approved manner to distinguish phase or polarity.

The material of all labels and the dimensions, legend, and method of printing shall be to approval. The surface of indoor labels shall have a matt or satin finish to avoid dazzle from reflected light.

Colours shall be permanent and free from fading. Labels mounted on black surfaces shall have white lettering. 'Danger' plates shall have red lettering on a white background.

All labels and plates for outdoor use shall be of non corroding material. Where the use of enamelled iron plates is approved, the whole surface including the back and edges, shall be properly covered and resistant to corrosion. Protective washers of suitable material shall be provided front and back on the securing screws.

Labels shall be engraved in Hindi, English and Oriya. Name plates shall be white with black engraved lettering and shall carry all the applicable information specified in the applicable items of the Standards.

Any other relevant information which may be required for groups of smaller items for which this is not possible e.g. switch bays etc. a common name plate in Oriya with the title and special instructions on it shall be provided.

No scratching, corrections or changes will be allowed on name plates.

All equipment mounted on front and rear sides as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved.

On the top of each panel on front as well as rear sides large name plates with bold size lettering shall be provided for circuit/ feeder/ cubicle box designation.

All front mounted equipment shall be also provided, at the rear, with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate tracing of the wiring. The name plates shall be mounted directly by the side of the respective equipment wiring.

Name plates of cubicles and panels may be made of non rusting metal or 3 ply lamicaid. These name plates may be black with white engraved lettering.

The name plate inscription and size of name plates and letters shall be submitted to the Engg. Incharge (Divisional Engr.)/Engineer for approval.

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

- Concise descriptive title of the equipment
- Rating and circuit diagrams
- Manufacturer's name, trade-mark, model type, serial number
- Instruction book number
- Year of manufacture
- Total weight (for capacitor racks indicate weight, for capacitors indicate quantity of liquid)
- Special instructions, if any, about storage, transportation, handling etc.

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

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

#### **10.6. Padlocks**

For each item of plant the Contractor shall provide a padlockable handle and a non-ferrous padlock with different key changes in order to prevent access to control cabinets, cubicles and relay panels. The Contractor shall provide two keys for each lock and a master key for each substation.

Cabinets for the accommodation of padlocks and keys, whilst not in use, shall be provided and shall be suitably labelled so that keys will be readily identifiable.

#### **10.7. Earthing**

Metal parts of all equipment other than those forming part of an electrical circuit shall be connected directly to the main earth system via two separate conductors of adequate capacity at two different points.

All main members of structural steelworks shall be earthed by galvanised iron flat connections bonded by welding or bolting to the steelworks.

Connections to apparatus and structures shall be made clear of ground level, preferably to a vertical face and protected as appropriate against electrolytic corrosion. They shall be made between clean surfaces and of sufficient size and pressure to carry the rated short circuit current without damage.

Earth bars installed directly into the ground should normally be laid bare and the trench back-filled with a fine top soil. Where the soil is of a hostile nature, special precautions must be taken to protect the earth bar, the method used being subject to the agreement of the Engg. Incharge (Divisional Engr.).

Joints in earth bars shall be welded and then coated with a suitable anti-corrosion protection treatment.

Facilities shall be provided on the earth bar run between equipment and the base of structures, comprising a looped strip, so as to permit the attachment of portable earth connections for maintenance purposes.

The cross sectional area of the earth bar and connections shall be such that the current density is not greater than **100 A/mm<sup>2</sup>** for a **3** second fault duration.

## **10.8. Lubrication**

Bearings which require lubrication either with oil or grease shall be fitted with nipples.

## **11. PRODUCTION PROCESS REQUIREMENTS**

### **11.1. Castings**

#### **11.1.1. General**

All castings shall be true to pattern, free from defects and of uniform quality and condition. The surfaces of castings which do not undergo machining, shall be free from foundry irregularities. The castings shall be subject to NDT, chemical, mechanical and metallographic tests. Details of the same shall be furnished to Engg. Incharge (Divisional Engr.) for review/approval. Magnetic particle inspection (MPI) test, wherever applicable, shall be carried out in longitudinal and transverse direction to detect radial and axial cracks.

#### **11.1.2. Iron castings**

Iron casting material shall be in accordance with ASTM A 126 Class B. A copy of the ladle analysis shall be sent to the Engg. Incharge (Divisional Engr.). Each casting shall have a test bar from which tension test specimens may be taken. Test specimen shall be in accordance with ASTM A 370 and tested in accordance with ASTM E8. The Contractor shall submit his procedures for testing and acceptance for iron castings for approval by the Engg. Incharge (Divisional Engr.).

#### **11.1.3. Steel castings**

Steel castings shall be manufactured in accordance with ASTM A 27 and shall be subjected to appropriate tests and inspection as detailed herein.

Copies of mandatory documentation, such as ladle analyses and mechanical test results, shall be sent to the Engg. Incharge (Divisional Engr.). (Non-ferrous casting material and castings shall be manufactured in accordance with the appropriate ASTM standards for the material concerned).

### **11.2. Forgings**

When requested by the Engg. Incharge (Divisional Engr.), forgings will be subjected to inspection in the regions of fillets and changes of section by suitable method. Magnetic particle, dye-penetration, radiographic or ultrasonic, or any combination of these methods may be used to suit material type and forging design.

The testing is to be carried out after the rough machining operation and is to be conducted according to the appropriate ASTM standards.

MPI test on forging shall be carried out to detect both radial and axial cracks. Ferrous forgings shall be demagnetised after such tests.

Any indentations which prove to penetrate deeper than 2.5% of the finished thickness of the forging shall be reported to the Engg. Incharge (Divisional Engr.) giving location, length, width and depth. Any indentations which will not machine out during final machining shall be gouged out and repaired using an approved repair procedure.

Repair of rotating elements by welding will only be accepted subject to detailed examination of the proposal by the Engg. Incharge (Divisional Engr.) prior to the repair being carried out.

The forging shall be tested for mechanical and metallographic tests as per ASTM. The details shall be mutually discussed/agreed upon.

### **11.3. Fabricated components**

All components machined or fabricated from plate, sheet or bar stock shall meet the material requirements of ASTM or material specification approved by the Engg. Incharge (Divisional Engr.).

Structural steel, rolled shapes, bars, etc. shall comply with the latest ASTM for A36.

Plate steel shall be of a designation and quality suitable for the function it is intended to perform. Insofar as it is compatible with its function, it shall comply with ASTM A283 structural quality.

All, or a representative number of such components, shall be subjected to one or more of the following tests: visual, dye penetration, magnetic particle (transverse and longitudinal), ultrasonic or radiographic. These tests shall be in accordance with the recommended practices of the ASTM. The terms of reference for acceptance shall be the applicable ASTM Specifications.

### **11.4. Welding and welders qualifications**

#### **11.4.1. General**

All welding shall be carried out by qualified welders only.

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

Other standards to determine the quality of welding process and qualifications of welders may be considered, provided that sufficient information is first submitted for the approval of the Engg. Incharge (Divisional Engr.).

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

The Contractor shall be responsible for the quality of the work performed by his welding organisation. All welding operators, to be assigned work, including repair of casting, shall pass the required tests for qualification of welding procedures and operators. The Engg. Incharge (Divisional Engr.) reserves the right to witness the qualification tests for welding procedures and operators and the mechanical tests at the samples.

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

#### **11.4.2. Welding**

All welding shall be performed in accordance with the appropriate standards. The design and construction of welded joints subject to hydraulic pressure shall conform to the applicable requirement of ASME "Boiler and Pressure Vessel Code" shall be qualified in accordance with Section IX of this Code. The design and construction of welded joints not subjected to hydraulic pressure shall, as a minimum, conform to the requirements of AWS "Specification for Welded Highway and Railway

Bridge” D2.0. Except for minor parts and items specifically exempted from stress relieving, all shop-welded joints shall be stress relieved in accordance with the requirements of the ASME “Boiler and Pressure Vessel Code” Section VIII.

In addition to satisfying the procedural and quality requirements set forth in the applicable code and/or these Specifications, all welding shall meet the following requirements for workmanship and visual quality:

- Butt welds shall be slightly convex, of uniform height and shall have full penetration.
- Fillet welds shall be of the specified size, with full throat and legs of equal length.
- Repairing, chipping and grinding of welds shall be done in a manner which will not gouge, groove or reduce the thickness of the base metal.
- The edges of the member to be joined shall expose sound metal, free from laminations, surface defects caused by shearing or flame-cutting operations or other injurious defects.

Welded joints subject to critical working stress shall be tested by approved methods of non-destructive testing, such as radiographic and ultrasonic examination, magnetic particle and liquid penetration inspection. All expenses in connection with these tests shall be borne by the Contractor. The extent of testing shall be as stipulated by the ASME ‘Boiler and Pressure Vessel Code’, Section VIII, but without prejudice to the rights of the Inspector or the Engg. Incharge (Divisional Engr.)to ask for additional tests,

The arc-welding process to be used and the welding qualifications of the welders employed on the work shall be used in accordance with AWS requirements and Section VIII and IX of the ASME (American Society of Mechanical Engineers) Code, latest edition, as they may apply. All welding rods shall conform to the requirements of the latest issue of Section It, part C of the ASME Code.

Gas shielded welding (TIG or MIG) used as appropriate for aluminium, stainless steel or other material shall be carried out in accordance with the best commercial practice and the following standard specifications:

- Specifications for copper and copper-alloy welding rods (AWS A5.7, ASTM B259)
- Specification for corrosion-resisting chromium and chromium-nickel steel welding rods and bare electrodes (AWS A5.9, ASTM A371)
- Specifications for aluminium and aluminium alloy rods and bare electrodes (AWS A5.10, ASTM B285).
- Specifications for nickel and nickel-base alloy bare welding filler metal (AWS A5.14, ASTM B304).

Gas welding will not normally be used in the equipment. When a particular equipment manufacture requires the use of gas welding, the proposed process and the welder’s qualification shall be in accordance with AWS B3.0.

Welding of galvanised components will not be allowed in the equipment.

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

A procedure for the repair of defects shall be submitted to the Engg. Incharge (Divisional Engr.)for his approval prior to any repairs being made.

#### 11.4.3. Welding of pipes

Before welding, the ends shall be cleaned by wire brushing, filing or machine grinding. Each weld-run shall be cleaned of slag before the next run is deposited.

Welding at any joint shall be completed uninterrupted. If this cannot be followed for some reason, the weld shall be insulated for slow and uniform cooling.

Welding shall be done by manual oxy-acetylene or manual shielded metal arc process. Automatic or semi-automatic welding processes may be done only with the specific approval of Engg. Incharge (Divisional Engr.).

As far as possible welding shall be carried out in flat position. If not possible, welding shall be done in a position as close to flat position as possible.

Downward technique is not allowed while welding pipes in horizontal position, unless permitted by the Engg. Incharge (Divisional Engr.).

Combination of welding processes or usage of electrodes of different classes or makes in a particular joint shall be allowed only after the welding procedure has been duly qualified and approved by the Engg. Incharge (Divisional Engr.).

No backing ring shall be used for circumferential butt welds.

Welding carried out in ambient temperature of 5C or below shall be heat treated.

A spacer wire of proper diameter may be used for weld root opening but must be removed after tack welding and before applying root run.

Tack welding for the alignment of pipe joints shall be done only by qualified welders. Since tack welds form part of final welding, they shall be executed carefully and shall be free from defects. Defective welds shall be removed prior to the welding of joints.

Electrodes size for tack welding shall be selected depending upon the root opening.

Tack welds should be equally spaced.

Root run shall be made with respective electrodes/filler wires. The size of the electrodes shall not be greater than 3.25 mm (10 SWG) and should preferably be 2.3 mm (12 SWG). Welding shall be done with direct current values recommended by the electrode manufacturers.

Upward technique shall be adopted for welding pipes in horizontally fixed position. For pipes with wall thickness less than 3 mm, oxyacetylene welding is recommended.

The root run of butt joints shall be such as to achieve full penetration with the complete fusion of root edges. The weld projection shall not exceed 3 mm inside the pipe.

On completion of each run craters, weld irregularities, slag etc. shall be removed by grinding or chipping.

During the process of welding, all movements, shocks, vibration or stresses shall be carefully avoided in order to prevent weld cracks.

Fillet welds shall be made by shielded metal arc process regardless of thickness and class of piping. Electrode size shall not exceed 10 SWG. (3.25 mm). At least two runs shall be made on socket weld joints.

## **12. WIRING, CABLING AND CABLE INSTALLATION**

### **12.1. Cubicle wiring**

Panels shall be complete with interconnecting wiring between all electrical devices in the panels. External connections shall be achieved through terminal blocks. Where panels are required to be located adjacent to each other all inter panel wiring and connections between the panels shall be carried out internally. The Contractor shall furnish a detailed drawing of such inter panel wiring. The Contractor shall ensure the completeness and correctness of the internal wiring and the proper functioning of the connected equipment.



All wiring shall be carried out with **1.1 kV** grade, **PVC** insulated, single core, stranded copper wires. The PVC shall have oxygen index not less than ‘**29**’ and Temperature index not less than **250C**. The wires shall have annealed copper conductors of adequate size comprise not less than three strands. The minimum cross sectional area of the stranded copper conductor used for internal wiring shall be as follows :

- All circuits excepting CT circuits and energy metering circuit of VT 2.5 sq.mm
- All CT circuits and metering circuit of VT 2.5 sq. mm

All internal wiring shall be supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters and troughs shall be used for this purpose.

Cubicle connections shall be insulated with PVC to IEC 227. Wires shall not be jointed or teed between terminal points.

Bus wires shall be fully insulated and run separately from one another. Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panel suite. Longitudinal troughs extending throughout the full length of panel shall be preferred for inter panel wiring.

All inter connecting wires between adjacent panels shall be brought to a separate set of terminal blocks located near the slots of holes meant for the passage of the inter connecting wires. Interconnection of adjacent panels on site shall be straightforward and simple. The buswires for this purposes shall be bunched properly inside each panel.

Wire termination shall be made with solderless crimping type and tinned copper lugs which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. Numbers 6 and 9 shall not be included for ferrules purposes unless the ferrules have numbers underscored to enable differentiation. (i.e. 6 and 9 ).

Fuses and links shall be provided to enable all circuits in a cubicle, except a lighting circuit, to be isolated from the bus wires.

The DC trip and AC voltage supplies and wiring to main protective gear shall be segregated from those for back-up protection and also from protective apparatus for special purposes. Each such group shall be fed through separate fuses from the bus wires. There shall not be more than one set of supplies to the apparatus comprising each group. All wires associated with the tripping circuits shall be provided with red ferrules marked “**Trip**”.

It shall be possible to work on small wiring for maintenance or test purposes without making a switchboard dead.

The insulation material shall be suitably coloured in order to distinguish between the relevant phases of the circuit.

When connections rated at 380 volt and above are taken through junction boxes they shall be adequately screened and “**DANGER**” notices shall be affixed to the outsides of junction boxes or marshalling kiosk.

Where connections to other equipment and supervisory equipment are required the connections shall be grouped together.

## **12.2. LV power cabling**

**LVAC** cable terminals shall be provided with adequately sized, hot pressed, cast or crimp type lugs. Where sweating sockets are provided they shall be without additional clamping or pinch bolts. Where

crimp type lugs are provided they shall be applied with the correct tool and the crimping tool shall be checked regularly for correct calibration. Bi-metallic joints between the terminals and lugs shall be provided where necessary.

Terminals shall be marked with the phase colour in a clear and permanent manner.

A removable gland plate shall be provided by the Contractor. The Contractor shall be responsible for drilling the cable gland plate.

Armoured cables shall be provided with suitable glands for terminating the cable armour and shall be provided with an earthing ring and lug to facilitate connection of the gland to the earth bar.

### **12.3. Multi-core cables and conduit wiring**

External multi-core cabling between items of main and ancillary equipment shall form part of the Contract Works and shall consist of un-armoured multi-core cable with stranded copper conductors PVC insulated and PVC over sheathed complying with the requirements of IEC 227 and 228 as applicable.

Multi-core cable for instrumentation and control purposes shall be supplied with 2.5 mm<sup>2</sup> stranded copper cores. Multi-core cables for CT and VT circuits shall be supplied with two by 2.5 mm<sup>2</sup> stranded copper cores and the cores shall be identified by the phase colour.

Where conduit is used the runs shall be laid with suitable falls and the lowest parts of the run shall be external to the equipment. All conduit runs shall be adequately drained and ventilated. Conduits shall not be run at or below ground level.

Multi-core cable tails shall be so bound that each wire may be traced to its cable without difficulty. All multi-core cables shall be provided with 20 % spare cores and the spare cores shall be numbered and terminated at a terminal block in the cubicle. Where cables are terminated in a junction box and the connections to a relay or control cubicle are continued in conduit, the spare cores shall be taken through the conduit and terminated in the cubicle. The dc trip and ac voltage circuits shall be segregated from each other as shall the circuits to main protective gear be segregated from those for back-up protection.

The screens of screened pairs of multi-core cables shall be earthed at one end of the cable only. The position of the earthing connections shall be shown clearly on the diagram.

All wires on panels and all multi-core cable cores shall be crimped with the correct size of crimp and crimping tool and will have ferrules which bear the same number at both ends. At those points of interconnection between the wiring carried out by separate contractors where a change of number cannot be avoided double ferrules shall be provided on each wire. The change of numbering shall be shown on the appropriate diagram of the equipment. The same ferrule number shall not be used on wires in different circuits on the same panels.

The Contractor shall provide a two (2) metre loop of spare cable at both ends of all multi-core cable runs and shall leave sufficient lengths of tails at each end of the multi-core cables to connect up to the terminal boards. The Contractor shall also strip, insulate, ring through and tag the tails and shall also seal the cable boxes. The Contractor shall be responsible for re-checking the individual cores and for the final connecting up and fitting of numbered ferrules within all equipment provided on this contract.

The drilling of gland plates, supply and fitting of compression glands and connecting up of power cables included in the Contract scope of work shall be carried out under this contract.

### **12.4. Laying and installing of cables**

#### **12.4.1. General**

For cable laying the following shall apply:

- Switchyard area                      In concrete cable troughs (cable trench having cable racks with cable trays)

- Control Room                      On cable racks consisting of slotted type and ladder type cable trays
- Buildings                              Conduits

Directly buried cables shall be used wherever necessary with the approval of Engg. Incharge (Divisional Engr.).

#### 12.4.2. Laying of cable

Cables shall be laid in concrete troughs provided under this contract or drawn into pipes or ducts or on cable racks or directly buried as may be required by the Engg. Incharge (Divisional Engr.). Concrete troughs shall be designed so that the cables are supported on cable support systems and the supports shall be arranged so as to allow the segregation of power, control (including CT and VT circuits) and communications cables onto different layers of cable supports. All cable supports shall be earthed in accordance with IS 3043. The minimum vertical separation between layers of cable tray shall be not less than 300 mm.

The cable support system shall be designed and constructed to carry the required cables without undue crowding of the supports and without overloading the supports. The maximum number of layers of cable that shall be permitted on a single cable support shall be three. The width of the cable supports shall be selected to ensure that the supports are not crowded, the cable supports are not overloaded and that sufficient space is provided in the cable trough to allow for personnel access during and after cable installation. The width of cable supports should not exceed 750 mm.

Cables shall be laid direct in the ground only at the discretion of the Engg. Incharge (Divisional Engr.). All cables laid direct in the ground outside buildings shall be laid in a trench and protected by reinforced concrete slabs or cable tiles.

For auxiliary cables the top of the slab or tile shall be at a depth not less than 300 mm below the surface of the ground and there shall be a layer of fine well packed riddled earth 75 mm thick in between the cable and the bottom of the trench and between the top of the cable and the underside of the slab.

The Contractor shall be responsible for the proper laying of all cables in the ground. Where cables in the same trench are laid over each other, they shall be separated by not less than 75 mm of riddled earth. The riddled earth used for this purpose shall have been passed through a screen having a 12 mm square mesh.

Where cables pass under roadways they shall be laid in pipes at a depth not less than 800 mm below the surface.

The Contractor shall be responsible for the excavation of trenches which shall include all pumping and baling required and the provision of all necessary labour, plant, tools, water, additional soil, fuel or motor power for such purposes.

Cables in trenches will be inspected by the Engg. Incharge (Divisional Engr.) before the trenches are backfilled.

The running of communications and power cables along the same route shall be avoided as far as possible. Where this is not possible they shall be segregated, the one group from the other. Power and communication cables shall be laid in separate tiers. For other than directly buried cables the order of laying of various cables shall be as follows:

- Power cables on top tiers.
- Control/ instrumentation and other service cables in bottom tiers.

#### 12.4.3. Cable tags and markers

Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS 280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

Location of cables laid directly in the ground shall be clearly indicated with cable marker made of galvanised iron plate.

Location of buried cable joints shall be indicated with a cable marker having an additional inscription "**Cable joint**".

Cable markers shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings.

Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct, conduit entry and at every twenty meters (20 m) in cable tray/trench runs. Cable tags shall be provided inside switchgear, motor control centres, control and relay panels etc.. and wherever required for cable identification when a number of cables enter together through a gland plate.

The price of cable tags and markers shall be included in the installation rates for cables/conduits quoted by the Bidder.

#### 12.4.4. Cable supports and cable tray mounting arrangements in control room

The control room will normally be provided with embedded steel inserts on concrete floors/walls for the purpose of cabling in the control room. The supports shall be secured by welding to these inserts or available building steel structures. However, in cases where no such embedded steel inserts are available, the same shall have to be secured to the supports on walls or floors by suitable anchoring .

#### 12.4.5. Cable support structure in switchyard cable trenches

The contractor shall fabricate and install cable support structures in cable trenches. These supports shall be provided at 750 mm spacing along the run of cable trenches.

Cable supports and cable racks shall be fabricated from standard structural steel members, channels, angles and flats of required size. The fabrication, welding and erection of these structures shall conform to the relevant clauses of this Specification, in addition to the specification given herein.

### 12.5. Termination of cables and wires

Where cables leave the apparatus in an upward direction the cable boxes shall be provided with a barrier joint to prevent leakage of cable oil or compound into the apparatus. Where cable cores are liable to contact with oil or oil vapour the insulation shall be unaffected by oil.

PVC sheathed cables shall be terminated by compression glands complying with BS 6121 (or equivalent).

Auxiliary PVC insulated cables shall be terminated with compression type glands, clamps or armour clamps complete with all the necessary fittings.

Colours shall be marked on the cable box, cable tail ends and single core cables at all connecting points and/or any positions the Engg. Incharge (Divisional Engr.) may determine. Cable boxes shall be provided with suitable labels indicating the purpose of the supply where such supply is not obvious or where the Engg. Incharge (Divisional Engr.) may determine.

All cables shall be identified and shall have phase colours marked at their termination.

All incoming and outgoing connections shall be terminated at a terminal block. Direct termination into auxiliary switches will not be accepted.

## 13. DEGREES OF PROTECTION

Degrees of protection shall be provided in accordance with IEC 144 and IEC 529 and be as follows:

- For outdoor applications, IP 55.
- For indoor applications where purpose built accommodation is provided, e.g. switch and control and relay rooms in auxiliary plant buildings, IP 41.
- Where dust can adversely affect equipment within the enclosure, this equipment should be separately housed with a degree of protection of IP 51.
- For indoor applications where the equipment is housed in the same building as that enclosing water and steam operated equipment, the degrees of protection stated in the previous paragraph shall be up-rated to IP 44 and IP 54 respectively.

Where more severe environments exist, e.g. steam and oil vapour or other deleterious chemical environments, special measures will be necessary and the degree of protection required will be specified separately.

The Contractor shall submit a schedule for providing the degree protection to various control boxes, junction boxes etc. for the Engg. Incharge (Divisional Engr.)s approval.

#### 14. SUPPLY VOLTAGE

All incoming supplies of greater than 125 V to earth shall have their termination shrouded by a suitable insulating material.

The auxiliary supply voltages on site shall be as follows:

Nominal Voltage V	Variation	Frequency Hz or DC	Phase	Wires	Neutral Connection
430	±10%	50±5%	3	4	Solidly earthed
240	±10%	50±5%	1	2	Solidly earthed
220	187V - 242V	DC	DC	2	Isolated 2 wires
50	45V - 55V	DC	DC	2	+ve earthed

#### 15. MAINTENANCE TELEPHONE POSITIONS

Telephone jack plug points shall be provided at each circuit breaker, at each power transformer marshalling kiosk and on each control and relay panel. At each substation these plug points are to be connected in parallel to form a site telephone circuit for use during maintenance and testing operations.

#### 16. ERECTION CONDITIONS

##### 16.1. General

The following shall supplement the conditions already contained in the other parts of these specifications and documents and shall govern that portion of the work on this Contract to be performed at Site.

##### 16.2. Regulation of local authorities and statutes

The Contractor shall comply with all the rules and regulations of local authorities during the performance of his field activities. He shall also comply with the Minimum Wages Act, 1948 and the

payment of Wages Act (both of the Government of India and Govt of Orissa ) and the rules made thereunder in respect of any employee or workman employed or engaged by him or his Sub-Contractor.

All registration and statutory inspection fees, if any, in respect of his work pursuant to this Contract shall be to the account of the Contractor. However, any registration, statutory inspection fees lawfully payable under the provisions of the statutory laws and its amendments from time to time during erection in respect of the substation ultimately to be owned by the Employer, shall be to the account of the Employer. Should any such inspection or registration need to be re-arranged due to the fault of the Contractor or his Sub-Contractor, the additional fees to such inspection and/or registration shall be borne by the Contractor.

The Contractor shall ensure that he obtains, from the Government of Orissa, an Electrical Contractor's Licence and a supervisory certificate of the appropriate grade to allow him to execute the electrical works included in the Contract. The Contractor shall ensure that all workmen possess Workman Permits, issued by the Government of Orissa, for engagement in the Contract Works.

### **16.3. Inspection, testing and inspection certificates**

The provisions of the General Conditions of Contract shall also be applicable to the erection portion of the Works. The Engg. Incharge (Divisional Engr.) shall have the right to re-inspect any equipment though previously inspected approved by him at the Contractor's works, before and after the same are erected at Site.

### **16.4. Contractor's field operation**

#### 16.4.1. General

The Contractor shall inform the Engg. Incharge (Divisional Engr.) in advance of field activity plans and schedules for carrying-out each part of the works. Any review of such plans or schedules or methods of work by the Engg. Incharge (Divisional Engr.) shall not relieve the Contractor of any of his responsibilities towards the field activities. Such reviews shall not be considered as an assumption of any risk or liability by the Employer or any of his representatives, and no claim of the Contractor will be entertained because of the failure or inefficiency of any such plan or schedule or method of work reviewed. The Contractor shall be solely responsible for the safety, adequacy and efficiency of plant and equipment and his erection methods.

#### 16.4.2. Progress Report

Progress reports shall be provided by the Contractor to the Engg. Incharge (Divisional Engr.) in accordance with the relevant parts of this specification. Appropriate photographs shall accompany the monthly progress reports.

### **16.5. Facilities to be provided by the contractor**

#### 16.5.1. Unloading

Contractor shall make his own arrangement for unloading the equipment at site.

#### 16.5.2. Tools, tackle and scaffoldings

The Contractor shall provide all the construction equipment tools, tackle and scaffoldings required for offloading, storage, pre-assembly, erection, testing and commissioning of the equipment covered under the Contract. He shall submit a list of all such materials to the Engg. Incharge (Divisional Engr.) before the commencement of pre-assembly at Site. These tools and tackles shall not be removed from the Site without the written permission of the Engg. Incharge (Divisional Engr.).

### **16.6. First-Aid and general hygiene**

The Contractor shall provide necessary first-aid facilities for all his employees, representatives and workmen working at the site. At all times at least ten percent of all Contractors personnel assigned to the worksite shall be trained in administering first-aid.

The labour colony, offices and residential areas of the Contractor's employees and workmen shall be kept clean and neat to the entire satisfaction of the Engg. Incharge (Divisional Engr.). Proper sanitary arrangements shall be provided by the Contractor in work-areas, offices and residential areas of the Contractor.

Waste oil shall be disposed of in a manner acceptable to the Engg. Incharge (Divisional Engr.). Under no circumstances shall waste oil be dumped into uncontrolled drains.

### **16.7. Security**

The Contractor shall have total responsibility for all equipment and material in his custody, stored, loose, semi-assembled and/or erected by him at Site. The Contractor shall make suitable security arrangements including employment of security personnel to ensure the protection of all materials, equipment and works from theft, fire, pilferage and any other damages and loss.

### **16.8. Materials handling and storage**

All the equipment furnished under the Contract and arriving at Site shall be promptly received, unloaded and transported and stored in the stores by the Contractor.

Contractor shall be responsible for examining the complete shipment and notifying the Engg. Incharge (Divisional Engr.) immediately of any damage, shortage, discrepancy etc. for the purpose of Engg. Incharge (Divisional Engr.)'s information only. The Contractor shall submit to the Engg. Incharge (Divisional Engr.) every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages during transit, handling, storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

The Contractor shall maintain an accurate and exhaustive record detailing all equipment received by him for the purpose of erection and keep such record open for the inspection of the Engg. Incharge (Divisional Engr.).

All equipment shall be handled carefully to prevent any damage or loss. All equipment stored shall be properly protected to prevent damage. Equipment from the store shall be moved to the actual location at an appropriate time so as to avoid damage of such equipment at Site.

All the materials stored in the open or dusty location shall be covered with suitable weather-proof and flameproof covering material.

The Contractor shall be responsible for making suitable indoor facilities for the storage of all equipment which requires to be kept indoors.

## **17. CONSTRUCTION MANAGEMENT**

### **17.1. General**

Time is the essence of the Contract and the Contractor shall be responsible for performance of his Works in accordance with the specified construction schedule. If at any time the Contractor is falling behind the schedule, he shall take necessary action to make good for such delays by increasing his work force or by working overtime to accelerate the progress of the work and to comply with schedule and shall communicate such actions in writing to the Engg. Incharge (Divisional Engr.), providing evidence that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

### **17.2. Field office records**

The Contractor shall maintain at his Site office up-to-date copies of all drawings, specifications and other supplementary data complete with all the latest revisions thereto. The Contractor shall also maintain in addition the continuous record of all changes to the above contract documents, drawings, specifications, supplementary data, etc. effected at the field. On completion of his total assignment

under the Contract, such drawings and engineering data shall be submitted to the Engg. Incharge (Divisional Engr.) in the required number of copies.

### **17.3. Protection of property and Contractor's liability**

The Contractor will ensure provision of necessary safety equipment such as barriers, sign-boards, warning light and alarms, personal protective equipment etc. to provide adequate protection to persons and property. The Contractor shall be responsible for giving reasonable notice to the Engg. Incharge (Divisional Engr.) and the owners of public or private property and utilities when such property and utilities are likely to be damaged or injured during the performance of his works, and shall make all necessary arrangements with such owners, related to removal and/or replacement or protection of such property and utilities.

## **18. CODE REQUIREMENTS**

The erection requirements and procedures to be followed during the installation of the equipment shall be in accordance with the relevant Indian/International Standards/Regulations, ASME codes, accepted good engineering practice, drawings and other applicable Indian codes and laws and regulations..

## **19. EMPLOYER'S SUPERVISION**

To eliminate delays and avoid disputes and litigation, it is agreed between the Parties to the Contracts that all matters and questions shall be referred to the Employer and without prejudice the Contractor shall proceed to comply with the Employer's decision.

The work shall be performed under the direction and supervision of the Engg. Incharge (Divisional Engr.). The scope of the duties of the Engg. Incharge (Divisional Engr.), pursuant to the contract, will include but not be limited to the following:

- Interpretation of all the terms and conditions of these documents and specifications.
- Review and interpretation of all the Contractors drawing, engineering data etc.
- Witness or authorise his representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the Contract.
- Inspect, accept or reject any equipment, material and work under Contract.
- Issue certificate of acceptance and/or progressive payment and final payment certificates.
- Review and suggest modification and improvements in completion schedules from time to time.
- Supervise the Quality Assurance program implementation at all stages of the Works.

## **20. TESTING AND INSPECTION**

The Contractor shall carry out the tests stated in accordance with the conditions of this Specification, without extra charge for such additional tests as in the opinion of the Engg. Incharge (Divisional Engr.) are necessary to determine that the Contract Works comply with this Specification. The tests shall be carried out generally in accordance with the relevant IEC's or IS or equivalent standards. The specific details of testing and inspection are given in the appropriate section of this Specification.

The Contractor shall submit Type Test Reports for all equipment being supplied by him for the Engg. Incharge (Divisional Engr.)'s approval. The Engg. Incharge (Divisional Engr.) may also give instruction to carry out Type Tests, routine tests or acceptance tests. Type Test Charges shall be paid as per the rates indicated in the Price Schedules.



All materials used shall be subjected to such routine tests as are customary in the manufacture of the types of plant included in the Contract Works. These materials shall withstand satisfactorily all such tests.

All tests shall be carried out to the satisfaction of the Engg. Incharge (Divisional Engr.), in his presence, at such reasonable times as he may require, unless agreed otherwise. Not less than three weeks notice of all tests shall be given to the Engg. Incharge (Divisional Engr.) in order that he may be represented if he so desires. As many tests as possible shall be arranged together. Six copies of the Contractor's test reports and test sheets shall be supplied to the Engg. Incharge (Divisional Engr.) for approval.

Measuring apparatus shall be approved by the Engg. Incharge (Divisional Engr.) and if required shall be calibrated at the expense of the Contractor at an approved laboratory.

The Contractor shall be responsible for the proper testing of the work completed or plant or materials supplied by a sub-contractor to the same extent as if the work, plant or materials were completed or supplied by the Contractor himself.

All apparatus, instruments and connections required for the above tests shall be provided by the Contractor, but the Engg. Incharge (Divisional Engr.) may permit the use for the tests on site, any instruments and apparatus which may be provided permanently on site as part of the contract works conditional upon the Contractor accepting liability for any damage which may be sustained by such equipment during the test.

The contractor shall supply suitable test pieces of all materials as required by the Engg. Incharge (Divisional Engr.). If required by the Engg. Incharge (Divisional Engr.), test specimens shall be prepared for check testing and forwarded at the expense of the Contractor to an independent testing authority selected by the Engg. Incharge (Divisional Engr.).

Any costs incurred by the Employer in connection with inspection and re-testing as a result of a failure of the subject under test, or damage during transport, or erection on site before take-over by the Employer, shall be to the account of the Contractor.

No inspection or lack of inspection or passing by the Engg. Incharge (Divisional Engr.) of work, plant or materials, whether carried out or supplied by the Contractor or sub-contractor, shall relieve the Contractor from his liability to complete the Contract Works in accordance with the Contract or exonerate him from any of his guarantees.

## **21. FIRE PRECAUTIONS**

All apparatus, connections and cabling shall be designed and arranged to minimise the risk of fire and any damage which might be caused in the event of fire. When cabling is carried out as part of this Contract the Contractor shall be responsible for sealing all holes in floors, walls, roofs etc. through which the cabling may pass.

The work procedures that are to be used during the erection shall be those which minimise fire hazards to the maximum extent practicable. Combustible materials, combustible waste and rubbish shall be collected and removed from the site at least once each day. Fuels, oils and volatile or flammable materials shall be stored away from the construction site and equipment and material stores in appropriate safe containers.

All Contractor's supervisory personnel and at least ten percent all of workers shall be trained for fire-fighting and shall be assigned specific fire protection duties. At least ten percent of all personnel assigned to site at any one time shall be trained for fire fighting.

The contractor shall provide sufficient fire protection equipment of the types and sizes for the warehouses, office temporary structures, labour colony area etc.. Access to such fire protection equipment shall be easy and kept open at all time.

## **22. PACKING, SHIPPING AND TRANSPORT**

The Contractor shall be responsible for the packing, loading and transport of the plant and equipment from the place of manufacture, whether this is at his own works or those of any Contractor, to Site, and for off-loading at site.

All apparatus and equipment shall be carefully packed for transport by air, sea, rail and road as necessary and in such a manner that it is protected against tropical climate conditions and transport in rough terrain and cross country road conditions. The method of packing shall provide complete protection to all apparatus and equipment during transport and storage at site in heavy rain. The method of packing shall provide adequate protection to main items of plant and those parts contained within and attached without, for transportation.

Precautions shall be taken to protect parts containing electrical insulation against the ingress of moisture.

All bright parts liable to rust shall receive a coat of anti-rusting composition and shall be suitably protected. The machined face of all flanges shall be protected by means of a blank disc bolted to each face.

Where appropriate all parts shall be boxed in substantial crates or containers to facilitate handling in a safe and secure manner. Each crate or container shall be marked clearly on the outside of the case to show "TOP" and "BOTTOM" positions with appropriate signs, and where the mass is bearing and the correct position for slings. Each crate or container shall also be marked with the notation of the part or parts contained therein, contract number and port of destination. It shall be the Contractor's responsibility to dispose of all such packing.

Any damage due to defective or insufficient packing shall be made good by the Contractor at his own expense and within reasonable time when called upon by the Engg. Incharge (Divisional Engr.) to do so. Four (4) copies of complete packing lists showing the number, size, marks, mass and contents of each package shall be delivered to the Engg. Incharge (Divisional Engr.) immediately the material is despatched.

The Contractor shall inform himself fully as to all relevant transport facilities and requirements and loading gauges and ensure that the equipment as packed for transport shall conform to these limitations. The Contractor shall also be responsible for verifying the access facilities specified.

The Contractor shall be responsible for all costs of repair or replacement of the equipment, including those incurred by the Employer, arising from damage during transport, off-loading or erection on site, until take-over by the Employer.

The Contractor shall be responsible for the transportation of all loads associated with the contract works and shall take all reasonable steps to prevent any highways or bridges from being damaged by his traffic and shall select routes, choose and use vehicles and restrict and distribute loads so that the risk of damage shall be avoided. The Contractor shall immediately report to the Engg. Incharge (Divisional Engr.) any claims made against the Contractor arising out of alleged damage to a highway or bridge.

## **23. ERECTION MARKS**

Before leaving the Contractor's Works all apparatus and fittings shall be painted or stamped in two places with a distinguishing number and/or letter corresponding to the distinguishing number and/or letter on an approved drawing and material list. All markings shall be legible; weatherproof tags, where used, shall be durable, securely attached and duplicated

The erection marks on galvanised material shall be stamped before galvanising and shall be clearly legible after galvanising.

## **24. SPANNERS AND SPECIAL TOOLS**

A complete set of spanners shall be supplied for each station to fit every nut and bolt head on the apparatus supplied under this Contract, together with all special tools required for the adjustment and maintenance of the equipment. These tools shall be mounted in a lockable cabinet at each substation, also to be provided under this Contract. Eye bolts which have to be removed after use shall be accommodated in the cabinets.

Spanners and other maintenance equipment provided under the Contract shall not be used for the purpose of erection of the contract Works.

Any special devices, slings or tackle necessary for the complete overhaul of the plant shall be handed over to the Engg. Incharge (Divisional Engr.) in working order on completion of the Contract.

On delivering any or all of these tools to the Engg. Incharge (Divisional Engr.), a signature shall be obtained from the Engg. Incharge (Divisional Engr.)'s representative. Any tools not signed for shall be deemed not to have been delivered.

## **25. RUNWAY BEAMS, EYE BOLTS AND LIFTING TACKLE**

Runway beams shall comply with the requirements of BS 2853, or its equivalent, and shall be tested after erection in accordance with this standard and this Specification. The Contractor shall be responsible for the provision of the appropriate test certificates which must be in accordance with Appendix C of BS 2853.

All slings, eye bolts and other lifting tackle provided shall be proof tested to twice the safe working load and suitably marked with embossed labels to show clearly the safe working loads.



ODISHA POWER TRANSMISSION CORPORATION LIMITED

COMMON DOCUMENT

**TECHNICAL SPECIFICATION**

**FOR**

**SYSTEM DATA**

**SYSTEM DATA**

Sl.No	Description of Technical Parameter	Unit	System			
1	Nominal system voltage	kVrms	<b>400kV</b>	<b>220kV</b>	<b>132kV</b>	33kV
2	Maximum system voltage	kVrms	<b>420kV</b>	245kV	145kV	36.kV
3	Power frequency with stand voltage	kVrms	<b>630kV</b> <b>520kV</b>	460kV	275kV	70kV
4	Switching surge withstand voltage (for 250/2500µs 1. Line to earth 2. Across isolating gap	kVp	<b>1050kVp</b> <b>900kVp+345</b> <b>kV<sub>rms</sub></b>	Not applicable	Not applicable	Not applicable
5	Lightning impulse withstand voltage 1. Line to earth 2. Across isolating gap	kVp (for 1.2 /50µs)	<b>1425kVp</b> <b>1425kV<sub>p</sub>+</b> <b>240kV<sub>rms</sub></b>	1050kVp 1200kV <sub>p</sub>	650kVp 750kV <sub>p</sub>	<b>170kVp</b> <b>195kV<sub>p</sub></b>
6	One minute power frequency withstand value	Dry kV <sub>rms</sub> Wet kV <sub>rms</sub>	<b>630</b> <b>610</b>	460 530	275 315	70 80
7	System frequency	Hz	<b>50</b>			
8	Variation in frequency	%	<b>±2.5</b>			
7	Corona extinction voltage		<b>320kV</b>	156kV	105kV	
8	Radio interference voltage		<b>500µV at</b> <b>266KV</b>	500µV at 167KV	1000µV at 93KV	
9	System neutral rating		<b>Solidly earthed</b>			
10	Continuous current rating		<b>2000A</b>	2000A	1250A	800A
11	Symmetrical short circuit current	kA	<b>63/40</b>	40	31.5	25
12	Duration of short circuit fault current	Second	<b>1</b>	1	1	3
12	Dynamic short circuit current rating	kAp	<b>157.5/100</b>	100	79	62.5kA
13	Air clearances Phase to ground Phase to phase System to system within a phase	meters meters meters meters	<b>3.5</b> <b>4.2</b> -	2.1 2.4 -	1.3 1.3	480 530
14	Conductor spacing for AIS layouts Phase to ground Phase to phase	meters meters meters	<b>6.5</b> <b>7.0</b>	4.5 4.5	3 3	1.5 1.5
15	Design ambient temperatures	°C	<b>50</b>			
16	Pollution level as per IEC-815 and 71		<b>III</b>			
17	Creepage distance	mm	<b>10500</b>	6125	3625	900
18	Maximum fault clearing time	ms	<b>≤100</b>	not exceeding ≤100ms		not exceeding ≤150ms

19	Safety clearances					
	1. Section clearance	metres	6.5	5	4	4
	2. Ground clearances( between ground and bottom most part of energised object)	metres	8	5.5	5	4
	3. Horizontal clearance between the fence and energised object	metres	As per I.E. Rules	As per I.E. Rules	As per I.E. Rules	As per I.E. Rules
4. Horizontal clearance between the road centre line and energised part of the nearby equipment	metres	As per I.E. Rules	As per I.E. Rules	As per I.E. Rules	As per I.E. Rules	
20	Bay width	metres	27	18	11-13.1	5.5
21	Height of bus equipment interconnection from ground	metres	8	5.5	5	4
22	Height of strung busbar	metres	>15	10.5	8.5	5.5



**ODISHA POWER TRANSMISSION CORPORATION LIMITED**

**TECHNICAL SPECIFICATION**

**FOR**

**GENERAL METEOROLOGICAL**

**DATA**

## METEROLOGICAL DATA

<b>Description</b>	<b>Data</b>
Annual mean of maximum monthly average temperature.	50
Annual mean of minimum monthly temperature in °C	5
Average rain fall in mm	1500
Average thunder storms days per year	77days
Design ambient temperature in °C	50
Maximum wind velocity in meter/sec.	50
Maximum relative humidity in %	100
Average relative humidity in %	85
Seismic co-efficient	0.06g Hori 0.01g Vert





**ODISHA POWER TRANSMISSION CORPORATION LIMITED**

**TECHNICAL SPECIFICATION**

**FOR**

**DESIGN CLAUSES FOR SUBSTATIONS**

**DESIGN CLAUSES FOR SUBSTATIONS**  
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## **1. 0 GENERAL**

The substation shall adopt switching scheme as shown on the attached single line diagrams. The Contractor shall propose the most economical substation layout that meets the desired degree of operational flexibility, reliability, service continuity and expandability. The contractor shall submit design considerations establishing the above and proposals for the Engg Incharge (Divisional Engr.) approval. The attached drawings are intended to show the basic requirements to be satisfied, i.e. switching arrangement, number of busbars, site location, available area, line termination etc. It is the responsibility of the Contractor to prepare a detailed layout showing the manner in which the various items of equipment offered can be accommodated to best advantage within the available area.

The arrangement shown on the attached drawings may be modified as necessary to accommodate the various items, e.g. different types of disconnecter, provided the basic principles are maintained.

The Bidder is at liberty to offer substation arrangements based on significantly different principles where it is considered that these offer economies or technical advantages. It is emphasised, however, that the Bidder's main offer should comply with the principles shown in the attached drawings, other arrangements being submitted solely as alternatives to the main offer.

## **2. 0 DESIGN PARAMETERS - OPEN TERMINAL**

The substation design should be such as to minimise the number of levels of conductors and to ensure that the consequences of a failure of one set of high level conductors are limited to the loss of that circuit and a single busbar section. This principle shall also be applied with regard to earth wire conductors. All materials and equipment for use in the substation shall be suitably rated to meet the site conditions specified in the schedules.

All gantry type structures supporting conductors shall include facilities for ready access to all insulator sets. There shall be permanently attached climbing devices with guard-rails and access to high level beams shall not be possible without proper authorisation. Safety screens shall be provided between adjacent circuits to maintain the specified safety clearances and to prevent accidental access to live circuits.

Vehicle access to permit the transport of major switchgear equipment shall be provided. This shall be achieved without the need to de-energise circuits. Access for vehicles which require the de-energisation of circuits shall be kept to a minimum and avoided wherever possible.

Each substation shall be adequately protected against direct lightning strikes, either by the use of spikes or earth wires located on the substation structures, the use of spikes is preferred. The height, location, and number of spikes or earth wires shall be such as to protect all equipment installed within the substation to a failure rate of shielding from direct lightning strikes of not greater than 0.1 per cent per annum.

Where the connection to the substation is by overhead line, overhead line conductors will be terminated either at the substation gantry structures or to anchor blocks adjacent to the overhead line terminal towers. The overhead line conductors complete with tension insulators, line tee off clamps, and compression fittings (bi-metallic where necessary) shall be supplied and erected under a separate contract. The Contractor shall provide facilities on the gantry structure for the fixing of the tension insulators and arrange branching of conductors in to the sub-station from the transmission line conductors.

The overhead line earth wire will be extended into the substation and the substation gantry structure shall be arranged to receive this.

Where line traps are to be located within the substation, these should preferably be mounted integrally with the coupling capacitor. Should this be impracticable, then the use of post type insulators is preferred to suspension mounting.

Where disconnectors are of the pantograph type, the contact arrangements shall cater for conditions of maximum wind loading coincident with either the maximum or minimum ambient temperature and shall conform to the requirements of IEC 129. The Contractor shall also establish, through calculations, the length of arm of each pantograph isolator so that the contact is proper and robust. The Contractor shall also provide the required size and number of sag compensating springs where necessary.

Sub-station equipment, structures, roads, concrete cable troughs, drains etc.. shall be laid out in a neat and organised manner to meet the employers requirement, facilitate movement of vehicles and ensure safety of personnel and equipment.

Each substation shall be provided with safety grounding mat as per clause relevant clauses of this section. While designing the ampacity of the buried conductor suitable corrosion allowance shall be considered for thirty five (35) years. The conductors shall be buried at a depth of 700 mm from finished formation level. The conductors shall be welded suitably for maintaining a high degree of mechanical rigidity and electrical connectivity.

The substation earth mat shall be designed to provide a ground potential rise within safe limits of tolerable touch and step potential. The margins of limits shall confirm the international practices. The design of earthmat shall be in accordance with IEEE-80/1986 and shall be submitted for Engg Incharge (Divisional Engr.) approval.

### **3.0 BUSBAR CONSTRUCTION.**

Busbars shall be made of aluminium tubes in 400 KV side and connection from equipment to equipment & the top bus shall be twin ACSR Moose conductor. Bus bars of aluminium tube in 220 KV side (wherever specifically asked for) or ACSR conductor (**Main Buses shall be Twin Moose ACSR conductor and Reserve /Transfer Bus shall be single Moose ACSR conductor**) and aluminium tube for connection from equipment to equipment . The bus bar capacity shall be designed for maximum ambient temperature conditions and symmetrical short circuit condition of 63 KA for 400 KV side 40kA for 220 KV & 132 KV side. The continuous current rating shall be so designed that no portion of the bus bar is unduly loaded, or over heated. For EHV sub-stations, the bus bar and bus bar fittings shall be made corona free by the provision of corona rings or corona bells. There shall not be any harmful RIV from the constructed bus bars .

Tubular bus bars shall be mounted on support insulators of adequate strength, mounted on support structures above the ground in upright position, or hang from the structures depending upon the chosen lay out.

Strain bus bars shall be made bundled wherever necessary to carry the rated maximum continuous current. The bundle size shall be determined by the Contractor to make such that it is corona free, and fitted with spacers to limit the snatch forces such that no dangerous tensions are passed on to the structures.

Interconnections to equipment shall be made from aluminium tubes or suitable flexible ACSR conductors, through clamps and connectors only. Jumpers shall be made from flexible ACSR conductors only.

There shall be no conductor joints in a span of strung strain busbars. Tubular busbars shall have a maximum of one welded joint and shall be designed for thermal stresses and linear expansion, due to temperature, so as to relieve the support structure and busbar fittings from stress.

The Contractor shall submit design calculations in support of the various dimensions of the busbar for Engg Incharge (Divisional Engr.) approval.

The busbar deflection in respect of tubular busbars shall not exceed 50% of diameter. The stranded conductor sag shall not exceed 1/80th of conductor span.

### 3. 0 PROVISION OF EARTH SWITCHES

The earth switches shall be provided liberally in compliance to Indian Electricity Rules and as per latest recommendations of CBIP Manual on EHV substations.

However the Employer's practice is to provide earth switches with disconnecter on busbar side and feeder side of the circuit bay for all voltage class substations. For 400kV class substations earth switches shall also be provided with disconnectors on circuit breaker side. In case the Electrical Inspectorate requires provision of any further earth switches the same shall also be provided by the Contractor.

Additional cost payable on account of providing such earth switches shall be mutually agreed between the Contractor and the Employer on the basis of rates quoted by him for spare parts.

Each substation shall be provided with sufficient number of portable earth switches so as to carry out maintenance works for at least two circuit bays.

### 4. 0 INTERLOCKING

#### 4.1 General

The applicable recommended interlocking facilities of IEC 517 shall be provided. Padlocking to the requirements of this specification shall be provided for operational and maintenance security.

Earth switches on line circuits shall be capable of interrupting the current induced in the line at the voltage specified in the schedules. This current may arise by induction from a fully loaded line in parallel with the earthed line. If earth switches without the rated breaking capacity are provided, the interlocking arrangements shall ensure the interruption of this induced current by the circuit breaker before the earth switch is opened. Interlocking facilities shall be provided to release the circuit breaker for maintenance whilst maintaining the earthing of the incoming line.

#### 4.2 Philosophy

All disconnecting and earthing devices within the substation shall be interlocked in a manner that ensures that they always operate safely. The system employed shall satisfy two distinct categories:

- **Operational interlocking:** Interlocking associated with normal system operation and switching and intended to ensure that a predetermined switching sequence is satisfied. Such interlocking shall be achieved by electrical means in a manner that permits the equipment to perform any safe operation.
- **Maintenance Interlocking:** Interlocking associated with a series of switching operations to render the equipment or sections of the substation safe for access and maintenance by personnel. Such interlocking shall be achieved by mechanical interference type interlocks.

#### 4.3 Principles

The design of the interlocking scheme shall be based upon the following principles:

- a) Dis connectors are capable of switching the capacitive currents of associated connections.
- b) Circuit breakers shall not be used as a point of safety isolation, this is the function of a disconnecter.
- c) Dis connectors have neither load making nor breaking capacity.
- d) Dis connectors are not capable of making or breaking transformer magnetising current.
- e) Dis connectors are capable of the duty imposed when operated under parallel switching conditions.

- f) It shall not be possible to close or open any earth switch unless the point of application is disconnected from all possible sources of supply, and the power operating devices of such disconnectors are selected to the local control position.
- g) It shall not be possible to operate any disconnector unless its associated circuit breaker is open.
- h) It shall not be possible to operate any disconnector if an associated earth switch is already closed.
- i) Disconnectors concerned with supplies from a remote point cannot be fully interlocked and shall carry a warning notice to this effect. Similar notices shall be applied to earth switches.

## **5. 0 DESIGN PHILOSOPHY FOR PROTECTION, CONTROL AND METERING SYSTEM**

### **5.1 Protection Philosophy.**

The control and protection system shall be closely inter related in the sub-station.

The protection system shall be designed for the fault clearing time, so that it prevents or limits damage to primary equipment of the transmission system, and stability of the power system shall be protected. The main protective system shall be capable of tripping (excluding circuit breaker operating time ) within 10 - 50ms. However, in any case the fault clearing time from the instant of inception of fault to completion of the circuit breaker operation shall not exceed 100ms for 400kV and 220kV systems, 120ms for 132kV system and 150ms for 33kV system. Operating time of breakers to be provided by the Employer are 40ms for 400kV, 50ms for 220kV, 50 ms for 132kV and 60 to 85ms for 33kV.

The protection system shall generally be a dedicated system organised at bay level for lines, transformers etc., and at sub-station level for bus bar and breaker failure protection .

In the highest range of protection functions the protection unit and function shall be segregated as much as possible. The protection shall not be compromised in any way by the requirements of the other functions. The protection shall be permanently on line and shall be capable of tolerating faults in both the hardware and software at bay level and sub-station level. The system shall be so designed that in the event of loss of communication between the bay level and sub-station level, the continuity of protection function shall be ensured.

The protection sub-system (relays ) should communicate with control and monitoring system to provide information regarding operation, faulted phase, settings etc.. Information should also be available at station computer level and for transmission to LDC via SCADA.

The protection system may also include new designs of protective relays incorporated with features such as auto reclosing, fault recording , fault locating and synchronising check.

The recommended protection arrangement for different bays shall be in accordance with the protection single line diagrams attached to this Specification.

Busbar protection systems shall be designed to initiate immediate tripping of all circuit breakers connected to the faulted section of the busbar. In the event of non operation of a circuit breaker of a bay all the circuit breakers connected to the associated busbar shall trip under breaker failure protection.

### **5.2 Control Philosophy.**

The control function of the sub-station shall be the following:

- Control — Operation ( switching on or off or position change)
- Control — Monitoring ( alarms, annunciation, indication etc.)

The system shall efficiently perform the operation of circuit breakers, isolators, tap changers etc.. It shall also perform the interlocking at bay level as well as substation level. The control system shall be

suitable for operating manually, electrically (remote) and via SCADA system from a remote control centre.

Control shall be achieved at bay level, substation level and remote control centre level through conventional MMI or computer based automated system, as specified in this Specification.

The system shall be designed, along with the communication system so that there shall be high availability of bay protection associated with automatic functions such as auto reclosing. The systems shall function autonomously and independently of adjacent bays, substation functions and units etc.

## **6. 0 EARTHING SYSTEM**

Electrical measurements of the subsoil at various depths up to 20 metres shall be made at the site of each substation in order to determine the layered effects of the ground from which the effective ground resistivity and hence the expected resistance of the proposed earth grid system may be predicted. Wagner's 4 - Electrode method as per IEEE-Std 81 may be followed for measurement of earth resistivity.

The earthing system shall comprise a mesh grid formed by hot dip galvanised iron flat bar (GI flat) of 75 X 10 mm (for 220/132 KV & 132/33 KV) and 40 mm MS rod (for 400 KV) buried directly in the ground and arranged so as to utilise fully the available site area. A continuous conductor shall be laid outside the periphery of the substation site at a distance of two metres from the switchyard fence and at a depth of at least 0.7 metres (the earth mat top shall be at 700 mm below the finished ground level) below the surface. A mesh system shall be formed by interconnection at various points to the perimeter conductor. The distance between two buried earth mat (flat/rod) shall be maximum 5 meters both way. The mesh system shall be designed such that the grid potential rise limits the touch voltage to a value not greater than the maximum tolerable touch potential; the fault clearance time to be used in the earthing calculations shall be taken as one second.

The earthing system shall be designed to meet the requirements of this specification and shall be in accordance with IEEE 80 and IS 3043. The Contractor shall present calculations to show the earthing system meets these requirements and can be shown to be safe in terms of touch, step and transferred potentials. The calculations shall be carried out considering a layer of crushed metals of thickness 100mm and without the same; and if applicable recommend suitable site surfacing. The resistance of the earth mat shall not exceed  $0.5\Omega$ .

In the event of the substation resistance obtained with the foregoing installation being of a magnitude unacceptable to the Engg Incharge (Divisional Engr.), then where practicable, the ground area enclosed by the earth system should be increased by installing directly in the ground a GI flat /MS rod conductor in the form of a ring around the site at a significant distance from the boundary fence. Alternatively, earth conductors can be directly buried radially outside the substation perimeter fence. The use of earth plates as current carrying electrodes is not acceptable.

The earthing system shall be designed so as to include all overhead line terminal towers, which shall be earthed by extending the system so as to envelope all towers within the earth system. Each tower shall be bonded directly to the earth system from at least two locations. Structures and masts for lighting and security surveillance equipment shall also be within the perimeter of the earth grid. No fixed low voltage equipment, with the exception of a warning or alarm button and intruder alarms which shall be of the double insulation type, shall be erected outside the perimeter of the earth grid.

Where a metal substation fence is provided, this shall be bonded electrically to the earthing grid on each side at spacing not exceeding  $0.25r$  (where  $r$  is the equivalent circular plate radius), at points adjacent to each corner and immediately below any overhead line entering or leaving the Site. The location of the mesh conductors shall be such as to enable all items of equipment to be connected to the earth system via the shortest possible route.

Gate posts forming part of the substation fence shall be bonded together with below ground connections and the gates themselves shall be electrically bonded to the posts at two points through flexible braids.

The current density of the earth conductor shall be not greater than  $100A/mm^2$ . Single connections between equipment and the earth system shall carry the total short circuit current, but the cross sectional area of branch connections may be reduced to take account of current distribution in two or more conductors. A distribution of 60 per cent shall be assumed for this purpose, i.e. the cross sectional area of branch connections may be reduced to 60 per cent of the corresponding single conductor.

The earth conductor may be sized as per IEEE 80 and sufficient allowance for corrosion may be taken in to account.

The grid voltage rise under fault conditions shall not exceed 15 kV. If the calculated grid voltage rise exceeds 430V, the local Telephone Authority shall be advised, by the Contractor, of the grid voltage rise and the distance of the 650V contour from the substation grid periphery.

The alternative approach of independently earthing the fence and placing it outside the earth grid area shall only be adopted if the above mentioned procedures prove insufficient or impracticable. The Contractor shall provide calculations to show that this approach produces safe touch voltages at the fence and shall ensure that the fence is isolated from all other buried metalwork.

Metal parts of all equipment, other than those forming part of an electrical circuit, shall be connected directly to the main earth system at two points. For the same the size of the G.I flats shall also be 75X10mm. This is the raiser of the earth to the structures of column, beam and all equipment structures. The arrangement of the mesh earth system shall be such as to minimise the length of these connections.

A separate set of earth electrodes (at least two), GI pipe, perforated, 50mm dia, heavy duty having 3000mm long in a treated earth pit, shall be provided for the earthing for high frequency coupling equipment (CVT etc), surge arresters, IVT, each neutral of the transformers and reactors at a position immediately adjacent to the equipment being earthed in addition to the normal earth connection.

All main members of structural steelworks shall be earthed by GI flat(size 75X10mm) earthing connections being bonded to the steelworks. The Contractor shall be responsible for earthing of the transformers and circuit breakers installed on the substation site as per recommended.

Connections to apparatus and structures shall be made clear of ground level, preferably to a vertical face and protected against corrosion.

Earth bars installed directly into the ground should normally be laid bare and the trench back-filled with a fine top soil. Where the soil is of a hostile nature, precautions must be taken to protect the earth bar.

All exposed joints shall be at a minimum height of 150 mm above floor or ground level.

A facility shall be provided on the earth bar run between the equipment and the base of the structure, comprising a looped copper strip(test link), so as to permit the attachment of portable earth connections for maintenance purposes.

After installation of the earth system the Contractor shall measure the resistance of the substation. The method used shall preferably be the "fall of potential" method, requiring the availability of a local low voltage supply, but other methods using an earth resistance meter will be acceptable in the event of a local supply being unavailable.

The fencing of the switch yard also to be earthed by using G.I flats of size 75X10mm to each post and a continuous earth strip of size 50X6mm shall run all through the fence. The periphery of the switch yard shall be provided with non-treated earth pit at a distance of 5 mtrs all along the periphery. The size of the non-treated pit conductor shall be 40 mm dia MS rod of length 3000mm. The said earth MS Rod to be placed in earth pit as per standard practice and the pit shall be filled with Bentonite powder mixed with lomy soil at a ratio 1:10. There shall be provision of watering into the earth pits. A pipe of adequate size should run all along the periphery and outlets shall be provided to each pit. The pipe shall be connected to the overhead tank provided on the control room building and proper water control valve should be provided. Contractor shall prepare a detail earthing provision considering as per specification and shall obtain approval from OPTCL and the top of the MS rod shall be welded to the buried earth mats.





**ODISHA POWER TRANSMISSION CORPORATION LIMITED**

**TECHNICAL SPECIFICATION**

**FOR**

**CIVIL WORKS**

# CIVIL WORKS

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## **1. GENERAL**

### **1.1 Scope of work**

The scope of Civil works includes the following items.

The scope shall generally cover switch yard structures, including gantries and equipment support structures and their foundations, cable trenches along with covers, cable trench crossings of road and rails, sump pits, marshalling box/control cubicle foundations, switch yard levelling, site clearance, soil investigation, roads, drains, fencing, gravel filling, transformer / reactor foundations, firewalls, control room building, other auxiliary buildings. Any other items, not specifically mentioned here but required for the commissioning of switch yard/substation shall be deemed to be included in the scope of this Specification. The scope shall further cover design, engineering, erection, testing and commissioning of all civil works at each substation. All civil works shall also satisfy the General Technical Clauses specified in other sections of this specification and as detailed below.

Excavation, de watering, carriage of excavated earth, plain cement concrete (PCC), casting of reinforced cement concrete (RCC) foundations, super-structures for switch yard structures, equipment supports, their control cubicles, bus post supports, lighting poles and panels, brick and stone masonry, cable trenches, pipe trenches with necessary pre cast RCC removable covers, with lifting facility and sump pits, cable supports and their embodiment in cable trenches and cable trench crossings road or rail track with backfilling complete as per drawings approved by the OPTCL, shall be carried out by the contractor. The cable trenches inside the control room shall be provided with MS chequered plate with angle stiffeners at the bottom for mechanical strength and painting there of as per the standard practice.

The Contractor shall furnish all designs, (unless otherwise specified) drawings, labour, tools, equipment, materials, temporary works, constructional plant and machinery, fuel supply, transportation and all other incidental items not shown or specified but as may be required for complete performance of the Works in accordance with approved drawings, specifications and as per direction of the Engg Incharge (Divisional Engr.).

The work shall be carried out according to the design/drawings to be developed by the Contractor, and approved by the Engg Incharge (Divisional Engr.) or supplied to the bidder by the Engg Incharge (Divisional Engr.). For all buildings, structures, foundations etc. necessary layout, levels and details shall be developed by the Contractor keeping in view the functional requirement of the plant and facilities and providing enough space and access for operation, use and maintenance based on the input provided by the Engg Incharge (Divisional Engr.). Certain minimum requirements are indicated in this specification for guidance purposes only. However, the Bidder shall quote according to the complete requirements.

## **2.0 SITE CLEARANCE**

### **2.1 Clearing and Grubbing**

The work shall consist of numbering of trees, removing and disposing of all materials such as trees, bushes, woods, shrubs, grass, stumps, rubbish, rank vegetation, roots, foreign materials, etc., which in the opinion of the Engg Incharge (Divisional Engr.) are unsuitable for incorporation in the works, from within the limits and such other areas as may be specified on the drawings or directed by the Engg Incharge (Divisional Engr.). Clearing and grubbing shall be performed in advance of earthwork operations and in accordance with the requirements of these Specifications. During clearing and grubbing, the contractor shall take all adequate precautions against soil erosion, water pollution etc., and where required undertake additional works to that effect.

#### **2.1.1 Provision of plantation and developing a garden inside the sub-station.**

At least, 100 nos. of fruit & 100 nos. flowers bearing plants as per the advice of OPTCL to be planted along the road side and in and around the control room and DG room building after making surface treatment. Also, provision of developing a garden in front of the control room building, the land to be developed shall be of size 30mtrs X 20 mtrs. Garden grass with variety of flowering plants and show plants with croutons are to be provided after making proper surface treatment. Provision of water taps facilities at different locations for watering the plants.

### **2.2 Setting out and making profiles**

After the site has been cleared as per Clause 2.1 above, the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engg Incharge (Divisional Engr.). The

Contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete, etc., required in connection with the setting out of works and the establishment of bench marks. A grid system of co-ordinates shall be established by the Contractor at the site.

Masonry or concrete pillars shall be erected suitably at minimum of four places in the area to serve as bench marks for the execution of the work. Each bench mark shall be protected from damage or disturbance. These bench marks shall be connected with G.T.S. of any other permanent bench mark approved by the Engg Incharge (Divisional Engr.). Necessary profiles with pegs, bamboos and strings or "Burjis" shall be made to show the correct formation levels before the work is started and the same shall be approved by the Engg Incharge (Divisional Engr.).

### **2.3 Programme**

The Contractor shall construct the works in compliance with the outline programme appended to the Bidding Document, and shall submit for the approval of the Engg Incharge (Divisional Engr.) a detailed programme in accordance with the requirements of this Specification.

### **2.4 Inclement weather**

As per relevant Code, during hot weather, precautions shall be taken to avoid premature stiffening of the fresh mix and to reduce water absorption and evaporation losses. During hot weather ( atmospheric temperature above 40 degree C ) or cold weather ( atmospheric temperature at or below 5deg.C ) concreting shall be done as per the procedure set out in IS 7861.

## **3. 0 STANDARDS**

All Civil works shall be carried out as per applicable Indian Laws, latest revision of International Standards and Codes. All materials shall be of best quality conforming to relevant Indian Standards and Codes.

Civil works shall be designed to the required service conditions and /or loads as specified elsewhere in this Specification or implied as per National and International Standards.

A list of code of practice and standards used for civil works in general is enclosed for reference. In case of any conflict between I.S. Code and the Procedures specified herein, the later shall prevail.

## **4. 0 SOIL INVESTIGATION**

### **4.1 General**

The Contractor shall perform a detailed soil investigation to arrive at sufficiently accurate general as well as specific information about the soil profile/strata and the necessary soil parameters of the site in order that the foundations of the various structures can be designed and constructed safely and rationally. Foundation systems adopted by the contractor shall ensure that relative settlement shall be as per provision in IS 1904 and any latest IS and other Indian Standards.

This Specification covers all the work required for detailed soil investigation and preparation of a detailed report. The work shall include mobilisation of necessary equipment, provision of necessary engineering supervision and technical personnel, skilled and unskilled labour etc., as required to carry out field investigation and tests, laboratory tests, analysis and interpretation of data and results, preparation of detailed soil report including specific recommendations for the type of foundations and the safe bearing capacity for different sizes of foundations at different founding strata for the various structures of the substation. The Contractor shall make his own arrangements for locating the coordinates and various test positions in field and also for determining the reduced level of these locations with respect to the bench mark .All the test are to be carried out before the OPTCL officials or before any agency engaged by OPTCL. Prior intimation in this effect has to be given to OPTCL.

A report to the effect will be submitted by the Contractor for the Engg Incharge (Divisional Engr.) specific approval giving details regarding his assumed data for Civil structures design.

Any variation in soil data shall not constitute a valid reason for any additional cost and shall not affect the terms and condition of the Contract. Nothing extra what so ever shall be paid to the Contractor on account of any variation in subsoil properties /or conditions. Tests must be conducted under all the critical locations i.e. Control room building,

autotransformer, lightning mast, 400 kV/220 kV/132 kV column location etc. However, some of the soil parameters given below for substations have to be determined and submitted to Engg Incharge (Divisional Engr.).

- Dry density
- Bulk density
- Angle of internal friction/cohesion
- \* Specific gravity
- Natural moisture content.

#### **4.2 Bore holes**

Drilling of a specified number of bore holes of 150 mm dia. in accordance with the provisions of IS 1892 at approved locations to specified depths or to refusal which ever occurs earlier. (By refusal it shall mean that a standard penetration blow count (N) of 100 is recorded for 30 cm penetration). However, at least 5 boreholes or as specified in BOQ shall be drilled to the required depth (15 mts. approximately).

Performing Standard Penetration Tests at approximately 2.0 m intervals in the bore hole starting from 0.5 m below ground onwards and at every change of stratum. The disturbed samples from the standard penetrometer shall also be collected for necessary tests.

Collecting undisturbed samples of 100/75 mm diameter 450 mm long from the bore holes at intervals of 2.5 m and every change of stratum starting from 1.0 m below ground level onwards.

The depth of Water Table shall be recorded in each bore hole.

All samples, both disturbed and undisturbed, shall be identified properly with the bore hole number and depth from which they have been taken. The sample shall be sealed at both ends of the sampling tubes with wax immediately after the sampling and shall be packed properly and transported to the Contractor's laboratory without any damage or loss.

The logging of the bore holes shall be compiled immediately after the boring is completed and a copy of the borelog shall be handed over to the Engg Incharge (Divisional Engr.).

#### **4.3 Dynamic cone penetration test**

Two Dynamic cone penetration tests under the locations of auto transformers shall be carried out with the circulation of bentonite slurry at specified location and a continuous record of penetration resistance (NG) upto 15 metre from natural ground level or refusal, shall be maintained by the Contractor.

Dynamic cone penetration tests are conducted to correlate engineering properties such as stratification density, bearing capacity, settlement, etc., of soils which are primarily cohesive in nature. The tests shall be conducted by driving a standard size cone attached loosely or screwed to a string of drill rods. The specification for the equipment and accessories required for performing this test, test procedure, field observations and reporting of results shall conform to IS 4968 part 11 latest revision. The driving system shall comprise of 65 kg weight having a free fall of 75 cm. The cone size shall be 65 mm diameter, and provided with vents for continuous flow of bentonite slurry through the cone and rods in order to avoid friction between the rods and soil. The location for tests shall be as directed by the Engg Incharge (Divisional Engr.). On completion of the test, the results shall be presented as a continuous record as the number of blows required for every 300 mm penetration of the cone into the soil.

#### **4.4 Trial pits**

Trial pits shall be made at two locations as approved by the Engg Incharge (Divisional Engr.). The trial pits shall two metres square in size extending to (four) metres depth or as specified by the Engg Incharge (Divisional Engr.). Undisturbed samples shall be taken from the trial pits as per the direction of the Engg Incharge (Divisional Engr.).

#### **4.5 Field California Bearing Ratio test**

This test shall be carried out to obtain the properties of soil required for the construction of roads. The equipment and accessories required for carrying out the test, test procedure, recording of observations and presentation of results shall

confirm to IS 2770 part **XXXI**. The test locations of CBR test shall be on the road locations as per GA drawing. These tests shall be performed on remoulded and undisturbed, soaked and un soaked samples.

#### **4.6 Electrical resistivity test.**

This test shall be conducted to determine the electrical resistivity of soil required for designing safety grounding system for the entire station area. The specifications for the equipment and other accessories required for performing electrical resistivity test, the test procedure, and reporting of field observations shall confirm to IS 3043. The test shall be conducted using Wagner's four electrode method as specified in IS 1892, Appendix-B2. Unless otherwise specified at each test location, the test shall be conducted along two perpendicular lines parallel to the coordinate axis.

#### **4.7 Plate load test**

Plate load test shall be conducted to determine the bearing capacity and load/ settlement characteristics of soil at shallow depths by loading a plane and level steel plate kept at the desired depth and measuring the settlement under different loads, until a desired settlement takes place or failure occurs. The specification for the equipment and accessories required for conducting the test, the test procedure, field observations and reporting of results shall conform to IS 1888. The location and depth of the test shall be given by the Contractor and approved by the Engg Incharge (Divisional Engr.). Undisturbed tube samples shall be collected at 1.0 m and 2.5 m depths from the natural ground level for carrying out laboratory tests.

The size of the pit shall not be less than five times the plate size and shall be taken upto the specified depth. All provisions regarding excavation and visual examination of pit shall apply here.

If the ground water table is at a depth higher than the specified test depth, the ground water table shall be lowered and maintained at the test depth for the entire duration of the test. Dewatering shall be at Contractor's cost.

Unless otherwise specified the reaction method of loading shall be adopted. Settlement shall be recorded from dial gauges placed at four diametrically opposite ends of the test plate. The test plate shall be 600 x 600 mm size and at least 25mm thick. The bottom of the pit shall be levelled before placing the plate in position for conducting the test.

A seating load of 70 gm/sq.cm shall be applied and after the dial gauge readings are stabilised, the load shall be released and the initial readings of the dial gauges recorded after they indicate constant reading. The load shall be increased in stages. These stages shall be 20, 40, 70, 100, 150, 200, 250, 300, 400, 500, 600 and 800 KN per sq.m. or as directed by the Engg Incharge (Divisional Engr.). Under each loading stage, record of time versus settlement shall be kept as specified in IS 1888.

The load shall be maintained for a minimum duration of one hour or till the settlement rate reduces to 0.02 mm/m. whichever is latter. No extrapolation of settlement rate from periods less than one hour shall be permitted.

Loading shall be carried out in stages as specified above till one of the following conditions occurs:

- Failure of the soil under the plate i.e. the settlement of the plate at constant load becomes progressive and reaches a value of 40 mm or more.
- Total settlement of the plate is more than 40mm.
- Load intensity of 800 kN/sq.m is reached without failure of the soil.

Backfilling of the pit shall be carried out as per the directions of the Engg Incharge (Divisional Engr.). Unless otherwise specified the excavated soil shall be used for this purpose. The quoted rates shall include backfilling.

Dial gauge readings for settlement shall generally be taken at 1, 2, 4, 6, 9, 16, 25, 60, 90 and 120 minutes from the commencement of each stage of loading. Thereafter the readings shall be taken at hourly intervals upto a further four hours and at two hours intervals thereafter for another six hours.

#### **4.8 Water sample**

Representative samples of ground water shall be taken when ground water is first encountered before the addition of water to aid drilling of boreholes. The samples shall be of sufficient quantity for chemical analysis to be carried out and shall be stored in air-tight containers.

#### 4.9 Laboratory Test

The laboratory tests shall be carried out progressively during the field work after a sufficient number of samples have reached the laboratory, in order that the test results of the initial bore holes can be made use of in planning the later stages of the field investigation and quantum of laboratory tests.

All samples brought from field, whether disturbed or undisturbed shall be extracted/prepared and examined by competent technical personnel, and the tests shall be carried out as per the procedures laid out in the latest edition of the relevant IS Codes and Standards.

The following laboratory tests shall be carried out:

- Visual and engineering classification.
- Liquid limit, plastic limit and and shrinkage limit.
- Natural moisture content, bulk density, dry density and specific gravity.
- Grain size distribution.
- Unconfined compression test.
- Unconsolidated undrained test.
- Swell pressure and free swell index determination.
- California bearing ratio.
- Consolidated undrained test.
- Consolidated drained test.
- Chemical tests on soil and water to determine the carbonates, sulphates, nitrates, chlorides, Ph value, and organic matter and any other chemicals harmful to the concrete foundation.

#### 4.10 Test results and reports

The Contractor shall submit the detailed report in four (4) copies wherein information regarding the geological detail of the site, summarised observations and test data, bore logs, and conclusions and recommendations on the type of foundations with supporting calculations for the recommendations. Initially the report shall be submitted by the Contractor in draft form and after the draft report is approved, the final report in eight (8) copies shall be submitted.

The report shall include, but not be limited to the following :

- A plan showing the locations of an exploration work i.e. bore holes, dynamic cone penetration tests, trial pits, plate load test, etc.
- Bore logs: Bore logs of each bore holes clearly identifying the stratification and type of soil stratum with depth upto the refusal. The values of Standard Penetration Test (SPT) at the depths where the tests were conducted on the samples collected shall be clearly shown against that particular stratum.
- Test results of field and laboratory shall be summarised strata wise as well in combined tabular form. All relevant graphs, charts tables, diagrams and photographs, if any, shall be submitted along with report.
- **Recommendation** The report should contain specific recommendations for the type of foundation for the various structures envisaged at site. The Contractor shall acquaint himself about the type of structures and their functions from the Engg Incharge (Divisional Engr.). The observations and recommendations shall include but not be limited to the following :
  - Geological formation of the area, past observations or historical data, if available, for the area and for the structures in the nearby area, fluctuations of water table, etc..
  - Recommended type of foundations for various structures. If piles are recommended the type, size and capacity of pile shall be given.
  - Allowable bearing pressure on the soil at various depths for different sizes of the foundations based on shear strength and settlement characteristics of soil with supporting calculations for the recommendations.



- Recommendations regarding slope of excavations and dewatering schemes, if required.
- Comments on the chemical nature of soil and ground water with due regard to protective measures.
- If expansive soil is met with, recommendation on removal or retainment of the same under the structure/road etc. shall be given. In the latter case detailed specification of any special treatment required including specification for materials to be used, construction method and equipment to be deployed etc. shall be furnished.
- Recommendations for additional investigation beyond the scope of the present work, if Contractor considers such investigation necessary.

## **5. 0 MATERIALS AND WORKMANSHIP**

### **5.1 General**

All materials used in the works shall be new and of the best quality of their respective kinds. They shall comply with the requirements of the latest edition of any relevant Indian Standard or Code of Practice where such exist, and current at the date of tendering.

All workmanship shall be of the highest standard, and shall be executed by competent men skilled in their respective trades.

### **5.2 Samples**

In addition to the special provisions made in this specification for sampling and testing of materials by particular methods, samples of any materials and workmanship proposed to be used in the Works may be called for at any time during the Contract by the Engg Incharge (Divisional Engr.) and shall be furnished by the Contractor without delay and at the expense of the Contractor. Samples when approved, shall be regarded as the acceptable standard, and any material or workmanship subsequently not complying with that standard shall be rejected and replaced by those of acceptable standard at the expense of the Contractor. Sample storage boxes shall be provided by the Contractor free of cost if requested by the Engg Incharge (Divisional Engr.).

### **5.3 Tests**

Whenever considered desirable by the Engg Incharge (Divisional Engr.), Inspectors may be sent to manufacturer's or subcontractors' premises to test materials or supervise their manufacture.

Where specified or requested the Contractor shall obtain from the manufacturer and send to the Engg Incharge (Divisional Engr.) certificates of test, proof sheets, mill sheets, etc., showing that materials have been tested in accordance with this Specification or the relevant Indian Standard.

Notwithstanding any tests which may be directed to be carried out at a manufacturer's and/or subcontractor's works, the Engg Incharge (Divisional Engr.) may carry out any tests or further tests he considers necessary or desirable after delivery of materials to the Site.

The Contractor shall provide all labour, equipment and facilities necessary for carrying out the tests both in works and on site.

The cost of routine tests required by IS and this Specification shall be borne by the Contractor. The cost of other tests shall be borne in accordance with the Conditions of Contract.

### **5.4 Names of suppliers and copies of orders**

If so required, and before ordering material of any description, the Contractor shall submit for approval the names of makers or suppliers proposed. Copies of orders shall also be submitted if so required. The Engg Incharge (Divisional Engr.) may at any time withdraw his previously given approval to obtaining materials from any maker or supplier should such maker or supplier fail to supply materials of the specified quality or quantity in the requisite time.

### **5.5 Rejection of materials and workmanship**

The Engg Incharge (Divisional Engr.) shall at any time have power to reject materials and workmanship not complying with this Specification or with the approved Drawings. Materials so rejected shall be immediately removed from site and

replaced by materials of an approved standard at the expense of the Contractor. Rejected workmanship shall be broken out and replaced by work of an acceptable standard including the supply of new materials by the Contractor, at the expense of the Contractor, and without delay.

## **5.6 Explosives and Blasting**

All rules under the Explosive Act or other local rules in force shall be fully observed. All blasting works shall be done in accordance with the stipulation contained in IS 4081. Written approval shall be obtained from the Engg Incharge (Divisional Engr.) before explosives are used for excavating foundations in rock and the Engg Incharge (Divisional Engr.) may impose conditions for their use. The Contractor shall be responsible for complying with local regulations concerning the use of explosives and for the safe-keeping and handling of explosives. Proper warning shall be given of all blasting operations. During operations involving the handling or use of explosives, the Contractor shall be responsible for the safety of personnel, Site Works and people or properties in the vicinity of the site. The Contractor shall make good at his own expense any damage caused by the use or mishandling of explosives.

## **6. 0 EXCAVATION AND BACKFILL**

Excavation and backfill for foundations shall be in accordance with the relevant Code. The back fill around the foundations shall be compacted according to Clause 6.7 for Compaction.

Whenever water table is met during the excavation, it shall be dewatered and water table shall be maintained below the bottom of the excavation level during excavation, concreting and backfilling.

When embankments are to be constructed on slopes of 15% or greater, benches or steps with horizontal and vertical faces shall be cut in the original slope prior to placement of embankment material. Vertical faces shall measure not more than one metre in height.

Embankments adjacent to abutments, culverts, retaining walls and similar structures shall be constructed by compacting the material in successive uniform horizontal layers not exceeding 15 cm in thickness, (of loose material before compaction). Each layer shall be compacted as required by means of mechanical tampers approved by the Engg Incharge (Divisional Engr.). Rocks larger than ten centimetres shall not be placed in embankment adjacent to structures.

Earth embankments of roadways and site areas adjacent to buildings shall be placed in successive uniform horizontal layers not exceeding 20 cm in thickness in loose stage measurement and compacted to the full width specified. The upper surface of the embankment shall be shaped so as to provide complete drainage of surface water at all times.

### **6.1 Rock excavation**

The rock to be excavated shall be classified under the following categories :

#### **6.1.1 Ordinary rock**

Rock which does not require blasting, wedging or similar means for excavation is considered as ordinary rock.. This may be quarried or split with crowbars or pickaxes and includes lime stone, sand stone, hard laterite, hard conglomerate and reinforced cement concrete below ground level. It will also include rock which is normally hard requiring blasting when dry but can be excavated without blasting, wedging or similar means when wet. It may require light blasting for loosening materials, but this will not in any way entitle the material to be classified as hard rock.

#### **6.1.2 Hard Rock**

Any rock or boulder for the excavation of which blasting is required, for example quartzite stone, granite, basalt, reinforced concrete (reinforcement to cut through but not separated from concrete) below ground level.

#### **6.1.3 Hard Rock (Blasting prohibited)**

This shall cover any hard rock requiring blasting as described in above but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging or any other approved method.

#### **6.1.4 Authority for classification**

The classification of excavation shall be decided by the Engg Incharge (Divisional Engr.) and his decision shall be final and binding on the Contractor. Merely the use of explosives in excavation will not be considered as a reason for higher classification unless blasting is clearly necessary in the opinion of the Engg Incharge (Divisional Engr.).

## **6.2 Excavations for foundations and other purposes**

Excavations shall be of the minimum sizes necessary for the proper construction of the works, and excavations shall not be kept open for periods longer than that reasonably required to construct the works. The Contractor shall take all precautions necessary to ensure that the bottoms of excavations are protected from deterioration and that the excavations are carried out in such a manner that adjacent foundations, pipes or such like are not undermined, damaged or weakened in any way. Any excavation taken out below the proper level without approval shall be made good at the expense of the Contractor using concrete or other material as directed.

All excavated materials obtained from excavation shall remain OPTCL's property. The useful portion shall be separated from the useless one and deposited in regular stacks at places indicated and as directed by the Engg Incharge (Divisional Engr.).

## **6.3 Support of excavations**

The Contractor shall be responsible for the stability of the sides of the excavations. Excavations shall be close timbered or sheeted, planked and strutted as and when necessary during the course of the work and shall ensure the safety of personnel working within them. If any slips occur, they shall, as soon as practicable, be made good in an approved manner at the expense of the Contractor. Shoring shall not be removed until the possibility of damaging the works by earth pressure has passed. No payment for shoring or timber left in shall be made, unless agreed in writing by the Engg Incharge (Divisional Engr.).

## **6.4 Works to be in dry**

All excavations shall be kept free from water and the Contractor shall take whatever action is necessary to achieve this. Pumping, well pointing and other means necessary to maintain the excavations free from water shall be at the expense of the Contractor, and carried out in an approved manner.

## **6.5 Backfill**

As soon as possible after the permanent works are sufficiently hard and have been inspected and approved, backfill shall be placed where necessary and thoroughly consolidated in layers not exceeding two hundred (200) millimetres in depth.

On completion of structures, the earth surrounding them shall be accurately finished to the line and grade as shown on the drawings. Finished surfaces shall be free of irregularities and depressions.

The soil to be used for back filling purposes shall be from the excavated earth or from borrow pits, as directed by the Engg Incharge (Divisional Engr.).

## **6.6 Disposal of surplus**

Surplus excavated material not required or not approved for fill or backfill shall be loaded and deposited either on or off site as directed. The Contractor shall not delay disposal of surplus material after receipt of instructions from the Engg Incharge (Divisional Engr.). The contractor shall arrange to transport the excavated earth by mechanical transport, not necessarily on Pucca roads. The soil so transported shall be stacked and levelled neatly and dressed. The location where the soil is to be stacked / disposed shall be as directed by the Engg Incharge (Divisional Engr.).

## **6.7 Compaction**

The method and equipment used to compact the fill material to a density that will give the allowable soil bearing pressure required for the foundations, roads, etc. in each layer of fill material. Each layer of earth embankment when compacted shall be as close to optimum moisture content (OMC) as practicable. Embankment material which does not contain sufficient moisture to obtain proper compaction shall be wetted. If the material contains an excess of moisture, then it shall be allowed to dry before rolling. The rolling shall begin at the edges overlapping half the width of the roller each time and progress to the center of the road or towards the building as applicable. Rolling will also be required on rockfills. No compaction shall be carried out in rainy weather.

At all times unfinished construction shall have adequate drainage. Upon completion of the road's surface course, adjacent shoulders shall be given a final shaping, true alignment and grade.

The density to which fill material shall be compacted shall be as per relevant IS and as per direction of Engg Incharge (Divisional Engr.). All compacted sand filling shall be confined as far as practicable. Backfilled earth shall be compacted

to minimum 95% of the Standard Proctor's density at OMC. The subgrade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor's density at OMC

## **6.8 Requirement for fill material under foundations**

The thickness of fill material under the foundations shall be such that the maximum pressure from the footing, transferred through the fill material and distributed onto the original undisturbed soil will not exceed the allowable soil bearing pressure of the original undisturbed soil.

Where compacted fill is required it shall consist of suitable sand, or other selective inorganic material, subject to approval by the Engg Incharge (Divisional Engr.). The filling shall be done with locally available sand. The filled in sand shall be kept immersed in water for sufficient time to ensure compaction, if so desired by the Engg Incharge (Divisional Engr.).

## **7.0 SITE SURFACING**

### **7.1 Scope of Work**

The contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawings, specification and direction of the Engg Incharge (Divisional Engr.).

### **7.2 General Requirement**

The material required for site surfacing/gravel filling shall be free from all types of organic materials and shall be of standard approved quality, and as directed by the Engg Incharge (Divisional Engr.).

The Contractor shall furnish and install the site surfacing to the lines and grades as shown in the drawing and in accordance with the requirements and direction of the Engg Incharge (Divisional Engr.). The soil of the entire switchyard area shall be levelled before placing the site surfacing/gravel fill material. After all the structures and equipment have been erected and accepted the site shall be maintained to the lines and grades indicated in the drawing and rolled or compacted by using three ton roller with suitable water sprinkling to form a smooth and compact surface condition, which shall be matching with finished ground level of the switchyard area. After due compaction of the surface of the entire switchyard area shall be provided with plain cement concrete of 75 mm thickness after proper compaction, and antiweed treatment having cement concrete ratio 1:4:8. Care shall be taken for proper gradient for easy discharge of storm water.

After the PCC is applied and surface prepared to the required slope and grade a base layer of uncrushed/crushed broken gravel of 20 mm nominal size shall be spread, rolled and compacted by using 1/2 ton roller (30" width and 24" dia) with 4 to 5 passes and water sprinkling to form a minimum 50 mm layer on the designed finished formation level of the entire switchyard area.

As a final surface course minimum 50 mm. uniform layers of un crushed /crushed broken metals (gravel) of 20 mm. nominal size shall be spread over the base layer/course. This final surface course shall be applied in all areas exclusive of roadways and shall extend beyond the fenced area as indicated in the drawing. This surface course shall then be compacted by light roller using 1/2 ton steel roller (width 30" x dia 24") and 4 to 5 passes or any other means with water sprinkling as directed by the Engg Incharge (Divisional Engr.). Water shall be sprinkled in such a manner that bulking does not take place. The 20 mm. nominal size (for both layers) shall pass 100% through IS sieve designation 37.5 mm and nothing through 16.0 mm. IS sieve.

In areas that are considered by the Engg Incharge (Divisional Engr.) to be too congested with foundations and structures for proper rolling of the site base course material by normal rolling equipments, the material shall be compacted by hand, if necessary. Due care shall be exercised so as not to damage any foundation structure or equipment during rolling or compaction.

Engg Incharge (Divisional Engr.) by no means shall relieve the contractor of their contractual obligations as stipulated in General and Special Conditions of Contract.

### **7.3 Measurements**

#### **7.2.1 Payment of gravel filling**

The measurement shall be based on square metre of finished area of minimum specified compacted thickness of 100 mm above finished ground level. Nothing shall be paid extra for any additional material labour etc. used for achieving the specified compacted thickness of 100 mm. above finished ground level.

## **8. 0 SITE DRAINAGE**

### **8.1 General**

Adequate site drainage system shall be provided by the Contractor. The Contractor shall obtain rainfall data and design the storm water drainage system, (culverts, ditches, drains etc.) to accommodate the most intense rainfall that is likely to occur over the catchment area in one hour period on an average of once per ten years. The surfaces of the site shall be sloped to prevent the ponding of water.

The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8m/sec respectively. However, minimum non silting velocity of 0.6m/sec shall be ensured. Longitudinal bed slope not milder than 1:1000 shall be provided.

For design of RCC pipes for drains and culverts, IS 456 and IS 783 shall be followed.

The Contractor shall ensure that water drains are away from the site area and shall prevent damage to adjacent property by this water. Adequate protection shall be given to site surfaces, roads, ditches, culverts, etc., to prevent erosion of material by water.

The drainage system shall be adequate without the use of cable or pipe trenches.

For pipe drains, concrete pipes of class NP2 shall be used. However, for road crossings higher strength pipe of class NP3 shall be provided. For rail crossings, pipes conforming to railway loading standards or at least NP4 class shall be provided. Manholes shall be provided at 30 m intervals, at connection points and at every change of alignment. All manholes deeper than 1.2 m shall be provided with galvanised M.S. foot rests. Foot rests shall be of 20 mm M.S. square bars.

Open surface drains shall be of RCC (1:1.5:3) type. Design and drawings shall have the approval of the Engg Incharge (Divisional Engr.). For expansive soils, the guide lines of IS 9451 shall be followed. Suitable expansion joints shall be provided as per standard.

In general, all plant effluent drainage shall be through buried concrete pipes and all storm water drainage shall be through open drains/pipe drains. Open storm water drains shall be provided on both sides of the roads and shall be designed to drain the road surface as well as all the free and covered areas.

Pipe drains shall be connected through manholes at an interval of maximum 30 m. Plant effluents shall be suitably treated by the Contractor to meet all the prevalent statutory requirements and local pollution control norms and treated effluents shall be conveyed to the storm water drainage system at a suitable location for their final disposal.

Invert of the drainage system shall be decided in such a way that the water can easily be discharged above the High Flood Level (HFL) outside substation boundary at suitable location and approved by Engg Incharge (Divisional Engr.). Pumping of drainage water, if required, shall be provided by Contractor.

All internal site drainage systems, including the final connection and disposal to Engg Incharge (Divisional Engr.) acceptance points shall be part of Contractor's scope including all required civil work, mechanical and electrical systems. The Contractor shall connect his drain(s) at one or more points.

Precast manholes shall be preferred against cast-in-situ type. The drainage scheme may either employ open drain system or underground pipe system or a combination of both. A man hole shall be provided at every turn or corner in case of underground type in addition to the normal requirement.

Suitable pumping arrangement shall be provided by the Contractor to pump out the water from sump to the open channel; automatic float valve type pump shall be provided and installed by Contractor.

The Contractor shall locate the outfall point outside the substation vicinity and the substation storm drainage must be connected to this point.

The drainage scheme and associated drawings shall be subject to approval of the Engg Incharge (Divisional Engr.).

## **8.2 Excavation and backfill**

Trench excavations for drains shall be carried out with the minimum disturbance to adjacent ground and in such a way that existing or new work shall not be undermined. No backfill shall be placed until pipes, etc. have been inspected, tested and approved. Backfill shall be carefully placed by hand tools round pipes, etc. and rammed in layers not exceeding one hundred (100) millimetres thick in a manner which will not cause damage. When a minimum thickness of three hundred (300) millimetres above the pipes has been so placed, normal methods of backfilling and ramming may be adopted.

## **8.3 Laying Of Pipes**

Pipes and fittings shall be of the types, qualities and sizes specified and shown on the approved drawings. They shall be laid to the lines and levels shown, and the barrel of each pipe shall bear firmly and uniformly on the trench bottom or prepared foundation bed, any projections in the trench bottom which could cause damage to pipes being first removed. Pipes shall be kept clean during and after laying, and open ends shall be provided with the temporary plugs to prevent entry of foreign matter. Each pipe shall be accurately bonded to gradient between sight rails and drain. Laying shall commence at the lowest end and proceed uphill. Pipes shall be laid with the sockets leading uphill.

## **8.4 Testing of drains**

All drains, other than open channels, stone filled drains and porous drains, shall be of watertight construction, and all soil drains shall be subjected to a water test before backfilling of trenches is commenced. Drains may be tested in sections, and manholes may be tested separately. The Contractor shall submit to the Engg Incharge (Divisional Engr.) for approval his proposals for testing. The drains shall withstand, without leakage, a water pressure of not less than one and one half (1.5) metres at any point for a period of 20 minutes or such other time as the Engg Incharge (Divisional Engr.) may direct. All necessary plugs, temporary connections and other equipment and all labour required for the tests shall be provided by the Contractor and at the expense of the Contractor. For testing of pipes in areas where an adequate supply of water is not readily available, the Engg Incharge (Divisional Engr.) will accept an air (smoke) pressure test, provided that the method of testing is approved by the Engg Incharge (Divisional Engr.). Further testing may be called for after backfilling of trenches to ensure that pipes have not been damaged during that operation.

## **8.5 Regulations**

The regulations and recommendations of any relevant drainage or sanitary authority shall be fully observed, and the Contractor shall be responsible for acquainting himself with any such regulations.

## **9.0 SEWAGE SYSTEM**

A sewage system shall be provided for all utility buildings including the Control room building and other auxiliary buildings.

The Contractor shall construct suitable septic tank and soak pit for the discharge of effluents.

Sewers shall be designed for a minimum self cleansing velocity of 0.6m/sec and the maximum velocity shall not exceed 2.4m/sec.

The sewage system shall consist of all necessary piping, pumps, if required, fittings, manholes, clean - outs, piping connections and all other materials required for safe and efficient sewage collection. Sewer pipes and fittings shall conform to the relevant Indian Standards.

Cast iron pipes shall be used below ground level for sewage disposal.

Manholes shall be provided at every 20 metres along the length, at connection points, and at every change of alignment, gradient or diameter of a sewer pipe line.

## **10.0 ROADS AND CULVERTS**

The Contractor shall be responsible for constructing approach roads, sub-station roads and service roads etc. within the substation area. Layout of the roads shall be based on general details and arrangement drawings for the substation.

Parking areas shall be provided for Site personnel and a minimum of twenty numbers of visitors at convenient locations. Adequate turning space for vehicles shall be provided and bend radii shall be set accordingly. Roads to the transformer bays shall be as short and straight as possible. Where the substation layout warrants headroom safety barriers shall be installed to prevent vehicles coming into contact with overlying conductors. Such barriers shall be included as part of the scope of the work.

All substation roads shall be constructed so as to permit transportation of all heavy equipment. A minimum seven metres black topping with 1.6 m wide shoulders on either side of the road shall be constructed for double lane roads. The other service roads shall be with 3.75 m black topping and 1.3 m wide shoulders on either side of the road.

Finished top (crest) of roads shall be a minimum of 300 mm above the surrounding grade level (Formation level).

Road construction shall be as per Indian Road Congress (IRC) standards.

Adequate provision shall be made for road drainage.

All culverts and allied structures required for road/rail, drain, trench crossings etc. shall be designed for class AA loading as per IRC standard.

All roads shall be designed for class 'E' of traffic i.e. traffic intensity of 450-1500 vehicles per day (heavy vehicles exceeding 3 tonnes laden weight) as per IRC-37-1984, Guide-lines for the design of flexible pavements.'

California Bearing Ratio (CBR) method shall be followed for the design of roads. A detailed CBR test which is an adhoc penetration test shall be carried out as per the procedure outlined in IS 2720 (Part XVI).

The surface of the hardstanding shall be laid with falls to the drainage system. Care shall be taken during the construction that no materials enter the drainage system.

At the junction of the hard standing and roads due to different thickness of foundations, precautions shall be taken to ensure that sub-surface drainage from the hard standing does not have a detrimental affect upon the road foundations.

#### **A) CONCRETE ROAD:**

The side shoulder of all the roads shall be with kerb stone at two sides. The kerb stones shall be painted yellow and black alternatively. In case of switch yard road (concrete road) the shoulder would be compacted earth 600 mm wide on the sides of the road. The concrete road shall have 100 mm thick PCC (1:2:4 nominal ratio). Below it 100 mm thick PCC (1:4:8) shall be provided. 300 mm thick water bound macadam (WBM) in three equal layers of 100 mm each at the bottom.

PCC and WBM shall extend upto the shoulder width on both sides of the road outside switch yard area as per drawing. In case of road within the switch yard area the PCC and WBM shall placed only up to the width of the road. Polythene sheet of 125 microns shall be placed between the RCC and PCC slab. Expansion joints (12mm thick) shall be provided at every 8 mtrs. In addition, in case of 7 mtrs wide roads 100 mm Dia hume pipe (NP-3) shall be provided at every 100 mtrs interval across the length of the road for cable crossing.

#### **B) BITUMINOUS ROAD:**

The following procedure shall be followed for the construction of bituminous roads.

1. Compacted WBM at the bottom end of the road up to a thickness of 300 mm in three equal layers 100 mm each. The compaction shall be done by laying stone aggregates of size 100mm. each layer shall be laid and compacted with water spreading and using rollers as per the standard practice adopted in the CPWD guide line.

2. Above, the compacted WBM 1st layer as stated under (1), 200 mm thick consolidated WBM in two layers with stone aggregates of size 90 – 45mm shall be laid. Each layer shall be laid and compacted with water spreading and using rollers as per recommended.

3. Above the compacted 2nd layer of WBM, 75 mm thick consolidated WBM in two layers with stone aggregates of size 63mm-45mm shall be laid. Each layer shall be compacted with water spreading and using rollers as per recommended.

4. Above the compacted 3rd layer of WBM, 75 mm thick consolidated WBM in two layers with stone aggregates of size 53mm-22.4mm shall be laid. Each layer shall be compacted with water spreading and using rollers as per recommended.

5. Above the 4th layer of compacted WBM, 25mm thick pre mix carpet surfacing has to be done. The carpet surfacing shall be done with 2.25 cum and 1.12 cum of stone chippings of 13.2 mm size and 11.2 mm size respectively per 100 sq mtrs and 52 Kgs of hot bitumen per cum of stone chippings. Complete with paving ASPHALT 80/100 heated and thin

mixed with solvent @70g/Kg of ASPHALT. Hot bitumen of grade 80/100 shall be spread on road surface @750g/Kg per sqmtr. There shall be shoulder on both side of the roads as per given data. The curvature of the road shall be R=7M and additional metalling for turning has to be maintained. The shoulder shall also be made compacted morrum filling and other as specified.

### **1.1 Periphery roads out side the fencing:**

Periphery roads to be constructed out side the fencing. The width of the road is 3.5 mtrs having borm of 1 mtr each at both sides of the roads. The roads shall be concrete road with general specifications as in 10(A).

### **1.2 The width and type of other roads are:**

- a) Approach roads shall be 7 mtr wide with both side shoulder of 1.75 ` mtrs. The roads shall be of bitumen grade type wherever specifically mentioned.
- b) Other roads shall be (peripheral and colony) 3.75 mtrs width having shoulder of 1.3 mtr at both the side. The roads shall be of bituminous type.
- c) Main road shall be 7 mtr wide with both side shoulder of 1.75 ` mtrs. The road will be Concrete(SPECS. 10(A))

## **11. 0 AUTO TRANSFORMER / TRANSFORMER/REACTOR FOUNDATION, RAIL TRACK / ROAD CUM RAIL TRACK**

### **11.1 General**

The Contractor shall provide a permanent transfer track system integrated with the auto transformer foundation to enable installation and the replacement of any failed unit with a spare unit. The transfer track system shall be suitable to permit the movement of any failed unit fully assembled (including OLTC, bushings) with integral radiators and oil, without the de-energization of any other equipment in the station. The system shall enable the removal of any failed unit from its foundation to a repair area and the installation of a spare unit. The system shall not interfere with the normal internal road and trench system. If trench or drain crossings are required then suitable R.C.C culverts shall be provided in accordance with IRC Code and /or relevant IS.

Rail tracks shall be of RCC, M20(1:1.5:3 mix) grade. The space between the tracks shall be suitably filled with local sand and 75 mm thick PCC of grade 1:3:6 placed over sand filling. The top of PCC shall be up to the formation level. In case of road cum rail track, 75mm thick PCC of grade 1:1.5:3 shall be placed up to the road level. Suitable drainage system between the tracks shall be provided.

The rails shall be first quality 52 kg/m medium manganese steel as per Indian Railway specification T-12-64 and its subsequent revision, joined together by fish plates as per Indian Railway specification T-1/57, and 27 mm diameter fish bolts.

A pylon support system shall be provided for supporting the fire fighting system by the Contractor.

For design of foundation for transformer refer the weightage of the transformer indicated in the BPS (civil works)

### **11.2 Oil Recovery System**

#### **11.2.1 General**

An oil recovery system shall be provided for all transformers (containing insulating oil or any flammable or polluting liquid) in order to avoid spread of fire by the oil, and for environmental protection.

#### **11.2.2 Description**

Each auto transformer/transformer including oil conservator tank and cooler banks etc. shall be placed in a transformer pit surrounded by retaining walls (pit walls). The clear distance of the retaining wall from the transformer shall be 20% of the transformer height or 0.8 m whichever is greater. The transformer pit thus formed shall have a capacity equal to volume of oil, usually 125%, in the transformers. The MS grating placed at the formation level shall be covered with 100mm thick gravel of 40 mm nominal size which acts as an extinguisher for flaming oil. The bottom of the pit shall have an uniform slope towards the sump pit.



Each transformer pit shall be drained towards a common sump pit whose role is to recover the infiltrating water and the drained oil from of the pit. The sump pit shall have sufficient capacity to receive, without overflowing, the oil content of large transformers plus the water content of any fixed fire fighting system and a certain quantity of rain water collected from the pit connected to it. The system shall be provided with air vents large enough to avoid over-pressure during operation. The whole internal surface of the sump pit should be impermeable.

### 11.2.3 Materials

The retaining walls which make up the transformer pit shall be made of fire resistant material such as reinforced cement concrete, fire brick etc., and shall be impervious to oil.

The minimum height of the retaining walls shall be 15 cm above the finished level of the ground to avoid ingress of water from outside.

The floor of the transformer pit shall be of plain cement concrete of concrete grade 1:2:4

### 11.2.4 Drainage

A device showing level of sump pit shall be fitted along with an automatic pumping system which shall have sufficient capacity to evacuate the fire fighting and rain water from the sump pit. The water/oil separation and drainage scheme shall be provided as described in the paper (23-07/1972 Cigre Session) presented by working group 23.04 regarding oil pollution. The Contractor may propose an alternative better scheme, which will be subject to the approval of the Engg Incharge (Divisional Engr.).

### 11.2.5 Particular Specification

If the height of the retaining walls which form the transformer pit exceed 60 cm, steps shall be provided to facilitate access to the transformer or auto transformer and reactor

When designing the transformer pit, the movement of the auto transformer must be taken into account.

It must be assured that the coefficient of crushed stone (granular material) penetration which fills the transformer pit will be retained regardless of the climatic conditions.

## 12. 0 FIRE PROTECTION WALLS

### 12.1 General

Fire protection walls shall be provided in accordance with Tariff Advisory Committee (TAC) recommendations.

### 12.2 Application criteria

A fire wall shall be erected between the transformers and or the reactors if the free distance between the various pieces of equipment is less than 10 m, to protect each one from the effects of fire on another.

Fire walls shall also be erected between the transformers, reactors, and auxiliary services transformers if the free distance is less than ten metres.

### 12.3 Fire resistance

The fire wall shall have a minimum fire resistance of three hours. Partitions which are made to reduce the noise level of the transformers shall have the same fire resistance where they are also used as fire walls. The walls of buildings which are used as fire walls, shall also have a minimum fire resistance of three hours.

Fire walls shall be designed in order to protect against the effect of radiant heat and flying debris from an adjacent fire. The column of the fire walls shall be type be RCC, M20 (1:1.5:3 mix).

### 12.4 Mechanical resistance

Fire walls shall have the mechanical resistance to withstand local atmospheric conditions. If the wall is intended to serve as a support for equipment such as insulators etc., its mechanical rigidity must be increased accordingly.

Connecting the walls by steel or other structures, which may produce a reversing torque if overheated, shall be avoided.

## 12.5 Dimensions

Fire walls shall extend at least two metres on each side of the power transformers or reactors and at least one metre above the conservator tank or safety vent.

These dimensions might be reduced in special cases, and if TAC permits so, where there is lack of space. A minimum of two metres clearance shall be provided between the equipments e.g. reactors, transformers and fire walls.

Building walls which act as fire walls shall extend at least one metre above the roof in order to protect it.

## 12.6 Materials

Fire walls may be made of reinforced concrete (M20 grade), fire brick, concrete blocks or corrugated iron on a steel structure as per the system requirements. Materials used must conform to the standards of the National Fire Prevention Association and TAC norms.

## 12.7 BOUNDARY WALL/COMPOUND WALL:

The scope includes the design, engineering and construction of the boundary wall all along the property line of the OPTCL on each sub-station.

**Construction of Boundary wall:** The boundary wall shall be constructed to a height of 2 mtrs above finished ground level of the substation area with 10" wide brick masonry work with RCC(1:1.5:3) ground tie beam to be rested on the RCC pillars (**pillar to pillar distance @ 3mtrs**) as detailed below. Galvanised barbed wire (12 SWG) of 3-rows each limb of Y shaped frame (Total 6 nos) and concertina coil fencing 600mm Dia 10guage with Razer edges all as per standard drg fencing shall be provided on top of the boundary wall as detailed below.

The boundary wall shall be designed based on the soil investigation data.

Salient points to be considered at the time of design:

- (1) RCC (1:1.5:3) pillars to be considered. RCC pillar to pillar distance shall be maximum 3mtrs along the boundary line. The height of the RCC pillars shall be 2 mtrs above finished ground level of the substation area and below the virgin soil a minimum of 750 mm depth.  
Size of the RCC Pillar: 250mmX250mm.  
Provision of MS rod: (a) Vertical 12 mm Ø: 6 Nos. (b) Stirrup: 8 mm Ø,200 mm c/c.  
There shall be provision of RCC Raft at the bottom of the RCC pillar. Size of the Raft shall be 750 mmX900mmX200mm.  
Provision of MS rod: (a) Both way top & Bottom 12 mm Ø in two layers: 3 Nos. each (total 12 nos)
- (2) RCC (1:1.5:3) tie beam: continuous RCC tie beam to be rested on the RCC pillars below the finished ground level all along the boundary line.  
  
Provision of MS rod: (a) Horizontal 12 mm Ø: 6 Nos. (b) Stirrup: 8 mm Ø,200 mm C to C.
- (3) Brick works: 1<sup>st</sup> Class Brick of size 250 mm all along the boundary wall to be provided. Cement sand mortar of ratio (1:5) to be provided for brick masonry works. The height of the brick wall shall be minimum 2 mtrs height from the top of the tie beam provided at the finished ground level. A 50mm height of finished concrete (ratio 1:2:4) shall be provided on the top of the boundary wall.  
250mm Brick masonry work of 500mm depth below the tie beam also to be considered where ever required.

**BRICK:** The brick shall be machine moulded and made from suitable fly ash, cement, lime, gypsum, etc. They shall be free from cracks and nodules of free lime. They shall have smooth rectangular faces with sharp corners and shall be of uniform colour. The bricks shall be moulded with the frog of 100mm x 40 mm and 10mm to 20mm deep on one of its flat sides. The bricks shall not break when thrown on the ground from a height of 600mm.

The size of the modular bricks shall be 190 x 90 x 90 mm.

The size of the conventional bricks shall be 250 x 125 x 75mm.

Only bricks of one standard size shall be used on one work. The following tolerance shall be permitted in the conventional size adopted in a particular work. Length +3.0mm, Width + 1.50mm, Height +1.50mm.

The crushing strength of the brick shall not be less than 75.0 Kg / Sq cm. The average water absorption shall be within 13-15% by weight. Similarly, the porosity of the fly ash bricks shall be within 12-20%. Necessary test for crushing strength and water absorption shall be carried out as per IS 3495 : (Part I to Part IV) 1976.

- (4) Cement Plastering works: Cement sand mortars of ratio(1:5) to be provided both the sides of the boundary wall.
- (5) Galvanised barbed wire fencing shall be provided on top of the boundary wall to a height of 0.5 mtr. 'Y' Type anti climbing device with inclined length of each angle 640mm and vertical height 500 mm with 6 rows of 12 gauge Galvanised barbed wire at 3mtr c/c and concertina coil fencing 600mm Dia 10gauge with Razer edges shall be provided & fixed in position as per standard drg including cutting, welding, drilling holes, transporting, all leads & lifts erecting the same and stretching of barbed wire 12 gauge, U clip, hooks etc. complete.  
  
A minimum length of 450 mm (bottom portion of the Y shaped frame) shall be grouted on the top of the concrete pillar and a clear height of 500 mm from the finished portion of the top of the wall shall be maintained for the Y shaped frame with GI barbed wires. The “Y” post shall be galvanised one and the size of the GI angle shall be 65X65X6 mm.
- (6) Colouring: After the cement wash on the entire boundary wall two coats of weather coats paint to be applied.
- (7) In case the boundary wall to be designed considering pile foundation, the minimum dia of the pile shall be 250mm of required length as per the design based on soil investigation. Rest of the boundary wall shall be in line with the above description from Sl. No-2 to Sl. No.-6.
- (8) Boundary shall have one main gate as per stipulation elsewhere in the spec. The gate shall be supported by gate pillars of RCC (1:1.5:3).A separate wicket gate shall be provided adjacent to the main gate.

## 12.8 CABLE AND PIPE TRENCHES

### 12.8.1 General

Cable trenches and pre-cast removable RCC covers (with lifting arrangement) shall be constructed using RCC of M20 grade.

The cable trenches shall be designed for the following loads.

- Dead load of 155 kg/ m length of cable support plus 75 kg on one tier at the end.
- Triangular earth pressure plus uniform surcharge pressure of 2 tonnes per sq.metre.
- Cable trench covers shall be designed for (i) self weight of top slab plus concentrated load of 200 kg at centre of span on each panel and a surcharge load of 2 tonnes per sq. metre.

Cable trench crossings of road and rails shall be designed for class AA, class A and class 7OR loading of IRC or relevant IS Code and should be checked for transformer loading.

Trenches shall be drained. Necessary sumps be constructed and sump pumps shall be supplied. Cable trenches shall not be used as storm water drains.

The top of trenches shall be kept at least 250 mm above the finished ground level. The top of cable trench shall be such that the surface rain water does not enter the trench.

All metal parts inside the trench shall be connected to the earthing system.

Cables from trench to equipments shall run in hard conduit pipes(GI pipe and necessary G.I bends and sockets)

A suitable clear gap shall be maintained between trench walls and foundations.

A clear ( vertical ) space of at least 300 mm shall be available for each tier in cable trench. From trench bed to lowest tier, a minimum clearance of 200 mm shall be available for one tier trench and 300 mm for trenches having more than one tier. The spacing between stands shall be 400mm.

The trench bed shall have a slope of 1/500 along the run and 1/250 perpendicular to the run.

All construction joints of cable trenches i.e. between base slab to base slab and the junction of vertical wall to base slab, as well as from vertical wall to wall, and all expansion joints shall be provided with approved quality PVC water stops of approximately 230 x 5 mm size for those sections where the ground water table is expected to rise above the junction of base slab and vertical wall of cable trenches.

Cable trenches shall be blocked at the ends if required with brick masonry in cement sand mortar 1:6 and plaster with 12mm thick 1:6 cement sand mortar.

Cable tray supports( all galvanised structures) shall be designed and constructed to be a single complete fabrication or assembly such that every layer of the horizontal cable tray supports are fixed, either bolted or welded, to a vertical steel support that is embedded in the concrete wall of the cable trough. It shall not be permitted to embed a horizontal support beam directly into the wall of the trough in order to use the concrete wall as a means of load bearing.

Concrete troughs shall be provided with concrete covers of suitable load bearing strength. Where the cable troughs are run across or within 3 m of substation roads, the trough covers shall be capable of bearing an accidental wheel load of 20 kN.

**MORE ON CABLE TRENCH.**

All the cable trenches shall be RCC type with mixing ratio 1:1.5:3. The size of MS rod to be used for the same are of 8mm tor and 6mm. All the vertical rod shall be 8 mm continuous and the wall and raft shall contain 2 nos 8 mm rods at two layers and spacing shall be 150mm. The horizontal binders shall be of 6mm rod two nos in two layers and to be placed at 200mm centre to centre for both on the wall and raft portion of the trench. The mentioned rod placements are for section 1-1,2-2,and 3-3. For section 4-4 instead of two 8mm and 6mm rods single rods can be used.

A frame of hot dip galvanized angles of size 50X50X6 mm having provision of MS chairs on the grouting side on to the walls of the trench preferably at two locations(at top and bottom) of the frame (these chairs have to be welded with the rods of the wall for better rigidity). For section 1-1 there shall be of 4 tier mechanism for fixing of cable tray having width of the angle 450mm (3 nos) and the top angle shall be of 300 mm, and the quantity of such type of frame shall be 2 (for both way). For section 2-2 only one frame of the above mentioned one shall be used. For section 3-3 there shall be one frame but with three tier mechanism for fixing the cable trays. For section 4-4 two tier system of angle width shall be 200 mm width at the bottom and 100 mm width at the top. Fixing of the cable tray support stand (Frame) is to be fixed at a distance of 1 mtrs from one frame to the other.

The thickness of the RCC wall of the trench shall be 100mm and thickness of the raft shall be 75mm. All the frames for fixing of cable trays shall be of hot dip galvanized. A running earth strip has to run all through the cable trench for proper earthing of the cable trays and stand (frame).The size of the earth strip is of 50X6mm G.I flats. Welding the GI flats to the frame to be carried out. Earthing strips to be welded with the running earth mat at 10mtrs interval

The bidder also to supply and fix G.I perforated cable trays (of thickness 2mm) of appropriate size before laying of cables on the cable tray stand.

The other dimensions of the cable trench are as below.

Sl No	Section	No of tiers in each frame/ and no of such frame	Gap between the two angles in mm	Inside clearance in mm		Outside clearance in mm		Concrete thickness in mm	
				Top to Botto m	Wall to wall	Top to bottom of wall	Raft width	Wall	Raft

1	1-1	Four tiers/Two (both way)	200	1275	1400	1350	1750	100	75
2	2-2	Four tiers/single(one way)	200	1275	900	1350	1450	100	75
3	3-3	Three/single	200	1075	900	1150	1450	100	75
4	4-4	Two/single	200	545	250	620	350	100	75

The covers of the slab are also of RCC with ratio mixing 1:1.5:3. The thickness of the slab shall be 75mm for section 1-1 (MS Rods to be used 10mm & 8mm), section 2-2, 3-3 shall be 60mm (MS Rod to be used 8mm) and section 4-4 shall be 50mm (MS Rods to be used 8mm & 6mm). The MS rods to be used shall be placed at 100 mm centre to centre both way and properly binded. The cover slab shall have provision of lifting hooks at two points for easy lifting of the slabs. Slabs having lifting hooks shall be placed at every 10<sup>th</sup> slabs. The lengths of the cable trench cover slabs are as below.

Section	Length of the slab	Thickness of the slab
1-1	1600mm	75mm
2-2	1100mm	60mm
3-3	1100mm	60mm
4-4	400mm	50mm

The covers for the cable trench inside the control room shall be provided with MS chequered plate with MS angle stiffeners at the bottom for proper mechanical strength.

### 12.9 Excavation

Excavation for cable ducts shall generally be carried out in accordance with Clause no. 6.2 of this specification.

### 12.10 Back fill

Except where ducts are to be encased in concrete, sand is to be packed and well tamped round the duct until it is covered to a depth of 75 mm above the upper surface of the duct. Filling above this level is to be with suitable excavated material free from large stones. In multiple duct runs the interstices between the ducts are to be filled with sand and compacted. A cover of 75 mm above the uppermost ducts shall be maintained. The sand used shall be the same quality as approved for use in making concrete.

### 12.11 Laying of ducts

Telephone and electrical cable ducts shall be laid and jointed in accordance with the Manufacturer's instructions.

### 12.12 Multiple runs to ducts

Electrical cable ducts in multiple runs whether encased in concrete or not, shall be laid at approved centres vertically and/or horizontally. The minimum concrete encasement where required is to be 150 mm. The final jointing of ducts in multiple runs shall be done in the trench, i.e. the duct shall be lowered and jointed singly not in groups, and duct joints shall be staggered by approximately half the duct length in alternate lines.

### **12.13 Cutting of ducts**

The Contractor shall carry out any necessary cutting of pipe ducts according to the requirements of the work. Except where ducts enter the cable trench at an angle, they shall be cut at right angles to the length of the duct. The inside edges of cut ducts shall be thoroughly rounded off or so dressed before being placed in position so that there can be no possibility of damage to cables from the edges of the ducts. All electrical ducts entering draw pits shall be provided with suitable bellmouths.

### **12.14 Cleaning and testing of ducts**

On completion of all electrical cable ducting, two mops of appropriate size connected one to each end of an iron mandrel shall be passed twice through each way to clean the conduit and to remove any foreign matter which may have entered. If any obstruction or other defect be discovered it shall be removed or rectified forthwith.

### **12.15 Sealing of electrical ducts**

As soon as every duct or set of ducts has been proved and its draw wire material installed, the ends of the cut or its bellmouth where provided, shall be sealed to a depth of 5 mm with an appropriate sealer, and a single coat of bitumastic paint shall then be applied over the end of the ducts and the seal. The length of draw wire installed shall be such that at least one metre of draw wire extends from each end of each duct. After the ends of ducts have been sealed the free ends of draw wires shall be neatly coiled.

### **12.16 Concrete cable and pipe trenches**

In-situ concrete trenches are to be provided inside and outside the Substation. The trenches are to have falls in the floor and must be drained at regular intervals.

All trenches must have trench covers suitable for their location and loading. Any beams or supporting covers must be as shallow as possible to avoid interfering with the pipes and cables in the trench.

Once the trench covers have been made they are to be stored and not laid until all trench cabling, piping, etc. is finished. Any covers laid before this time which become damaged shall be replaced at the Contractor's expense.

Trench covers and bridging beams for covers, except where heavy duty, shall be light enough for two men to lift.

### **12.17 Buried cables**

Cables are to be laid in neat lines and at suitable levels. Their depth below ground level will depend upon the voltage associated with the cables but in all cases the excavation must provide a clear trench. Sand filling below, around and above the cables will always be required and protection covers or tiles will be placed in position over the sand filling before final backfilling to the ground level. The line of the cable trenches shall be marked with suitable posts as required by relevant section of this Specification.

## **13. 0 FOUNDATION/RCC DESIGN**

### **13.1 General**

All foundations/RCC Design shall be of reinforced cement concrete. The design and construction of RCC structures shall be carried out as per IS 456 and minimum grade of concrete shall be M20 corresponding to 1:1.5:3 (M20) nominal mix ratio with 12-20 mm coarse aggregate. Higher grades of concrete than specified above may be used at the discretion of the Bidder without any financial implication to the owner. Work covered under this clause of the specification comprises the construction of foundations and other RCC constructions for switchyard structures, equipment support, trenches, drains, jacking pad, pulling block, control cubicles, bus supports, Auto transformer/power transformer/reactors, marshalling kiosks, auxiliary equipments and system buildings, tank or for any other equipment or service and any other foundation required to complete the work. Also applicable to other RCC constructions.

If the site is sloping, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate such slopes.

The switcyard foundations plinths and building plinths shall be minimum 300mm above finished ground level respectively. Minimum 75 mm thick lean concrete shall be provided below underground structures, foundations, trenches etc to provide a base for construction.

The design and detailing of foundations shall be done based on the approved soil data and sub-soil conditions as well as for all possible critical loads and the combinations thereof. The special footing or pile foundations as may be required based on soil/sub-soil conditions and superimposed loads shall be provided.

Admixtures in concrete shall confirm to IS:9103. The water proofing cement additives shall confirm to IS:2645. Concrete Admixtures/Additives shall be approved by the owner.

Limit state method of design shall be adopted unless stated otherwise in the Specification.

For design and construction of steel-concrete composite beams IS 11384 shall be followed.

For detailing of reinforcement IS 2502 and SP:34 shall be followed. Cold twisted deformed bars ( $F_y = 415$  N/sq mm) conforming to IS 1786 shall be used as reinforcement. However, in specific areas, mild steel (Grade1) conforming to IS 432 can also be used. Two layers of reinforcement (on inner and outer face) shall be provided for wall and slab sections having thickness of 150 mm and above. Clear cover to reinforcement towards the earth face shall be minimum 40 mm.

RCC water retaining structures such as storage tanks, cooling water basin etc. shall be designed as uncracked sections in accordance with IS 3370 (Part 1 to IV) by working stress method and shall also be tested for water tightness at full water level. However, water channels shall be designed as cracked sections with limited steel stresses as per IS 3370 (Part 1 to IV) by working stress method.

The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and /or equipment and /or superstructure, and other conditions which produce the maximum stresses in the foundation or the foundation component, and as per the relevant IS Codes of foundation design. The design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used.

All foundations shall rest below virgin ground level and the minimum depth of foundation below the virgin ground level shall be maintained.

Design shall consider any sub-soil water pressure that may be encountered.

Necessary protection to the foundation work, if required, shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil which is detrimental or harmful to the concrete foundations.

RCC columns shall be provided with rigid connection at the base.

All building sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factors of safety for these cases shall be as stated in relevant IS Codes or as stipulated elsewhere in the Specifications.

Earth pressure for all underground structures shall be calculated using coefficient of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable). However, for the design of substructures of any underground enclosures, earth pressure at rest shall be considered.

In addition to earth pressure and ground water pressure etc., a surcharge load of  $2T/\text{sq.m}$  shall also be considered for the design of all underground structures including channels, sumps, tanks, trenches, and substructures of any underground hollow enclosure etc., to allow for vehicular traffic in the vicinity of the structure.

The following conditions shall be considered for the design of water tanks, pump houses, channels, sumps, trenches and other underground concrete structures such as basements etc.

- Full water pressure from inside and no earth pressure, ground water pressure and surcharge pressure from outside (applicable only to structures which are liable to be filled with water or any other liquid).
- Full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

Design shall also be checked against buoyancy due to the ground water during construction and maintenance stages. Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings.

Base slabs of any underground enclosures shall be designed for empty condition during construction and maintenance stages with maximum ground water table (GWT). Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the super-imposed loadings.

Base slab of underground enclosures such as water storage tank shall also be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum GWT. Intermediate dividing piers of such enclosures shall be designed considering water in one pump sump only and the other pump sump being empty for maintenance.

The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate.

The foundation of the transformer and circuit breaker shall be of block type foundation. Minimum reinforcement shall be governed by IS:2974 and IS:456.

The tower and equipment foundations shall be checked for a factor of safety of 2.2 for normal condition and 1.65 for short circuit condition against sliding, overturning and pullout. The same factor shall be used as partial safety factor over loads in limit state design also.

All underground concrete structures such as basements, pump houses, water retaining structures etc. shall have plasticizer cum water proofing cement additive conforming to IS 9103. In addition, the limit on permeability as given in IS 2645 shall also be met. The concrete surface of these structures in contact with earth shall also be provided with two coats of bituminous painting for water /damp proofing.

In case of water leakage in the above structures, leakage repair shall be achieved by the injection method.

### **13.2 Machine Foundations**

All machine foundations shall be designed in accordance the provisions of the relevant parts of the latest revisions of IS 2974, IS 456 and IS 2911. The provisions of DIN 4024 (latest) shall also be followed.

All block foundations resting on soil or piles shall be designed using the elastic half space theory.

The mass of the RCC block shall not be less than three times the mass of the machine. Dynamic analysis shall be carried out to calculate natural frequencies in all the modes including coupled modes, and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down by the relevant IS codes and/or machine manufacturers, shall be satisfied. Minimum reinforcement shall be governed by IS 2974 and IS 456.

For the foundations supporting minor equipments weighing less than one tonne, or if the mass of the rotating parts is less than one-hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structures, floors etc. suitable vibration isolation shall be provided by means of springs, neoprene pads etc. and such vibration isolation system shall be designed suitably.

### **13.3 Other Foundations**

All foundations shall be designed in accordance with the provisions of the relevant parts of latest revisions of IS 2911 and IS 456.

Type of foundation system i.e. isolated footing, raft or piling shall be decided based on the load intensity and soil strata.

A minimum three piles shall be provided in any pile group.

Gantry and tower foundations shall be designed for an additional factor of safety of 1.1 for normal/ broken wire conditions and for short circuit condition.

Circuit breaker foundations shall be designed for impact loading and shall be strictly in accordance with the Manufacturer`s recommendations.

## **14. 0 FOUNDATIONS AND R CC CONSTRUCTION**

### **14.1 General**

Work covered under this Clause of this Specification comprises the design, supply and installation of foundations and other RCC constructions for switchyard structures, equipment supports, trenches, rains, jacking pads, pulling blocks,



fencing, control cubicles, bus supports, transformers, marshalling kiosks, auxiliary equipments and systems, buildings and tanks, or for any other equipment or service and any other foundation required to complete the work. This clause is as well applicable to the other RCC constructions.

Concrete shall conform to the requirements of IS 456 and all the tests shall be conducted as per relevant Indian Standard Codes.

If the site is sloping, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate for such slopes.

Switchyard foundation plinths and building plinths shall be minimum 300 mm and 500 mm above finished ground level respectively.

A minimum of 75 mm thick lean mix concrete (1:3:6) shall be provided below all underground structures, foundations, trenches etc. to provide a base for construction.

Concrete made with portland cement(OPC-43 grade) shall be carefully cured and special consideration shall be given during the placing of concrete and removal of shuttering.

The design and detailing of foundations shall be done based on the approved soil data and sub-soil conditions as well as for all possible critical loads and combinations thereof. Spread footing foundations or pile foundations as may be required based on soil and subsoil conditions and superimposed loads shall be provided.

If pile foundations are adopted, the same shall be cast-in-situ, driven, bored, precast or underreamed type as per relevant IS. Only RCC piles shall be provided. Suitability of the adopted pile foundations shall be justified by way of full design calculations. Detailed design calculations shall be submitted by the contractor showing complete details of piles and pile groups proposed to be used. Necessary initial load tests shall also be carried out by the contractor at their entire cost to establish the pile design capacity. Only after the design capacity of piles has been established, shall the Contractor commence of piling. All the design and testing work shall be planned in such a way that these shall not cause any delay in project completion.

## **14.2 Cement**

The cement to be used shall be the best quality of its type.

All cement shall be sampled and tested in accordance with Indian Standards.

Cement shall be Ordinary Portland Cement as per I.S.269-1976 or Portland Slag Cement as per I.S. 455-1976

The Ordinary Portland cement(OPC-43 grade) used in concrete shall conform to IS 269.

Requirement of sulphate resistant cement (SRC) for sub structural works shall be decided in accordance with the Indian Standards based on the findings of the detailed soil investigation to be carried out by the contractor.

High Alumina cement shall NOT be used.

## **14.3 Delivery and storage of cement**

Cement shall be delivered to the site in bulk or in sound and properly sealed bags and while being loaded or unloaded whether conveyed in vehicles or by mechanical means, and during transit to the concrete mixers, must be protected from the weather by effective coverings. Efficient screens are to be supplied and erected to prevent wastage of cement during strong winds.

If the cement is delivered in bulk, the Contractor shall provide at his own cost approved silos of adequate size and number to store sufficient cement to ensure continuity of work. The cement shall be placed in these silos immediately it has been delivered on the site. Suitable precautions shall be taken during unloading to ensure that the resulting dust does not constitute a nuisance.

If the cement is delivered in bags, the Contractor shall provide at his own cost perfectly waterproof and well-ventilated sheds having a floor of wood or concrete raised at least 150 mm above the ground. The sheds shall be large enough to store sufficient cement to ensure continuity of work. Each consignment of each type of cement shall be stacked separately therein. On delivery at site the cement shall at once be placed in these sheds and shall be used in the order in which it has been delivered.

All cement shall be used within 3 months of the date of manufacture.

#### **14.4 Aggregate**

Coarse and fine aggregate shall conform to the requirements of IS 383-1970.

Sampling and testing of aggregates shall be in accordance with the relevant Indian Standard.

Fine and coarse aggregates shall be obtained from the same source and the Contractor shall ensure that material from the source is known to have a good service record over a long period of time.

Aggregate shall be hard and dense and free from earth, clay, loam and soft, clayey, shaley or decomposed stone, organic matter and other impurities.

#### **14.5 Storage of aggregates**

Coarse and fine aggregates shall be stored on site in bins or on clean, dry, hard surfaces, and be kept free from all sources of contamination. Aggregates of different gradings shall be stored separately, and no new aggregate shall be mixed with existing stocks until tested, and approved by the Engg Incharge (Divisional Engr.).

#### **14.6 Approval of Supplies**

As soon as possible after the Contract has been placed the Contractor shall submit a list giving details of the sources from which he proposes to obtain concrete and mortar materials. Only materials from approved sources shall be brought to site, but the Engg Incharge (Divisional Engr.) will be prepared to extend his approval to other satisfactory sources of supply which may be proposed by the Contractor. Approval of a source of supply shall not imply acceptance of material found not to conform to this Specification

#### **14.7 Water**

Water used for mixing concrete and mortar shall be clean, fresh water obtained from an approved source and free from harmful chemicals, oils, organic matter and other impurities. Normally potable water may be considered satisfactorily for mixing and curing concrete and masonry work.

#### **14.8 Steel bar reinforcement (FE500)**

Reinforcement shall comply with the appropriate Indian Standards.

All bar reinforcement shall be hot rolled steel except where the use of cold worked steel is specified on the drawings or otherwise approved.

The bars shall be round and free from corrosion, cracks, surface flaws, laminations, rough, jagged and imperfect edges and other defects.

The bar reinforcement shall be new, clean and of the lengths and diameters described on the Drawings and Schedules. Bars shall be transported and stored so that they remain clean, straight, undamaged and free from corrosion, rust or scale. Bars of different diameters shall be separately bundled.

#### **14.9 Bending of reinforcement**

All steel bars are to be accurately bent cold to the shapes and sizes indicated on the Drawings and Schedules unless otherwise approved. Re-bending of bars and bending in position in the works shall not generally be allowed.

#### **14.10 Welding of reinforcement**

Spot or tack welding for positioning bars in heavily reinforced areas will only be allowed with the express permission of the Engg Incharge (Divisional Engr.). Extension of lengths of reinforcement by welding will not be permitted.

Welding will be approved only in low stress members, and lap welding will not be approved in any circumstances.

#### **14.11 Fixing of reinforcement**

Before fixing in the works bars shall be seen to be free from pitting, mud, oil, paint, loose rust or scale or other adherents harmful to the bond or strength of the reinforcement. Bars shall be fixed rigidly and accurately in position in accordance

with the working drawings, unless otherwise approved by the Engg Incharge (Divisional Engr.). Reinforcement at all intersections shall be securely tied together with 1.5 mm soft annealed tying wire the ends of which shall be cut and bent inwards. Cover to the reinforcement shall be in accordance with Clause 15.12 of this specification and sufficient spacers and chairs of precast concrete of approved design shall be provided to maintain the specified cover and position. No insertion of bars in previously placed concrete shall be permitted. Projecting bars shall be adequately protected from displacement. The fixing of reinforcement in the works shall be approved by the Engg Incharge (Divisional Engr.) before concrete is placed. Measurement will be based on the calculated weights of steel actually used in tonnes corrected to second place of decimal.

#### **14.12 Concrete cover to reinforcement**

For durability the minimum concrete cover to any reinforcing bar shall be as follows:

##### **Concrete above ground.**

- Internal faces of slabs 25 mm
- Internal faces of beams and walls 30 mm
- Exposed faces of slabs, beams and walls 50 mm
- All faces of columns 50 mm

##### **Concrete below ground (including piles).**

- Faces in contact with soil including blinding concrete 75 mm
- All other faces (i.e. internal faces of basement wall) 50 mm

Only concrete or steel spacers shall be used to achieve the required minimum thickness of concrete cover to reinforcement. Concrete spacers shall have non metallic ties. Timber blocks for wedging the steel off the formwork will not be allowed.

#### **14.13 Formwork**

Form work shall be constructed from timber, metal, lined as necessary for special finishes and designed with the quality and strength required to ensure rigidity throughout placing, ramming, vibration and setting of the concrete, without detrimental effect.

Form work shall be erected true to line, level and shapes required using a minimum of approved internal ties. Faces in contact with the concrete shall be true and free from defect, jointed to prevent loss of water or fines, in panels or units which permit easy handling, and designed to permit side forms to be struck independently of soffit shuttering. Ties or spaces remaining embedded shall have the minimum cover specified for reinforcement. Forms for exposed concrete beams, girder casings and columns shall provide for a twenty five millimetre chamfer on external corners.

Wedges and clamps shall be kept tight during vibration operations. Before commencement or resumption of concreting, the interior of forms shall be cleaned and free of sawdust, shavings, dust, mud or other debris and openings shall be formed to facilitate this cleaning and inspection. The inside of the forms shall be treated with a coating of an approved substance to prevent adhesion. Care shall be taken to prevent this substance being in contact with the reinforcement.

#### **14.14 Grades of concrete**

Concrete shall be either ordinary or controlled and in grades designated M10, M15, M20 and M25 as specified in IS 456 (latest edition ). In addition, nominal mixes of 1:3: 6 and 1: 4: 8 of nominal size 40 mm maximum, or as indicated on drawings, or any other mix without any strength requirements as per mix design shall be used where specified.

#### **14.15 Ordinary concrete**

Ordinary concrete shall be used for all plain cement concrete work and where shown on drawings or allowed by the Engg Incharge (Divisional Engr.). Ordinary concrete shall not require preparation of trial mixes.

In proportioning concrete, the minimum quantity of cement shall be as specified in Table 15.15.1 of this clause and the amount to be used shall be determined by actual weight. The quantities of fine and coarse aggregate may be determined by volume, but preferably by weight.

The water cement ratio shall not be more than those specified in IS 456.

Grade of Concrete	Minimum cement content per c.m. of finished concrete
M 10	236 kg
M 15	<b>323</b> kg
M 20	<b>410</b> kg
M 25	<b>530</b> kg

**Table - 15.15 Minimum Cement content.**

## 14.16 Controlled concrete

### 14.16.1 Mix proportions

The mix proportions for all grades of concrete shall be designed to obtain strength corresponding to the values specified in IS 456 for respective grade of concrete. Preliminary tests as specified in the IS Code or as required by the Engg Incharge (Divisional Engr.), shall be carried out, sufficiently ahead of the actual commencement of the work, with different grades of concrete made from representative samples of aggregate and cement expected to be used on the job. The purpose of this test is to ascertain the water cement ratio required to produce a concrete having specified strength, and to demonstrate sufficient workability to enable it to be well consolidated and to be worked into corners of shuttering and around the reinforcement.

### 14.16.2 Mix design

As a guide to perform the mix design properly, the relationship between water cement ratio, aggregate to cement ratio, workability and strength of concrete will be as per relevant IS.

The cement /total aggregate ratio is not to be increased beyond 1: 9.0 without specific permission of the Engg Incharge (Divisional Engr.). It should be noted that such high aggregate/cement ratios will be required for concretes of very low slump and high water cement ratios which may be required to be used in mass concrete work only.

The actual cement aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used, and from trial mixes.

## 14.17 Strength requirements

The mix proportions for all grades of concrete shall be designed to produce the grade of concrete having the required workability and a characteristic strength not less than the value given table 15.17.

Grade Designation	Characteristic Compressive Strength at 28 days
M 10	10 N / sq. mm
M 15	15 N / sq. mm
M 20	20 N / sq. mm
M 25	25 N / sq. mm

**Table - 15.17 Strength Characteristic**

The strength of concrete given above is the 28 days characteristic compressive strength of 15 cm cube.

#### **14.18 Workability**

The workability of concrete shall be checked at frequent intervals by slump test, where facilities exist and if required by the Engg Incharge (Divisional Engr.), alternatively the compaction factor test in accordance with IS 1199 shall be carried out.

#### **14.19 Mixing of Concrete**

Unless otherwise approved, concrete for foundations will be M 20 grade, corresponding to nominal mix of 1:1.5:3 as per IS 456. The proportions of fine and coarse aggregate, cement and water shall be as determined by the mix design or according to fixed proportions in case of nominal mix concrete and shall always be approved by the Engg Incharge (Divisional Engr.). The quantities of the cement, fine and coarse aggregates shall be determined by weight, the water shall be measured accurately after giving proper allowance for surface water present in the aggregate. Water shall be added to make a workable mix and it is important to maintain the water-cement ratio at its correct value of 0.55 in accordance with the requirements of IS 456.

Water shall not be added to the mix until all the cement and aggregates constituting the batch are already in the drum and dry mix for at least one minute. Mixing of each batch shall be continued until there is uniform distribution of materials and the mass done for less than 2 minutes and at least 40 revolutions after all the materials and water are in the drum.

When hand mixing is permitted by the Engg Incharge (Divisional Engr.) for concrete to be used in unimportant locations it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand mixing, an extra 10% of cement shall be added to each batch and additional cost due to extra cement will be borne by the Contractor.

#### **14.20 Conveying Concrete**

Concrete shall be handled and conveyed from the place of mixing to the place of final laying as rapidly as practicable by approved means before the initial setting cement starts. Concrete should be conveyed in such a way which will prevent segregation or loss of any of the ingredients. If segregation does occur during the transport of concrete same shall be re-mixed. The requirements to be fulfilled during transportation are :

- No segregation or separation of materials in the concrete, and
- Concrete delivered at the point of placing should be uniform and of proper consistency.

#### **14.21 Placing Concrete**

Form work and reinforcement shall be approved in writing by the Engg Incharge (Divisional Engr.) before concrete is placed. The forms shall be well wetted and all shavings, dirt and water that may have collected at the bottom shall be removed before concrete is placed. Concrete shall be deposited in its final position without segregation, re-handling or flowing. As far as possible concrete shall be placed in the formwork by means approved by the Engg Incharge (Divisional Engr.) and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 180 cm. shall have to be approved by the Engg Incharge (Divisional Engr.). Once the concrete is deposited in its final position, it shall not be disturbed. Care should be taken to avoid displacement of reinforcement or movement of formwork.

The placing of concrete shall be a continuous operation with no interruption in excess of 30 minutes between the placing of continuous portions of concrete. When fresh concrete is required to be placed on previously placed and hardened concrete, special care should be taken to clean the surface of all foreign matter. For securing a good bond and water tight joint, the receiving surface should be made rough and a rich mortar placed on it unless it has been poured just before. The mortar layer should be about 15 mm thick with cement and sand proportion as that of the mix in use, and have the same water-cement ratio as the concrete to be placed.

After the concrete has been placed it shall be thoroughly compacted by approved mechanical vibration to a maximum subsidence without segregation and thoroughly worked around reinforcement or other embedded fixtures into the correct form and shape. Vibrators must be operated by experienced men and over vibration shall not be permitted. Care should be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or disturbed during placing of concrete. No concrete shall be placed in open while it rains. If there is any sign of washing of cement and sand, the concrete shall be entirely removed immediately. Slabs, beams and similar structure shall be poured in one operation

normally. In special circumstances with the approval of Engg Incharge (Divisional Engr.) these can be poured in horizontal layers not exceeding 50 cm. in depth. When poured in layers, it must be ensured that the under layer is not hardened. Bleeding of under layer if any shall be effectively removed.

#### **14.22 Compaction of Concrete**

Compaction is necessary for production of good concrete. After the concrete has been placed it shall be thoroughly compacted by approved mechanical vibrator to a maximum subsidence without segregation and thoroughly worked around reinforcement or other embedded fixtures into the correct form and shape. Vibrators must be operated by experienced men. Care should be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or disturbed during the vibration of the concrete. The Contractors shall provide standby vibrators. Vibration is commonly used method of compaction of concrete, the use of mechanical vibrators complying with IS 2505, IS 2506, IS 2514 and IS 4656 for compacting concrete is recommended

For all practical purposes, the vibration can be considered to be sufficient when the air bubbles cease to appear and sufficient mortar appears to close the surface and facilitate easy finishing operations. The period of vibration required for a mix depends upon the workability of the mix.

#### **14.23 Curing of Concrete**

In order to achieve proper and complete strength of the concrete, the loss of water from evaporation should be prevented. Eighty to eighty five per cent of the strength is attained in the first 28 days and hence this 28-day strength is considered to be the criterion for the design and is called characteristic strength. The concrete after setting for 24 hours shall be cured by keeping the concrete wet continuously for a period of 10 days after laying.

The curing increases compressive strength, improves durability, impermeability and abrasion resistance. Failure to carry out satisfactory curing can lead to cracking in the concrete. This in turn can lead to salt attack of the reinforcement and consequential failure of the structure. If cracks occur in a structure which are severe enough to affect the structure, the Contractor shall cut out and replace the defective concrete at his own cost. The Contractor's attention is, therefore, drawn to this particular aspect of proper and adequate curing

#### **14.24 Construction joints**

Construction joints are a potential source of weakness and should be located and formed with care and their number is kept to a minimum.

When the work is to be interrupted, the concrete shall be rebated at the joint to such shape and size as may be required by the Engg Incharge (Divisional Engr.) or as shown on the drawings. All vertical construction joints shall be made with water bars which are rigidly fixed and shall provide a positive barrier against movement of water through the joint. Great care shall be taken when placing concrete around water bars because the space is often congested. Concreting shall be carried out continuously up to construction joints. Construction joints, if not described on the drawings, shall be in accordance with the following:

- In a column, the joint shall be formed about 75 mm below the lowest soffit of the beams framing into it, at the meeting points of the columns and the raft, and at the point of contraflexure in the columns.
- Concrete in a beam shall be placed throughout without a joint. However if the provision of a joint is unavoidable, the joint shall be vertical and at the middle of the span.
- A joint in a suspended floor slab shall be vertical at one of the quarter points of the span and at right angle to the principal reinforcement.
- Additional reinforcements and shear keys shall be provided at the construction joints.

In forming a joint, concrete shall not be allowed to slope away to thin edge. The locations of construction joints shall be planned by the contractor well in advance of pouring and be approved by the Engg Incharge (Divisional Engr.).

Construction joints in foundation of equipment shall not be provided without the approval of Engg Incharge (Divisional Engr.).

#### 14.25 Expansion and separation joints

Expansion joints shall be as shown on the drawings or as specified in the schedules. Expansion joint filler boards conforming to IS 1838 and sealing strips shall have minimum transverse joints. Joints shall be vertical and straight except where otherwise approved and concrete surfaces and faces shall be flush on both sides of the joint.

Separation joints shall be with standard water proof paper or with as alkathene sheets about 1 mm in thickness. Lap length and sealing of laps shall be to the satisfaction of the Engg Incharge (Divisional Engr.).

#### 14.26 Removal of form work

Form work shall be kept in position fully supported, until the concrete has hardened and gained sufficient strength to carry itself and any loads likely to be imposed upon it. Stripping must be effected in such a manner and at such a time that no shock or other injury is caused to the concrete. The responsibility for safe removal rests with the Contractor but the Engg Incharge (Divisional Engr.) may delay the time of striking if he deems it necessary.

Minimum periods, in the absence of agreement to the contrary, between completion of concreting and removal of forms are given below but due regard must be paid to the method of curing and prevailing conditions during this period.

- |   |         |
|---|---------|
| • Removal of shuttering to sides of rafts, walls, beams and columns   | 2 days  |
| • Removal of shuttering to slabs, beams and arches (props left under) | 6 days  |
| • Removal of props to slabs, beams and arches                         | 16 days |
| • Lifting of pre cast members   | 16 days |

#### 14.27 Pre cast concrete members

Pre cast concrete members shall be used in the works only where specified on the Drawings or approved by the Engg Incharge (Divisional Engr.).

The technical specifications for cement concrete, formwork and reinforcement covered under earlier clauses shall form a part of these specifications and shall be followed for carrying out pre cast concrete work.

Pre cast members shall not be disturbed or lifted until the minimum periods specified for formwork removal have elapsed.

#### 14.28 Load Test on Parts of Structures

The load test on concrete, if desired by the Engg Incharge (Divisional Engr.) shall be carried as soon as possible after the expiry of 28 days from the time of placing of concrete as per the clause 16.5 to 16.6 of IS : 456. The structure shall be subjected to a load equal to full dead load of the structure plus 1.25 times the imposed load for a period of 24 hours and then the imposed load shall be removed. The entire cost of load testing shall be borne by the contractor and if any portion of the structure found unacceptable under the relevant clause of IS : 456, the same shall be dismantled and replaced by a new structure as per specification at no extra cost to the Employer. If during dismantling any of the adjacent structure is damaged, the same shall be made good free of charge by the contractor to the satisfaction of the Engg Incharge (Divisional Engr.).

#### 14.29 Finish of concrete surface

##### 14.29.1 Concrete cast against formwork.

The following finishes to concrete surfaces, unless otherwise specified or shown on the drawings, shall be as follows—

- **Class A1:** All permanently exposed surfaces, including exposed sides of foundations.
- **Class A2:** Surfaces to be covered by backfill, plasters or the like.

Class A1 surfaces shall be dense, fair, smooth, even, free from honeycombing, water and air holes and other blemishes, true to line and surface and free from board or panel marking. They shall be of uniform colour. Rendering of defective surfaces shall not be permitted, and, if ordered by the Engg Incharge (Divisional Engr.), the Contractor shall at his own expense cut out to expose reinforcement and make good any unsatisfactory work. All areas so treated shall be rubbed down and kept moist for several days.

Class A2 surfaces shall be dense, even, free from honeycombing and true to line and surface.

Any special finishes will be to details or instructions given by the Engg Incharge (Divisional Engr.).

#### 14.29.2 Concrete not cast against form work.

The following finishes shall be provided unless otherwise specified or shown on the drawings—

- **Class B1:** All permanently exposed surfaces, including tops of equipment foundations, wall copings, window sills, precast items (except paving flags ).
- **Class B2:** Paving flags and paths. Floors and slabs to be surfaced with blocks, tiles or waterproofing materials.
- **Class B3:** Roads, buried concrete and floors or slabs to be covered by screed.

Class B1 surfaces shall first be levelled and screened to produce a true surface. After the moisture film has disappeared, and the concrete has hardened sufficiently, the surface shall be finished with a steel trowel under firm pressure to give a smooth, dense, even and hard surface free from all marks and defects.

Class B2 surfaces shall be levelled and screened to produce a true surface, and be finished with wooden or steel float to give a level surface free from screed marks. Excessive floating shall be avoided.

Class B3 surfaces shall be levelled and screened to produce a true and uniform surface.

#### 14.30 Holes, pockets, threaded inserts, etc.

The threaded inserts for casting into concrete shall be electro-galvanized and of malleable iron or mild steel. Holes, cavities and fixings shall be provided in the works only at the positions indicated on the drawings or as directed and they shall be incorporated as necessary during the work of concreting. Unless otherwise agreed a tolerance in position of plus or minus five millimetres shall be allowed. Inserts and bolts shall be fixed square in the works by means of temporary bolts or nuts, and then concrete cast around them. The projecting portions of such fixings, and concrete within fifty millimetres of them, shall be bitumastic painted and all threads well greased on completion of the work. Holes and pockets shall be stripped down clean on completion.

#### 14.31 Blinding

Blinding concrete shall be made with nominal aggregate sizes of both 20mm and 40mm diameter. They shall be referred to respectively as grade M 10/20 and M 10/40.

Under all foundations and elsewhere as indicated on the drawings a layer of concrete grade M10 (1:3:6) shall be laid immediately the excavation is carried down to foundation level. The blinding surface shall be thoroughly cleaned before foundation concrete is deposited thereon. Sumps shall be provided where necessary to facilitate the control of drained water. The grade shall be applied as shown in Table 15.31.1

Location	Grade	Thickness of layer
Foundations and bases	M 10 / 1:3:6	75 mm
Floors of ducts, trough and reinforced slabs not exceeding 100 mm	M 10 / 1:3:6	50 mm

**Table 15.31.1. Blinding layer thickness values**

#### 14.32 Admixtures and Additives

Only approved admixtures shall be used in the concrete for the Works. When more than one admixture is to be used, each admixture shall be batched in its own batch and added to the mixing water separately before discharging into the mixer. Admixtures shall be delivered in suitably labelled containers to enable identification.

Admixtures in concrete shall conform to IS:9103. The water proofing cement additives shall conform to IS:2645. Concrete admixtures and additives shall be approved by the Engg Incharge (Divisional Engr.).



The Contractor shall use an approved neutralized vinsol resin air-entraining agent in all concrete. The Air entraining agent shall be supplied and batched as a solution with a solids content not exceeding 15 percent by weight with suitable, stable and consistent pH.

The Contractor may propose and the Engg Incharge (Divisional Engr.) may approve the use of a water-reducing set-retarding admixture in some of the concrete. The use of such an admixture will not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations and shall only be approved as an aid overcoming unusual circumstances and placing conditions.

Water-reducing set-retarding admixture shall be an approved brand of Igno-sulphonate type admixture.

Water proofing cement additives shall be used as required or advised by the Engg Incharge (Divisional Engr.).

## **15. 0 FENCING**

### **15.1 General**

Fencing shall be designed for the most critical loading combination taking into account wind forces, stability, tension on wires, minimum requirements as per this clause and relevant IS recommendations.

The un climbable or security, or anti-intruder fencing shall consist of chain link mesh, all as soon on the drawings and as specified below, supported on approved sections of structural steel. The posts shall be erected truly vertical, and all posts and struts shall be set in concrete block foundations.

Concrete kerbing shall be provided between the fence posts as shown on the drawings.

### **15.2 Areas requiring fencing**

Fencing shall be provided for the following areas:

- Site fencing for the complete station, complete with barbed wires on top. Separate gates shall be provided for men and equipment.
- Internal fence surrounding the various equipments (if) mounted on ground or a height lower than 2.5 m, without barbed wires on top. Necessary gates shall be provided for each area so surrounded.
- Wherever necessary anti-reptile fixture/arrangement shall be provided along with fencing.

### **15.3 Product materials**

#### **15.3.1 General**

Chain Link fence fabric in accordance to IS :2721, and shall also meet the following requirements.

- Size of mesh 75 mm
- Size of coated wire 3.15 mm diameter
- Width of chain link 2000 mm
- Class of zinc coating medium
- Zinc coated after weaving

Posts shall be as shown in Table.

The posts shall be of medium M.S tube of 50 mm diameter conforming to Yst-22 (Kg / sq. mm ).The tubes shall be also confirm to IS:1161/IS 806.The length of the tubular post shall be 3200mm.

An M.S base plate of size 160X160X6mm thick shall be welded with the tubular post. The post shall be provided on the top with M.S plate.

The tubular post shall be welded with 8 numbers of M.S flat of size 50X6mm – 75 mm long. Two numbers of 13.5 mm dia holes on each cleats shall be provided to bolt the fence fabric panel. The cleats shall be welded at equal spacing in such a way that 4 nos of cleats are on the opposite side and remaining 4 nos cleats are on the opposite side of the post. The cleats on the corner posts shall be welded in such a way that it suits the site requirement.

The whole assembly of tubular post shall be hot dip galvanised. The zinc coating shall be minimum 615 gram per sq mm. The purity of the zinc shall be 99.95% as per IS:209.

Fence fabric panel:

Chain link fencing shall be fabricated in the form of panel 2000X2928 mm. GI angle frame (50X50X6 mm) with bracing of 50X6 mm GI flat on both the corners shall be welded all round fence fabric to form a panel. Four pairs of 13.5 mm diameter holes on the vertical MS flat matching the spacing of holes in cleats fixed with pipe shall be provided to fix the fence panel with tubular posts. A washer shall also be provided below each nut. 12 mm diameter bolts and nuts including washers **shall also be supplied. All bolts, nuts and washer shall be hot dip galvanised.** The fence panel shall be provided with two GI flats of size 50X6 mm placed cross wise for rigidity of chain link.

Installations:

Fence shall be installed along switch yard line as per the approved GA drawing. Post holes shall be excavated by approved method. All posts shall be 3 mtrs apart measured parallel to ground surface.

Posts shall be set in 1:2:4 plain cement concrete block of minimum 0.4X0.4X1.2mtr depth. 75 mm thick PCC 1:4:8 shall be provided below concrete block.

Fence posts shall be erected in vertical and kept for minimum 7 days curing before fence fabri erection.

Fence fabric panel shall be fixed to the post at 4 nos. M.S flat each of 50X6 mm,75mm long through 2 nos of 12 mm dia bolts on each flat.

Paintings as per decision of the Engineer in charge have to be carried out.

Continuous running earth by using 50 X 6 mm GI flats to be provided for safety purpose.

A 345/380 mm thick (one and a half brick size) toe wall of Brick/Rubble masonry, or concrete with notches shall be provided below all fencing and shall be minimum 200 mm above and 500 mm below finished ground level. All exposed surfaces for brick toe wall shall be provided with 15 mm 1:6 cement sand plaster and coated with two coats of water proofing snowcem cement paint. In case if rubble masonry is provided suitable pointing shall be done.

#### **GATES:**

Gates shall be installed in locations shown on drawings. Next to the main gate, a men gate (1.25 m wide, single leaf) shall also be provided.

Bottom of gates shall be set approximately 40 mm above ground surface and necessary guiding mechanism (with roller on the bottom of the gate and fixed guider in the road)shall be fitted to avoid hanging of the main gate.

#### 15.3.2 Gates

Gate frames shall be of galvanized steel of 40 mm dia main pipe and vertical pipes of 15mm dia @ 125 mm spacing (pipe to relevant IS) welded to the main pipe for frames or Black steel pipe to relevant IS for frames with welded joints and shall be painted with one coat of steel primer and two coats of synthetic enamel paints.

Gates shall be fabricated with welded joints or other approved methods to achieve rigid connections. The gate frames shall be hot dip galvanized after welding.

Gates shall be fitted with galvanized malleable iron hinges, latch and latch catch. Latch and latch catch shall be suitable for attachment and operation of padlock from either side of gates. Hinges shall permit gates to swing through 180 degree back against fence.

Gates shall be fitted with galvanized chain hook or gate hold back to hold gates open. Double gates shall be fitted with centre rest and drop bolt to secure gates in closed position.

### 15.3.3 Patching

Damaged galvanized surfaces shall be repaired. Damaged surfaces shall be cleaned with wire brush removing loose and cracked spelter coating. Two coats of approved zinc pigmented paint shall be applied to damaged areas in accordance with manufacturers instructions.

There shall be one gate located on boundary wall as main gate having wicket gate and one gate as switchyard gate, located on the fencing.

## 16. 0 BUILDING

### 16.1 General

The scope includes the design, engineering and construction of control room and colony quarters building. For control room and colony quarter building the tentative layout showing the facilities to be provided is indicated some where and also to be proposed by the bidders for better utility and aesthetic view. However, the size and layout of the building may be modified as per requirements of Single Line Diagram (SLD) with the approval of the Engg Incharge (Divisional Engr.).

### 16.2 Dimensions

An open space of one metre minimum shall be provided on the periphery of the rows of panels, and equipment generally, in order to allow easy operator movement and access as well as maintenance.

The building design shall also take into consideration the layout of the panels, switchboards, switchgear and other equipment in order to allow enough area for the future extension of switchyard depending upon the availability of substation area.

### 16.3 Design

The buildings shall be designed:

- to the requirements of the National Building Code of India. and the standards quoted therein
- for the specified climatic and loading conditions
- to adequately suit the requirements of the equipment and apparatus contained in the buildings and in all respects to be compatible with the intended use and occupancy
- with a functional and economical space arrangement
- for a life expectancy of structure, systems and components not less than that of the equipment which is contained in the buildings, provided regular maintenance is carried out
- to be aesthetically pleasing. Different buildings shall show a uniformity and consistency in architectural design
- to allow for easy access to equipment and maintenance of the equipment
- with, wherever required, fire retarding materials for walls, ceilings and doors, which would prevent supporting or spreading of fire
- with material preventing dust accumulation

Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns.

Individual members of the building frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion etc.

Permissible stresses for different load combinations shall be taken as per relevant IS Codes.

All cable vaults shall be located above ground level i.e. cable vaults shall not be provided as basements in the buildings.

The building lighting shall be designed in accordance with the requirements of relevant section.

The building auxiliary services such as air conditioning and ventilation systems, fire protection and detection systems and all other miscellaneous services shall be designed in accordance with the requirements specified in relevant sections of this Specifications.

The doors and windows of the building shall be of aluminium extruded channels, angles etc. The windows shall be provided with sliding shuttering facilities and also to be provided with aluminium make grills.

#### 16.4 Design Loads

Building structures shall be designed for the most critical combinations of dead loads, super-imposed loads, equipment loads, crane loads, wind loads, seismic loads, and temperature loads. In addition, loads and forces developed due to differential settlement shall also be considered.

Dead loads shall include the weight of structures, complete finishes, fixtures and partitions and should be taken as per IS:1911 (latest revision).

Super-imposed loads in different areas shall include live loads, minor equipment loads, cable trays, small pipe racks/hangers, and erection, operation and maintenance loads. Equipment loads shall constitute, if applicable, all load of equipments to be supported on the building frame.

For crane loads an impact factor of 30% and lateral crane surge of 10% of (lifted weight plus trolley weight) shall be considered in the analysis of frame according to provisions of IS:875 (latest revision). The horizontal surge shall be 5% of the static wheel load.

For temperature loading, the total temperature variation shall be considered as two thirds of the average maximum annual variation in temperature. The average maximum annual variation in temperature for the purpose shall be taken as the difference between the mean of the daily minimum temperature during the coldest month of the year and mean of daily maximum temperature during the hottest month of the year. The structure shall be designed to withstand stresses due to 50% of the total temperature variation.

Wind loads shall be computed as per IS:875. Seismic coefficient method shall be used for the seismic analysis as per IS 1893 (latest revision), wind and seismic forces shall not be considered to act simultaneously.

Floors/slabs shall be designed to carry loads imposed by equipment, cables, piping travel of maintenance trucks and equipment and other loads associated with the building. In general, floors shall be designed for live loads as per relevant IS and cable and piping loads not less than 5 kN/ sq.m hanging from the underside. In addition, beams shall be designed for incidental point loads of 20 kN to be applied at any point along the beams. The floor loads shall be subject to the approval of the Engg Incharge (Divisional Engr.).

For consideration of loads on structures, IS 875, “Code of practice for structural safety of buildings” shall be followed. The minimum superimposed live loads shown in Table 17.4.1. shall be considered for the design.

Roof	150 kg / sq m.	for accessible roofs.
	75 kg / sq m.	for non - accessible roof.
R C C Floors.	500 kg / sq m.	for offices and minimum 1000 kg / sq m. for equipment floors or actual requirement, if higher than 1000 kg / sq m., based on equipment component weight and layout plans.
Stairs and balconies.	500 kg / m.	
Toilet Rooms.	200 kg / m.	
Chequered plate floor.	400 kg /sq. m	
Walkways.	300 kg /sq. m.	

## **Table 17.4.1. Superimposed live loads**

### **16.5 Submission of data for approval**

The following information shall be submitted for review and approval to the Engg Incharge (Divisional Engr.):

- Design criteria for structural steel and reinforced concrete design. The criteria shall comprise the codes and standards used, applicable climatic data including wind loads, earthquake factors and maximum and minimum temperatures applicable to the building locations, assumptions of dead and live loads, including equipment loads, impact factors, safety factors and other relevant information.
- Structural design calculations and drawings including those for construction and fabrication for all reinforced concrete and structural steel structures.
- Fully dimensioned floor plans, cross sections, longitudinal sections and elevations of each building. These drawings shall be drawn at a scale not less than 1:50 and shall identify the major building components.
- Fully dimensioned drawings showing details and sections, drawn to scales of sufficient size to clearly show sizes and configuration of the building components and the relationship between them.
- Product information of building components and materials, including walls, partitions, flooring, ceilings, roofing, doors and windows and building finishes.
- A detailed schedule of building finishes including colour schemes.
- A door and window schedule showing door types and locations, door lock sets and latch sets and other door hardware.

Approval of the above information shall be obtained before ordering materials or starting fabrication or construction as applicable.

### **16.6 Electrostatic radio interference shielding**

The building inside the energized area of the stations shall be electrostatically shielded to limit the exposure of the equipment and personnel to specified electric field strengths. The shielding system shall be grounded properly.

### **16.7 Control Room Building/Colony quarters**

Design and construction, including anti termite treatment of control room building and colony quarters for each sub-station or switchyard shall be in the scope of the contract. The control room buildings and colony quarters shall be of RCC framed structure of concrete M20 grade. The control room and some other rooms of the control room building shall be fully air conditioned.

### **16.8 Finish Schedule**

The preliminary indicative finishing schedule is given in subsequent clauses. However, at the time of detailed engineering, the Engg Incharge (Divisional Engr.) reserves the right to alter the finishing schedule and specifications and such changes shall have no additional financial implication whatsoever to the Employer.

### **16.9 Flooring (52 mm Thick)**

50mm thick cement concrete 1:2:4. & finishing with vitrified tiles in the main control room area, conference room and MCCDB (AC & DC ) room. The other area flooring shall be with vitrified tiles of reputed make. There shall be dado of 9 inches by the same. The toilets and bath rooms shall be provided with antiskid ceramic tiles and the walls are also to be provided with ceramic tiles of adequate height as per standard practice. The battery room floorings and walls (up to 3mtrs height) shall be provided with acid proof industrial based tiles. The left over portion of the walls shall be painted with acid proof paints.

### **16.10 Walls**

Control room buildings shall have framed superstructure. All walls shall be non-load bearing walls. Minimum thickness of external walls shall be 230 mm with 1:6 cement sand mortar. A 50 mm thick DPC shall be provided at plinth level before starting masonry work.

## 16.11 Plastering

All internal walls shall have minimum 12mm thick 1:6 cement sand plaster. The ceiling shall have 6mm thick 1:4 cement sand plaster.

## 16.12 External Finish

All external surfaces shall have painted with weather proof synthetic paints over 18mm thick cement sand plaster in two layers. Under layer 12mm thick cement plaster 1:5 (1 cement:5 coarse sand) and a top layer 6mm thick cement plaster 1:3 (1 cement:3 coarse sand) finished rough with sponge.

All ceilings shall be white based plastic emulsion paints and the internal walls are also to be provided with plastic emulsion synthetic paints. The outer of the building shall be provided with weather seal coats of synthetic paints.

### **Painting details:**

Following colour paints of *M/s Berger paints India Ltd.*, *M/s Asian Paints India Ltd.* & *M/s Kansai Nerolac Paints Ltd.* with specified standards are to be followed for all type of buildings.

Sl. No.	Description	Berger Paints	Asian Paints	Nerolac Paints
1	Interior wall	3P 0778- Soft Light (Easy Clean)	7907-Candle Wick (AP Royale)	2016P- Lemon balm (Lotus Touch)
2	Exterior wall (body)	2P 0229-Calming Touch (Weather Coat Smooth)	8564- Sweet Dreams (Apex)	4051- Lightest Peach (Excel)
3	Exterior wall (border)	2A 0232- Cookie Crisp (Weather Coat Smooth)	8645-Rich Chocolate (Apex)	2798C- Kitty Kat (Excel)

The following procedure need be adopted for maintaining optimum quality & durability in painting the walls (both internal & external walls).

### **(a) Internal wall:**

- (i) The walls are to be applied with 2 coats of putty (JK/ Birla/ Bison make) of minimum 2 mm of thickness. After the first coat is applied, minimum of 2 days may be spared for drying up the wall. Then the second coat may be applied over the first coat so that 2mm thickness is achieved & uniformity is maintained.
- (ii) After applying the second coat, another 2 days may be spared & then sand paper is to be applied to remove the undulation of the wall.
- (iii) White primer (water thin-able / solvent thin-able) of one coat (Berger/Nerolac/ Asian Paints) is to be applied.
- (iv) Then two coats of colour paints are to be applied on the wall.

### **(b) External wall:**

- (i) One coats of primer (Weather Coat) are to be applied.
- (ii) Then two coats of weather coat need to be applied on the wall. The two coats should be applied with an minimum interval of 12 hours in between.

## 16.13 Roof

Roof of the building shall consist of cast in situ R.C.C. slabs. Extra heavy water proofing treatment shall be done after grading underbed with 1:4 cement sand plaster of 25mm thickness. The under bed shall be laid to provide an ultimate run off gradient of 1:120. The extra heavy treatment shall be concrete based with water proof treatment as per the standard to protect the roof from damage due to water logging. Proper slope and adequate no of water drains outlets shall be provided for easy discharge of water from the roof. These drains shall be connected to the main drain.

#### **16.14 Glazing (glass)**

Minimum thickness of glazing shall be 6 mm. The glazing for the control room area ,which will be air-conditioned shall be provided with double toughned glass each of 6mm thickness.

#### **16.15 False Ceiling**

The control room and all other air conditioned areas shall have closed aluminium ceiling system comprising 84mm wide, 12.5mm deep panels of approved colour with a recessed flange of 23.9mm roll formed out of 0.5mm thick aluminium alloy 5050/5052/3003 or equivalent, coated with chromatised and stone enamelled on both sides, panels to be fixed on roll formed carriers 32 mm wide 39 mm deep out of minimum 0.9 mm thick aluminium alloy strip with cut outs to hold panels in a module of 100mm minimum at maximum 1.6 mc/c carrier suspended from roof by 4mm diameter galvanised steel wire rod hangers with special height adjustment springs/clips made out of spring steel at maximum spacing of 1.5 m c/c hangers fixed to roof, J'hooks and nylon insert including providing laying and fixing 25mm thick resin bonded mineral wool of approved quality, encased in 100 G black polythene and laid over top of places panels, all complete. The system is subject to approval by the Engg Incharge (Divisional Engr.) before installation

#### **16.16 Doors and Windows**

The doors and windows of the control room building shall be of aluminium with aluminium grill and all the frames of doors and windows also of aluminium sections in accordance with the relevant IS Codes. Size and shapes shall be adequate for entering in to the room. In the Air conditioned area shall be double glass (toughened) and doors suitably made to have efficient air conditioning. The windows shall be of sliding type. Anodised aluminium work for doors and windows, ventilators and partitions shall be provided and fixed in the building with extruded built up standard tubular and other sections approved make confirming to IS:733 and IS:1285, anodised transparent or dyed to required shade according to IS:1868 (minimum anodic coating of grade AC 15) fixed with rawl plugs and screws with fixing clips, or with expansion hold fastners including necessary filling up of gaps at junctions at top, bottom and sides with required PVC/neoprene felt etc and joined mechanically wherever required including cleat angle, Aluminium snap beading for glazing/panelling, C.P brass/stainless steel screws including glazing and fittings as specified.

#### **16.17 Plumbing And Sanitation**

All plumbing and sanitation work shall be executed to comply with the requirements of the appropriate bye laws, rules and regulations of the Local Authority having jurisdiction over such matters. The Contractor shall arrange for all necessary formalities to be met in regard to inspection, testing, obtaining approval and giving notices etc.

An overhead water tank of adequate capacity depending on the number of users for 24 hours storage shall be provided.

Galvanised MS pipe of medium class conforming to IS : 1239 shall be used for internal piping works for portable water supply.

Sand C I pipes with lead joints conforming to IS:1729 shall be used for sanitary works above ground level.

A list of toilet fittings will be approved by the Engg Incharge (Divisional Engr.), before procurement by the contractor and same will be inspected by the Engg Incharge (Divisional Engr.) before installation. Sufficient nos of toilets and bath rooms including separate urinal provision shall be provided at both ground and first floors. Required nos of wash basins (stand type) with good quality mirrors and other accessories as required are also to be provided at both ground and first floor of control room building. Same procedure for colony quarters also.

#### **16.18 Building storm water drainage**

The building design shall provide for the collection of storm water from the roofs. This water shall be collected in junction boxes and these boxes shall drain to the main drainage system of the station.

Cast iron rain water downcomers conforming to IS:1230 with water tight lead joints or medium class galvanised mild steel pipes conforming to IS:1239/ IS:3589, shall be provided to drain off the rain water from the roof. These shall be suitably concealed with masonry work of cement concrete or cladding material. The number and size of downcomers shall be governed by IS:1742 and IS:2527.

All drains inside the buildings shall have minimum 40 mm thick grating covers and in areas subject to movement heavy equipment loads, precast RCC covers shall be provided in place of steel grating.

For all buildings, suitable arrangement for draining water collected from equipment blowdowns, leakages, floor washings, fire fighting etc. shall be provided for each floor.

### 1.3 Flooring

Entire area around the control room building (out side) shall be provided with PCC paving starting from the building upto 2 mtrs clear distance for the full length of the building.

The above specified PCC paving shall be with M15 mix grade concrete over suitable under bed arrangement as specified for other ground floor slab.

Above the PCC paving suitable Cement pavers chequered plate of size as per the standard to be provided. The colour of the chequered plate shall be fixed over the PCC paving by using cement mortar and the colour of such plate shall be red.

The cable vault below the main control room shall have 50 mm thick smooth floor finish units of cement concrete.

### 1.4 Provision of rooms in the control room building.

a) 220/132/33 KV S/S Building:

>The plinth area for the control room building shall be as below:-

**Ground floor: 50mtrX25mtr**

**Ground floor portico: 5mtrX5mtr (at two locations)**

**First floor: 25 mtr X 25 mtr**

i) Ground floor shall have cable vault, Battery room, Office rooms(3 nos), MCCB room, Library, Conference room, Testing lab, Pantry room, Toilets and bath room(two nos and one attached), Corridor with lounge, Portico at front and side, Ramp etc.

ii) First floor shall have control room, PLCC room, office room, toilets and bath room etc.

\* All internal walls shall 125 mm thick. (Excluding cement plastering)

\* All external walls shall 250 mm thick. (Excluding cement plastering)

\* For RCC works refer the relevant specification.

\* The quarter shall be of framed RCC structure based.

\* Concrete grade shall be 1:1.5:3 for all RCC works

\* Reinforcement shall be Fe 415 Grade, confirming to IS:1786. All hooks,bands,laps shall be as per IS:456-2000.All laps shall be staggered and minimum lap length shall be 50XDia of Bar.

\* Clear cover to main reinforcement for footing = 50mm,column=50mm,beam=25mm & slab=20mm.

\* Rain water pipes 100 sq mm to be provided at suitable location.

\* The stair case width=1100mm, Tread=300mm, riser=148/150mm and suitable platform at different level.

\* The height of the ground floor of the building from the finished plinth level (minimum 1.0 mtr from the finished ground level) shall be 3.9 mtrs and the height of the parapet wall shall be 750mm. The height of the first floor from the top of the roof of the first floor shall be 3.4 mtrs and the height of the parapet wall shall be 750mm.The stair case top shall be at a height of 2.75 mtrs from the top of the parapet top.

\* The stair case shall be RCC having Granite stone fixing.

b) 132/33 KV & 220/33 KV S/S Building:

>The plinth area for the control room building shall be as below:-

**Ground floor: 42mtrX13 mtr =546 Sqm**



## **Ground floor portico: 5mtrX5mtr**

### **First floor: 21 mtr X 13 mtr=273 Sqm**

i) Ground floor shall have Control room( also can be kept on the first floor for better visibility of switch yard area), PLCC room, Battery room, MCCDB room, ,Toilets and bath room, Verandah & Portico etc..

ii) First floor shall have office rooms (3 Nos), a Library, a Conference room, a Rest room, ,Pantry room ,toilets(2 No.) and toilet cum bath room (1 no.) etc.

- \* All internal walls shall 125 mm thick. (Excluding cement plastering)
- \* All external walls shall 250 mm thick. (Excluding cement plastering)
- \* For RCC works refer the relevant specification.
- \* The quarter shall be of framed RCC structure based.
- \* Concrete grade shall be 1:1.5:3 for all RCC works
- \* Reinforcement shall be Fe 415 Grade, confirming to IS:1786. All hooks,bands,laps shall be as per IS:456-2000.All laps shall be staggered and minimum lap length shall be 50XDia of Bar.
- \* Clear cover to main reinforcement for footing = 50mm,column=50mm,beam=25mm & slab=20mm.
- \* Rain water pipes 100 sq mm to be provided at suitable location.
- \* The stair case width=1100mm, Tread=300mm, riser=148/150mm and suitable platform at different level.
- \* The stair case shall be RCC having Granite stone fixing.
- \* The height of the ground floor of the building from the finished plinth level (minimum **1.0** mtr from the finished ground level) shall be 3.9 mtrs and the height of the parapet wall shall be 750mm. The height of the first floor from the top of the roof of the first floor shall be 3.4 mtrs and the height of the parapet wall shall be 750mm.The stair case top shall be at a height of 2.75 mtrs from the top of the parapet top.
- \*\* **Stair case of all type of buildings shall have stainless steel pf 304 grade in hand railing using 50mm dia of 2mm thick circular pipe with balustrade of size 32mmx32mmx32mm @0.90mtr C/C and stainless square pipe bracing of size 32mmx32mmx32mm in three rows in staircase as per approved design and specification, buffing, polishing.**

## **1.5 Provision of rooms in the colony quarter (building).**

- a) **“D” Type quarter:** Tentative plinth area shall be **120 sq mtrs (excluding the area of the portico)**. D type quarter shall have two bed rooms of size 3.6 mtrX3.6 mtr having porticos; one bed rooms of size 3.9 mtrX3.3 mtr having portico; one living room of size 4.2 mtrX3.6 mtr; one dining cum lobby of size 4.2 mtrX4.7 mtr; one kitchen of size 2.75mtrX3.3 mtr; Two nos attached toilet cum bath room of size 2.15 mtr X 1.5mtr, one no common toilet cum bath room of size 1.5mtr X 2.2 mtr, Portico and space for vehicle parking. The kitchen shall have provision of Kitchen platform (granite one) two sides of the wall with stainless steel sink having water tap provision as per standard practice. Kitchen room shall have provision of cupboard for storing the kitchen utensils and other items including locking arrangement of the cup board. Provision of cup-boards in all other rooms as per standard practice shall be provided. Shall have stair case to go to the top of the roof and have stair case head room. A portico of adequate size in front of the quarter/flat to be provided to park the four & two wheeler vehicle.
- b) **“E” Type quarter:** Tentative plinth area shall be **73 sq mtrs (excluding the area of the portico)** E type quarter shall have two bed rooms of size 3.3 mtrX3.3 mtr having porticos; one no attached toilet cum bath room of size 2.15 mtr X 1.5mtr, one no common toilet cum bath room of size 1.5mtr X 2.2 mtr, one living room of size 4.5 mtrX3.3 mtr Portico and space for vehicle parking. The kitchen shall have provision of Kitchen platform (granite one) two sides of the wall with stainless steel sink having water tap provision as per standard practice. Kitchen room shall have provision of cupboard for storing the kitchen utensils and other items including locking arrangement of the cup board. Provision of cup-boards in all other rooms as per standard practice shall be provided. Shall have stair case to go to the top of the roof and have stair case head room. A portico of adequate size in front of the quarter/flat to be provided to park the four & two wheeler vehicle.
- \* All internal walls shall 125 mm thick. (Excluding cement plastering)

- \* All external walls shall 250 mm thick. (Excluding cement plastering)
- \* For RCC works refer the relevant specification.
- \* The quarter shall be of framed RCC structure based.
- \* Concrete grade shall be 1:1.5:3 for all RCC works
- \* Reinforcement shall be Fe 500 Grade, conforming to IS:1786. All hooks,bands,laps shall be as per IS:456-2000.All laps shall be staggered and minimum lap length shall be 50XDia of Bar.
- \* Clear cover to main reinforcement for footing = 50mm,column=50mm,beam=25mm & slab=20mm.
- \* Rain water pipes 100 sq mm to be provided at suitable location.
- \* The stair case width=1100mm,Tread=300mm, riser=148/150mm and suitable platform at different level.
- \* The stair case shall be RCC having Granite stone fixing.
- \* The height of the building from the finished plinth level (0.5 mtr from the finished ground level) shall be 3.15 mtrs i.e. up to the terrace level. A clear 1.15 mtrs shall be above the terrace and up to the top of the parapet. The stair case top shall be at a height of 2.75 mtrs from the top of the parapet top.
- \* Details of doors & windows to be provided in the colony quarters are as indicated below.
- \*\* Stair case of all type of buildings shall have stainless steel pf 304 grade in hand railing using 50mm dia of 2mm thick circular pipe with balustrade of size 32mmx32mmx32mm @0.90mtr C/C and stainless square pipe bracing of size 32mmx32mmx32mm in three rows in staircase as per approved design and specification, buffing, polishing.**

All the frame of doors & windows shall be of M.S as per below.

The doors and windows of the colony quarters shall be of M.S with M.S grill and all the frames of doors and windows also of M.S sections in accordance with the relevant latest IS Codes for construction of building. Size and shapes shall be adequate for entering in to the room. The windows shall be centre open & twin panel type, rigidly hinged on the frame with minimum three hinges on one side for windows & minimum four hinges for doors. All the panel of the external doors and windows shall also be of M.S sheet having minimum thickness of 03 mm, with proper support on the frame of the door for rigidity & the support shall also be of M.S flat having minimum size of 25X5 mm. The Door frames & Chaukat shall be of 45X45X6 mm M.S (G.I ) sections. The window frame & Chaukat shall be of 25X25X6 mm M.S (G.I ) sections. Proper locking arrangement with stoppers to be provided on the door and windows. Surface cleaning, application of red oxide primer paint and two coats of synthetic enamel paint (Asian paints/Berger/Nerolac) of the doors , windows & grill are to be provided. All the windows shall be provided with M.S grill and care should be taken while designing the grill frame that the entering of cat should be restricted.

The inside doors of the quarters shall be one side open & the panels shall be of flush type , water ,termite & weather proof resistant hard board of minimum 32 mm thickness (reputed make of ISI brand hard board flush type door) & the door shall be hinged with the door frame with suitable support for rigidity. The Door frames / Chaukat shall be of extruded aluminium sections suitably anodised. Surface cleaning, application of red oxide primer paint and two coats of synthetic enamel paint (Asian paints/Berger/Nerolac) of the inside doors are to be provided. Proper locking arrangement with stoppers to be provided on the door. The size of the door frame/chaukat shall be as indicated in the specification. Size of the door frame/ chaukat shall be 39 inchX78 inch ( inside to inside). The flush door panel shall be of size 39 inchX78 inch. The door for the kitchen and toiletcum bath room shall be of standard adequate size PVC door shall be provided.

Anodised aluminum work for inside doors and ventilators shall be provided and fixed in the quarters with extruded built up standard sections of approved make conforming to IS: 7333 and IS:1285, anodized transparent or dyed to required shade according to IS:1868 (Minimum anodic coating of grade AC 15) fixed with raw plugs and screws or with fixing clips, or with expansion hold fasteners including necessary filling up of gaps at junctions at top, bottom and sides with required PVC/neoprene felt etc and joined mechanically wherever required including cleat angle, Aluminium snap beading for glazing/paneling, C.P. brass/stainless steel screws including glazing and fittings as specified.

ventilators shall be provided and fixed with hinges/pivots fittings wherever required including PVC/neoprene gasket.

The building design shall provide for the collection of storm water from the roofs. This water shall be collected in junction boxes and these boxes shall drain to the main drainage system of the station.

Cast iron rain water downcomers conforming to IS:1230 with water tight lead joints or medium class galvanised mild steel pipes conforming to IS:1239/ IS:3589, shall be provided to drain off the rain water from the roof. These shall be suitably concealed with masonry work of cement concrete or cladding material. The number and size of downcomers shall be governed by IS:1742 and IS:2527.

All drains inside the buildings shall have minimum 40 mm thick grating covers and in areas subject to movement heavy equipment loads, precast RCC covers shall be provided in place of steel grating.

For all buildings, suitable arrangement for draining water collected from equipment blowdowns, leakages, floor washings, fire fighting etc. shall be provided for each floor.

## **17. 0 MISCELLANEOUS GENERAL REQUIREMENTS**

Dense concrete with controlled water cement ratio, preferably 0.45, shall be used for all underground concrete structures such as pump-house, tanks, water retaining structures, cable and pipe trenches etc. for achieving water-tightness.

All joints including construction and expansion joints for the water retaining structures shall be made water tight by using PVC ribbed water stops with general bulb. However, kicker type (externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 5 mm and minimum width shall be 230 mm.

All steel sections and fabricated structures which are required to be transported by sea shall be provided with anti-corrosives paint.

All mild steel parts used in the water retaining structure shall be hot-dip galvanised. The minimum coating of the zinc shall be 750 gm/sq.m. for galvanised structures and shall comply with IS:2629 and IS:2633. Galvanizing shall be checked and tested in accordance with IS:2629. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen.

A screed concrete layer not less than 100 mm thick and of grade not weaker than M10 conforming to IS:456- 1978, shall be provided below all water retaining structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structures.

Bricks having minimum 75kg/sq.cm compressive strength can only be used for masonry work. Bidder shall ascertain himself at site regarding the availability of bricks of minimum 75kg/ sq.cm compressive strength before submitting his offer.

Monorails, monorail girders and fixtures shall be provided, wherever required.

Doors and windows on external walls of buildings other than areas provided with insulated metal claddings shall be provided with a RCC sun-shade over the openings with 300 mm projection on either side of the openings. Projection of sunshade from the wall shall be minimum 450 mm over window openings and 750 mm over door openings.

All stairs shall have maximum riser height of 180 mm and a minimum tread width of 250 mm. Minimum width of stairs shall be 1200 mm. There shall be provision of of stair case to the roof of the building.

Angles of 50x50x6 mm minimum with lugs shall be provided for edge protection all round cut out and openings in floor slab, edges of drains with grating covers, edges of RCC cable/pipe trenches with covers, edges of manholes with covers, edges of precast covers and any other place where breakage of corners of concrete is expected.

Anti-termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc. as per IS:6313 and other relevant Indian Standards.

Hand railing of a minimum height of 900 mm shall be provided around all floor or roof openings, projections and balconies walk ways, platforms, steel stairs etc. All handrails and ladder pipes shall be The railing of the staia-rcase shall be made of proper aluminium sections. All rungs for ladders shall also be of aluminium as per IS:.

For RCC stairs, also hand railing with aluminium sections are to be provided.

## **18. 0 INTERFACING**

Proper coordination and execution of all interfacing civil works activities such as fixing of conduits in roofs/walls/floors, fixing of foundation bolts, fixing of lighting fixtures, fixing of supports/embodiments, provision of cut-outs etc. shall be the sole responsibility of the contractor. He shall plan all such activities in advance and execute in such a manner that interfacing activities do not become bottlenecks and such that dismantling, breakage etc. is reduced to minimum.

## **19. WATER SUPPLY**

The Contractor shall be overall responsible for supply of water within switch yard for fire fighting, drinking purposes and other miscellaneous purposes. Water shall be made available at a single point by the Employer. The scope is also inclusive of supply and erection of all tanks, pipes, fittings etc. required for the water supply to be taken from the terminal point to the respective buildings. A scheme shall be prepared by the contractor indicating the layout and details of water supply which shall subject to the approval of the Engg Incharge (Divisional Engr.) before actual start of work. Any extra bore holes required shall be within the scope of the contractor.

There shall be separate bore wells for the control room building and colony quarters. There shall be pump houses for the bore wells and approach road to the pump houses shall be provided.

The Contractor shall have overall responsibility to provide a suitable arrangement for permanent supply for and retention of water within switch yard building and to the yard for watering to the earth pits, drinking purposes as well as for township and other miscellaneous purposes. The scope is inclusive of supply and erection of all tanks, pipes, fittings etc. required for the water supply to be taken from the terminal point/points to the respective buildings. A scheme shall be prepared by the contractor indicating layout and details of water supply which shall subject to the approval of the Engg Incharge (Divisional Engr.) before commencement of work. Any extra bore holes required shall be within the scope of this contract. The capacity of each submersible pump shall be 5 HP and all control as per standard has to be provided. The no of bore holes shall be two nos , one for colony township and the other one for the switch yard building. Two nos pump house as per standard are also within the scope of this contract. The height of the pump house (LXW=3mtrsX3mtrs) shall be 3 mtrs and shall have RCC roof and brick walls having MS doors. The capacity of RCC overhead tank for control room building shall be 2000 liters each .Two nos of overhead water tank for control room building and for colony quarters each quarter shall have 1000 liters capacity.

There shall be interconnection between tow pump sections in order to meet any exigencies.

## **20. 0 STATUTORY RULES**

The Contractor shall comply with all the applicable statutory rules pertaining to Factories Act (as applicable for ORISSA State), Fire Safety Rules of Tariff Advisory Committee, Water Act for pollution control etc.

Provisions for fire proof doors, numbers of staircases, fire separation wall, plastering on structural members (in fire prone areas) etc. shall be made according to the recommendations of Tariff Advisory Committee.

Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.

### **21.0 SECURITY WATCH TOWERS:**

There shall be provision of security watch tower at the corners of the switch yard. These watch towers shall be of RCC type. Standard practice in this effect shall be followed. The maximum numbers of such towers shall be 4. The size of the tower platform shall be 2.5mtrsX2.5mtrs and height as per standard practice.

### **22.0 SECURITY SHED NEAR THE MAIN GATE.**

There shall be one RCC type security shed near the main gate to be provided. The shed shall have also provision of sitting arrangement for the guests. The shed shall be provided with telephone internal, electrical lighting and ceiling fan facilities. There shall be provision of gate lights. The size of the security cum guest shed shall be 5mtrsX3.5mtrsX3.5mtr(LengthXwidthXHeight). A portion of the shed shall be used for the guest who

comes for visit the sub-station. Adequate no of MS doors and windows are also to be provided. Necessary paintings as per standard are also to be done.

### **23.0 PROVISION OF STORE SHED, PLAT FORM, RAMP AND WINCH FOR LIFTING MATERIALS & VEHICLE PARKING SHED.**

23.1 One no store shed of size 10X10 mtr having brick walls and plastering with RCC roof of 10X10 meters. The flooring shall be of 75 mm thickness PCC (mix ratio1:2:4) over RR masonry works (as per standard practice of flooring). Provision of adequate nos of MS racks (proper paintings also to be done as per the direction of site in charge) for keeping the spare materials. The height of the shed shall be 4mtrs above the plinth.

23.2 One no platform outside the store shed RR masonry (compacted) with PCC at the top for storing the transformer bushings, Instrument transformers, transformer oil drums etc. The size of the platform shall be 15mtrX10 mtr. Details of flooring as mentioned under 23.1. The platform shall have top covers by using TATA GC sheets.

23.3 Provision of a RCC based ramp of adequate size for loading and unloading of the materials from the lorry near the store shed.

23.4 A winch is to be provided near the ramp for lifting and lowering of materials up to 5 tons capacity. The two side vertical pillars shall be by MS Rail/joist and the top horizontal also of same type. A chain pulley of 5 ton capacity is to be provided at the centre of the frame on the horizontal bar.

23.5 Erection of Isolator Mechanism Box.

Separate RCC foundation to be provided for the Isolator Mechanism boxes.

23.6 There shall be one no vehicle parking shed inside the sub-station area. The size of the parking area shall be 15mtrs X 15 mtrs, out of the entire area there shall be provision of shed for 5 mtrs X 15 mtrs and rest of the area shall be without shed. The flooring of the entire area of the vehicle parking shall be as mentioned under 23.1.

### **24.0 ANTIWEED TREATMENT AND SITE SURFACING**

#### **SCOPE OF WORK**

The contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawings, specification and direction of the Engg Incharge (Divisional Engr.).

#### **General Requirement**

The material required for site surfacing/gravel filling shall be free from all types of organic materials and shall be of standard approved quality, and as directed by the Engg Incharge (Divisional Engr.).

The Contractor shall furnish and install the site surfacing to the lines and grades as shown in the drawing and in accordance with the requirements and direction of the Engg Incharge (Divisional Engr.). The soil of the periphery area of the switchyard area shall be subjected to sterilisation or anti-weed treatment before placing the site surfacing/gravel fill material or strictly as per instruction or requirement of the manufacturer of the chemical required for soil sterilisation or anti-weed treatment. After all the structures and equipment have been erected and accepted, and soil sterilisation of the peripheral area (except the switch yard area) as specified is complete, the site shall be maintained to the lines and grades indicated in the drawing and rolled or compacted by using three ton roller with suitable water sprinkling to form a smooth and compact surface condition which shall be matching with finished ground level of the switchyard area.

#### **Chemical to be used for soil sterilisation /anti-weed treatment:**

The details of quantities and method of application of chemicals used for soil sterilisation /and anti-weed treatment shall be as per manufacturer`s recommendations. Bidders are required to submit the details of chemicals proposed to be used and recommendations of manufacturer with required guarantee alongwith their bids for necessary approval of the Engg Incharge (Divisional Engr.). Approval of the Engg Incharge (Divisional Engr.) by no means shall relieve the contractor of their contractual obligations as stipulated in General and Special Conditions of Contract.

## **25.0 PROVISION OF GARDEN INFRONT OF CONTROL ROOM BUILDING AND PLANTATION OF PLANTS (FRUIT BEARING & OTHER SHOW PLANTS):**

A garden in front of the control room building is to be developed. It includes treatment of the land of size (30mtrsX10mtrs), manuring, and plantations of sufficient flower based, show based, crotons and entire portion shall be provided with garden grass. Proper land slope also to be maintained for better and aesthetic looking. Provision of water taps and garden lights at different locations are to be provided for watering the plants and lighting of the garden.

100 nos fruit bearing plants and 100 nos other show plants along the road side, near colony quarters and near control room building are required to be planted. Treatment of the soil and manuring are to be done before plantation of these plants. Water taps at different locations are to be provided for watering the plants.

## **26.0 RAINWATER HARVESTING:**

In addition to drainage of rainwater, the contractor shall make arrangement for rainwater harvesting also.

Rainwater harvesting shall be done by providing two numbers recharge structures with bore wells. The recharge structures shall be suitably located with in the S/S. Branch drains from the main drain carrying rainwater from entire switchyard shall be connected to the recharge structures.

The internal diameter of recharge shafts shall be 4.5 meter with 230mm thick lining of brick work upto a depth of 2.0 meter from ground level and 345mm thick brickwork below 2.0 meter depth. The brickwork shall be constructed with cement mortar 1:6 (1 cement : 6 coarse sand ). The overall depth of shaft shall be 5.0 meter below invert level of drain. The shaft shall be covered with RCC slab for a live load of 300Kg. per Sq.m. two openings of sizes 0.7X0.7 meter shall be provided in the RCC cover slab as shown in the drawing. An iron cover made of 5mm thick chequered plate with hinges shall be provided in the openings. Galvanized M.S. rungs of 20mm diameter at spacing of 300mm shall be provided in the wall of the shaft below the opening of the RCC slab to facilitate cleaning of shaft.

A 300mm diameter bore well shall be drilled in the centre of the shaft. The depth of bore well shall be 5.0 meter more than the depth of the sub soil water.

A 100mm diameter medium duty MS pipe confirming to IS 1161 shall be lowered in the bore well keeping bail plug towards bottom of bore well. The pipe shall have 1.58mm holes for 4.0 meter length starting from 1.0 meter from bottom of bore well. Holes of 3.0mm dia. Shall be provided for a length of 2.0 meter starting from the bottom level of coarse sand and downwards. The overall length of the pipe shall be equal to the total depth of the bore well plus depth of shaft.

Gravel of size 3mm to 6mm shall be filled around 100 dia MS pipe in the bore well. The shaft shall be filled with 500mm thick layers each from the bottom of shaft with boulders of size 50mm to 150mm, gravel of size 5mm to 10mm, coarse sand having particle size 1.5mm to 2.0mm and boulders of size not less than 200mm respectively.

27.0 Fire water Tank: This is a lump-sum item. The contractor shall be required to complete the work in all respect as per requirement. All the items including excavation, compaction, brick work, roof truss, corrugated A.C. Sheet roofing, all types of miscellaneous steel internal and external plastering, painting, etc shall be deemed to be included in this lump-sum water tank. However the concrete (all types), reinforcement and the steel embedments(except roof truss & purlins) shall be measured and paid on lumpsum basis.

## **MORE ON CIVIL WORKS**

### **I) WATER SUPPLY (EXTERNAL)**

- (i) Water shall be made available by Owner (unless stated otherwise elsewhere) at any feasible point near scope boundary at single point to the contractor. Contractor shall state the total water requirement both in terms of quantity and head to the Owner.
- (ii) The contractor shall carry out all the external plumbing/erection works required for supply of water to the control room building beyond the single point as at (i).
- (iii) The contractor shall carry out all the plumbing/erection works required for supply of water to fire water tank beyond the single point as at (i).
- (iv) A scheme shall be prepared by the contractor indicating the layout and details of water supply which shall be got approved from the Owner before actual start of work including all other incidental items not shown or specified but as may be required for complete performance of the works.
- (v) Bore wells and pumps for water supply is not in the scope of contractor.

### **II) TECHNICAL DETAILS OF THE BUILDINGS**

1. 12mm cement plaster of mix 1:6 (1 cement: 6 fine sand) shall be provided on the smooth side of internal walls.
2. 6mm cement plaster of mix 1:3 (1 cement: 3 fine sand) to all ceiling.
3. 15mm cement plaster of mix 1:6 (1 cement: 6 fine sand) on rough side of single or half brick wall.
4. 12mm thick per-laminated three layer medium density (exterior grade) particle board Grade I, Type II conforming to IS: 12823 bonded with phenol formaldehyde synthetic resin, of approved brand and manufacture shall be provided in paneling fixed in aluminium doors, windows shutters and partition frames with C.P. brass/stainless steel screws etc. complete as per architectural drawings and directions of engineer-in charge.
5. Distemping on all internal walls and ceilings with oil bound washable distemper of approved brand and manufacture to give an even shade (two or more coats) over and including priming coat with cement primer.
6. Enamel Painting with synthetic enamel paint of approved brand and manufacturer of required colour to give an even shade shall be provided on the steel glazed doors, windows, ventilators and rolling shutters in various buildings as specified in drawings. Two or more coats over an under coat of suitable shade with primer paint of approved brand and manufacture.
7. Two or more coats of French spirit polishing with a coat of wood filler shall be provided on the wooden doors of Control Room building.
8. ACDB and DCDB room in Control Room building and FPH building shall be provided 52mm thick cement concrete flooring with "Hardcrete" concrete hardener topping under layer 40mm thick cement concrete 1:2:4 (1 cement :2 coarse sand : 4 graded stone aggregate 20mm nominal size) and top layer 12mm thick metallic concrete hardener consisting of mix 1:2 (1 cement hardener mix:2 stone aggregate 6mm nominal size) by volume with which "Hardcrete" hardening compound of "Snowcem India Ltd" or equivalent is mixed @ litre "hardcrete" per 50kg of cement including cement slurry, complete. (In ACDB/DCDB Room and FPH building only).

9. Cement plaster skirting (up to 15 cm height) with cement mortar 1:3 (1 cement:3 coarse sand) mixed with metallic concrete hardener in same ratio as for floor finished with a floating coat of heat cement. 21 mm thick in ACDB/DCDB room.
10. Floor tiles of Polished porcelain (vitrified) in different sizes with water absorption less than 1% and flexural strength not less than 30 N/mm<sup>2</sup> in all colours and shades, laid on 20mm thick cement mortar 1:4 (1 cement: 4 coarse sand) including grouting the joints with white cement and matching pigments shall be provided as mentioned in drawings. Size of Tile shall be 50X50 cm.
11. 1<sup>st</sup> Quality Ceramic glazed floor tiles (anti-skid) 300 x 300mm (thickness to be specified by the manufacturer) of 1<sup>st</sup> quality conforming to IS:13755 of NITCO, ORIENT, SOMANY, KAJARIA or equivalent shall be provided in toilet/pantry area in all colour shades as approved by Engg-incharge laid on 20mm thick cement mortar 1:4 (1 cement: 4 coarse sand) including pointing the joints with white cement and matching pigment etc complete.
12. 1<sup>st</sup> quality ceramic glazed tiles conforming to IS:13753 of minimum thickness 5mm of approved make like NITCO, ORIENT, SOMANY, KAJARIA or equivalent make shall be provided in toilet/pantry area in all colours shades of any size as approved by Engg-incharge in dados (height as specified in drawings) over 12mm thick bed of cement mortar 1:3 (1 cement:3 coarse sand) and jointing with grey cement slurry @3.3kg per sqm including pointing in white cement mixed with pigment of matching shade complete.
13. 13mm polished granite in cement mortar 1:4, 20mm thick made to a level cut to size shall be provided and laid as specified in drawings. The joints are filled with jointing compound matching to the tiles. Wherever granite tiles are specified for the floor, 100mm granite skirting shall be provided with the walls. The granite outer surface shall be flushed to the plaster finish of the wall.
14. Granite counter shall be provided and fixed in the pantry with 18mm granite slab mounted on 75mm RCC slab supported by 115mm brick wall plastered on all sides as per the drawing. The shelves are made of 18mm thick well cut and polished white marble slabs. The outer side of the brick wall and the RCC slab visible in the front is finished with 18mm granite with edges molded on the exposed end. The shutters shall be finished with 19mm particle finished laminate edge lapping. The shutters are to be provided with 100mm handless and shutter locks. The inside of the shutter shall be painted with synthetic enamel paint.
15. All Brick work shall be with cement mortar 1:6 (1 cement :6 coarse sand). Half brick work masonry shall be with cement mortar 1:4 ( 1 cement: 4 coarse sand). Bricks used shall be of class-75.
16. Anti termite treatment shall be carried out for all buildings.
17. M.S. Rolling shutters as per drawing shall be provided and fixed interlocked together through their entire length and jointed together at the end by end locks mounted on specially designed pipe shaft with brackets along with ball bearing for rolling shutter, side guides and arrangements for inside and outside locking with push & pull operation including the cost of providing and fixing necessary 15.5 cm long wire springs grade No.2 and M.S. top cover of required thickness for rolling shutters. 80 x 1.25mm M.S. laths with 1.25mm thick top cover.
18. Circular/hexagonal M.S. sheet ceiling fan box shall be provided in the ceiling with clamp of internal dia. 140mm, 73mm height, 3mm thick rim, top and bottom lid of 1.5mm M.S. sheet. Lids shall be screwed in to M.S. box by means of 3mm round headed screws, clamps shall be made of 12mm dia M.S bar bent to shape as per standard drawing with over all length as 80 cm.
19. Anodised aluminum work for doors, windows, ventilators and partitions shall be provided and fixed in control room building with extruded built up standard tubular and other sections of approved make conforming to IS: 7333 and IS:1285, anodized transparent or dyed to required shade according to IS:1868 (Minimum anodic coating of grade AC 15) fixed with raw plugs and screws or with fixing clips, or with expansion hold fasteners including necessary filling up of gaps at junctions at top, bottom and sides with required PVC/neoprene felt etc and joined mechanically wherever required including cleat angle, Aluminium



snap beading for glazing/paneling, C.P. brass/stainless steel screws including glazing and fittings as specified.

Shutters of doors, windows and ventilators shall be provided and fixed with hinges/pivots fittings wherever required including PVC/neoprene gasket.

**(a) SPECTION FOR AL. WINDOWS:**

Shutters bottom section-61.85x37x45.5 WS 1027, 1.058 Kg/mt, side and top section 61.85X31.75, WS 1029, 0.650 Kg/mt, shutter sections, one side and both side open 40X18X10 WS 1023, 0.433 Kg/mt, Interlock sections 40X18X26.5X10, WS 1022, 0.530 Kg/mt, with 4 mm plain float glasses, PVC gaskets, Nylon wheels, Aluminium handles cum locks. Indal/Indal/Hinalco make as per drawing.

**(b) SECTION FOR AL. DOORS:**

Anodised aluminum work for doors, windows, ventilators and partitions shall be provided and fixed in control room building with extruded built up standard tubular and other sections of approved make conforming to IS: 7333 and IS:1285, anodized transparent or dyed to required shade according to IS:1868 (Minimum anodic coating of grade AC 15) fixed with raw plugs and screws or with fixing clips, or with expansion hold fasteners including necessary filling up of gaps at junctions at top, bottom and sides with required PVC/neoprene felt etc and joined mechanically wherever required including cleat angle, Aluminium snap beading for glazing/paneling, C.P. brass/stainless steel screws including glazing and fittings as specified.

Shutters of doors, windows and ventilators shall be provided and fixed with hinges/pivots fittings wherever required including PVC/neoprene gasket. Anodised aluminum work for doors, windows, ventilators and partitions shall be provided and fixed in control room building with extruded built up standard tubular and other sections of approved make conforming to IS: 7333 and IS:1285, anodized transparent or dyed to required shade according to IS:1868 (Minimum anodic coating of grade AC 15) fixed with raw plugs and screws or with fixing clips, or with expansion hold fasteners including necessary filling up of gaps at junctions at top, bottom and sides with required PVC/neoprene felt etc and joined mechanically wherever required including cleat angle, Aluminium snap beading for glazing/paneling, C.P. brass/stainless steel screws including glazing and fittings as specified.

Shutters of doors, windows and ventilators shall be provided and fixed with hinges/pivots fittings wherever required including PVC/neoprene gasket. with 5.5 mm plain float glasses and rubber gasket with bottom three feet pre-laminated sheet of 12mm thick of colour grey, ivory Jindal/Indal/Hindalco make as per drawing.

**(c) SECTION FOR AL. PARTITION:**

Outer frames 2-1/2 x 1-1/2, 63.5 x 38.10 X 1.5mm, DP 1212, 0.700 Kg/mt, to work as fixed partition & door with door verticals 44.45 x 47.62 x 1.5mm, DP 2022, 0.850 Kg/mt, top and center pieces as per drawing.

20. Cement based water proofing treatment of roofs, balconies, terraces etc. shall be provided with average thickness of 120 mm and minimum thickness at Khurra as 65 mm and laid consisting of following operations:

- (a) A slurry coat of neat cement using 2.75 kg/m<sup>2</sup> of cement admixed with proprietary water proofing compounds conforming to IS: 2645 shall be applied and grouted over the RCC slab including cleaning the surface before treatment.
- (b) Plain Cement concrete 1:5:10 (1 Cement : 5 fine sand : 10 burnt brick aggregate of 40 mm nominal size) admixed with proprietary water proofing compound conforming to IS:2645 over 20 mm thick layer of cement mortar of min :5 (Cement :5 coarse sand) admixed with proprietary water proofing compound conforming to

IS: 2645 to required slope an treating similarly the adjoining walls upto 300 mm height including rounding of junctions of walls and slabs.

- (c) After two day of proper curing, a second coat of cement slurry admixed with proprietary water proofing compound conforming to IS:2645 shall be applied.
- (d) The surface shall be finished with 20 mm thick joint less cement mortar of mix 1:4 (1 cement :4 coarse sand) admixed with proprietary water proofing compound conforming to IS : 2645 and finally the surface shall be finished with trowel with neat cement slurry and making of 300 x 300 mm square.
- (e) The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test. All above operations shall be done in order an as directed and specified by the Engineer-in charge.

21.Unplasticised rigid PVC rain water pipes 110 mm dia shall be provided and fixed on the wall face conforming to IS : 13592 type A as per drawing including jointing with seat ring conforming to IS:5382 leaving 10 mm gap for themal expansion single socketed pipes.

22.Unplasticised PVC Moulded fittings / accessories including 110 mm bend and 110 mm shoes shall be provided and fixed for uplasticised rigid PVC rain water pipes conforming to IS : 13592 type A including jointing with seat ring conforming to IS : 5382 leaving 10 mm gap for thermal expansion.

- Unplasticised PVC pipe clips of approved design shallbe provided and fixed to uplasticised 110 mm PVC rain water pipes by means of 50x50x50 mm hard wood plugs, screwed with MS screws of required length including cutting brick work and fixing in cement mortar 1:4 (1 cement : 4 coarse sand) and making good the wall etc.
- Double action hydraulic floor spring of approved brand and manufacture IS: 6315 marked “hardwyn” make (model 3000) or equivalent for doors shall be provided and fixed at the following door including cost of cutting floors as required, embedding in floors and cover plates with brass pivot and single piece MS sheet outer box with slide plate etc. as per the direction of Engineer- in charge. With stainless steel cover plate:
  - (a) Main Entrance to Control Room Building.
  - (b) Sub-Station In charge room
  - (c) Conference Room
  - (d) Control Room.
- Plinth protection 50 mm thick of cement concrete 1:2:4 (1 cement :2 coarse sand : 4 graded stone) aggregate 20 mm nominal size) shall be laid over 75 mm bed of dry brick ballast 40 mm nominal size well rammed and consolidated and shall be grouted with fine sand including finishing the top smooth.
- Coloured vitreous china pedestal type water closet (European type) with seat and lid, 40 mm flush bend, overflow arrangement with specials of standard make and mosquito proof coupling of approved municipal design including painting of fittings and brackets, cutting and making good the walls and floors shall be provided for all toilets.
- Coloured vitreous china wash basin of size 630 x 450 mm with C.I / M.S brackets alongwith single 15 mm C.P brass pillar taps, Kingston / Gem / Techno / Parko. 32 mm C.P brass waste of standard pattern, shall be provided and fixed in the toilets including painting of fittings and brackets, cutting and making good the walls wherever required alongwith C.P brass trap and C.P brass union.
- All urinals shall be coloured vitreous china flat back half stall urinal of 580 x380x350 mm with 10 litre PVC automatic flushing cistern, Parryware / Hindware / Seabird / Orient (Coral) with fittings, standard size C.P. brass flush pipe, speaders with unions and clamps (all in C.P. brass) with waste fitting as per

IS : 2556 C.I. trap with outlet grating and other couplings in C.P brass including painting of fittings and cutting and making good the walls and floors wherever required.

- Following fittings shall be provided in all the toilets :

(a) Toilet paper roll holder.

(b) Double type coat & hat hooks with flanges, fixed to wall / shutter, etc. with necessary screws, washers & plugs.

(c) CP / PP liquid soap holder of approved make fixed with each wash basin to the wall with necessary CP / PP brackets, CP screws, washers, plugs etc.

(d) 100 mm dia vitreous chinaware half round channel of approved make fixed to correct grade, level, opening for floor trap below urinals set in CM 1:3 & pointed using white cement etc.

(e) CP brass bid cock 15 mm nominal bore of approved quality conforming to IS : 8931.

(f) CP brass angle valve of 15 mm nominal bore provided and fixed in position for basin and cistern points of approved quality conforming IS : 8931.

(g) Best quality marble partition slab provided and fixed in position for urinals, of size 610 x 1150 mm, 20 mm thick, polished on both sides & machine cut, exposed corners rounded etc.

(h) Towel rail of approved make of 600 mm length, 25 mm dia with a pair of brackets or flanges provided and fixed to wall beside each wash basin / set of wash basin with necessary screws, plugs, etc.

(i) 6 mm thick beveled edge mirror 1000 x 600 mm shall be provided and fixed mounted on 12 mm thick water proof plywood backing and hardwood beading all-round and mirror fixed to the backing with 4 Nos. of CP cap screws & washers, including fixing the mirror to the wall with necessary screws, plugs & washers etc, with each wash basin.

(j) Salem Stainless steel A ISI 304 (18/8) Kitchen sink of 510 x 1040 mm Bowl depth 178 mm with drain board shall be provided and fixed as per IS: 13983 with C.I. Brackets and stainless steel plug 40 mm including painting of fittings and brackets, cutting and making good the wall.

### 23) GI Pipe work for Internal and External works:

- i) All concealed GI pipe shall be painted with anticorrosive bitumastic paint including cutting of chases and making good the wall.
- ii) All exposed GI pipes and fittings shall be painted with synthetic enamel paint of desired shade over a ready mixed priming coat, both of approved quality for new work.
- iii) Wherever GI pipe are buried the same shall be provided and laid in position including trenching sand cushion and refilling, painted with anticorrosive bitumastic paint etc.
- iv) Gun metal ball valve with operating levers, non-return valves conforming to IS specification shall be provided and fixed in position as per drawing or direction of Engineer-in-charge.

24) Masonry chamber for sluice valve shall be 600x600mm size in plan and depth 750mm, or matching with the site condition inside with 50 class designation brick work in cement mortar 1:5 (1 cement :5 fine sand) with CI surface box 100mm. Top diameter, 160mm bottom dia and 180mm deep (inside) with chained lid and RCC top slab 1:2 :4 mix (1 cement :2 coarse sand: 4 graded stone aggregate 20 mm nominal size) necessary excavation foundation concrete 1:5:10 (1 cement:5 fine sand :10 graded stone aggregate 40mm

- nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12 mm thick finished with a floating coat of neat cement complete as per standard design with FPS bricks of class 75.
- 25) Polyethylene water storage tanks (2 nos. of 2000 litres capacity each) shall be provided and placed on roof of control room building of approved brand and manufacturer with cover and suitable locking arrangement, float valve and making necessary holes for inlet, outlet and overflow pipes.
- 26) PVC floor traps of self cleansing design shall be provided & fixed in position with outlet size of 75mm diameter of approved make, including making connection with PVC soil/waste pipes using rubber gaskets, embedding the trap in 150mm thick PCC 1:2:4, providing & fixing of top tile & strainer of CP or PVC on top of the trap etc.
- 27) Square-mouth SW gully trap grade "A" 100x100mm size P type with FPS Bricks class designation 75 shall be provided and fixed complete with CI grating brick masonry chamber with water tight C.I. cover with frame of 300x300mm size (inside) the weight of cover to be not less than 4.5 Kg and frame to be not less than 2.70 Kg as per standard design.
- 28) Glazed stoneware pipes of 150mm diameter grade 'A' shall be provided, laid and jointed with stiff mixture of cement mortar in the proportion of 1:1 (1 cement: 1 fine sand) including testing of joints etc. complete.
- 29) Cement concrete 1:3:6 (1 cement:3 coarse sand:6 graded stone aggregate 40 mm nominal size) shall be provided and laid around S.W. pipes including bed concrete.
- 30) Brick masonry manhole shall be constructed in cement mortar 1:4 (1 cement:4 coarse sand) RCC top slab with 1:2:4 mix (1 cement:2 coarse sand: 4 graded stone aggregate 20mm nominal size) foundation concrete 1:4:8 mix (1 cement:4 coarse sand:8 graded stone aggregate 40mm nominal size) inside plastering 12mm thick with cement mortar 1:3 (1 cement:3 coarse sand) finished with floating cot of neat cement and making channels in cement concrete 1:2:4 (1 cement:2 coarse sand:4 graded stone aggregate 20mm nominal size) finished with a floating coat of neat cement complete as per standard design.
- a) Inside size shall be 90 x 80 cm and 60 cm deep including CI cover with frame (light duty) 455 x 610 mm internal dimensions total weight of cover and frame shall not be less than 38 kg (weight of cover 23 kg and weight of frame 15 kg) and shall be constructed with F.P.S. bricks with class designation 75.
- b) Inside size shall be 120 x 90 cm and 90 cm or more deep including CI cover with frame (medium duty) 500 mm internal diameter total weight of cover and frame to be not less than 116 kg (weight of cover 58 Kg and weight of frame 58 kg) with FPS Bricks class designation 75.
- 31) MS foot of 20 x 20 mm square rests shall be provided and fixed in manholes with 20 x 20 x 10 cm cement concrete blocks 1:3:6 ( cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size) as per standard design.
- 32) Steel glazed doors, windows and ventilators of standard rolled steel section shall be provided and fixed in FFPH building, joints mitred and welded with 15 x 3 mm lugs, 10cm long, embedded in cement concrete blocks 10 x 10 x 10 cm of 1:3:6 (1 cement 3 coarse sand : 6 graded stone aggregate 20 mm nominal size) or with wooden plugs and screws or rawls plus and screws or with fixing clips or with bolts and nuts as required, including providing and fixing of glass panes with glazing clips and special metal sash putty of approved make complete including applying a priming coat of approved steel primer, necessary hinges or pivots as required.
- 33) Pressed steel door frames manufactured from commercial mild steel sheet of 1.25 mm thickness shall be provided and fixed in FFPH building including hinges jamb, lock jamb, bead and if required angle threshold of mild steel angle of section 50x 25 mm or base ties of 1.25 mm pressed mild steel welded or rigidly mixed together by mechanical means, adjustable lugs with split end tail to each jamb including steel butt hinges 2.5 mm thick with mortar guards, lock strike-plate and shock absorbers as specified and applying a coat of approved steel primer after pre-treatment of the surface as directed by Engineer-in-charge.

- 34) Asbestos cement 6 mm thick corrugated sheets roofing shall be provided and fixed with G, I, J or L hooks, bolts and nuts 8 mm diameter G, I plain and bitumen washers complete excluding the cost of purlins, rafters and trusses for water tank.

### **(III) MODE OF MEASUREMENT ON CIVIL WORKS**

#### **(a) Earthwork**

This shall include excavation in all kinds of soil including rock, all leads and lifts including back filling, compacting, de-watering (if required) and disposal of surplus earth to a suitable location. The quantity of excavation for foundations of towers, equipment structures, all transformers, rail-cum-road, firewall, cable trenches, water tank, reactors and buildings shall only be measured. The quantity of excavation for roads, drains, rainwater harvesting, septic tank, soak pit, external water supply system, site surfacing (graveling), chain link fencing (including gate) shall not be measured separately and shall be deemed to be included in the composite rates quoted by the bidder for the respective works. All other excavation required for the completion of the work including fixing of lamp posts, plinth protection, flooring sewerage system, manholes, pipes, earthmat etc. shall also not be paid for. The measurement of excavation of all concrete works shall be made considering dimension of the pit leaving 150 mm gap around the base pad (lean concrete) or actually excavated pit, whichever is less. The quantity shall be measured in cubic meters.

#### **(b) PCC**

Providing and laying Plain Cement Concrete of all types and at all locations including all leads and lifts. The quantity shall be measured in cubic meters as per lines and levels indicated in the drawings.

- (i) PCC 1:2:4 (1 cement : 2 sand : 4 coarse aggregate 20 mm nominal size) shall be measured in flooring of buildings, plinth protection, fencing, transformer foundation, reactor foundation, rail track, drain, culverts, septic tank, chain link fencing, gate etc. as indicated in the drawings.
- (ii) PCC 1:4:8 (1 cement : 4 coarse sand : 8 stone aggregate, 40 mm nominal size) shall be measured below all foundations of buildings, cable trench, roads, under flooring, rail-cum-road, transformer foundation, reactor foundation, drain, water tank, culverts, gate etc. as indicated in the drawings.
- (iii) All other PCC required for the completion of the work including hold fasts of doors / windows / rolling shutters, fixing of plumbing pipes, bedding concrete for sewer lines, embedment of electrical conduits etc. shall not be measured and deemed included in the composite rates quoted by the bidder for respective works. Water proofing compound wherever specified shall be added without any extra cost.

#### **(c) RCC**

Measurement of reinforced cement concrete at all locations shall be made and shall include all leads, lifts, formwork, grouting of pockets and underpinning, (but shall exclude reinforcement) of mix 1:1.5:3 (1 cement : 1.5 coarse sand : 3 stone aggregate 20 mm nominal size). This shall also include pre-cast RCC work and addition of water proofing compound wherever required for which no additional payment shall be made. The quantity shall be measured in cubic meters as per lines and levels indicated in the drawings. No deduction shall be made for volume occupied by reinforcement / inserts sleeves and for openings having cross-sectional area up to 0.1 sq.m.

#### **(d) Steel Reinforcement**

Reinforcement shall be measured in length (actual of theoretical as per drawing whichever is less) including hooks, if any, separately for different diameters as actually used in work, excluding overlaps. From the length so measured, the weight of reinforcement shall be calculated in tones on the basis of sectional weights as adopted by Indian Standards. Wastage, overlaps, couplings, welded joints, spacer bars, chairs, stays, hangers and annealed steel wire or other methods for binding and placing shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement.

#### **(e) Stone filling**

Measurement of stone (40mm nominal size) for transformer foundations shall be made as per theoretical volume of the space to be filled in the transformer foundation as per drawings. This shall be measured in cu.m.

### 1.1 **Miscellaneous structural steel.**

Measurement for Supply, fabrication, transportation and erection of all miscellaneous structural steel work for mono rails (RS joists), rails for transformers/ reactors, trusses, frame work, purlins, gratings, steel tubes, built up sections along with all other steel fittings and fixtures, inserts and embedment in concrete shall be made as per drawings. The unit rate for this item shall be inclusive of cutting, grinding, drilling, bolting, welding, pre-heating of the welded joints, applying a priming coat of steel primer and anti corrosive bitumastic paint/ synthetic enamel paint etc. (wherever specified), setting of all types of embedment in concrete, etc. steel required for foundation bolts, nuts and bolt, doors, windows, ventilators, louvers, rolling shutters, chain link fencing, gratings in drains, soil pipes, plumbing pipes, floor traps, embedments required for rainwater harvesting, septic tank, soak pit, roof truss and purloins required for fire water tank, etc. shall not be considered for payment and measurement.

Quantity shall be measured in Kg.

### 1.2 **Roads**

The measurement for the concrete roads shall be measured as per the UNIT OF MEASUREMENT specified in the BOQ along with the entire line of the road and shall include all items such as excavation, compaction, rolling, watering, WBM, Kerb stone, grating, inter locking tiles etc. complete as per drawing but excluding concrete and reinforcement.

The measurement of bituminous road shall be measured on LOT basis along the center line of the road and shall include all items such as excavation, compaction, rolling, watering, sub case course, WBM, Bitumen, pre mix carpet complete as per drawing.

### 1.3 **Drain**

The measurement of drains shall be measured on LOT basis along the center line of the drain and shall include excavation, compaction, brickwork, plastering, grating, weep holes etc. complete as per drawing but excluding concrete.

### **(f) Antiweed Treatment and Stone Spreading**

The measurement shall be done as per the UNIT OF MEASUREMENT specified in the BOQ for the actual area in square meters of stone spreading provided in the switchyard and shall include anti weed treatment including material and providing and spreading of 100mm thickness of uncrushed/crushed/broken stone of 40mm nominal size as per the specification for the specified area.

### **(g) Chain Link Fencing and gate.**

The measurement shall be made in running meters of the fence provided as per drawing. The rate shall be including the post, fencing, MS Flat etc. complete but excluding the concrete. The gate shall be measured in numbers.

### **(h) Fire Fighting Pump House**

This is lump sum item, Contractor has to assess the quantity as per drawings of control room cum administrative building, Fire Fighting Pump House and quote for the same for each building separately. This shall include following items.

- 1) External plastering: 18 mm cement plaster of mix: 1:4 (1 cement : 4 coarse sand) including all grooves as specified.
- 2) Providing and applying two or more coats of Novakote exterior flat paint over an under coat of suitable pliolite based primer nova prime on new cement plaster surfaces of the buildings inclusive of required tools, scaffolding, materials and other painting accessories etc. as per recommendations of manufacturer.

### **(i) Hume Pipe**

Hume pipe shall be measured diameter-wise and laid as per the drawings and shall be measured in running metres. The item shall be inclusive of excavation, laying, back filling, jointing etc. excluding concrete and reinforcement (if any).

**(j) Building.**

This is a lump sum item for each building. The entire work required to complete the building in all respect as per the drawings approved by the Owner shall be deemed to be included in this lump sum rate.

**(k) Rain Water Harvesting:**

This is a lump sum item. The contractor shall be required to complete the work in all respect as per drawings approved by the Owner. All the items including excavation, miscellaneous steel, bricks work, fillings of boulders, gravel, sand, pipe, concrete (all types) and the reinforcement etc. shall be deemed to be included in this lump sum rate.

**(l) Septic Tank and Soak Pit.**

This is a lump sum item. The contractor shall be required to complete the work in all respect as per drawings furnished by the Owner. All the items including excavation, masonry work, all types of fillings all types of pipes including plumbing and vent pipes, all type of fittings, concrete (all types) and the reinforcement etc. shall be deemed to be included in this lump sum rate.

**(m) Fire Water Tank.**

This is a lump sum item. The contractor shall be required to complete the work in all respect as per drawings furnished by the Owner. All the items including excavation, compaction, brick work, roof truss, corrugated AC Sheet roofing, all types of miscellaneous steel, internal and external plastering, painting, concrete (all types) and the reinforcement etc. shall be deemed to be included in this lump sum cost.

**(n) External water supply from Bore-well to Fire water tank.**

The external water supply from Bore-well shall be on LOT basis. It shall include all the items such as excavation, piping, fittings, painting, brick work, sand filling, concrete, valves, chambers cutting chases in walls, openings in RCC and repairs etc. required to complete the job.

**(III) MISCELLANEOUS GENERAL REQUIREMENTS:**

- (a) Dense concrete with controlled water cement ratio as per IS-code shall be used for all underground concrete structures such as pump-house, tanks, water retaining structures, cable and pipe trenches etc. for achieving water-tightness.
- (b) All joints including construction and expansion joints for the water retaining structures shall be made water tight by using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 5 mm and minimum width shall be 1230 mm.
- (c) All mild steel parts used in the water retaining structures shall be hot-double dip galvanized. The minimum coating of the zinc shall be 750 gm/sq.m. for galvanized structures and shall comply with IS:2629 and IS:2633. Galvanizing shall be checked and tested in accordance with IS:2633. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen in accordance with BS:3416.
- (d) Bricks having minimum 75 kg/cm<sup>2</sup> compressive strength can only be used for masonry work. Contractor shall ascertain himself at site regarding the availability of bricks of minimum 75 kg/cm<sup>2</sup> compressive strength before submitting his offer.
- (e) Angles 50x50x5 mm (minimum) with lugs shall be provided for edge protection all round cut outs/openings in floor slab, edges of drains supporting grating covers, edges of RCC cable/pipe trenches supporting covers, edges of manholes supporting covers, supporting edges of manhole precast cover and any other place where breakage of comers of concrete is expected.
- (f) Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc. as per IS:6313 and other relevant Indian Standards.

(g) For all civil works covered under this specification, nominal mix by volume batching as per CPWD specification is intended. The relationship of grade of concrete and ratio of ingredients shall be below:

	<b>Nom Mix.</b>	<b>Cement</b>	<b>Sand</b>	<b>Coarse aggregate of 20mm down grade as per IS: 383</b>
1.	M 10	1	3	6
2.	M 15	1	2	4
3.	M 20	1	1.5	3

(h) The material specification, workmanship and acceptance criteria shall be as per relevant clauses of CPWD specification and approved standard Field Quality Plan, Items/components of buildings not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope.

#### **(IV) INTERFACING**

The proper coordination & execution of all interfacing civil works activities like fixing of conduits in roofs/walls/floors, fixing of foundation bolts, fixing of lighting fixtures, fixing of supports/embedment, provision of cut cuts etc. shall be the sole responsibility of the Contractor. He shall plan all such activities in advance and execute in such a manner that interfacing activities do not become bottlenecks and dismantling, breakage etc is reduced to minimum.

#### **(V) STATUTORY RULES.**

\* Contractor shall comply with all the applicable statutory rules pertaining to factories act (as applicable for the State). Fire safety Rules of Tariff Advisory Committee. Water Act for pollution control etc.

\* Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.

\* Requirement of sulphate resistant cement (SRC) for sub structural works shall be decided in accordance with the Indian Standards based on the findings of the detailed soil investigation.

\* All building/construction materials shall conform to the best quality specified in CPWD specifications if not otherwise mentioned in this specification.

\* All tests as required in the standard field quality plans have to be carried out.



**ODISHA POWER TRANSMISSION CORPORATION LIMITED**

**STANDARD FIELD QUALITY PLAN  
FOR SWITCHYARD CIVIL WORKS.**

**Section: FOUNDATION MATERIALS**

Sl. No.	Component/Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance	Testing Agency.	Remarks	Check
1.	<b>CHECKING OF FOUNDATION MATERIAL</b>					
A)	<b>CEMENT</b>					
i)	Fineness	One sample per lot of 100 MTR or part thereof from each source for MTCs and one sample per lot of 200 MT or part thereof from each source for site testing.	IS:456, IS:269,IS:8112 IS:12269, IS:1489 & OPTCL specification.	Manufacturer/ As per OPTCL approved lab.	Review of manufacturers test certificates (MTCs) and laboratory test results by OPTCL	
ii)	Compressive Strength					
iii)	Initial & final setting time					
iv)	Soundness					
v)	Heat of Hydration for low heat cement (Not applicable for OPC & PPC)					
vi)	Chemical Composition of Cement.	One sample per lot of 100 MT or part thereof from each for MTCs	IS:456, IS:269,IS:8112 IS:1489 & OPTCL specification.	Manufacturer	Review of manufacturers test certificates by OPTCL	
B)	<b>COARSE AGGREGATES</b>					
i)	Determination of Particle size (Sieve Analysis)	One sample per lot of 100 cubic meter or part thereof from each source for each size.  ** Applicable to concrete work subject to frost action.	IS:383, IS:2386 and OPTCL specification	OPTCL approved lab. However, Moisture content test for design mix concrete shall be done on all day of concreting at site.	Each source to be approved by OPTCL Review and acceptance of test result by OPTCL.	
ii)	Flakiness Index					
iii)	Crushing Value					
iv)	Specific Gravity*					
v)	Bulk Density*					
vi)	Absorption Value*					
vii)	Moisture Content*					
viii)	Soundness of Aggregate**					
ix)	Presence of deleterious materials.  * Applicable Design concretes only					
C)	<b>FINE AGGREGATE</b>					
i)	Gradation/Determination of particle size (Sieve Analysis)	One sample per lot of 100 cubic meter or part thereof from each source	IS:383,IS:2386, IS:456 and OPTCL specification	OPTCL approved lab. However, Moisture content test	Each source to be approved by OPTCL Review and acceptance	
ii)	Specific Gravity and density					
iii)	Moisture content					
iv)	Absorption Value					
v)	Bulking					

vi) vii)	Silt Content Test Presence of deleterious materials.			for design mix concrete shall be done on all days of concreting at site.	of test result by OPTCL.	
D)	BRICKS					
i) ii) iii) iv)	Dimension tolerance Compressible Strength Water Absorption Efflorescence		OPTCL Specification.	OPTCL approved Lab.	Approved by OPTCL	
E)	WATER					
i)	Cleanliness (Visual Check)  Chemical & Physical properties of water for checking its suitability for construction purposes  * Applicable to design mix concrete only.	Random  One sample per source	IS:456, IS:3025 and OPTCL specification. The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalies, organic materials, or other deleterious materials.  IS:456, IS:3025 & OPTCL specification.	Contractor.  Contractor/ OPTCL Approved Lab.	Each source to be approved by OPTCL  Approved by OPTCL	

**ODISHA POWER TRANSMISSION CORPORATION LIMITED  
(Quality Assurance & Inspection Deptt.)**

Sl. No.	Component/Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norm	Testing Agency.	Remarks	Check
1.	REINFORCEMENT STEEL					
i)	Identification & size	Random	IS:432, IS:1139, IS:1786 & OPTCL Specification.	Contractor	Approved by OPTCL	
ii)	Chemical Analysis test	One sample per heat.	IS:432, IS:1139, IS:1786 OPTCL Specification.	Manufacture r	Review of manufacturer s test certificate by OPTCL	
iii)	Tensile Test	One sample per lot of 40MT or part thereof for each size of steel conforming to IS:1139 and 5 MT or part thereof for HDS wire for each size of steel as per IS:432. For steel as per IS:1786 under 10mm 1 sample for each 25 MT or part thereof. 20 mm-16 mm I sample for each 35 MT or part thereof. Over 16mm 1 sample for each 45 MT or part thereof.	IS:432, IS:1139, IS:1786 OPTCL Specification.	Manufacture rs/ OPTCL approved Lab.	Review of manufacturer s test certificates as well as lab. Test results by OPTCL	
iv)	Yield stress/proof stress					
v)	Percentage Elongation					
vi)	Bent/re-bend Test	One sample per lot of 20MT or part thereof for each size of steel as per IS:432, IS:1139. For steel as per IS:1786 under 10mm- 16mm 1	IS:432, IS:1139, IS:1786 OPTCL Specification.	Manufacture rs/ OPTCL	Review of manufacturer s test certificates as well as lab. Test results by OPTCL	

vii)	Reverse Bend Test for HDS wire.	<p>sample for each 25MT or part thereof 10mm-16mm 1 sample for each 45 Mt or part thereof.</p> <p>One sample per lot of 5MT or part thereof for each size.</p>	IS:432, IS:1139, IS:1786 OPTCL Specification.	Manufacturers/ OPTCL approved Lab.	Review of manufacturer's test certificates as well as lab. Test results by OPTCL	
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**ODISHA POWER TRANSMISSION CORPORATION LIMITED**

**TECHNICAL SPECIFICATION**

**FOR**

**SWITCH YARD STRUCTURES**

**STRUCTURES FOR OUTDOOR EQUIPMENT**  
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## **GENERAL**

### **1.1 Design of structures**

Substation structures shall be designed in accordance with the requirements of IS 802. The wind pressures for the substation sites shall be as per data in schedules and wind pressure map of the State of Orissa.

Structures shall be designed to carry the equipment and associated connections, insulator sets, earth conductors and all fittings under all specified conditions of service of operation and loading.

The substation gantry structures shall be designed to carry the down lead spans and the Contractor shall be provided with the details and location of the terminal tower and the type of conductor used on the overhead line in order to do so. All structures intended to carry equipment or materials on more than one side of the structure shall be designed to cater for all possible stages of equipment erection, installation and maintenance. The substation gantry structures shall be designed to terminate the overhead line down lead spans which may enter  $\pm 30$  degrees horizontally and  $\pm 15$  degrees vertically.

### **1.2 Conductor spacing and clearances**

Structures shall be dimensioned to maintain the specified minimum phase to earth, phase to phase and insulation height clearances under conditions of maximum conductor swing and sag. The spacing between individual phase conductors, and the clearance between clamps, arcing horns, jumper loops or other live metal and the structure steelwork and other obstacles, under all specified conditions of temperature and loading shall not be less than the specified values.

### **1.3 Applied loads**

The assumed maximum simultaneous loadings on the substation structures shall be as follows—

#### **1.3.1 Wind loads**

The normal wind load shall be given by the wind pressure, as stated in the Schedules, acting on the whole projected area of the phase and earth conductors and, where applicable, the horizontal resultant of the maximum line and earth conductor tensions, together with the wind pressure, as stated in the Schedules, on 1.5 times the projected area of the members of one face of the structure plus the projected area of the plant being supported.

#### **1.3.2 Vertical loads**

The normal vertical load shall be the mass of the line and earth conductors, insulators, the plant item, insulator fittings, earth conductor fittings, spacers, line traps and ancillary apparatus where applicable. For the overhead line terminating span it shall be assumed that the mass of the conductors and earth wires shall include the actual total mass of the down lead span.

### **1.4 Electro mechanical loads**

Electro dynamic forces due to short circuit conditions, snatch forces, aeolin vibration and other similar loads shall be computed and applied for design of structures. The different mechanical effects due to short circuit current etc. shall be estimated as per IEC 865 and CIGRE guide line No. 7

### **1.5 Construction**

The structures shall be of an approved design and construction. All stressed members (tension and compression) of steel structures shall consist of rolled steel sections unless otherwise approved.

The material used for the members shall not be less than 6 mm thick except for unstressed members where the thickness may be reduced to 4 mm.

No bolt hole shall be more than 1.5 mm larger than the corresponding bolt diameter. As far as possible, bolt heads, rather than nuts, shall be on the outer or upper faces of structure connections.

To facilitate inspection and maintenance, all tall structures shall be provided with step bolts and ladders complete with hoops. Handrails, screens, guards and other appropriate facilities shall also be provided.

Where the structure is to terminate overhead transmission lines supplied under another contract, suitable provisions shall be made to accept the transmission line insulator fittings and earth conductor clamps.

Means shall be provided for fixing and bonding GI flat strip to the steelwork at a minimum of two points. Earth connections shall be made to a vertical face, clear of the ground. Foundation bolts shall not be used for their attachment. GI flats for earth connections, bolts, nuts washers etc.. shall be included in the structures.

Gantry type structures which support more than one three phase circuit shall have suitable interbay screens installed to prevent access along the beam from a dead to an energised circuit. The location of the screens shall be agreed with the Engg Incharge (Divisional Engr.).

## **1.6 Material**

All rolled steel sections, flats, plates and bolt and nut bars used shall consist of steel manufactured by an approved process and shall be to the requirements of ISO 630 (minimum yield strength 255 N/mm<sup>2</sup>). The steel shall be free from blisters, scales, laminations and other defects. Steel sections shall preferably be British Standard or metric standard sections chosen with a view to avoiding delays in obtaining material.

All members shall be cut to jig and all holes shall be drilled or punched to jig. All parts shall be carefully cut and holes accurately located so that when the members are in position the holes will be truly opposite to each other before being bolted up. Drifting or reaming of holes will not be allowed.

Built members shall, when finished, be true and free from all kinks, twists and open joints, and the material shall not be defective or strained in any way.

If the structures are fabricated or galvanised by subcontractors, the Contractor shall, if required by the Engg Incharge (Divisional Engr.), provide a resident inspector at the works of each subcontractor during the time that the steelwork is being fabricated or galvanised.

All bolts and screwed rods shall be galvanised, including the threaded portions; all nuts shall be galvanised with the exception of the threads, which shall be oiled.

Except where specified to the contrary, all iron and steel used in the construction of the Contract works shall be galvanised after all sawing, shearing, drilling, punching, filing, bending and machining are completed.

Galvanising of all material shall be in accordance with the requirements of this Specification. The preparation for galvanising and the galvanising itself shall not adversely affect the mechanical properties of the coated material.

Sherardizing or other similar process shall not be used.

## **2. 0 SUPPORT STRUCTURES OF SWITCHYARD**

### **2.1 General**

The scope of works covers design, fabrication, proto -assembly, supply and erection of galvanised steel structure for portals (columns, girders), lightning masts and equipment support structures.

Portals (columns, girders), lightning masts, and equipment support structures shall be lattice type structures fabricated from structural steel conforming to IS 226/2062. The design of all support structures for 220kV, 132kV and 33kV equipment. The column and beam and lightning cum lighting mast of 400 KV side shall be of lattice type. The equipment support structure for 400 KV shall be GI Tubular pipe of adequate height and strength conforming to the latest IS. All the structural materials are within the scope of the Contractor. The use of GI pipes conforming to IS 806 to support certain equipment will also be considered. However approval of the Engg Incharge (Divisional Engr.) should be obtained for the same before commencement of detailed design.

It is the intent of the Employer to provide structures which allow inter changeability of equipment at a later stage. Keeping this in view, the height of all the structures must be maintained as per approved drawings. It is stressed that the Contractor has to provide minimum steel sections as per the standard



drawings. However, if a higher section is required from design point of view the same shall be acceptable. Additional structures called stools shall be connected to the equipment and the bottom of the stool shall be connected to the support structure where required.

The scope shall include the supply of all types of bolts, nuts, hangers, shackles, clamps, anticlimbing devices, bird guards, climbing systems, inserts in concrete, gusset plates, equipment mounting bolts, structure earthing bolts, foundation bolts, spring washers, fixing plates, angles and bolts for structure mounted or ground mounted marshalling boxes (ACDC marshalling box and equipment control cabinets), and any other items as required to complete the works.

The connection of all structures to their foundations shall be by base plates and embedded anchor and foundation bolts. All steel structures and anchor or foundation bolts shall be fully galvanised. The weight of the zinc coating shall in accordance with this Specification. One additional nut shall be provided below the base plate which may be used for the purpose of levelling.

## **2.2 Design requirements**

The minimum bolt diameter shall be 16 mm.

In order to facilitate inspection and maintenance, the structures shall be provided with climbing devices. Each substation gantry structure shall be provided with step bolts not less than 16mm diameter and 175mm long spaced not more than 450mm apart, staggered on faces of one leg extending from about 2.5 metres above ground level to the top of the tower. The step bolts shall conform to IS 10238. Ladders on lighting masts and other tall structures shall be provided with safety guards.

All structures shall be designed for the worst combination of dead loads, live loads, wind loads as per code IS 802, seismic forces as per code IS 1893, loads due to deviation of conductor, load due to unbalanced tension in conductor, torsional load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including 'snatch' in the case of bundled conductors etc. Short circuit forces shall be calculated considering a fault level of 40kA. IEC 865 and CIGRE Guide No. 7 may be followed to estimate the various forces of conductor for structural design.

Substation gantry structures shall be designed in accordance with IS 802 for the three conditions i.e. normal conditions, three conductors on one side broken, and broken wire condition and short circuit force. The design of all structures shall be based on the condition where stringing is done only on one side i.e. all the three (phase) conductors broken on the other side.

A factor of safety of 2.0 under normal and broken wire conditions and 1.5 under combined short circuit and broken wire conditions shall be considered for the design of switch yard structures. For purpose of design 110% of static tension pull and transverse reaction on the gantries as calculated for each span shall be considered.

Vertical load of half the span of conductors/string and the earth wires on either side of the beam shall be taken into account for the purpose of design. The weight of a man with tools shall be considered as 150 kg for the design of structures.

Torsional effect on towers and beams due to unbalanced forces may be taken care of as per American Code DS-10.

Terminal line take off gantries shall be designed for a minimum conductor tension of four metric tonnes per phase for 400kV and two metric tonnes per phase for 220kV & 132 kV. The distance between terminal gantry and dead end tower shall be taken as 200 metres. The design of these terminal gantries shall also be checked considering  $\pm 30$  degree horizontal and  $\pm 15$  degree vertical deviation of conductor. The transmission line conductors would be either single ACSR conductor per phase on AC side for all lines except for 400kV. For 400kV the line side conductor shall be twin ACSR.

The girders shall be connected with lattice columns by bolted joints.

All pipe supports used for supporting equipment shall be designed for the worst combination of dead loads, erection load, wind load, seismic forces, short circuit forces and operating forces acting on the equipment and associated busbars as per IS 806 and IS 1161. Minimum sections for 400kV, 220kV and 132kV & 33kV structures shall be as per standard drawings approved by the Engg Incharge (Divisional Engr.). However, the Contractor can increase the sections if required. The height of the structures shall be as per standard drawings.

If lighting fittings are proposed to be fixed on gantries or towers, the proper loading for these shall be considered in the design. Holes for fixing the brackets for lighting fittings should be provided wherever required.

Foundation bolts and stubs shall be designed for the loads for which the structures are designed.

Lightning masts shall be designed as per IS 802 for diagonal wind condition for a height of 47.5 m for lattice structures and 2.5m for MS pipe with conical head at top.

Lightning masts shall be provided with a structural steel ladder within its base up to a height of 25 metres. The ladder shall be provided with protection rings. Two platforms shall be provided one each at 12.5m and 25m height for mounting of lighting fittings. The platforms shall also have protection railing.

### **2.3 Design drawings, bill of materials and documents.**

The fabrication drawings to be prepared and furnished by the Contractor shall be based on the design approved by the Engg Incharge (Divisional Engr.). These fabrications drawings shall indicate complete details of fabrication and erection including all erection splicing details and typical fabrication splicing details, lacing details, weld sizes and lengths, bill of materials in the proforma approved by the Engg Incharge (Divisional Engr.), bolt details and all customary details in accordance with standard structural engineering practice whether or not given by the Contractor.

Fabrication work shall start only after the final approval of the design and fabrication drawings is accorded by the Engg Incharge (Divisional Engr.).

Such approval shall, however, not relieve the Contractor of his responsibility for the safety of the structure and good connections. Any loss or damage occurring due to defective fabrication, design, or workmanship shall be borne by the Contractor.

### **2.4 Fabrication of steel**

The Contractor shall bear all the expenditure at all stages on account of loading and unloading, transportation and other miscellaneous expenses and losses and damages for all materials up to the fabrication yard/shop and thereafter to the erection site including all other expenses till the erection of work has been completed and accepted. His unit rates shall be deemed to be inclusive of all such incidental expenses and no extra shall be payable on any account in this regard.

The fabrication and erection works shall be carried out generally in accordance with IS 802. A reference however may be made to IS 800, in case of non stipulation of some particular provision in IS 802. All materials shall be completely shop fabricated and finished with proper connection material and erection marks for ready assembly in the field.

### **2.5 Assembly**

#### **2.5.1 General**

The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified camber, if any, is provided. In order to minimise distortion in members the component parts shall be positioned by using clamps, clips, dogs, jigs and other suitable means. Fasteners (bolts and welds) shall be placed in a balanced pattern if the individual components are to be bolted, paralleled and tapered.

Sample towers, beams and lightning mast shall be trial assembled keeping in view the actual site conditions, before erection in the fabrication shop and shall be inspected and approved by Engg Incharge (Divisional Engr.) before mass fabrication. Necessary erection marks shall be made on these components in the shop before disassembly and despatching.

#### **2.5.2 Bolting**

Every bolt shall be provided with a washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.

- All steel items, bolts, nuts and washers shall be hot dip galvanised.

- 2.0% extra nuts and bolts shall be supplied for erection.

### 2.5.3 Welding

The works shall be done in accordance with the General Technical Clauses (TS-GTC) and as per approved fabrication drawing which shall clearly indicate various details such as joints to be welded, type of weld, length and size of weld, and whether shop or site welded. Symbols for welding on erection and shop drawings shall be according to IS 813. Efforts shall be made to reduce site welding so as to avoid improper welding due to constructional difficulties.

Those welds which are considered to be critical to the design and the integrity of the construction of the structure shall be subject to radiographic inspection.

The Contractor shall carry out non-destructive testing of all butt welds subject to tensile stresses. Testing shall be carried out in the fabrication shop or on site as the case may be.

Unless otherwise approved, non-destructive testing shall be by radiographic examination.

## 2.6 Foundation bolts

Foundation bolts for the towers and equipment supporting structures and elsewhere shall be embedded in first stage concrete while the foundation is cast. The Contractor shall ensure the proper alignment of these bolts to match the holes in the base plate.

The Contractor shall be responsible for the correct alignment and levelling of all steel work on site to ensure that the towers and structures are plumb.

All foundation bolts for all structures and supports are to be supplied by the Contractor.

All foundation bolts shall be fully galvanised in accordance with the General Technical Clauses of this specification.

The contractor shall provide templates for all stanchion bolt spacing. Holding down bolts, assemblies, templates, tubes and washers shall be delivered to the site in sufficient time to position and build them into the foundations. Boxing out for bolts shall not be permitted. The projection of threaded portions of bolts above the foundation level shall be adequate to properly secure the nuts.

## 2.7 Stub setting

Stub for towers and lightning mast shall be set in such a manner that the distance between the stubs and their alignment and slope shall be exactly as shown in the fabrication drawings.

## 2.8 Stability of structure

The Contractor shall be responsible for the stability of the structure at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracing's and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations.

## 2.9 Grouting

The method of grouting the column bases shall be subject to approval of Engg Incharge (Divisional Engr.) and shall be such as to ensure a complete uniformity of contact over the whole area of the steel base. The Contractor will be fully responsible for the grouting operations. The mix for the grouting shall contain one part of cement and two parts of coarse sand. Non shrinkage admixtures of approved quality and of standard make shall also be added in adequate proportion as specified by the manufacturers of the admixtures.

## 2.10 Galvanising

All structural steel works and single pipe supports shall be galvanised after fabrication in accordance with this Specification. The galvanising of structures having length not exceeding 6m for lattice type, and 5m along with base plate size of 750x 750mm for other type, shall be made in one dip only.

The Contractor shall be required to make arrangements for frequent inspection by the Engg Incharge (Divisional Engr.) as well as continuous inspection by a resident representative of the Engg Incharge (Divisional Engr.), if so desired for this fabrication work.

### **2.11 Painting**

Where members of steel structures are required to be painted it shall meet the requirements as specified in relevant sections of this Specification.

The preparation, protection and painting systems selected for ferrous surfaces provided inside the switchyard shall provide a life to first maintenance of 20 years and for doors, windows, louvres etc., it shall provide life to first maintenance of 10 years. Finish colour will be selected as per relevant sections of this Specification.

## **3. 0 INSPECTION BEFORE DESPATCH**

Each part of the fabricated steel work shall be inspected for correctness of physical parameters, welding, joints, erection marks etc.. before it is despatched to the erection site. In any case the Contractor shall be fully responsible for correctness, quality, adequacy and completeness of structures being erected under the scope of this contract.

### **3.1 Testing and inspection**

The Contractor shall give full access to the Engg Incharge (Divisional Engr.) at all times to the place of fabrication and storage for the purpose of inspection and testing. Mill test certificates relating to the material procured by the Contractor for works shall be forwarded to the Engg Incharge (Divisional Engr.).

When so instructed by the Engg Incharge (Divisional Engr.), the Contractor shall provide samples of the steel to be used in the works for tests to be carried out at an independent laboratory approved by the Engg Incharge (Divisional Engr.). The cost of these independent tests shall be paid for by the Contractor.

Should the works or any part thereof fail to pass any test or in the opinion of the Engg Incharge (Divisional Engr.) fail to comply with the specification, the Contractor shall immediately take such action as is necessary to ensure that the works comply with the specification at no extra cost to the Employer.

All defective material and workmanship will be rejected and shall be replaced and reconstructed at the Contractor's expense.

No splice welding of members between connections shall be permitted without the prior approval of the Engg Incharge (Divisional Engr.).

### **3.2 Despatch, handling and storage.**

All bolts, nuts, washers, plates etc. shall be transported to site in properly marked and sealed containers, suitably protected to prevent damage during transportation.

### **3.3 Test certificate.**

Copies of all test certificate relating to material procured by the Contractor for the works shall be forwarded to the Engg Incharge (Divisional Engr.).

## **4. 0 ERECTION.**

The Contractor should arrange his own erection plant and equipment, welding sets, tools and tackles, scaffolding, trestles equipment etc. and any other accessories and ancillaries required for the work.

Finished structures shall be plumb, level and true to dimensions, within the tolerances specified.

### **4.1 Safety precautions.**

The Contractor shall strictly follow at all stages of fabrication, transportation and erection of steel structures, raw materials and other tools and tackles, the stipulations contained in Indian Standard Code for erection for structural steel work, IS 7205.

#### 4.2 Fire protection to steelwork.

The fire protection to steelwork shall be an approved luminescent paint, spray or board system to give two hours fire protection when tested. Fire protection shall only be required in the immediate vicinity of potential fire sources.

If applicable, fire protection coatings shall be sprayed or painted onto previously primed steelwork. Application to be made in strict accordance with product loading rates for base coat and top sealer specified for two hours fire resistance in manufacturers product application notes. Suitable mesh reinforcement shall be incorporated to prevent loss of insulation when subject to mechanical damage.

The coatings shall be applied by a specialist applicator strictly in accordance with the product manufacturers recommendations. The whole of the fire protection proposals and application shall be in accordance with the current Building Regulations and to the satisfaction of the Local Authority and the Fire Authority.

Surfaces which are to receive a fire protective coating shall be delivered to site with travel coatings applied and shall be suitably protected until immediately prior to the fire protective coatings or casings being applied. The latter shall be applied as late as possible in the construction programme subject to other trades and operations. Primer and travel coat shall be compatible with the fire protection coating.

#### 5. 0 WIDTH AND HEIGHT OF THE BUS AT SUB-STATION

<u>VOLTAGE LEVEL</u>	<u>BAY EIDTH</u>	<u>BOTTOM BUS HEIGHT</u>	<u>TOP BUS HEIGHT</u>
132 KV	11MTRS / 13.1 MTRS	8.5 MTRS	13.5 MTRS
220KV	18MTRS	10.5 MTRS	16.0 MTRS
33KV	5.5MTRS	5.5 MTRS	9.5 MTRS
400KV	27 MTRS	>15	>23 MTRS

Remarks: The structure height shall be maintained as per data provided for getting mnimum clearance and sectional clearance and as OPTCL standard. Contractors to furnish the drawings of all the structural items to the owner for according approval.



**ODISHA POWER TRANSMISSION CORPORATION LIMITED**

# **TECHNICAL SPECIFICATION**

**FOR**

**MANUFACTURERS DRAWING, TEST CERTIFICATES**

**AND**

**(O &M) MANUALS**

<b>Sl.No.</b>	<b>DESCRIPTION</b>	<b>PAGE No.</b>
<b>1.0</b>	<b>DRAWINGS, TEST CERTIFICATES OPERATING AND MAINTENANCE MANUAL.</b>	<b>3</b>
<b>2.0</b>	<b>GENERAL</b>	<b>3</b>
<b>3.0</b>	<b>DETAILED DRAWINGS</b>	<b>4</b>
<b>4.0.</b>	<b>RECORD DRAWING</b>	<b>5</b>
<b>5.0.</b>	<b>SPECIFIC REQUIREMENT</b>	<b>5</b>
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<b>7.0</b>	<b>TEST CERTIFICATE</b>	<b>8</b>

## **TECHNICAL SPECIFICATION FOR DRAWINGS, TEST CERTIFICATE & O&M MANUALS**

### **1. DRAWINGS, TEST CERTIFICATES, OPERATING AND MAINTENANCE MANUAL.**

### **2. GENERAL**

Separate drawings shall be prepared and submitted for equipment/installation pertaining to each substation/site.

All drawings to be furnished by the Bidder shall be in standard size of sheets with maximum size being A0. Drawings shall contain the following particulars in the title block at lower right hand corner in addition to the Bidder's name, date, scale, drawing number title, etc.

- a) Client : OPTCL
- b) Project Title:- PROJECT for System improvement for (\*AS PER PACKAGE DESCRIPTION)

A blank space of size 100 mm x 100 mm shall preferably be provided for the Employer's approval stamp and provision shall also be made by way of a block for details of revisions to be recorded. The drawing number shall be marked with a subsequent revision number every time the drawing is revised. The drawing title shall also identify name of the substation/site.

The equipment/systems which are to be bought out from the sub vendors are also required to be approved by the Employer prior to placement of order. The relevant technical literature/drawings pertaining to such equipment/systems shall be submitted for approval.

Six copies of each of the drawings are to be submitted for approval of Employer. Bidder shall ensure that the contents of copies of drawings are legible and are complete with all details. Drawings that are not legible or are incomplete will not be reviewed.

Two copies of approved drawings will be furnished to the Bidder. Drawings returned "not approved"/ "approved with comments" shall be resubmitted with Revision No. for approved till the final approval is obtained.

Delays caused by submission of incomplete/ incorrect drawings shall be to Bidder account.

Drawings submitted by sub-vendor/sub-contractor shall carry Bidder's approval stamp and the Bidder shall be responsible for their contents, accuracy and completeness. These drawings shall also carry details indicated in this Clause in addition to the Bidder's name.



### 3. DETAILED DRAWINGS

The bidder shall submit to the Employer all working drawings, equipment data and detailed drawings. These shall include general arrangement, details of equipment, foundations, cable routing, openings in walls and floors, wiring diagrams, cable schedules, interconnection diagrams etc. necessary for the erection of plant. These drawings/data having been corrected or amended as necessary based on the Employer's comments shall become the approved drawings/data to be used for manufacture and erection of plant.

Minimum details required on drawings of different categories are given below:

<b>Type of Drawing.</b>	<b>Minimum details required.</b>
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List of Drawing	:	A detailed list of drawings which The bidder proposes to prepare for The substation in indicating therein Drawing nos. and titles.
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Programme:	1)	All activities from the start Date up to commissioning shall Be included. Separate Programme shall be furnished for each of the activities.
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2)	Earliest and latest occurrence of each activity.
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3)	Constraints, if any.
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The activities for each of the items shall essentially cover time-table for activities such as placement of order with sub-vendors, Empowering, submission of drawing, review and approval by the Employer, manufacture, inspection, delivery, erection and commissioning. All events shall be represented in a proper in proper sequence of occurrence with due consideration for inter-dependent activities and all period shall be counted from the start date.

<b>Type of Drawing</b>	<b>Minimum details required</b>
------------------------	---------------------------------

<b>Single line diagrams.</b>	<ol style="list-style-type: none"> <li>1. All equipment connection with ratings, polarities, protection and metering details, etc.</li> <li>2. Cable details for all circuits.</li> <li>3. Details of relays, meters and Major components associated with each circuit.</li> </ol>
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**General Arrangement  
(All equipment,  
cabling earthing,  
lightning protection,  
lighting etc.)**

4. Busbar details, makes of equipment/ Components etc.
5. Reference Drawings.
  - 1) Dimensional layout drawings covering complete layout of these items/systems.
  - 2) Plans and sections as required to show details, access space/ Clearances etc.
  - 3) Details of foundations, cutouts. Openings, supporting/mounting Details etc. indicating weight on foundation.
  - 4). Bill of material and identification of components/rooms/ areas etc.
  - 5). Reference drawings.

**Installation Drawings**

Details of installation for equipment, accessories, cabling, lighting, earthing and lightning protection systems. These shall cover cross sectional details, cable trays/cable layouts for cables directly buried/along cable trays/ in conduits/along structures etc. details of marshalling boxes, embedment of conduits at building entry points/between cable trenches and structures, mounting arrangements and wiring for lighting fixtures, installation of earthing conductors directly buried/along structures, jointing/terminations (between conductors and at equipment ends), earth electrodes and pits, lightning shield wire, earth pads to be provided at specific places etc.

**a. RECORD DRAWING**

Within 6 (six) weeks of successful commissioning tests, the Bidder shall furnish the 'Record' (As Built) drawings. Submission to and approval by the Employer of the 'Record' drawing shall be pre-requisite for the 'Taking Over Certificate.' The drawing shall show the whole sub-station as installed and shall include electrical/mechanical and civil components with schematic and wiring diagrams for all items of electrical equipment included in the works. Six sets of recur drawings shall be furnished in neatly bound volumes. Reduced copies of the relevant drawings shall be included in the operating and maintenance manual.

**b. SPECIFIC REQUIREMENT**

Following drawings shall be enclosed with the bid :

- a) The programme shall be in the form of a network based on the principles of PERT/CPM. Detailed to cover entire scope of the project showing all activities (separately for each sub-station/site). Their durations start and finish dates and their inter-relationships.

b) Dimensioned general arrangement drawings showing plan, elevation and sections together with identification of parts/accessories, etc. for the major plant items, viz. 132 KV/33 KV. Outdoor transformer and equipment, 415 V A.C. and 220 V A.C. system equipment, control, relay and metering panels, communication equipment, lighting equipment along with manufacturer's catalogues/literature, etc.

Following information/drawings shall be submitted after the award of contract for approval of the Employer.

- (a) Updated programme along with the list of drawings.
- (b) Detailed design calculations for electrical, mechanical and civil equipment and systems etc. including design calculation of earthing grid and illumination system.
- (c) 33 KV/433 V transformer.
- (d) General arrangement drawing, showing plan, front and side elevations and all accessories and fittings. Detailed dimensions, net and shipping weights, crane lift for un tanking, size of lifting lugs and eyes, clearances between HV terminals, LV terminals and to ground and between adjacent bushing identification for fittings and accessories, enter lines in both the directions, details of anti-earthquake clamping device, details of HV/LV bushings. LV box foundation details, detailed manufacturer's catalogues/literature of accessories actually being supplied.
- (e) Rating and terminal marking plate, showing polarity vector group and other details.
- (f) GA drawing of OLTC and Marshaling Box.
- (g) Control and wiring diagram for OLTC marshalling box and cooler system.

**(1) 400KV,220KV,132KV AND 33KV outdoor type sub-station equipment:**

- (i) Detailed dimensional plan and sections for each equipment and for the sub-station indicating therein salient features of equipment, detailed bill of material for equipment, identification of clamps and connectors, etc. including weight of different equipment.
- (ii) Cable trench, lighting, earthing and lightning protection drawings for outdoor areas, control room drawings for equipment layout, cabling, lighting and earthing systems.
- (iii) Detailed drawings for the sub-station structures, equipment and clamps/connectors.
- (iv) Foundation layout drawings.
- (v) Control and protection schematic diagrams.
- (vi) Detailed one-line diagrams.
- (vii) Block logic diagrams.
- (viii) Cable schedules and inter-connection wiring diagrams in detail including all interlocking schematics.
- (ix) Typical installation detailed drawings.
- (x) Architectural and other civil drawings including that of state quantum.
- (xi) Manufacturer's catalogues/literature etc. of equipment being supplied.

**(2) 400KV/220KV/132 KV/33 KV SF6 Circuit Breaker.**

- (I) Complete assembly drawing of the Circuit Breaker showing plan, elevation and control cable terminal blocks.
- (ii) Foundation plan showing the location of channel sills, foundation bolts.

- (iii) Schematic diagram (AC and DC) for control protection, indication, alarm and trip circuits, relays, instruments space heaters, etc.
- (iv) Complete wiring diagrams of Marshalling Kiosk including terminal wiring designation.
- (v) Cable terminal details with dimensions.
- (vi) Manufacturer's catalogues/literature etc.

**(3) Control, relay and metering panels, 415/V AC and 220 V DC distribution boards, lighting panels, etc.**

**(4) Fully dimensioned general arrangement drawings for each of the above complete with plan, elevation and sectional views and complete bill of material, foundation drawing and cable entry details.**

- (I) Schematic diagrams for all power, control, protection and indication circuits.
- (ii) Alarm annunciation scheme drawings.
- (iii) Wiring diagrams.
- (iv) Manufacturer's catalogues/literature etc. for all items.

**(5) 220 V DC Battery and Battery Chargers.**

- (i) Dimensioned general arrangement drawings of battery and battery charges comprising plan, elevation and sectional views, foundation details, etc.
- (ii) Complete schematic and wiring diagrams for battery chargers.
- (iii) Detailed bill of material together with rating makes etc.
- (iv) Manufacturer's catalogues/literature.

**a) LIGHTING SYSTEM**

Lighting layout drawings for indoor and outdoor areas showing layout of lighting fixtures, conduit/cables, lighting circuit distribution scheme, complete bill of materials, locations of control switches, receptacles etc. and mounting details for fixtures, switches and receptacles as well as manufacturer's catalogues/literature.

**b) EARTHING AND LIGHTNING PROTECTION SYSTEM**

Layout drawings for earthing and lightning protection system showing earthing grid, locations of earth electrode3s, routes of conductor, interconnections, earth leads to various equipments, bill of materials, etc.

**c) MISCELLANEOUS SYSTEM**

Detailed general arrangement, schematic and other drawings, bill of material and manufacturer's catalogues/literatures.

**d) TYPICAL INSTALLATION DRAWING**

Cabling, lighting, earthing and lightning protection as well as miscellaneous system drawings showing all, necessary details.

**c. SUBMISSION OF DRAWING**

The list of drawings and the programme shall be submitted within 30 days from the start date.

All other drawings shall be submitted progressively thereafter within a maximum period of 180 days as per approved sequence of drawings to be submitted with the above period. But in no case the work progress should be hampered due to wrong/unscheduled sequence of drawings submission.

#### **d. TEST CERTIFICATE**

Type test certificates for the following items shall be furnished.

- a) 400KV, 220 KV, 132 KV and 33KV equipment like circuit Breaker, isolators, CTs, VTs and CVTs. Line traps, insulators, bushings, LAs, etc.
- b) Cables
- c) Clamps, connectors and hardwires.
- d) Transformers, OLTC etc.

Type test certificates shall be furnished for tests carried out on similar type/design of equipment. Type test to be carried out in presence of employer's representative for transformer.

#### **7.1.1 ROUTINE TEST CERTIFICATES**

Routine test certificates for all the plant items and accessories shall be furnished.

Routine test certificates shall be furnished in addition to test reports which will be collected at the time of inspection.

Routine test certificates shall be furnished for review by the Employer within seven (7) days after completion of inspection of relevant item or as instructed by the Employer in case of items for which witnessing of tests is waived.

Test certificates should be approved by the Employer for obtaining dispatch clearance of any material.

Six (6) copies of approved test certificates should be submitted for record.

#### **7.1.2 OTHER DOCUMENTS**

Technical catalogues, descriptive literature, characteristic curves, write-up on schemes where required in support of relevant control/annunciation drawings etc. shall be furnished for all the items of plant and accessories/components.

Documents pertaining to cables shall, in addition, include current ratings, de rating factors, physical and electrical data, recommended bending radii etc.

Documents in respect of lighting systems equipment shall include data in respect of each type of lighting fixture/switch, receptacles/miniature circuit breaker and wires to be used in circuit wiring. Data on lighting fixtures shall include dimensional drawings, cable

facility, mounting details and weight, light distribution diagrams, light absorption and utilization factors, lamp data etc.

Bidder shall note that the documents mentioned above shall be made available along with relevant drawings (listed in Clause 11.4 above items/ accessories components etc. as supporting documents to facilitate expeditious review of such drawings.

### **7.1.3 OPERATING AND MAINTENANCE MANUALS**

The Contractor shall provide five bound sets of approved manuals written in English language. All descriptive leaflets, instruction sheets, charts, lists, pamphlets and other documents that are used in compiling each manual shall be contained in one or more bundle designed to prevent loss of contents. Each binding shall be titled with a name of the Employer, the name of the project the Contract Number, the name of the Bidder and with information to identify the subject matter and shall include a detailed index to all the literature contained therein.

The manuals shall be initially approved in draft form by the Employer and shall cover all items of the works. For this purpose, three (3) draft copies shall be submitted to the Employer. Final submission of manuals shall be done after satisfactory completion of commissioning tests. A mere collection of manufacturer's descriptive leaflets, will not be acceptable in satisfaction of this clause. The manuals shall comprise both operating instructions and maintenance instructions. The operating manual should also highlight operation of the Plant in conjunction with the system. Thus, a general tie-up between system and equipment shall be available in the manuals.

A separate section of a manual shall be devoted to each size and type of equipment. It shall contain a detailed description of its construction and operation and shall include all relevant pamphlets and a list of parts with procedure for ordering spares. Operation of electrical equipment shall be described step by step giving the complete sequence of operation. The detailed sections of the manual if necessary, shall contain further maintenance instructions and fault location charts.

The manuals shall be printed on A4 size sheets and shall be bound. Reduced copies of record drawings shall also be included in the manuals.

Step to step of the plant to work, listing all adjustment necessary for the correct functioning of the plant alarms giving possible causes for alarm initiation and sequence of remedial actions to be taken.

Instructions on monitoring of plant performance and sample log sheet for each plant item, to be filled by operators on a routine basis.

“Do's and Don'ts” in plant operations. Operations attention shall be drawn to all operations considered to be dangerous to operators or likely to cause damage to the plant.

The maintenance instructions shall include the following.

Checking, testing and replacement procedures to be carried out on all plant items on a daily, weekly and monthly basis or at longer intervals to ensure trouble free operation.

Fault locations and remedy charts to facilitate tracing the cause of malfunctions or breakdown and correcting faults.

A spares schedule which shall consist of a complete list of itemized spares for all plant items with ordering references and part numbers.

Full instructions to cover the complete dismantling and reassembly of all items of plant.

Part list and drawings or exploded diagrams for such items of plant showing manufacturing tolerances, matching clearances between machined components at the time of supply, maximum wear and clearances permitted to facilitate replacement.

Complete list of recommended lubricants and lubricating charts insulating oil and insulation checking/replacement chart.



**ODISHA POWER TRANSMISSION CORPORATION LIMITED**

# **TECHNICAL SPECIFICATION**

**FOR**

**ELECTRICAL EQUIPMENT**

**INSTALLATION AND**

**COMMISSIONING**

<b>Sl.No.</b>	<b>DESCRIPTION</b>	<b>PAGE No.</b>
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## **1.0 ELECTRICAL EQUIPMENT INSTALLATION AND COMMISSIONING**

## **1.1 SCOPE**

This chapter describes board guidelines for installations, testing and commissioning of electrical equipment. The work shall, however, be carried out strictly as per the instruction of the MANUFACTURER / EMPLOYER.

## **1.2 CODES AND STANDARDS**

The electrical installation work shall comply with the latest applicable standards, regulations, electricity rules and safety codes of the locality where the installation is carried out. Nothing in this specification shall be construed to relieve the CONTRACTOR OF HIS RESPONSIBILITY

## **1.3 GENERAL**

The CONTRACTOR shall transport the equipments where required in actual position. Erect, assemble all parts of the equipments and test and commission the same.

The CONTRACTOR shall furnish all tools, welding equipment, rigging materials, testing equipment, test connections and kits, etc. required for complete installation, testing and commissioning of the items included in the contract work.

The EMPLOYER may engage specialist Employer to supervise the installation, testing and commissioning of their equipment. The CONTRACTOR shall extend full co-operation to these Employers and carry out the works as per their instructions. The CONTRACTOR'S work shall include minor rewiring modifications as may be necessitated during commissioning. Providing such assistance shall be deemed to be included in the CONTRACTOR'S basic scope.

The CONTRACTOR shall co-operate through the EMPLOYER with other contractors at site, in all matters of common interest, so as not to abstract operation of others and to ensure the safety of all personnel and works covered under this specification.

It will be the CONTRACTORS responsibility to assist the OWNER to obtain approval/ clearance from local statutory authorities including electrical inspector, wherever applicable, for conducting any work or for installation carried out which comes under the purview of such authorities.

The work shall be carried out strictly as per the instructions and layout drawings of the EMPLOYER/ manufacturer. In case of any doubt/ misunderstanding as to correct interpretation of the drawings or instructions, necessary clarifications shall be obtained from the EMPLOYER. The CONTRACTOR shall be held responsible for any damage to the equipment consequent to not following the MANUFACTURER'S instructions correctly. All necessary drawings. MANUFACTURER'S instructions correctly. All necessary drawings. MANUFACTURER'S equipment manuals will have to be arranged by the contractor as this is a Turn-key contract.

All thefts of equipment/component parts till the including executed portion handed over to the EMPLOYER shall be made good by the CONTRACTOR.

The CONTRACTOR shall have a separate cleaning gang to clean all equipment during erection and as well as the work area and the project site at regular intervals to the satisfaction of the EMPLOYER. In case the cleaning is not to the Employer's

satisfaction, he will have the right to carry out the cleaning operations and any expenditure incurred by the OWNER in this regard will be the CONTRACTOR'S account.

In order to avoid hazards to personnel moving around the equipment such as switcher etc. which is kept charged after installation before commissioning, such equipment shall be suitably cordoned off to prevent any one accidentally going near it.

Safety of the Contractor's personnel engaged in erection and commissioning job will be Contractor's responsibility.

The CONTRACTOR shall carry out touch-up painting on any equipment indicated by the EMPLOYER if the finish paint on the equipment is soiled or marred during installation handling.

The CONTRACTOR shall ensure workmanship of good quality and shall assign qualified supervisors/Employers and competent labour who are skilled, careful and experienced in their several trades in similar works. The EMPLOYER shall reserve the right to reject non-competent persons employed by the CONTRACTOR, if the workmanship is not of good order.

It shall be the responsibility of the CONTRACTOR to obtain necessary Licence/ Authorisation, Permit for work from the Licensing Board of the Locality/ state where the work is to be carried out. The persons deputed by the CONTRACTOR'S firm should also hold valid permits issued or recognized by the Licensing Board of the locality/State where the work is to be carried out. A list of the personnel engaged in erection and commissioning work should be submitted to the Employer before commencement of the work.

## **2. 0 INSTALLATION WORK SCOPE**

Equipment shall be installed in neat, workmanlike manners so that it is level, plumb, square and properly aligned and oriented. Tolerances shall be established in the Manufacturer's drawings or as stipulated by the EMPLOYER. No equipment shall be permanently bolted down to foundation or structure until the alignment has been checked and found acceptable by the EMPLOYER.

Care shall be exercised in handling to avoid distortion to stationary structures, the marring of finish, or damaging of delicate instruments or other electrical parts. Adjustment shall be made as necessary to the stationary structures for plumb and level, for the sake of appearance or to avoid twisting of frames, binding of hanged members, etc.

The CONTRACTOR shall move all equipment into the respective building through the regular doors or floor opening provided specially for lifting the equipment.

All external cabling including end connections and earthing shall also be carried out.

## **2.1 POWER AND INSTRUMENT TRANSFORMERS**

Physical inspection on receipt, storage, installation, testing and commissioning of transformers shall be in accordance with the specified code of practice and Manufacturer's instructions.

Transformer may be delivered without oil filled with inert gas and without bushings and external mounted accessories. As applicable, the CONTRACTOR shall.

- a) Assemble the transformers with all fittings such as bushings, cooler banks, radiator, conservators, valves, piping, cables boxes, marshalling boxes OLTC, cooling fans/pumps, etc.
- b) Arrange for vacuum and oil filtration of the transformers. Oil filtration shall be done as per the standard practice. Oil tanker in this effect are to be used and filtration to be done while the oil is inside the tanker. On getting the standard value of the oils the same shall be pushed into the main tank and other portion of the transformer. Final filtration to be done after entire oil is filled in the transformer. Prior to that vacuum treatment of the tank of the transformer with the windings are to be taken up.
- c) Provide wedges/clamps to rigidly station all transformers on rails.
- d) Connect up the transformer's terminals.
- e) Lay and terminate cables/ conduits between all the accessories mounted on the transformer tank/cooler and the transformer-marshalling kiosk and RTCC panels etc.
- f) Pre commissioning checks shall be carried out as per relevant standards and Employer's instructions.

The CONTRACTOR shall arrange the oil filtration equipment.

Care shall be taken during handling of insulating oil to prevent ingress of moisture or foreign matter. In the testing, circulating, filtering or otherwise handling of oil, rubber hoses shall not be used, circulation and filtering of oil, the heating of oil by regulated short-circuit current during drying runs and sampling and testing of oil shall be in accordance with the MANUFACTURER'S instructions and specified Code of Practice.

## **2.2 SWITCHGEAR, CONTROL/ RELAY PANELS**

Switchgears and control relay panels/desks shall be installed in accordance with specified Code of Practice and the Manufacturer's instructions. The switchgear panels shall be installed on finished surfaces or concrete or steel sills. The CONTRACTOR shall be required to install and align and channel sills which form part of the foundations. In joining shipping sections of the switchgear/panels /control centers together with adjacent housing or panes sections provided shall be bolted together after alignment has been completed. Power bus, enclosures, ground and control splices of conventional nature shall be cleaned and bolted together, being drawn up with torque wrench of proper size or by other approved means. Tape or compound shall be applied where called for by the MANUFACTURER'S drawings.

The CONTRACTOR shall take utmost care in handling instruments. Relays and other delicate mechanisms. Wherever the instruments and relays are supplied separately, they shall be mounted only after the associated control panel/desks have been erected and aligned. The blocking materials/mechanism employed for the safe transit of the instruments and relays shall be removed after ensuring that the panels/desks have been completely installed and no further

movement of the same would be necessary. Any damage to relays and instruments shall be immediately reported to the EMPLOYER.

Pre-commissioning checks on relays have to be carried out on all relays in accordance with manufacturers instruction and in presence of Employer.

### **2.3 BATTERY AND CHARGERS**

Installation and testing of battery and battery chargers shall be done in strict compliance with the manufacturer's instructions. Each cell shall be inspected for break ate and condition of cover seals as soon as received at site. Each cell shall be filled with electrolyte in accordance with the MANUFACTURER'S instructions. Battery shall be set up on racks as soon as possible after receipt, utilizing lifting devices supplied by the MANUFACTURER. The cells shall not be lifted by the terminals. Contact surfaces of battery terminals and inter-cell connectors shall be cleaned, coated with protective grease and assembled. Each connection shall be properly tightened. Each cell shall be tested with hydrometer and results logged. Freshening charge, if required, shall be added. When turned over to the EXPLOYER, the battery shall be fully charged and electrolyte shall be at full level and of specified specific gravity.

Battery shall be put in commercial use only after carrying out charge/discharge cycle as per Manufacturer's instruction.

### **3.0 SWITCHYARD**

The CONTRACTOR shall carry out switchyard installation as required as per approved plan and elevation drawings of switchyard showing bus bar configurations, sizes, tensions, insulator details, etc. All equipment including connectors (unless otherwise specified) will be supplied by the VENDOR. The bus bar arrangement shall be two Bus system, main Bus-1 and main Bus-2 for 220 KV side and Main bus and transfer bus arrangement for 132 KV side.

The CONTRACTOR shall install complete set of bus bars and all bays' conductors, complete with tension with tension suspension insulator strings, bus-post insulators, equipment connections, bus bar connections to equipment, lightning shield wires including down comers up to a height of 1000 mm. From ground level where they shall be connected to the Employer's test links.

Installation work of breakers and isolators shall include adjustment/ alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All insulators and bushings shall be protected against damage during installation. Insulators and bushings damaged due to negligence or carelessness of the CONTRACTOR shall not be in any way accepted and shall be replaced by him at his expense.

General requirements of Installation of Cabling:

- i) The supplier shall install, test and commission the cables. Cables shall be laid on cable trays and supports, in conduits and doctor or bare on walls, ceiling, etc. as required. The supplier's scope of work includes laying, fixing, jointing, bending and terminating cables. The supplier shall also supply necessary materials and equipment required for jointing and terminating of cables. The supplier shall prepare detailed layout drawing for cable trenches, cable tray layouts for approval by Employer and construct cable routes strictly according to these drawings.
- ii) Sharp bending, twisting and kinking of cables shall be avoided. The bending radius for various types of cables shall not be less than those specified by cable manufacturer.

- iii) In each cable run, some extra length shall be kept at a suitable point to enable one or two straight through joints to be made. Should the cable develop fault at a later date.
- iv) Cable joints in the middle of the run for control cables will not be accepted.
- v) All cable terminations shall be made in a neat, workmanlike manner. Terminations shall be made for each type of wire or cable in accordance with instructions issued by cable manufacturers and the Employer.
- vi) Metal sheath and Armour of the cable shall be bonded to the earthing system of the sub-station.

**3.1. GENERAL REQUIREMENTS OF INSTALLATION FOR CONDUITS, PIPES AND DUCTS.**

- i) The supplier shall supply and install conduits pipes(PVC thick but flexible suitable for taking inside the roof and walls) and ducts as necessary for the lighting system. All accessories/fittings required for making installation complete. Including but not limited to ordinary and inspection tees and elbows, check nuts, male and female reducers and enlargers, wooden plugs, caps, squat headed male plugs, nipples, gland sealing fittings, motion boxes, pull boxes, conduit outlets, outlet boxes, splice boxes, terminal boxes, glands, gaskets and box covers, saddles and all steel supporting work shall be supplied. Conduit fittings shall be of the galvanized one. Flexible metallic conduits shall be used for termination of connections to equipment such as motors or other apparatus to be disconnected at periodic intervals.
- ii) Conduits(thick and flexible PVC) and accessories shall be adequately protected against mechanical damage as well as corrosion.

**3.2. GENERAL REQUIREMENTS OF INSTALLATION FOR EARTHING AND LIGHTNING PROTECTION SYSTEMS**

**4. 0 SCOPE OF INSTALLATION**

- i) The supplier shall install steel conductors(GI flats) and braids, as required for system and individual equipment earthing. All work such as cutting, bending, supporting, painting coating drilling, brazing/soldering/welding, clamping, bolting and connection on to structures, equipment frames, terminals, rails or other devices shall be in the scope of work. All incidental hardware and consumables such as fixing cleats/clamps. Anchor fasteners, lugs, bolts, nuts, washers, bituminous compound, anticorrosive paints as required for the complete work shall be deemed to be included as part of the installation work.
- ii) The quantities, sizes and material of earthing conductors and electrodes to be installed and routes of the conductors and location of the electrodes shall be as per specification mentioned elsewhere and approved drawings for the optimal capacity of the Sub-station taking the future requirement in to account..
- iii) The scope of installation of earth conductors in outdoor areas, buried in ground shall include excavation in earth at least upto 700 mm. Deep and 450 mm, wide (unless otherwise stated), brazing/welding as required of main grid conductor joints as well as risers of 500 mm. Length above ground at required locations and back filling. Back

filling material to be placed over buried conductor shall be free from stones and other harmful mixtures. Backfill shall be placed in layers of 150 mm, uniformly spread along the ditch and tempered utilizing pneumatic tampers or other approved means.

- vii) The scope of installation of earth connection leads to equipment and risers on steel structures/walls shall include laying the conductors, welding/ cleating, at specified intervals, welding/brazing to the main earth grids risers, bolting at equipment terminals and coating welded/brazed joints by bituminous paint. Galvanized conductors shall be touched up with zinc rich paint, where holes are drilled at site for holding to equipment/structure.
- viii) The electrodes shall be installed either directly in earth or in constructed earth pits as shown in approved drawings.
- ix) The scope of installation of lightning conductors on the roof of buildings shall include laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods where necessary, laying, fastening/cleating/welding of the down comers on the walls/columns of the building and connection to the test links above the ground level.
- x) The scope of installation of the test links shall include mounting of the same at specified height on wall/column by suitable brackets and connections of the test link to the earth electrodes.

#### **4.1 Earthing connections:**

- i) All connections in the main earth conductors buried in earth/concrete shall be welded/brazed type,. Connection between main earthing conductor and earth leads shall also be of welded/brazed type.
- ii) Welding and brazing operations and fluzes/alloys shall be of approved standards.
- iii) All connections shall be of low resistance. Contact resistances shall also be minimum.
- iv) All bi-metallic connections shall be treated with suitable compound to prevent moisture ingress.

#### **4.2 Earth Electrodes:**

- i) Electrodes shall as far as practicable, be embedded below permanent moisture level.
- ii) Some electrodes shall be housed in test pits with concrete covers for periodic testing of earthing resistively. Installation of rod/pipe plate electrodes in test pits shall be convenient for inspection, testing and watering.
- iii) Earth pits shall be treated with salt and charcoal.
- iv) Soil, salt and charcoal placed around the electrode shall be finely graded free from stones and other harmful mixtures. Backfill shall be placed in the layers of 250 mm. Thick uniformly spread and compacted. If excavated soils are found unsuitable for backfilling, the contractor shall arrange for a suitable soil from outside.

### **5. 0 TESTING OF EARTHING SYSTEM**

The Supplier shall ensure the continuity of all conductors and joints. The Purchaser may ask for earth continuity tests, earth resistance measurements and other tests, which in his opinion are necessary to prove that the system is in accordance with the design,

specifications and code of practices. The supplier shall have to bear the cost of all such tests.

## **5.1. GENERAL REQUIREMENTS OF INSTALLATION FOR LIGHTNING SYSTEM AND POWER RECEPTACLES**

- i) The supplier shall supply, install, test and commission complete lighting system and power receptacles in accordance with relevant Standards. Concealed conduit wiring (thick flexible PVC pipes suitable for taking inside the roof and walls) shall be adopted for the control building.
- ii) Wiring shall be colour-coded so as to enable easy identification of phase and neutral conductors, and DC wire (colour-coded as follows – white – phase wire, black – neutral wire, grey / DC wires.)
- iii) There shall be switch on each live conductor of supply mains at the point of entry. The wiring throughout the installation shall be such that there is no break in neutral wire in the form of switch or fuse unit.
- iv) Fixtures shall be ground by 1.5sq mm .flexible PVC copper wires(green colour) and taken to earth strips.
- v) All fixtures, associated accessories, conduits, wires, junction boxes, cables, switches, switch boxes, etc. required for complete wiring of the lighting system as per approved drawings shall be supplied.

## **5.2. TESTING AND COMMISSION**

All checks and tests as per the Manufacturer's drawings/manuals, relevant code of installation/erection practices and commissioning checks for various types of equipment e.g. transformers, breakers, isolators, CTs, PTs, motors, relays, meters, etc. shall be carried out by the CONTRACTOR as part of the installation work.

The owner may ask for such additional tests on site as in his opinion are necessary to determine that the works comply with the specification, Manufacturer's guarantee/instructions or the applicable code of installation. The CONTRACTOR shall carry out such additional tests also.

The CONTRACTOR shall perform operating tests on all switchgear and panels to verify operation of switchgear/panels and correctness of the inter-connections between various items of the equipment. This shall be done by applying normal AC or DC voltage to the circuits and operating the equipment for functional checking of all control circuits e.g. closing, tripping, control interlock supervision and alarm circuits. All connections in the switchgear shall be tested from point for possible ground or short circuit.

Insulation resistance tests shall be carried out by following rating megger :

- a) Control circuits up to 220 V : By 500 V Megger
- b) Power circuits, busbars : By 5000 Motor  
connections for 132 KV. Operated Megger.
- c) Power circuits, busbars : By 5000 V Motor  
connections above 220 KV. Operated Megger.

The Employer's authorized representative shall be present during every test as called for by the EMPLOYER. The CONTRACTOR shall record all test values and furnish the required copies of the test data to the EMPLOYER. Electrical circuits and equipments shall be energized or used at nominal operating voltage only after such reports have been accepted as satisfactory by the EMPLOYER.



## **6. 0 COMPLETION CHECKS**

- a) Name plate details according to approved drawings/ specifications.
- b) Any physical damage or defect and cleanliness.
- c) Tightness of all bolts, clamps and connections
- d) Oil leakages and oil level.
- e) Condition of accessories and their completeness.
- f) Clearances.
- g) Earthing connections.
- h) Correctness of installation with respect to approved drawings/ specifications.
- i) Lubrication Moving parts.
- j) Alignment.
- k) Correctness and condition of connections.

### **6.1 COMMISSIONING TESTS**

- a) Insulation resistance measurement of equipment, accessories, cabling/ wiring. etc.
- b) Dielectric tests on equipment, accessories, cabling/wires. etc.
- c) Phase sequence and polarity.
- d) Voltage and current ratios.
- e) Vector group.
- f) Resistance measurement of winding. Contacts, etc.
- g) Continuity tests.
- h) Calibration of indicators, meters, relays. etc.
- i) Control and interlock checks.
- j) Settings of equipment accessories.
- k) Checking of accuracy/error.
- l) Checking of operating characteristics, pick/up voltages and currents. Etc.
- m) Operational and functional tests on equipment, accessories, control schemes, alarm/trip/indication circuits, etc.
- n) Measurement of guaranteed/approved design values including lighting levels, earth resistance measurements, etc.
- o) Complete system commissioning checks.



**ODISHA POWER TRANSMISSION CORPORATION LIMITED**

# **TECHNICAL SPECIFICATION**

**FOR**

**GENERAL EQUIPMENT AND SUBSTATION ACCESSORIES**

**GENERAL EQUIPMENT AND SUBSTATION ACCESSORIES**

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## **1. MOTORS**

### **1.1 General**

All motors shall comply with IEC 34 / IS 335 and dimensions with IEC 72, however they shall be capable of operating continuously under actual service conditions without exceeding the specified temperature rises, determined by resistance, at any frequency between 48 and 51.5 Hertz together with any voltage between  $\pm 10$  per cent of the nominal value.

All motors shall be totally enclosed, and if situated in the open they shall be weatherproof and suitable for outdoor working. They shall be provided with a suitable means of drainage to prevent accumulation of water due to condensation and with suitable means of breathing.

Motors operating in an ambient temperature not exceeding 40°C shall have insulation to at least Class B and preferably Class F standards. The temperature rise shall be restricted to that associated with Class B insulation. Where the motor may be appreciably affected by conducted heat the class of insulation shall be to approval.

All motors shall be suitable for direct starting at full voltage.

Motors shall have sealed ball or roller bearings.

The three line connections of AC motors shall be brought out to a terminal box. The terminal arrangement shall be suitable for the reception of aluminium cable. Terminal markings shall be made in a clear and permanent manner and shall comply with IEC 34. A permanently attached diagram or instruction sheet shall be provided giving the connections for the required direction of rotation. All terminal boxes shall be of the totally enclosed type designed to exclude the entry of dust and moisture and sealed from the internal air circuit of the motor. All joints shall be flanged with gaskets of neoprene or other approved material. Natural rubber insulation shall not be used.

Motors rated above 1 kW shall be three phase motors. Where single phase motors are employed the motors shall be grouped so as to form an approximately balanced three phase load.

### **1.2 Motor control gear**

Control gear shall comply with the requirements of IEC 292, the control gear being rated according to the duty imposed by the particular application.

Motor contactors shall comply with IEC 158 class of intermittent duty 0-3 with type 52 enclosure protection. Apparatus shall be capable of switching the stalled current, and shall have a continuous current rating of at least 50 per cent greater than the full load current of the motors they control.

The operating currents of overload trips fitted to motor contactors shall be substantially independent of ambient temperature conditions, including the effect of direct sunlight on the enclosure in which the contactors are installed.

Where small motors are connected in groups, the group protection shall be arranged so that it will operate satisfactorily in the event of a fault occurring on a single motor. The control and protection equipment shall be accommodated in the control cabinet or marshalling kiosk.

Each motor or group of motors shall be provided with control gear for starting and stopping by hand and automatically. Overload and single-phasing protection shall be provided.

## **2.0 CABLE BOXES**

Cable boxes shall be suitable for cables entering from above or below as may be required. They shall be weatherproof, rodent and insect-proof and be complete with all gaskets, compression glands, wiping glands and all associated fittings as may be required to make-off the cables.

Gland plates shall be insulated from the cable boxes and, in the case of single core cables, shall be of non-magnetic or insulating material. If metallic gland plates are used, single core cable glands shall be insulated from the gland plate. Gland plate insulation shall be capable of withstanding a dry high voltage test of 2000volts ac for one minute.

Where cable boxes are provided for three core cables, the sockets on the outer phases shall be inclined towards the centre to minimise opening of the cable cores. Cable sockets shall be supplied under this Contract.

Cable boxes for voltages up to and including 11kV shall be suitable for PVC or XLPE insulated steel wire-armoured PVC served cables. The boxes shall be air insulated and designed to accommodate all the fittings required by the cable manufacturer. Front covers and gland plates shall be removable and a 12mm diameter breathing hole covered with a wire gauze shall be provided.

Cable boxes shall be capable of withstanding on site the cable high voltage test level in accordance with IEC 502.

The drilling of gland plates, supply and fitting of compression glands and connecting up of power cables not included in the Contract scope of work shall be carried out under a separate contract.

Connection of the power cables included in the Contract scope of works shall be carried out under this Contract.

### **3.0 TERMINAL BOARDS AND TERMINAL BLOCKS**

Terminal boards shall be of good quality non-flammable insulating material with a comparative tracking index (CTI) of not less than 500 to IEC112.

Terminal boards shall be spaced not less than 150 mm apart. For relay panels, they shall be mounted at the sides of the cubicle, and set obliquely towards the rear doors to give easy access to termination and to enable ferrule numbers to be read without difficulty.

Studs of stud type terminal boards shall be locked in the base to prevent turning and all connections shall be made on the front of the terminal board using lock nuts or lock washers. Where crimped type termination are provided at least two sets of crimping tools for each size of crimp must be supplied for each installation.

Terminals shall be of the insertion clamp type incorporating captive pressure screws which do not bear directly on the wire but on a serrated clamping plate. The pressure screws shall have an inherent locking feature.

Where connections are to be made between multi-core cables and telephone type multi-pair cables, the terminal blocks shall be of the insulation displacement type and shall have a withdrawable insulated link in order to facilitate isolation (or busy out in the case of the apparatus associated with the telephone system) of the individual circuits. These terminals shall also be provided with facilities for the insertion of test probes on both sides of the link.

All terminations shall be numbered for identification and grouped according to function. Engraved white on black labels shall be provided on the terminal blocks.

Terminals for connections which exceed 110 Volts shall be separated from those of other circuits and shall be fitted with insulating screens and "DANGER" notices.

The use of terminal blocks as junction points for wires which are not required in the associated cubicle shall be avoided wherever practicable.

All termination racks shall have a minimum of 20 per cent spare terminals blocks. At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

All internal wiring to be connected to external equipments shall terminate on terminal blocks, preferably vertically mounted on the side of each panel. Terminal blocks shall be 650 V grade and have

10A continuous rating. Terminal blocks shall be moulded in one piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Terminal blocks shall include a white fibre marking strip with clear plastic, slip-on/clip-on terminal covers. Markings on the terminal strips shall correspond to terminal numbers on the wiring diagrams.

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

All terminal blocks shall be suitable for terminating on each side, two by 2.5 mm<sup>2</sup> standard copper conductors.

Wherever duplication of a terminal block is necessary it shall be achieved by solid bonding links.

Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors on each side :

- All CT and VT circuits : Minimum of two 2.5 mm<sup>2</sup> copper stranded.
- AC/DC power supply circuits : One 16 mm<sup>2</sup> aluminium.
- All other circuits : Minimum of one of 2.5 mm<sup>2</sup> copper stranded

There shall be a minimum clearance of 250 mm between the first row of terminal blocks and the associated cable gland plate or panel side wall, as per the terminal block mounting arrangement adopted. Also the clearance between the edges of two rows of terminal blocks shall be minimum of 150 mm.

Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel and close proximity along each side of the wiring duct to provide for convenient attachment of internal panel wiring. The side of the terminal blocks opposite the wiring duct shall be reserved for external cable connections. All adjacent terminal blocks shall also share this field wiring corridor. All wiring shall be provided with adequate support inside the panels to hold it firmly and to enable free and flexible termination without causing strain on terminals.

All necessary cable terminating accessories such as gland plates, supporting clamps and brackets, wiring troughs and gutters etc. including glands and lugs for cable shall be in Contractors scope of supply.

#### **4.0 FUSES AND LINKS**

Carriers and bases for fuses and links shall be in accordance with IEC 269 and colour coded to permit identification of the circuit rating.

The fuses and links mounted in cubicles for tripping circuits and protective gear test links shall be mounted on the front of the panel. Other links and fuses shall be accommodated within the cubicle or above the cubicle doors. Fuses and links shall be grouped and spaced according to their function in order to facilitate identification.

All incoming circuits in which the voltage exceeds 125V shall be fed through insulated fuses and/or links, the supplies being connected to the bottom terminal. The contacts of the fixed portion of the fuse or link shall be shrouded so that accidental contact with live metal cannot be made when the moving portion is withdrawn.

Main supply fuse links shall be of the high rupturing capacity cartridge type.

Where fuse carriers are mounted vertically the incoming (supply) side shall be the bottom terminal.

Where either fuses or circuit breakers are used it should be ensured that proper discrimination between main and sub-circuits is maintained.

## **5.0 COMMUNICATIONS CABLES**

All cables and wiring shall have copper conductors and PVC insulation and shall comply with IEC 227. Telephone type cables shall comply with IEC 96 and IEC 189.

Cabling and wiring installations shall be arranged to minimise the risk of fire and damage which may be caused in the event of fire.

For telephone type cables conductor wires with a cross sectional area of less than  $0.2 \text{ mm}^2$  shall not be used. Where twin or quad make up is required in any cable the cores shall be uniformly twisted and the lays arranged such that crosstalk is reduced to a minimum.

No conductor smaller than 32/0.2mm ( $1\text{mm}^2$ ), or having less than three strands shall be used for interconnecting cabling except in the case of telephone cables. All cables shall have insulation which will withstand the highest temperature to be experienced in service.

Each conductor of a multi-core cable shall be readily identified by a numbered marker tape or, in the case of telephone type cables, colour coded insulation.

The Contractor shall submit full details of all loading on cables and in the case of interposing current transformer connections, the loop resistance of each circuit.

Apparatus cubicles, cabinets, racks and panels shall be provided with gland plates and all necessary equipment for the termination of cables. The Contract Works shall include for the checking, termination and ferruling of the cable cores and their lacing into cable forms and connection to the equipment terminal boards or tag blocks using claw washers. Crimping ferrules shall be used for each conductor.

## **6.0 MARSHALLING KIOSKS AND CONTROL CABINETS**

The Contractor shall provide within every bay of the switch yard a bay marshalling kiosk to which all incoming and outgoing connections to and from the associated bay equipment will be run. The terminal blocks within the kiosks shall be grouped together by function and shall be properly labelled and segregated. Transformer and circuit breaker control/marshalling kiosks will be provided under a separate contract, but it shall be the Contractor's responsibility to cable up to the control/marshalling kiosks as provided by the transformer and circuit breaker suppliers. The Contractor shall provide a separate stand alone kiosk for busbar protection CT marshalling and the kiosk shall house the CT shorting and switching relays required for the correct function of the busbar protection scheme.

All outdoor cabinets and kiosks shall be protected in accordance with Class IP55 of IEC 947-1 and shall be insect and rodent proof. The minimum sheet steel thickness for all cubicles, kiosks and panels shall be not less than 2 mm cold rolled or 2.5 mm hot rolled sheet steel. The top of the outdoor boxes/kiosks shall be provided with Aluminium alloy sheets having 2 mm thick with proper sloping for easy discharge of water.

Anti-condensation heaters, 240V AC single phase, shall be provided and shall be controlled by a watertight switch mounted externally. Ventilation louvres shall be provided, suitably lined internally with a mesh screen, and divisions between compartments shall be perforated.

Control cabinets shall be illuminated with a switch operated and fused 240V CFL tube. Control cabinets shall be provided with a switch operated single phase 240V 15A power socket.

All cables shall enter cabinets and kiosks at the base.

Each compartment of all kiosks and cabinets shall be provided with access doors at the front and rear. Doors and access covers shall not be secured by nuts and bolts but shall be fastened with integral handles with provision for locking with a padlock.

Doors for kiosks shall be of the lift off and hinged type and shall be provided with glazed windows of adequate size to facilitate reading of indicators from outside the kiosk. Facilities shall be provided to permit removal of the temperature indicators without the need to pass the capillary tubing and bulb through the various compartments.



Doors and covers under 15kg mass may be of the slide on pattern, but above this mass hinged doors shall be used. Door shall be provided with padlocking facilities.

When three phase connections rated at 380V and above are taken through cabinets or kiosks, the terminal blocks shall be adequately screened, insulated and suitably marked with the phase colour; "DANGER" notices shall be affixed to the terminal blocks and a DANGER notice stating the voltage shall be fixed on the inside and outside of the kiosk or cabinet. Exterior DANGER notices shall be stove enamelled and shall be written in English and Oriya and shall be of an approved class/grade.

A durable copy of the circuit wiring diagram shall be affixed to the back of the kiosk door and labels shall be provided inside each kiosk or box to describe the functions of the various items of equipment.

When the marshalling kiosks are positioned in side the switchyard , flood water shall not ingress in to the marshalling kisok. The contractor may achieve the same either positioning the marshalling kiosk appropriately or providing adequate water proof arrangement.

**CT, CVT & IVT outdoor kiosks shall be of Aluminium alloy sheets having 3mm thickness. It shall have proper slop canopy for easy drainage of water.**

## **7.0 AUXILIARY SWITCHES**

With each disconnecter, contactor and earthing device, there shall be supplied all necessary auxiliary switches and mechanisms for indication, protection, control, interlocking, supervisory and other services as specified. Not less than four spare auxiliary switches of each type shall be provided.

All auxiliary switches shall be wired up to a suitable terminal board on the fixed portion of the switchgear whether they are in use or not in the first instance, and shall be arranged in the same sequence on all similar items of equipment. Switches shall be provided to interrupt the supply of current to the tripping mechanism of the circuit breakers and latched contactors. All such switches and mechanisms shall be mounted in accessible positions clear of the operating mechanism, and shall be adequately protected.

The contacts of all auxiliary switches shall be strong and be capable of adjustment in relation to the movement of the circuit breaker or other item of equipment. Auxiliary switches and auxiliary circuits shall be capable of carrying a continuous current of 10 Amps.

## **8.0 MINIATURE OR MOULDED CASE CIRCUIT BREAKERS**

Miniature or moulded case circuit breakers (MCB's or MCCB's) shall be designed and tested in accordance with IEC 157 and supplementary requirements of this specification. They shall be suitable for use over the full range of expected voltage variation as specified in the Schedules.

MCB's and MCCB's shall be suitably rated for both the continuous and short circuit loading of the circuits they are protecting under all service and atmospheric conditions stated in the specification. The Contractor shall ensure that correct discrimination is maintained between main and sub-circuits.

For three phase circuits, the miniature circuit breakers shall be of the three pole type; for single phase circuits they shall be of the single pole type and for dc circuits they shall be of the double pole type.

Where miniature circuit breakers are used in circuits containing inductive loads, e.g. operating coils, it is essential that they are suitable for satisfactory operation in the circuit in which they are used, i.e. account is taken of the circuit time constant.

All miniature circuit breakers shall be provided with an auxiliary contact for remote indication of circuit breaker operation.

Means shall be provided to prevent the miniature circuit breakers being inadvertently switched to the 'OFF' position.

Miniature circuit breakers shall be mounted in such a manner so as to give easily visible indication of breaker position and shall be grouped and spaced according to their function in order to facilitate identification and easy replacement.

## **9.0 SPACE HEATERS**

Heaters shall be suitably designed to prevent any contact between the heater wire and the air. They shall consist of coiled resistance wire centred in a metal sheath and completely encased in a highly compacted powder of magnesium oxide or other material having equal heat conducting and electrical insulation properties, or they shall consist of resistance wire wound on a ceramic and completely covered with a ceramic material to prevent any contact between the wire and the air.

Alternatively, they may consist of a resistance wire mounted into a tubular ceramic body built into an envelop of stainless steel or the resistance wire wound on a tubular ceramic body and embedded in vitreous glaze. The surface temperature of the heaters shall be restricted to a value which will not shorten the life of the heater sheaths or that of insulated wire or other component in the compartments.

## **10.0 LVAC CABLES**

### **10.1 General**

LVAC power cables shall have aluminium conductors with XLPE insulation, galvanised steel wire armour and PVC oversheath and shall comply with the requirements of IEC 227, 228 and 502 as applicable. Cables shall be sized to carry the highest anticipated load under the worst case ambient conditions. Where a three, three and a half or four core power cable is provided, the cores shall be coloured to distinguish the relevant phases.

All sheaths shall be free from defects and impervious to water.

### **10.2 1.1kV grade power and control cables**

#### **10.2.1 Codes and Standards**

The design, manufacture, testing and performance of cables covered under this specification shall comply with latest edition of the standards including amendments as indicated in the relevant schedules attached to this specification.

#### **10.2.2 Technical requirements**

The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled backfill and chances of flooding by water.

They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions. The XLPE insulated LV power cables shall withstand without damage a three phase fault current of at least 45 kA for a minimum of 0.12 seconds, with an initial peak of 105 kA in one of the phases. The armour for XLPE insulated power cables shall be capable of carrying 45 kA for at least 0.12 seconds without exceeding the maximum allowable temperature of PVC outer sheath.

Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of all cables.

Strip wire armouring following method (a) of the relevant IS shall not be accepted for any of the cables. For control cables round wire armouring only shall be used.

Cables shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250°C.

All the cables shall pass fire resistance test as per IS 1554 (Part-I)

The normal current rating of all PVC insulated cables shall be as per IS 3961.

Repaired cables shall not be accepted.

### **10.3 LV XLPE power cables**

XLPE insulated cables shall conform to IS 7098 (Part-I) and its amendments read along with this Specification. The conductor shall be stranded aluminium circular/sector shaped and compacted. In multi-core cables, the core shall be identified by red, yellow, blue and black coloured strips or colouring of insulation. A distinct inner sheath shall be provided in all multi-core cables even if they are unarmoured. For armoured or unarmoured cables, the inner sheath shall be of extruded PVC to type ST-2 of IS 5831. When armouring is specified for single core cables, the same shall consist of aluminium wires/strips.

### **10.4 LV XLPE power cables**

PVC (70C) insulated 1100V grade power cables shall conform to IS 1554 (Part-I) and its amendments, read along with this Specification and shall be suitable for a steady conductor temperature of 70°C . The conductor shall be stranded aluminium. Insulation shall be extruded PVC to type-A of IS 5831. A distinct inner sheath shall be provided in all multi-core cables. For multi-core armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC to Type ST-1 of IS 5831 for all cables.

### **10.5 LV PVC control cables**

The 1100V grade control cables shall conform to IS 1554 (Part-1) and its amendments, read along with this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of IS 5831. A distinct inner sheath shall be provided in all cables whether armoured or not. The oversheath shall be extruded PVC to type ST-1 of IS 5831 and shall be grey in colour except where specifically advised by the Project Manager to be black.

Cores shall be identified as per IS 1554 (Part-1) for cables up to five cores and for cables with more than five cores the identification of cores shall additionally be done by printing legible alphabets on all cores. The alphabets shall be white and shall be printed at approximately 100 mm intervals along the cable length. Cables without such core identifications will not be accepted.

### **10.6 Cable drums**

Cables shall be supplied non-returnable wooden or steel drums of heavy construction. Wooden drums shall be properly seasoned sound and free from defects. Wood preservative shall be applied to the entire drum.

Standard lengths for each size of power and control cables shall be 500/1000 meters. The cable length per drum shall be subject to a tolerance of plus or minus 5% of the standard drum length. The Project Manager shall have the option of rejecting cable drums with shorter lengths. However, the total quantity of cables after taking into consideration of all cable drums for each size shall be within the tolerance of  $\pm 2\%$ .

A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.

### **10.7 Tests**

All cables shall conform to all type, routine and acceptance tests listed in the relevant IS.

The temperature index tests shall be carried out as per ASTM-D-2863.

All cables shall meet the fire-resistance test as per IS 1554 (Part-I)

### **10.8 Cable sizes**

Following standard sizes of cables shall be considered by Bidder for various power distribution and protection, control and metering purposes in the system:

- XLPE power cables: 1c 630 mm<sup>2</sup>, 1c 300 mm<sup>2</sup>, 3 1/2c 300 mm<sup>2</sup>. (armoured)
- LV XLPE power cables: (armoured) 1c 150 mm<sup>2</sup>, 3 1/2 c 70 mm<sup>2</sup>, 3 1/2c 35 mm<sup>2</sup>, 4c 16 mm<sup>2</sup>, 4c 6 mm<sup>2</sup>, 2c 6 mm<sup>2</sup>.
- PVC control cables: 2c 2.5 mm<sup>2</sup>, 3c 2.5 mm<sup>2</sup>, 5c 2.5 mm<sup>2</sup>, 7c 2.5 mm<sup>2</sup>, 10c 2.5 mm<sup>2</sup>,  
14c 2.5 mm<sup>2</sup>, 19c 2.5 mm<sup>2</sup>, 27c 2.5 mm<sup>2</sup>

## 11.0 BUSHINGS

All bushings shall comply with the requirements of IEC 137 and the associated barrel porcelains shall comply with IEC 233 together with the requirements of this Specification. Provision shall be made for the fitting of arcing horns.

Transformer bushings rated at 66 kV and above shall be either of the oil impregnated paper or resin impregnated type. When filled with transformer oil there shall be no connection with the oil in the transformer and an oil gauge shall be provided. The visible oil levels in the gauge shall correspond to the range of average oil temperatures, from the minimum ambient stated in the Schedules to plus 70C. The oil level at 15C shall be marked. Connections from the main windings to bushings shall be flexible and shall be such that undue mechanical stresses are not imposed on them during assembly on site.

Terminal clamps shall be supplied with each bushing for flexible or rigid busbars as may be required. The material of the clamps shall be as stated in the Schedules.

## 12.0 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS

Bushings shall be manufactured and tested in accordance with IS 2099 and IEC 137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS 5621. The support insulators shall be manufactured and tested as per IS 2544/IEC 168 and IS 2099/IEC 273. The insulators shall also conform to IEC 815 as applicable.

The Contractor may also offer composite silicon insulators conforming to IEC 36.

Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.

Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and other similar defects.

Support insulators, bushings and hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators or bushings when operating at the normal rated voltage.

Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up, porcelain parts by grinding and metal parts by machining. Insulator and bushing design shall be such as to ensure a uniform compressive pressure on the joints.

## 12.1 Tests

In accordance with the requirements stipulated above bushing, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS 2099 and IS 2544.

All routine tests shall be conducted on hollow column insulators as per IEC 233. In addition the following tests shall also be conducted

1. Ultrasonic test as a routine test.
2. Pressure test as a routine test.
3. Bending load test in four directions at 50% specified bending load, as a routine test.
4. Bending load test in four directions at 100% specified bending load, as a sample test on each lot.
5. Burst pressure test as a sample test on each lot.
6. Hollow porcelain insulators should be in one integral piece in green and fired stage. No jointed porcelain will be acceptable.

## 12.2 Technical parameters of bushings, hollow column insulators and support insulators:

Parameter	420kV	245kV	145kV	36kV
Rated voltage kV	420	245	145	36
Impulse withstand (wet and dry) kVp	±1425	±1050	±650	±170
Switching surge withstand (wet and dry) kVp	±1050			
Power frequency withstand (wet and dry) kVrms	630	460	275	70
Total creepage distance mm	10500	6125	3625	900

Pollution level shall be Class III Heavy as per IEC 71, and as specified in Schedules for all classes of equipment.

Insulators shall also meet the requirements of IEC 815 for 420kV, 245kV and 145kV systems as applicable having alternate long and short sheds.

## 13.0 CIRCUIT BREAKERS

### 13.1 General

Circuit breakers shall be of three pole air break design, horizontal draw out type in accordance with IEC 947-2. In particular, evidence shall be provided of the performance when switching currents in the critical current range. They shall be capable of the ratings specified in the Schedules, when mounted in the switchboard.

Circuit breakers shall be fitted with trip-free, spring-operated mechanisms of the independent manually operated type and be provided with making and over current release facilities. A push-button shall be provided to trip the breaker electrically.

The breaker shall be provided with '**OPEN**', '**CLOSE**', '**SERVICE**', '**TEST**' and '**SPRING CHARGED**' position indicators and shall be provided with the necessary number of auxiliary contacts for interlocking, indication and tripping purposes plus two spare.

Each incoming circuit shall be provided with thermal overload relays and short circuit protection relays; they shall also be provided with an undervoltage relay to trip breaker in the event of a supply failure.

There shall be `SERVICE', `TEST' and fully withdrawn positions for the breakers. It shall be possible to close the door in `TEST' position.

Movement of a circuit breaker between `SERVICE' and `TEST' positions shall not be possible unless it is in `OPEN' position. Attempted withdrawal of a closed circuit breaker shall not trip the circuit breaker.

Closing of a circuit breaker shall not be possible unless it is in `SERVICE', `TEST' or fully withdrawn positions.

A breaker of particular rating shall be prevented from insertion in a cubicle of a different rating.

Circuit breakers shall be provided with electrical anti-pumping and trip free feature.

Means shall be provided to slowly close the circuit breaker in withdrawn position if required for inspection and setting of contacts. In service position slow closing shall not be possible.

Circuit breakers shall be provided with the following mechanism as specified in the Bill of Material.

### **13.2 Power operated mechanism**

Power operated mechanism shall be provided with a universal motor suitable for operation 220V DC control supply with voltage variation from 90% to 110% rated voltage. Motor insulation shall be class `E' or better.

The motor shall be such that it requires not more than 30 seconds for fully charging the closing spring.

Once the closing springs are discharged, after the one closing operation of circuit breaker, it shall automatically initiate, recharging of the spring.

The mechanism shall be such that as long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. After failure of power supply at least one open-close-open operation shall be possible.

Provision shall be made for emergency manual charging and as soon as this manual charging handle is coupled, the motor shall automatically be mechanically decoupled.

All circuit breakers shall be provided with closing and tripping coils. The closing coils shall operate correctly at all values of voltage between 85% to 110% at rated control voltage. Tripping coils shall operate satisfactorily under all values of supply voltage between 70% to 110% of rated control voltage.

Provision for mechanical closing of the breaker only in `TEST' and withdrawn positions shall be made.

### **14.0 RELAYS**

All relays and timers in protective circuits shall be flush mounted on panel front with connections from the inside. They shall have transparent dust tight covers removable from the front. All protective relays shall have a drawout construction for easy replacement from the front. They shall either have built-in test facilities, or shall be provided with necessary test blocks and test switches located immediately below each relay. Auxiliary relays and timers may be furnished in non-drawout cases.

All AC relays shall be suitable for operation at 50 Hz with 110 volts VT secondary and 1A or 5A CT secondary.

All protective relays and timers shall have at least two potential free output contacts. Relays shall have contacts as required for protection schemes. Contacts of relays and timers shall be silver faced and shall have a spring action. Adequate numbers of terminals shall be available on the relay cases for applicable relaying schemes.

All protective relays, auxiliary relays and timers shall be provided with hand reset operation indicators (flags) for analysing the cause of operation.

All relays shall withstand a test voltage of 2kV (rms) for one minute.

Motor starters shall be provided with three element, ambient temperature compensated, time lagged, hand reset type terminal overload relays with adjustable settings. The setting ranges shall be properly selected to suit the motor ratings. These relays shall have a separate black coloured hand reset push button mounted on compartment door and shall have at least one changeover contact.

All fuse protected, contactor controlled motors shall have single phasing protection, either as a distinct feature in the overload relays (by differential movement of bi-metallic strips), or as a separate device. The single phasing protection shall operate with 80% of the set current flowing in two of the phases.

## **15.0 CONTACTORS**

Motor starter contactors shall be of air break, electromagnetic type rated for uninterrupted duty as per IS 2959.

Contactors shall be double break, non-gravity type and their main contacts shall be silver faced.

Direct line starter contactors shall be of utilisation category AC2. These contactors shall be as per IS 1822.

Each contactor shall be provided with two normally open (NO) and two normally close (NC) auxiliary contacts.

Operating coils of contactors shall be of 240V AC unless otherwise specified elsewhere. The Contactors shall operate satisfactorily between 85% to 110% of the rated voltage. Contactors shall drop out at 70% of the rated voltage.

## **16.0 INSTRUMENT TRANSFORMERS**

All current and voltage transformers shall be completely encapsulated cast resin insulated type suitable for continuous operation at the temperature prevailing inside the switchgear enclosure, when the switchboard is operating at its rated condition and the outside ambient temperature is 50°C.

All instrument transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary current ratings of the associated switchgear.

All instrument transformer shall have clear indelible polarity markings. All secondary terminals shall be wired to a separate terminal on an accessible terminal block where star-point formation and earthing shall be done.

Current transformers may be multi or single core type. All voltage transformers shall be single phase type. Busbar VT's shall be housed in a separate compartment.

All VT's shall have readily accessible HRC current limiting fuses on both primary and secondary sides.

## **17.0 INDICATING INSTRUMENTS**

All indicating and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96 mm square size with 90 degree scales, and shall have an accuracy class of 2.5 or better. The covers and cases of instruments and meters shall provide a dust and vermin proof construction.

All instruments shall be compensated for temperature errors and factory calibrated to directly read the primary quantities. Means shall be provided for zero adjustment without removing or dismantling the instruments.

All instruments shall have white dials with black numerals and lettering. Black knife edge pointer with parallax free dials will be preferred.

Ammeters provided on motor feeders shall have a compressed scale at the upper current region to cover the starting current.

Watt-hour meters shall be of three phase, three element type. Maximum demand indicators need not be provided.

## 18.0 CONTROL AND SELECTOR SWITCHES

Control and instrument switches shall be rotary operated type with escutcheon plates clearly marked to show the function and positions. Switches shall be suitable for flush mounting with only switch front plate and operating handle projecting from the panel front. Switches shall be of sturdy construction suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred. Handles of different shapes along with suitable inscriptions on switches shall be provided as an aid to switch identification. The selection of operating handles for the different types of switches shall be as follows :

Switch Type	Application	Specification
Switchgear control switches	For closing and opening of breakers and isolators.	Pistol grip, black, three position type.
Synchronising switches	For synchronising check bypass facilities	Oval, black, keyed (common removable handle, or with locking facility and common key).
Selector switches	Auto, manual, local, remote and test facilities	Oval or knob, black
Instrument switches	Phase or meter selection	Round, knurled, black
Protection transfer switch	Transfer of protection.	Pistol grip, lockable and black.

**TABLE 18.1 Switch operating handles**

The control switches of breakers and isolators shall be of spring return to neutral type. The control springs shall be strong and robust enough to prevent inadvertent operation due to light touch. The spring return type switch shall have spring return from close and trip positions to “after close” and “after trip” positions respectively. They shall have at least two (2) contacts closing in close positions, and two (2) contacts closing in Trip positions unless specified otherwise.

Circuit breaker selector switches for breaker controlled motors shall have three stay put positions marked ‘**AUTO**’, ‘**MANUAL**’ and ‘**TEST**’ respectively. They shall have two contacts each of three positions and shall have black, pistol grip handles.

Instrument selection switches shall be of maintained contact stayput type. Ammeter selection switches shall have make-before-break type contacts so as to prevent open circuiting of CT secondaries when changing the position of the switch. Voltmeter transfer switches for AC shall be suitable for reading all line-to-line and line-to-neutral voltages for non effectively earthed systems, and for reading all line to line voltages for effectively earthed systems. Ammeter and voltmeter selector switches shall have four stayput positions with an adequate number of contacts for three phase four wire systems. These shall have black oval handles

Synchronising switches shall be of maintained contact stayput type having a common removable handle for a group of switches. The handle shall be removable only in the ‘**OFF**’ position and it shall be co-ordinated to fit in to all the synchronising switches. These switches shall be arranged to connect the synchronising equipment when turned to the ‘**ON**’ position. One contact of each switch shall be connected in the closing circuit of the respective breaker so that the breaker cannot be closed until the switch is turned to the ‘**ON**’ position.

Lockable type switches which can be locked in particular positions shall be provided when specified. The key locks shall be fitted on the operating handles.

The contacts of all switches shall preferably open and close with snap action to minimise arcing. Contacts of switches shall be spring assisted and contact faces shall be with rivets of pure silver or silver alloy. Springs shall not be used as current carrying parts.

The contact combination and their operation shall be such as to give completeness to the interlocking and function of the scheme. The contact rating of the switches shall be as follows :



Description	Contact rating in Amps		
	220V DC	50V DC	240V AC
Make and carry continuously	10A	10A	10A
Make and carry Make and carry for 0.5 sec.	30A	30A	30A
Break			
Resistive load	3A	20A	7A
Inductive Load with L/R=40ms	0.2A	—	—

**TABLE 18.2 Contact ratings of switches**

## 19.0 AIR BREAK SWITCHES

Air breaker switches shall be of the heavy duty, single throw group operated, load break, fault make type complying with IS 4064.

The Bidder shall ensure that all switches are adequately rated so as to be fully protected by the associated fuses during all abnormal operating conditions such as overload, locked motor, short circuit etc.

Switch operating handles shall be provided with padlocking facilities to lock them in 'OFF' position.

Interlocks shall be provided such that it is possible to open the cubicle door only when the switch is in 'OFF' position and to close the switch only when the door is closed. However suitable means shall be provided to intentionally defeat the interlocks explained above.

Switches and fuses for AC/DC control supply and heater supply wherever required shall be mounted inside and cubicles.

## 20.0 PUSH BUTTONS

Push-buttons shall be of spring return, push to actuate type. Their contacts shall be rated to make, continuously carry and break 10A at 240V and 0.5A (inductive) at 220V DC.

All push-buttons shall have one normally open and one normally closed contact, unless specified otherwise. The contact faces shall be of silver or silver alloy.

All push-buttons shall be provided with integral escutcheon plates marked with the appropriate function.

The colour of the button shall be as follows :

- GREEN** : For motor **START**, breaker **CLOSE**, valve /damper **OPEN**
- RED** : For motor **TRIP**, breaker **OPEN**, valve /damper **CLOSE**
- BLACK** : For overload reset, all annunciator and miscellaneous functions.

All push-buttons on panels shall be located in such a way that red push buttons shall always be to the left of green push buttons.

## 21.0 INDICATING LAMPS

Indicating lamps shall be of the panel mounting filament type and low watt consumption. Lamps shall be provided with series resistors, preferably built-in the lamps assembly. The lamps shall have

escutcheon plates marked with its function, wherever necessary. Lamps shall have translucent lamp covers of colours appropriate to the application as indicated in Table 21.1

Colour	Indication
RED	For motor <b>ON</b> , breaker/isolator <b>CLOSED</b> , valve/damper <b>OPEN</b>
GREEN	For motor <b>OFF</b> , breaker /isolator <b>OPEN</b> , valve/damper <b>CLOSE</b>
WHITE	For motor <b>Auto-Trip</b>
BLUE	For all healthy conditions (e.g. control supply) and also for ' <b>SPRING CHARGED</b> '
AMBER	For all alarm conditions (e.g. overload) Also for ' <b>SERVICE</b> ' and ' <b>TEST</b> ' positions indicators.

**TABLE 21.1 Indicating lamp colours**

Indication lamps should be located just above the associated push buttons/control switches. Red lamps shall invariably be located to the right of green lamps. In case a white lamp is also provided, it shall be placed between the red and green lamps along with the centre line of control switch/push button pair. Blue and amber lamps should normally be located above the red and green lamps.

When associated with push-buttons, red lamps shall be directly above the green push button, and green lamps shall be directly above the red push-button.

The wattage and resistance of the lamps shall be as follows:

- 220/250V      5 - 10W      4000 - 8000 ohms
- 110V          5 - 10W      1000 - 2000 ohms

Neon indicating lamps or LED's shall be provided when specified. The wattage of the neon lamp shall be 0.25 to 0.5W.

Bulbs and lenses shall be interchangeable and easily replaceable from the front of the panel. Tools, if required for replacing the bulbs and lenses shall also be included in the scope of supply.

All indicating lamps shall be suitable for continuous operation at 90 to 110% of their rated voltage.

## 22.0 FUSES

All fuses shall be of HRC cartridge fuse link type. Screw type fuses shall not be accepted. Fuses for AC circuits shall be of Class 2 type, 20kA (RMS) breaking current at 415V AC, and for DC circuits Class 1 type 4kA breaking current.

Fuses shall have visible operation indicators.

Fuses shall be mounted on fuse carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, they shall be directly mounted on plug in type bases. In such cases one set of insulated fuse pulling handles shall be supplied with each switchgear.

Fuse ratings shall be chosen by the Contractor depending upon the circuit requirements and these shall be subject to approval of Project Manager.

## 23.0 NAME PLATES AND LABELS

All switchgears and ACDC distribution boards etc. shall be provided with prominent, engraved identification plates. The module identification plate shall clearly give the feeder number and feeder designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear also. Language shall conform to the requirements stipulated elsewhere in the technical specification..

All name plates shall be of non-rusting metal or 3-ply lamincoid with white engraved lettering on black back ground. Inscriptions and lettering sizes shall be subject to Project Manager's approval.

Suitable plastic sticker labels shall be provided for easy identification of all equipment, located inside the panel or module. These labels shall be positioned so as to be clearly visible and shall give the device number as mentioned in the module wiring drawings.

## **24.0 ELECTRIC MOTORS (LV)**

### **24.1 Codes and Standards**

All motors shall conform to the latest revisions of the relevant IEC, Indian Standards, British Standards given in the schedules, except where modified or supplemented by this Specification.

The design, manufacture, installation and performance of motors shall conform to the provisions of latest Indian Electricity Act and Indian Electricity Rules. Nothing in these specifications shall be construed to relieve the contractor of his responsibility in this regard.

In case of contradiction between this specification and IS or BS or IEC, the stipulations on this specification shall prevail.

National Electrical Code for Hazardous locations and relevant NEMA standard shall also be applicable for motors located in hazardous location.

### **24.2 Service conditions and temperature rise**

Unless otherwise specified, machines shall be designed for a maximum ambient air temperature of 50C. Accordingly the temperature rise of the stator winding by resistance method over the ambient air temperature shall not exceed 70C.

For applications where the motor temperatures may be appreciably affected by conducted or radiated heat, the amount of heat must be specified by the Contractor and the appropriate temperature rises agreed.

### **24.3 AC Motors**

#### **24.3.1 General**

All AC motors shall be of squirrel cage type, unless otherwise specified and shall be suitable for direct on line starting.

Each motor shall be assigned a maximum continuous rating (MCR) corresponding to 70C temperature. Maximum continuous motor rating shall be at least ten percent above the maximum load demand of the driven equipment at designed capacity.

Rated voltage for AC motors shall be as given below for various MCR's of the motor, unless specified otherwise:

- From 0.2 kW to 220 kW            415 V, three phase, 50 Hz
- Below 0.2 kW                      240 V, single phase, 50 Hz

Voltage and frequency variations shall be as per clause 3.3 of IS 325.

The lowest voltage at the motor terminals throughout the starting period, with which the driven equipment shall satisfactorily start up even under the most arduous conditions specified, shall be 85% for motors rated up to 110 kW, and 80% for motors rated above.

The accelerating torque at any speed with the lowest starting voltage shall be at least ten (10) percent of rated full load torque of the motor.

The motors shall be suitable for two starts in succession under the specified conditions of load, torque and inertia, with the motor initially at its normal running temperature.

The ratio of locked rotor kVA at rated voltage to rated kW (MCR corresponding to 70C temperature rises) shall not exceed the following (without any further tolerance):

<b>Motor MCR kW</b>	<b>Start kVA/Rated kW</b>
Up to 110kW	1.0
Above 110kW	10.0

When tests to determine the breakaway starting current of cage induction motors are taken at reduced voltage, due allowance shall be made for the effect of saturation. The estimated value of breakaway starting current at rated voltage shall be given on all test certificates.

All motors shall be so designed that the maximum inrush currents and locked rotor and pull out torque, developed by them at 110% of the rated voltage, do not endanger the motor or the driven equipment.

The pull out torque at rated voltage shall not be less than 200 percent of the full load torque.

Motors for reciprocating compressors etc. shall be specially designed/rated to withstand the torque pulsation produced by the driven equipment.

#### 24.3.2 Transient recovery

The motors shall be capable of resuming normal operation after a system disturbance causing temporary loss of supply voltage for periods of up to 0.2 second (fault clearance time), followed by sudden restoration to 70 percent rated voltage. From this voltage the motors shall be capable of acceleration and ultimate recovery under the most arduous load conditions.

### 24.4 DC Motors

DC motors shall comply with IS 4722 and shall be shunt wound type rated for 220V. Motor MCR kW rating at 50C ambient shall be at least ten percent higher than the power requirement of the driven equipment under the most onerous operating conditions foreseen during the plant's life.

DC motors which are to operate from batteries shall be capable of operating continuously under actual service conditions at any voltage between 190V and 240V.

DC motors supplied from rectifier equipment connected to AC power supplies shall meet the voltage and frequency variations specified for AC motors.

Rectifier equipment shall be capable of meeting the condition of transient recovery given above for AC motors and shall be provided with the necessary current limiting devices.

The pull-out torque of DC motors at the rated voltage shall not be less than 200 percent of the full load torque.

### 24.5 Enclosure and method of cooling

The following types of enclosure may be supplied:

- Totally enclosed, fan ventilated.
- Totally enclosed, closed air circuit, integral heat exchanger.
- Totally enclosed, closed air circuit, machine mounted heat exchanger.

In all cases protective enclosure and method of cooling of motors shall be IP 54 and IC 0141 in accordance with IS 4691 and IS 6362 respectively.

Cooling fans shall be directly driven from the motor shaft.

Motors situated outdoors or exposed to the weather shall be weather protected (IPW-55).

All totally enclosed type of motors shall have a dust tight construction with suitable means of breathing and of drainage to prevent accumulation of water from condensation. Drain holes shall exclude bodies greater than 6 mm diameter.

## **24.6 Constructional features**

All components shall be of adequate mechanical strength and robustness and shall be constructed of metal unless otherwise approved. Glass fibre or plastic components, where employed, shall be of adequate design and robustness taking into account the conditions of service required and the effects of operating temperatures, ageing and thermal stability of the material. The material shall be resistant to flame propagation.

Rotors shall be so designed as to keep the combined critical speeds with the driven equipment away from the running speed by at least 20%.

Motors and their major components such as stators, rotors, terminal boxes, bearings and heat exchangers shall be designed to be readily interchangeable as integral units.

All motor rotors shall be dynamically balanced.

The enclosures shall be designed to provide an effective sealing between the primary and secondary air circuits.

The radial air gap between stator and rotor shall have an adequate margin to minimise the possibility of rubbing between the stator and rotor due to eccentric positioning, play and wear, shaft deflection due to rotor weight and unbalanced magnetic pull etc. The minimum radial air gap for all motors shall be in accordance with Clause 5.1.5 of IS 6381.

All requirements of clause 5.1.4 of IS 6381 shall also be complied with.

All the induction motors shall be capable of running at 75% of rated voltage for a period of 5 minutes.

Induction motors shall be designed to be capable of withstanding the voltage and torque stresses developed due to the difference between motor residual voltage and incoming supply voltage equal to 150% of the rated motor voltage during fast changeover of buses. The necessary features incorporated in the design to comply with this requirement shall be clearly indicated in this proposal.

## **24.7 Variable speed motors**

Variable speed motors shall be such that the speed can be continuously adjusted over the required range. The speed control gear shall be provided with an interlock to ensure that the motor can only be started when its control sequence is at the correct setting. When the motor is switched off, the speed control sequence shall automatically return to this position.

### **24.8 Brush gear, commutators and slip-rings**

Brush gear, commutators and slip-rings shall be designed to operate without injurious sparking and to run for at least three months without the need for adjustment or replacement of brushes.

Brushes shall be of electro graphite or metal graphite type. Adequate precautions shall be taken to protect the windings, commutators, slip-rings and brush gear against deposits of entrained carbon dust.

Removable covers shall be fitted to provide access to the brush gear, commutators and slip-rings. For totally enclosed type motors, windows shall be provided to permit observation of the brush gear whilst the motor is running.

Brush holders shall be of non-ferrous materials and located securely to accurately position the brushes on the commutator. Means for adjusting brush pressure and brush assembly shall be provided.

## **24.9 Internal electric heaters**

Internal electric heaters shall be provided on motors rated above 30 kW, to maintain the windings in a dry condition during periods of standstill. The heater shall be suitable for use on a 240V, 50 Hz, AC supply.

#### **24.10 Lifting facilities**

All heavy parts of the motors shall be provided with adequate arrangements for lifting or handling during erection or overhaul.

All material used for equipment construction including castings and forging etc. shall be of tested quality as per relevant codes and standards. No welding shall be carried out on cast iron components for repair or any other purpose.

#### **24.11 Winding and insulation**

Winding insulation shall be of class B or better and of proven high quality and reliability.

All winding insulation shall be non-hygroscopic, oil resistant and of materials resistant to flame propagation. All windings shall be impregnated and suitably processed to effectively seal them to prevent deterioration from adverse environmental conditions at site during the installation period and also during normal operation.

All winding overhangs and leads shall be adequately supported, braced and blocked to provide sufficient rigidity during all normal conditions of service.

Cage windings and all joints shall be designed to give an adequate safety factor on fatigue due to thermal and mechanical stresses, taking into account the specified starting and running conditions. The short-circuiting and rings shall be of joint less construction. All electrical joints and connections shall be of brazed or welded construction.

Motors shall be designed to give a life endurance of at least 18000 starts.

#### **24.12 Bearings**

Bearings shall be of rolling type. Vertical motors shall normally have rolling type guide and thrust bearings.

Bearings shall be designed to prevent ingress of dust and water and shall be sealed against leakage of lubricant along the shaft.

When the motor shaft is not located axially by its own bearings, it shall be permanently marked to indicate its normal running position and the extent of float in either direction.

Bearings shall comply with the relevant Indian or International Standards. The bearing housing shall be correctly packed with lithium based grease at the time of assembly. Construction shall be such that the bearings can be dismantled without risk of damage.

For direct drives, bearings shall have an expected life of at least 40,000 running hours. For motors with significant external radial or axial loads, e.g. belt drives, bearing shall have a life of at least 15000 running hours. The bearing assembly shall be provided with a grease relief device to eject any surplus grease in to a separate container.

Lubrication shall be possible without removal of the guarding. All grease nipples, oil cups and dip sticks shall be readily accessible.

#### **24.13 Heat exchangers**

An adequate margin shall be included in the design of heat exchangers to allow for fouling of cooling tubes or ducts under service conditions. Provision shall be made for the easy cleaning of the cooling tubes or ducts, preferably on load.

The cooling tubes or ducts shall be adequately braced and supported to prevent vibration and premature fatigue or fracture.

#### **24.14 Noise level**

Noise levels shall comply with BS 4999, Part-51.

#### **24.15 Vibration level**

The double amplitude of vibrations as measured at motor bearings shall be within the limits specified in IS 4729, and the limits specified for the driven equipment.

#### **24.16 Earthing terminals**

Two independent earthing points shall be provided in accordance with IS 3043(1966), on opposite sides of the motor for bolted connection of Employer's earthing conductor.

#### **24.17 Terminal boxes and associated fittings**

Terminal boxes for motors rated above 110 kW shall be capable of withstanding a system fault level of 31 MVA for 0.12 seconds.

Unless otherwise approved, the terminal box shall be capable of being turned through 360 degrees in steps of 90 degrees.

415 volt terminals shall be suitable for receiving 1.1 kV grade PVC or XLPE, unarmoured or armoured power cables.

Only three line terminals need be brought out from each three phase primary winding. All inter phase connections whether star or delta shall be made inside the machine.

Marking of all terminals shall be in accordance with IS 4728.

Leads from terminals to the windings shall be adequately sized and braced to withstand heating and forces produced by maximum fault current.

Cable boxes and terminations shall be designed to enable easy disconnection and replacement of cables.

All joints other than those on cable glands shall be gasketed with neoprene, neoprene bonded cork or other approved material.

For single core cables, gland plates shall be effectively non-magnetic.

The following shall be supplied along with each motor :

1. Crimping type tinned copper lugs for power cables, with all necessary hardware.
2. Compression type tinned brass cable glands for power cables (to be supplied loose).
3. Removable type undrilled gland plate.
4. Terminal boxes shall be of weather proof construction with a degree of protection of IP-55. At least one motor of each batch shall be type tested to comply with the following : the terminal boxes shall be subject to an internal air pressure of 0.207 bar g for 12 hours. After this period the pressure shall not be less than 0.104 bar g (after correcting for any change in temperature).

#### **24.18 Rating plate**

In addition to the requirements as called for in General Technical Clauses and relevant IS, the rating plate shall indicate the following:

- Maximum continuous rating in kW for 70C temperature rise.
- Bearing identification numbers (in case of ball or roller bearings) and recommended lubricant.

#### **24.19 Paint and finish**

All external parts shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, and sharp edges and scales removed and treated with one coat of primer and two coats of grey enamel paint. Motor colour codes shall comply with the requirements indicated elsewhere in this Specification.

All fasteners used in the construction of the equipment shall be either of corrosion resistant material or electro galvanised to service condition 4. Current carrying fasteners shall be either of stainless steel or high tensile brass or copper.

## 24.20 Tests

Induction motors shall be subjected to the following routine and type tests.

### 24.20.1 Routine Tests

Visual Checks of the following:

- Marking on rating plates
- Appearance and painting
- Location and details of terminal boxes and accessories.
- In order to observe compliance to degree of protection, following test will be performed. It shall not be possible to insert a feeler gauge of 1 mm thick in the enclosure or flange faces.

Dimensional checks

Measurement of Insulation Resistance (IR) of windings, and space heaters.

Measurement of winding resistance, and space heater resistance at ambient temperature.

High voltage test on main windings, and space heaters.

IR measurement after HV test in main windings, and space heaters.

No load running test (reading of current, voltage input and speed measurement).

Measurement of bearing temperature during steady state conditions.

Vibration measurement at rated speed and rated voltage, also measurement of vibration during coasting down.

Reduced voltage running test at no load

Locked rotor test.

Phase sequence polarity check and check for terminal markings.

Over speed test

Measurement of air gap

Functional check on auxiliaries

### 24.20.2 Type Tests

All tests as listed under routine tests

Measurement of noise at no load

Locked rotor test - measurement of VA power input

Momentary overload test

Temperature rise test at rated conditions as well as at maximum input conditions (during heat run test, measurement of bearing temperature, winding temperature, core temperature, coolant flow and coolant temperature). In case the temperature rise test is carried at other load than rated load, specified approval for the test method and procedure shall be obtained from the Project Manager.

Degree of protection test for the enclosure followed by IR, HV and no load run test.

Terminal box - fault level withstand test and pressure test.

Pull out torque measurement



Measurement of no-load starting time.

#### 24.20.3 DC motors

DC motors shall be subjected to all routine and type tests as per IS 4722. In addition, following tests shall be carried out:

- Noise level measurement as type test.
- Vibration measurement as routine test
- Degree of protection test as per IS 4691 as type test.

#### 24.21 Junction boxes and cables

Design and selection of all the components shall be made with a good margin of safety factor.

The equipment shall be installed indoor.

The reference ambient temperature outside the equipment shall be taken as 50C and relative humidity as 100%.

### 25.0 JUNCTION BOXES

#### 25.1 Construction

Contractor shall supply and install junction boxes complete with terminals as required.

Junction boxes shall be suitable for mounting on walls, columns, structures etc. The brackets, bolts, nuts, cable-glands, screws and all other accessories required for the erection shall be included in the Bidders scope.

Junction boxes shall be of square or rectangular type of 2.0 mm CRCA sheet steel and shall have bolted cover with good quality gasket lining.

Junction box and covers shall be hot dip galvanised.

All the terminals blocks of ESSEN make or equivalent shall be rated for 1100V and shall be of stud type. Each terminal shall be suitable for connecting two 2.5 mm<sup>2</sup> copper conductor.

All terminals shall be complete with insulated barriers, terminals studs, washers, nuts, locknuts, identification strips etc.

Junction boxes located inside shall have IP-54 protection as per IS 2147. Junction boxes located outside shall have IP-55 protection as per IS 2147.

Junction boxes shall be provided with one earthing terminal suitable for galvanised steel conductor.

The general arrangement, cross sectional details and other technical details are to be submitted in the form of drawing for Project Manager's approval.

#### 25.2 Interconnecting cables

All cables between junction box and field devices shall be stranded copper conductor, PVC insulated, extruded PVC inner sheathed, single galvanised steel wire armoured and overall PVC sheathed 1.1 kV grade and shall conform to IS 1554. The minimum size of cable used shall be 2.5 mm<sup>2</sup> copper conductor. All cables shall be supplied by the Contractor.

### 26.0 CONDUIT AND CONDUIT ACCESSORIES

The contractor shall supply and install all rigid steel conduit, flexible conduits, Hume pipes etc. complete with accessories such as tees, bends, adaptors and couplings as required for cabling work between various field devices to junction boxes.

All conduits shall be seamed by welding and shall be heavy gauge hot dip galvanised.

Each piece of conduit shall be straight, free from any defects and conform to IS 1653. The manufacturer's name shall be stamped on each piece.