



Da Afghanistan Breshna Sherkat
(DABS)

Employer s Requirements

Procurement of Design, Supply, Installation, test

And commissioning of 20/110kV, 40MVA Extension of TR Bay

In Sorobi Substation, District of Kabul Province

September 2024

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Technical Specifications for 20/110kV, 40MVA Extension Transformer Bay in Srobi Substation

1.1 GENERAL DESCRIPTION OF THE PROJECT

The Contractor shall carry out all work, whether specified in detail or not, in accordance with the Employer's Requirements. for Supply and Installation of 40MVA, 20/110 KV step up power Transformer Bay consisting of survey, design, manufacture, supply, installation and test and commissioning , insurance, packing for export, shipment, delivery to the site, unloading, complete construction, erection, all civil works including site leveling, diverting of water sources which may flow during rain or during melting of ice, control room, foundations, fences, compound walls, roads, finishing, site testing and commissioning for 20/110kV Step up Power Transformer in Srobi Substation.

1.2 Completion of Project and its Guarantee period: all the materials shall be delivered so that the project must be completed including testing and commissioning within 12 months from the date of execution of the contract agreement. The Contractor is to guarantee the efficient and satisfactory working of the plant erected under the Contract for a period of twelve (12) months from the date of energization on which the Employer takes over the plant in accordance with the General Conditions of Contract.

1.3 TOOLS AND APPLIANCES (OPTIONAL)

The Item Price Schedules list items which are required under this Contract. The Bidder must add to this list and price any special items in sufficient number, as may be required for maintenance of equipment supplied under this Contract. Each tool or appliance is to be clearly marked with its size and/or purpose and unless otherwise stated is not to be used for erection purposes. The tools and appliances with the appropriate boxes are to be handed to the Employer as soon as they arrive on site.

1.4 DESIGN AND CONSTRUCTION

In complying with the requirements of the Specification, both with respect to arrangement and detail, design is to conform to the best current engineering practice. Each of the several parts of the plant shall be of the maker's standard design provided that this design is in general accordance with the Specification. The essence of design should be simplicity and reliability in order to give long continuous service with high economy and low maintenance cost. Particular attention should be paid to internal and external access in order to facilitate inspection, cleaning and maintenance. The design, dimensions and materials of all parts shall be such that they will not suffer damage as a result of stresses under the most severe service conditions. Fully detailed specifications of the several parts of the plant shall be submitted describing particularly the materials to be used. The materials used in the construction of the plant shall be of the highest quality and selected particularly to meet the duties required of them. Mechanism shall be constructed to avoid sticking due to rust or corrosion. Workmanship and general finish shall be of the highest class throughout. All similar parts of the plant shall be interchangeable. All equipment is to operate without undue vibration and with the least possible amount of noise and is not to cause a nuisance. All equipment shall be designed to minimize the risk of fire and any damage which may be caused in the

event of fire. The equipment is also to be designed to prevent entry of all vermin and to minimize the ingress of dust and dirt. The use of materials which may be liable to attack by termites or other insects shall be avoided. The equipment shall be designed to prevent accidental contact with live parts.

1.5 UNITS OF MEASUREMENT

In all correspondence, in all technical schedules and on all drawings metric System International Unites (SI) units shall be used. On drawings where Imperial or other units have been used it will be in order if the equivalent SI units are suitably marked in addition.

1.6 CONTRACTOR'S RESPONSIBILITIES

The Contractor is to familiarize himself fully with Bidding Document, particularly in regard to the Conditions of Contract. The following clauses are intended to supplement but not supersede the information contained in Bidding Document. The execution of all contract work is to be adequately supervised by qualified representatives of the Contractor to the approval of the Employer and Engineer, who can demand removal of any of the Contractor's staff without assigning any reason. The Contractor shall replace staff at his own expense. Full facilities are to be provided by the Contractor to allow the Employer/Engineer to check and test the works. The Contractor is to seek advice from the Employer/Engineer regarding the parts of the plant which will be subject to inspection; such inspection shall not relieve the Contractor from his obligations under the Contract. The Employer/Engineer may require the opening up on site of equipment which has been delivered to site partly assembled.

1.6.1 Transport to Site

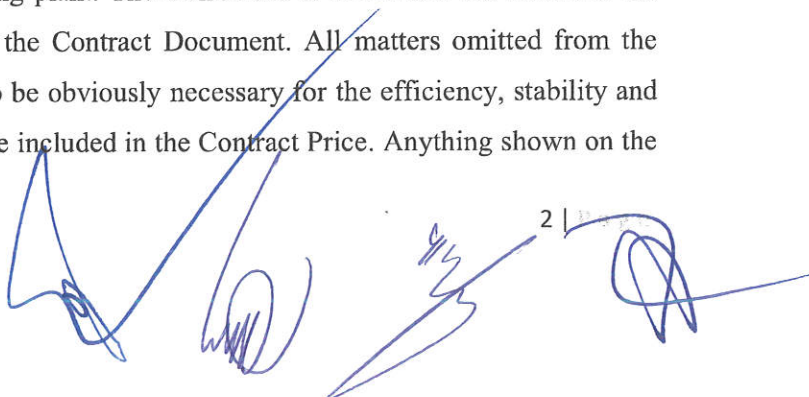
The Contractor is to bear all expenses in connection with the importation and transport to the Site of all Plant, material and things needed for the purpose of the Contract including warehouse rent, handling and other charges. The Contractor is to observe any regulations which limit loads on roads and bridges over which material may be conveyed.

The handling and storage of any Plant at the Site shall be at the risk of the Contractor and without responsibility to the Employer. The Contractor is to arrange for the protection, to the satisfaction of the Engineer, of all material against corrosion and mechanical damage during storage and erection at Site.

1.6.2 Design

Unless stated specifically to the contrary in the Bid with full supporting explanations, the Contractor will be deemed to have concurred as a practical manufacturer the design and layout of the Works as being sufficient to ensure reliability and safety in operation, freedom from undue stresses and satisfactory performance in all other essentials as a working plant. The Contractor is to include the whole of the Works which are described in or implied by the Contract Document. All matters omitted from the Contract Documents, which may be inferred to be obviously necessary for the efficiency, stability and completion of the Works, shall be deemed to be included in the Contract Price. Anything shown on the

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drawings, but not mentioned in the Specification or mentioned in the Specification and not shown on the drawings shall be deemed to be included in the Contract Price. The Contractor will be deemed to have visited site before preparing his tender to ascertain the local conditions under which the works will be carried out and obtain by own information on all factors which might affect the supply, construction and completion of the contract works.

1.6.3 Importation

All expenses concerned with importation of all plant, materials or any other items required for the purpose of the Contract are the Contractor's responsibility.

1.6.4 Compliance with Specification

Notwithstanding any descriptive literature, drawings or illustrations which may have been submitted with the Bid, all details other than those shown on the Schedule of Departures will be deemed to be in accordance with the Specification and the Standard Specifications and Codes referred to in the Specification. No departure from the Specification, except those shown in the Schedule of Departures and approved by Employer/Engineer shall be made without the written approval of the Employer/Engineer.

1.6.5 Drawings

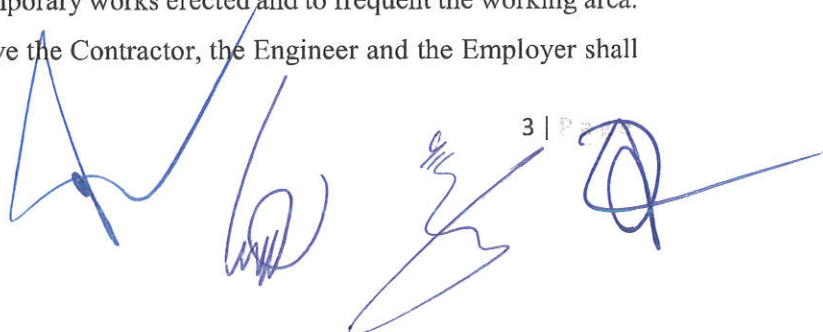
All drawings associated with the Contract are to have the following particulars in the lower right hand corner: **20/110 kV 40MVA Step-up Power Transformer in Srobi Substation, Da Afghanistan Breshna Sherkat (DABS)** and in addition, the title of the drawings, the Contractor's name, the date and the scale are to be shown. Before manufacture commences, dimensioned comprehensive drawings and diagrams giving full details of the Equipment are to be submitted to the Employer/Engineer for approval. Two prints of each drawing are to be provided to the Engineer and four prints submitted to the Employer for approval. The drawings are to be submitted in time to allow revisions or modifications as required by the Employer/Engineer. If the Contractor requires rapid approval of any drawings the Employer/Engineer is to be so advised when the drawing is submitted. After approval six copies of the approved drawings shall be submitted to the Employer with two copies to the Engineer.

Approval of the drawings does not relieve the Contractor from any responsibility in connection with the Works. At the completion of the Contract all drawings are to be marked up with any alterations made on site and two microfilm aperture cards, one true scale translucent print on plastic and one white print of each drawing are to be provided.

1.6.6 Safety of Personnel

The maximum safety, consistent with good erection practice in the case of work above or underground, must be afforded to personnel directly engaged on this Contract, or to persons who, in the normal course of their occupation, find it necessary to utilize temporary works erected and to frequent the working area. Once any section of the plant has been made alive the Contractor, the Engineer and the Employer shall

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establish and agree to a system for ensuring the safety of personnel and equipment. While the plant is under the control of the Contractor, the Contractor shall be primarily responsible for the safety precautions. While the plant is under the control of the Employer, the Employer shall be primarily responsible for these precautions.

1.6.7 Contractor's Employees

The Contractor is to fulfill all his obligations in respect of accommodation, feeding and medical facilities for all personnel in his employ, in accordance with the responsibilities imposed on him by Clauses 1.11 and 1.12 of General Particular of Contract or as necessary to ensure satisfactory execution of the Contract. He is also to comply with the requirements of all relevant Labor Laws of Afghanistan. The Contractor is to be responsible for the behavior on site of all personnel employed by him.

1.6.8 Instruction of Local Staff

The Contract price will be deemed to include for the instruction of the Employer's employees who will later operate and maintain the equipment.

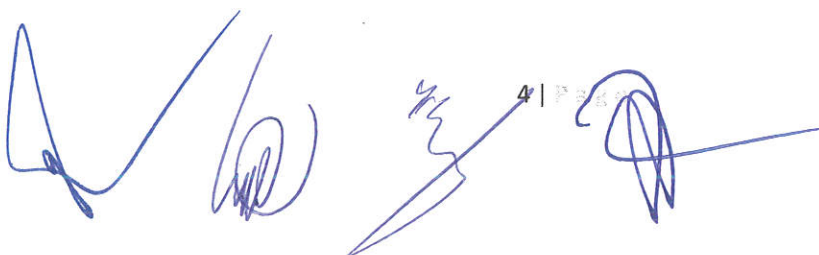
1.6.9 Program of Work

Within one month of acceptance of the Bid the Contractor is to forward to the Employer/Engineer four copies of a network chart detailing the program for the complete Contract work for approval. Copies of the approved chart, as required by the Employer/Engineer are to be provided by the Contractor. The chart is to indicate the various phases of work for all items of the Contract from the taking over of materials to its final completion. If at any time during the execution of the Contract it is found necessary to modify the approved chart, the Contractor is to inform the Employer/Engineer and submit a modified chart for approval. Such approval is not to be deemed to be consent to any amendment of the completion date stated in the Schedule.

1.6.10 Progress Reports

At monthly intervals, after approval of the program network chart referred to in Clause 1.6.10, the Contractor is to submit to the Engineer written detailed progress reports (in triplicate) in an approved form indicating the stage reached in the design, ordering of material, manufacture, delivery and erection of all components of plant. These reports are to be forwarded promptly so that, on receipt by the Employer/Engineer, the information contained therein is not more than seven days out of date. Copies are also to be forwarded to the Engineer's representative on Site.

If during the execution of the Contract the Engineer considers the progress position of any section of the work to be unsatisfactory, he will be at liberty to call such meetings, at the Contractor's works, as he deems to be necessary. These meetings may be held at the Contractor's Works, the Engineer's head Office, or in Afghanistan as determined the Engineer in Consultation with the Employer. If required by the Engineer, a responsible representative from the Contractor's works is to attend such meetings. Access to



the Contractor's and sub-Contractor's works shall be granted to the Engineer and Employer at all reasonable times for the purpose of ascertaining progress.

1.6.11 Erection and Checking at Site

All work at Site shall be carried out in such a manner as not to obstruct the operations of any other Contractor on the Site or the operation of the existing Power Stations or Substations. The carrying out of all work included in the Contract shall be supervised by a sufficient number of qualified representatives of the Contractor and full facilities and assistance shall be afforded by the Contractor for the Engineer to check the works.

The Contractor is to obtain from the Engineer details of the parts which he wishes to inspect, but such inspection shall in no way exonerate the Contractor from any of his obligations. The Contractor, if requested by the Engineer, is to open up for inspection before re-erection any equipment which has been delivered to the Site partly assembled. The Contractor is to keep the Site, on which he erects or stores Plant, reasonably clean, removing all waste material resulting from the work as it accumulates and as reasonably directed. On completion of the Works the Site shall be left clean and tidy to the satisfaction of the Engineer. Any damage done to buildings, structures and plant or property belonging to the Purchaser shall be made good at the Contractor's expense. The Contractor shall be responsible for satisfying himself as to the correctness of the electrical and mechanical connections to all Plant supplied under the Contract before such Plant is brought into commission.

During erection and commissioning the Contractor is to provide all temporary scaffolding, ladders, platforms with the boards and handrails essential for proper access or workmen and inspectors, cover or rail off all dangerous openings or holes in floors and afford adequate protection against materials falling from a high level on to personnel below. The operation of any items of Plant once made alive shall be subject to a "Permit to Work" system in a form agreed between the Engineer's representative and the Employer in accordance with the Employer's standard safety regulations for such work. While the Plant is still under the control of the Contractor the permit to work shall be endorsed by the Contractor's authorized representative. Permits to work on Plant which is handed over shall be under the control of the Employer.

1.6.12 Maintenance

The Contractor is to guarantee the efficient and good working of the Plant supplied under the Contract for a period of 12 calendar months from the date on which the Employer takes over the Plant after energization in accordance with the General Conditions of Contract.

1.6.13 Installation, Operating and Maintenance Instructions

The Contract Price will be deemed to include illustrated installation, operating and maintenance instructions written in English or Afghanistan language. When the general arrangements and details of the Plant have been finalized and not later than three months before delivery commences, the Contractor

is to submit to the Engineer for approval four (4) sets of fully detailed installation, operating and maintenance instructions for each substation including one copy of all drawings on reproducible heavy gauge polyester base film or similar. The details are to cover the main Plant and all associated ancillary equipment as supplied under the Contract. It will not be sufficient to incorporate manufacturer's standard brochures as part of the text unless they refer particularly to the equipment supplied and are free of extraneous matter. The information provided should include essential circuit diagrams, general arrangement and detailed drawings of the installation, make mention of special materials where used and include schedules of lubricants and all ball and roller races employed on the Plant. The drawings and diagrams, which may be approved existing drawings reduced to a convenient size, should be bound into the volume and not inserted into cover pockets. If the complete text is unduly bulky, then the manual shall be appropriately sub-divided and produced in multi-volume form. When approved, four copies of the complete text, diagrams and drawings as made up in draft form shall be handed to the Engineer for distribution at Site and these shall be provided not later than the date delivery commences. A further six copies for each substation shall be reproduced as a book or books of approximately A4 size and bound into strong yellow durable imitation leather covers inscribed with black letters upon the front generally in permanent form upon the front generally in the form of the title page to this document except that the references to Specification, Conditions of Contract, Drawings, etc., will be replaced by "Operating and Maintenance Instructions". The name of the main Contractor but not that of any sub-Contractor may also be inscribed upon the cover after the description of the Plant. The name of the Employer and substation or other identification followed by a classification of the Plant shall be inscribed upon the spine of the cover and, if the instructions are contained in several books, these shall be marked with the appropriate volume number. The finished books are to be handed to the Employer/Engineer not later than one month before taking over the plant.

SEGREGATED OR OPTIONAL PRICES

Bidders are requested to price the optional extra items of work as specified herein and listed in the Bid Price Schedule "Optional Prices". These optional price items are not part of the Lump Sum bid price and will only become part of the Contract on the issue of the Employer's written order for specific items.

1.8 COMPLETION OF WORK

There is urgency for the work to be carried out and completed at the earliest possible date.

1.9 SITE CONDITIONS

1.9.1 General

The Step-up Power Transformer and substations equipment covered in this Specification are located in Srobi District east of Kabul City, Afghanistan.

1.9.2 Site Services

i) Living accommodation

The Contractor is to make his own arrangements in regard to accommodation for his expatriate or locally recruitment staff during the erection and completion of work.

ii) Office Accommodation

The Contractor is to provide such temporary buildings as may be necessary for office accommodation for his Site staff during the erection of the Works and the cost of these shall be deemed to be included in the Contract Price.

iii) Medical Facilities

These will not be provided by the Employer and the Contractor will be required to make his own arrangements where these services may be required for his staff.

iv) Labor, Work permits, Accommodation and Insurance

It will be the responsibility of the Contractor to ensure that all grades of expatriate labor have valid work permits and/or visas, and to comply in every way with the immigration and/or emigration regulations. He shall also ensure that he complies with labor employment laws of the country and the requirements for leave, accommodation and insurance of all his employees and the employees of his sub-contractors. The Contractor in all dealings with labor in his employ shall have due regard to all recognized festival days of rest and religious or other customs.

2: GENERAL TECHNICAL REQUIREMENTS

2.1 REGULATIONS, STANDARDS, ETC.

2.1.1 Language

The English language is to be used on all Contract documents and in all correspondence between the Contractor and the Employer. All correspondence, drawings and Operating and Maintenance Instructions shall also be written in English.

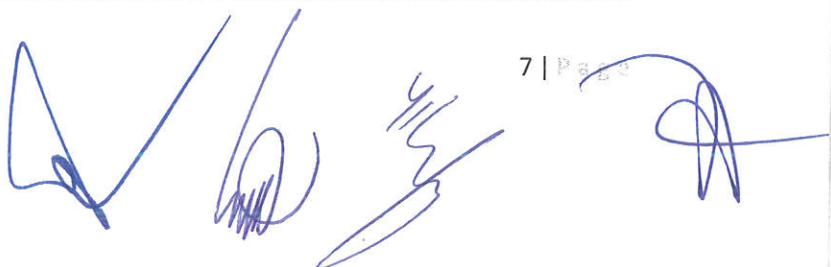
2.1.2 Units of Measurement

In all correspondence, in all technical schedules and on all drawings, Metric units of measurement (System International) shall exclusively be employed. Angular measurement shall be in degrees with 90 degrees comprising one right angle.

2.1.3 Compliance with Standards

Unless another standard is specifically mentioned in this Specification all materials and equipment used and provided under the Contract must be in accordance with IEC or ISO Recommendations. Where no such Recommendation exists then materials shall be in accordance with such other authoritative standards appropriate to the country of manufacture as in the opinion of the Employer ensures an equivalent or higher quality. The Recommendations or Standards used shall be those last published prior to the date of closing of bids. If the Contractor offers materials, equipment, design calculations or tests which conform to standards other than those published by the International Electro Technical Commission full details of

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the differences between the proposed standard and equivalent IEC, in so far as they affect the design or performance of the equipment, shall be submitted.

2.1.4 Statutory Regulations

The works and all plant, equipment and materials forming part of this Contract are to comply in all respects with all relevant Afghanistan Statutory Regulations, By Laws and Orders currently in force.

2.3 PARTICULARS OF SYSTEM

2.3.1 High Voltage 110 kV

1. Nominal system voltage: 110 kV
2. Highest system voltage: 123 kV
3. Method of system grounding: Solid

2.3.2 Medium Voltage 20 kV

1. Nominal system voltage: 20 kV
2. Highest system voltage: 24 kV
3. Method of system grounding: Resistance or Solid

2.3.6 Low Voltage 400/230 V

1. System frequency: 50 Hz
2. Phase rotation (clockwise): RST
3. Nominal system voltage: 400/230V

2.3 Design Parameters.7 the of plant voltage Levels.

A) Plant design Particulars of 110kV System

Nominal System Voltage	110 kV
Highest System Voltage	123 kV
Design Voltage (Um)	123 kV
Rated short time current	31.5kA for three second
Earthing	Solidly Earthed
Insulation Coordination	IEC60071-1
Rated lightning impulse withstand (peak)*:	550KV
Rated 1min power frequency withstand (KVrms)	230KV
Phase-to-earth air clearance:	
Minimum	1200mm
Phase-to-Phase air clearance:	
Minimum	1300mm
Creepage distance	31mm/KVPG

B) Plant design particulars of 20 KV System

Nominal System Voltage	20 kV
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Highest System Voltage	24 kV
Design Voltage (Um)	24 kV
Rated short time current	25 kA for three second.
Earthing	Solidly Earthed
Insulation Coordination	IEC60071-1
Rated lightning impulse withstand (peak)*:	125KV
Rated 1min power frequency withstand (KVrms)	50 KV
Phase-to-earth air clearance:	
Minimum	220
Phase-to-Phase air clearance:	
Minimum	220 mm
Creep age distance	31mm/KVPG

C) Plant design particulars of 400 Volts System

Table 1.1.1 Plant Design Conditions continued	
LV(400v) Distribution System	
LV Distribution System	
Nominal Voltage(Un)	400/230V
Design Voltage (Um)	1.1KV/0.6KV
Voltage Variation	±7.5%
Standard Frequency	50Hz
Rated Short Time Current	12.5kA/1sec
Earthing	Solidly earthed
Climatic and Geographic Conditions	
Altitude(Project Area only)	1020 m
Dry Period	June to November
Rain Period	December to May
Annual Rainfall	327mm
Maximum Solar Radiation	1,200W/m ²
Maximum Ground Snow Depth	1m
Maximum frost depth	1m
Maximum	42°C
Minimum	-25°C
Maximum Humidity	100%
Average	200ohmmeter(to be verified at site)
Wind:	
Maximum Wind Velocity	41m/s(148km/h)

2.4 MATERIAL AND FINISHES

In choosing materials and their finishes, due regard is to be given to the humid tropical conditions under which equipment is to work. Some relaxation of the following provisions may be permitted

where equipment is hermetically sealed but tropical grade materials should be used wherever possible.

2.4.1 Materials

a) Metal

Iron and steel are generally to be painted or galvanized as appropriate in accordance with this Specification. Indoor parts may alternatively have chromium or copper-nickel plated or other approved protective finish. Small iron and steel parts (other than rustless steel) of all instruments and electrical equipment, the cores of electromagnets and the metal parts of relays and mechanisms are to be treated in an approved manner to prevent rusting. Cores etc., which are built up of laminations or cannot for any other reason be anti-rust treated, are to have all exposed parts thoroughly cleaned and heavily enameled, lacquered or compounded.

b) Screw, nuts, springs, pivots, etc.

The use of iron and steel is to be avoided in instruments and electrical relays wherever possible. Steel screws, when used, are to be zinc, cadmium or chromium plated, or when plating is not possible owing to tolerance limitations, and are to be of corrosion-resisting steel. All wood screws are to be dull nickel brass or of other approved finish. Instrument screws (except those forming part of a magnetic circuit) are to be of brass or bronze. Springs are to be of non-rusting material, e.g. phosphor-bronze or nickel silver, as far as possible.

c) Fabrics, cork, paper etc.

Fabrics, cork, paper and similar materials, which are not subsequently to be protected by impregnation, are to be adequately treated with an approved fungicide. Sleaving and fabrics treated with linseed oil or linseed varnishes are not to be used. d) Wood The use of wood in equipment is to be avoided as far as possible. When used, woodwork is to be thoroughly seasoned teak or other approved wood which is resistant to fungal decay and is to be free from shakes and warp, sap and wane, knots, faults and other blemishes. All woodwork is to be suitably treated to protect it against the ingress of moisture and from the growth of fungus and termite attack, unless it is naturally resistant to those causes of deterioration. All joints in woodwork are to be dovetailed or tongued and pinned as far as possible. Metal fittings where used are to be of non-ferrous material.

e) Rubber

Neoprene and similar synthetic compounds, not subject to deterioration due to the climatic conditions, are to be used for gaskets, sealing rings, diaphragms, etc., instead of the standard rubber based material.

2.4.2 Finishes

a) Painting



All ferrous metalwork other than on the transmission towers and outdoor switch yard structures is to be provided with an effective vapor sealing paint finish, applied in accordance with the best trade practice. Before painting or filling with oil or compound, all un-galvanized parts shall be completely clean and free from rust, scale and grease and all external rough metal surfaces on casting shall be filled. The paint system is to be in accordance with best practice for hot and humid locations and this paint system shall be fully described in the Bid. Paint is not to be applied before tanks and chambers have passed any required pressure or vacuum tests. Internal surfaces of tanks and chambers which are to contain oil are to be treated with an approved oil resisting finish.

All external surfaces shall receive a minimum of three coats of paint. The primary coat shall be applied immediately after cleaning. The second coat shall be of oil and weather resisting nature and of a shade of color easily distinguishable from the primary)

Non Ferrous Parts and Bright Steel Parts

All exposed metal liable to corrosion is to be appropriately protected by coating with an approved anti rusting composition. Other non-ferrous parts shall be adequately protected against corrosion during shipment or in service. After erection these parts shall be cleaned with an approved solvent and polished bright where required.

Galvanizing shall be applied by the hot dipped process generally in accordance with ASTM A 123-73 and shall consist of a thickness of zinc coating equivalent to not less than 0.610 kg/square meter of surface. The zinc coating shall be smooth, clean and of uniform thickness and free from defects. The preparation for galvanizing and the galvanizing itself shall not adversely affect the mechanical properties of the coated material. All drilling, punching, cutting and bending and welding of parts shall be completed and all burrs shall be removed before the galvanizing process is applied. Surfaces which are in contact with oil shall not be galvanized or cadmium plated. All steel wires shall be galvanized by an approved process before stranding. The zinc shall be smooth, clean, of uniform thickness and free from defects and shall withstand the tests set out in IEC standard or such other standard as may be approved. If any galvanized part is found to be imperfect it is to be replaced. The whole of the expense involved in the replacement of the imperfect part is to be borne by the Contractor. The Contractor shall provide an instrument for checking galvanizing thickness, eg. Elcometer, or otherwise agree with the Engineer an approved method of testing galvanizing on Site. If, in the opinion of the Engineer, the extent of damage found on Site to a galvanized part appears capable of repair, the Contractor may, after receiving such agreement, attempt to effect such repair by approved methods. The agreement to attempt repair

shall not bind the Employer/Engineer to accept the repaired part when it is re-offered for inspection. In the event that it is found that galvanized parts are subject to the formation of white rust during shipment or storage on Site, the Employer/Engineer shall either : i) approve a system of scrubbing and protective painting to be applied on Site if, in his opinion, this is expedient or ii) forthwith order that the affected parts be condemned and that all future shipments receive, before dispatch from the Works, special dip or spray treatment to individual members to his approval without extra charge to the Purchaser. Either of the above measures shall not be held as a cause for failure to meet the Completion Dates

2.5 NUTS AND BOLTS

Nuts and Bolts for incorporation in the plant are preferably to conform to ISO Metric Coarse. Other sizes or threads are permitted for threaded parts not to be disturbed in normal use or maintenance.

Nuts and bolts for pressure parts are to be of the best quality bright steel, machined on the shank and under the head nut. Fitted bolts are to be a driving fit in the reamed holes they occupy, are to have the screwed portion of a diameter such that it will not be damaged in driving and are to be marked in a conspicuous position to ensure correct assembly at Site. On outdoor equipment all bolts, nuts and washers shall be of non-rusting material where they are in contact with non-ferrous parts in fittings and elsewhere where specifically required by the Employer / Engineer. Stud holes in those parts of the plant which are subjected to heat in use are to be adequately vented. All washers are to be included under this Contract, including locking devices and anti-vibration arrangements, which are to be subject to the approval of the Employer / Engineer. Taper washers are to be fitted where necessary. Where there is risk of corrosion, bolts and studs

are to be finished flush with the surface of the nuts. The Contractor shall allow for the supply of surplus bolts, nuts and washers in excess of the exact amount measured to allow for shortages due to loss, misappropriation, etc.

2.6 CASTING

All castings are to be as free from blowholes, flaws, and cracks as is practicable. No welding, filling or plugging of defective parts is to be done under any circumstances. All cast-iron is to be of close-grained quality approved by the Employer / Engineer.

2.7 WELDING

In all cases where fabrication welds are liable to be highly stressed, such as may be the case in parts subjected to reversals or stresses in operation, the Contractor is to supply the Engineer with a general arrangement drawing of the fabrication and, at a later date but before fabrication commences, a detailed drawing of all proposed weld preparations on the fabrication. Before such welding commences the Contractor is to satisfy the Employer / Engineer that welders or welding operators are qualified in

accordance with the approved standard. The Contractor may be required to submit evidence of the welder's abilities. After scrutinizing the general arrangement and welding detail drawings the Engineer will inform the Contractor of the stages at which inspection will be required. It shall be the Contractor's responsibility to notify the Engineer when one or more of the inspection stages will be reached and no further work is to be carried out until the specified stage has passed the Engineer's inspection. In addition to the above, the Employer / Engineer reserves the right to visit the Contractor's Works at any reasonable time during fabrication of the items of plant and to familiarize himself with the progress made and the quality of the work to date. In the event of the Contractor wishing to make an alteration to any part of the weld preparation, he is first to submit to the Engineer a copy of the revised drawing showing the amended preparation in detail and to wait confirmation of its acceptance or non-acceptance.

2.8 LABELS

All equipment shall be provided with labels or name plates, giving any identifying name, type or serial number, together with information regarding the rating, nominal voltage and current and the like under which the item of plant in question has been designed to operate. The labels shall be permanently attached in a conspicuous position. The English language is to be used, except on nameplates and labels associated with operation or maintenance of the plant which shall be in the Afghanistan language to the approval of the Employer / Engineer. Such nameplates or labels are to be of in corrodible non-hygroscopic material with lettering of contrasting color. Items of plant, such as valves, which are subject to handling, are to be provided with an engraved chromium plated brass nameplate or label with engraving filled with enamel.

2.9 PACKING AND SHIPPING

Any items liable to be damaged in transit shall be effectively protected and securely fixed in their cases. All lifts of over 2 tones shall be marked to show where slings should be placed. All cases shall be clearly identified giving particulars of manufacturer's name and type of equipment. All identification marks on the outside of cases are to be waterproof and permanent and as shown in drawing. All materials used in packing are to comply with the relevant Afghanistan regulations. Adequate protection and precautions are to be taken to exclude termites or other vermin, noxious insects, larvae or fungus from the packing materials or plant. All contents are to be clearly marked for easy identification against the packing list. The Contractor's attention is drawn to the provision of clause 2.4.2 wherein the contractor shall be required to suitably protect all steelwork before shipment to prevent corrosion and/or damage to galvanized surfaces by white rust. All accessory items shall be shipped with the equipment. Boxes and crates containing accessory items shall be marked so they are identified with the main equipment. The contents of box and crate shall be indicated by marking on the exterior. Packing cases where used shall be strongly constructed and in no case is timber less than 25 mm in thickness to be used. The contents of packing cases shall be securely bolted or fastened in position with struts or cross battens. Cross battens supporting weight in any direction shall not rely for their support on nails or screws driven lengthwise

into the grain of the wood, but shall be supported by cleats secured from the inside. Particular attention shall be given to strutting before packing cases are fastened down. Cases shall be up-ended after packing to prove that there is no movement of the contents. Timber wedges or chocks shall be firmly fastened in place to prevent their displacement when the timber shrinks.

All machined parts must be thoroughly greased & amply protected against rust forming and other corrosive elements. Where practicable, items such as electric motors, switch and control gear, instruments and panels, machine components, etc., are to be cocooned or covered in polyethylene sheeting, sealed at the joints and the enclosure provided internally with an approved desiccators.

2.10 SUBCONTRACTED PLANT AND MATERIALS

Where subcontracted plant and materials orders are let, triplicate copies of all such orders are to be submitted to the Employer/Engineer for approval at the time of placing. Copies of the orders shall be clearly marked with the Contract title and shall carry a statement to the effect that inspection of plant and materials may be required by the Employer/Engineer. The Contractor shall also provide the Engineer's representative on site with names and details of local subcontracts. The Engineer reserves the right to withdraw his consent to local subcontract arrangements if such is considered unsuitable, but consent will not be unreasonably withheld.

2.11 INSPECTION AND TESTING

2.11.1 General

In accordance with the General Conditions of Contract the whole of the plant and equipment provided under the Contract will be subject to inspection and testing by the Employer / Engineer during manufacture, erection and on completion. The approval of the Employer/ Engineer of the results of any such inspection or tests shall not prejudice the right of the Employer to reject the plant if it fails to comply with the Specification when erected or to fulfill the purpose for which it was supplied. The cost of tests including the provision of the necessary test equipment at the manufacturer's works, shall be deemed to be included in the Contract price.

2.11.2 Subcontractors

To facilitate inspection of bought out materials and plants, the Contractor shall submit three copies of all sub-orders placed by him, together with one copy of any drawings referred to in the sub-orders unless otherwise agreed. For the purpose of this clause, inter-works orders shall be treated as sub-orders. All sub-orders must include a statement advising sub- contractors that the items being ordered are subject to inspection and testing by the Employer / Engineer.

2.11.3 Site Tests

The site test shall be carried out by Contractor's, witnessed and approved by Employer.

2.12 DESIGN AND MANUFACTURE

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The design and manufacture of all equipment specified herein shall be such as to give long and continuous service with high economy and low maintenance costs and to ensure the continuity of electricity supply under all operating conditions. All materials used shall be of the best quality and of a class most suitable for the operating conditions, and shall withstand normal working conditions without deterioration. All equipment is to operate without undue vibration and with the least possible amount of noise. All equipment and accessories offered shall be of well proven design. The detailed design shall be such as to facilitate inspection, cleaning and repairs and permit simplicity of operation and maintenance. All workmanship is to be of the highest class throughout and the design dimensions and materials of all parts are to be such that the stress to which they are subjected shall not render them liable to distortion or damage under the most severe conditions encountered in service. No repairs of defective parts will be permitted under any circumstances. All similar equipment and accessories offered shall be identical to one another as regards their design materials and workmanship. Corresponding parts shall be interchangeable wherever possible throughout the Contract Works and be such as to facilitate the fitting or replacement parts.

2.13 PARTICULARS AND GUARANTEES

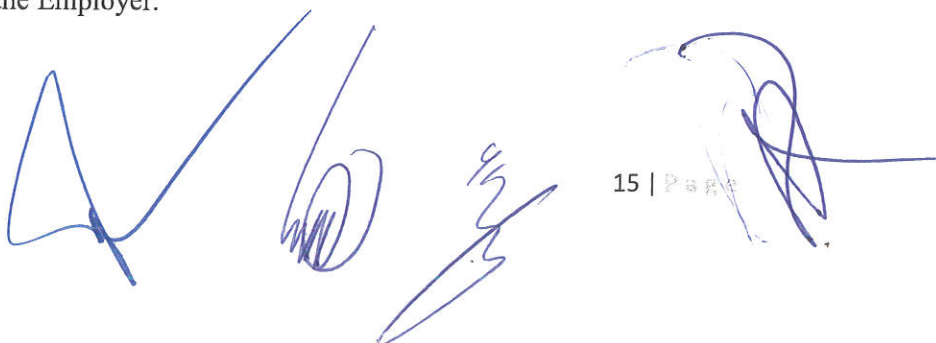
Bidders shall furnish full technical information and set out all particulars required in the Schedules. Drawings of all components shall be provided together with the equipment type and reference number to ensure their identification. Before approval for shipment will be issued by the Engineer, the manufacturer will be required to supply type test certificates and individual certificates for all goods supplied to testify that the goods comply with the applicable standards. If the tests proved unsatisfactorily, approval for shipment will not be issued. The Contractor is to guarantee the efficient and satisfactory working of the plant erected under the Contract for a period of twenty-four months from the date on which the Employer takes over the plant in accordance with the General Conditions of Contract.

2.14 PAD LOCKS

When required by the specification, non-ferrous pad locks with different key changes and two keys for each lock and a master key for each station, shall be provided.

Cabinets for the accommodation of padlocks and keys, whilst not in use, shall be provided and shall be suitably labeled so that keys will be readily identifiable. In the event that it is found that galvanized parts are subject to the formation of white rust during shipment or storage on Site, the Employer / Engineer shall either: a) Approve a system of scrubbing and protection painting to be applied on Site if, in his opinion, this is expedient or b) forthwith order that the affected parts be condemned and that all future shipments receive, before dispatch from the Works, special dip or spray treatment to individual members to his approval without extra charge to the Employer.

2.15 PIPE SUPPORTS



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The whole of the pipe work and accessories included in this Contract shall be supported and mounted in an approved manner. All necessary saddles, structural steelwork, foundation bolts, fixing bolts and all other attachments shall be supplied. All pipe supports and attachments are to be designed for compatibility with any particular building and foundation requirements. The number and positions of all intermediate flexible supports between anchor points shall be determined by the weights to be carried and by the steelwork available for the purpose and are to be subject to the approval of the Employer / Engineer.

2.16 VALVES

Valves shall be arranged so that the hand wheel moves in a clockwise direction to close the valve. The face of each hand wheel is to be clearly marked with the words "open" and "shut" and be provided with an arrow to indicate direction for opening and shutting. As far as possible valves shall not be fitted in an inverted position. It is to be possible to remove and replace, or recondition in site, the seats and to remove the gates. Valves of 50 mm nominal bore and over are to be provided with valve position indicators showing the amount by which the valve is open or closed in relation to its full travel. All valve hand wheels are to be fitted with nameplates complying with specification. Suitable means are to be provided to protect the operating mechanisms of all valves against mechanical damage and dust or dirt. Adequate provision is to be made for the lubrication of the mechanism and guides and this is preferably to be of the pressure type. Valves which are normally required to be locked in the open or closed position are to be provided with a non- detachable locking arrangement. Precautions are to be taken to prevent corrosion of the valve spindles in contact with the gland packing.

2.17 OIL LEVEL INDICATORS

Unless otherwise approved, oil level indicators of approved design shall be fitted to all oil containers other than hermetically sealed items. The indicators shall show the level at all temperatures likely to be experienced in service, and shall be marked with the normal level at 20°C clearly visible from normal access levels and shall be easily dismantled for cleaning.

2.18 PRESSURE GAUGES

All pressure gauges shall be fitted with stop cocks immediately adjacent to each gauge and all pressure gauge piping shall be fitted with an isolating valve at each point of connection to main system. Where pressure gauges are mounted on panels, the stop cocks shall be suitable for the connection of a test gauge. The finish of all pressure gauges shall be chromium plated. Where a difference in level exists between the situation of the gauge and the point at which pressure is to be measured, appropriate compensation shall be made in the dial reading and the dial must be marked with the amount of compensation applied. Where the compensation would amount to 2 per cent or less of the total movement indicated under normal conditions, it may be ignored. All pressure gauges where practicable shall be mounted on panels in locations approved by the DABS/Engineer. Stop cocks of gauges must be readily accessible. All pressure

gauges shall be clearly identified by means of separate labels of approved type and lettering. All high pressure gauge piping is to be of rustles steel but other pressure gauge piping may be of copper tube or other material approved by the Employer / Engineer.

2.19 THERMOMETER POCKETS

Thermometer pockets and instrument connections of an approved pattern are to be fitted in such positions as may be determined to suit the operation and testing of the plant to the approval of the Employer / Engineer. A thermometer pocket is to be fitted adjacent to each point of connection for distant remote temperature indication unless specifically stated to the contrary. Where necessary, the pocket shall be of approved alloy material suitable for the required service.

2.20 INSTRUMENTS

All indicating and recording instruments shall be of the flush mounted pattern with dust and moisture proof cases complying with IEC 60068. Unless otherwise specified, all indicating instruments shall have a 150mm or 140mm rectangular case. Instrument dials in general should be white with black markings and should preferably be reversible where double scale instruments are specified. Scales shall be of such material that no peeling or discoloration will take place with age under humid tropical conditions. The movements of all electrically actuated instruments shall be of the dead beat type.

Unless otherwise specified, circular chart recorders shall be arranged for one complete revolution every 24 hours and roll chart recorders shall move approximately 25 mm per hour, and the actuating mechanism shall be spring driven with automatic rewinding by means of a synchronous motor. Where two or more quantities are recorded on the same chart, they shall be distinguished by the use of distinctive colour not liable to fade. Recording instruments shall be fitted with glass windows so that the pen contact point on the chart and a length of chart on which the record has already been made are clearly visible. Indicating scales shall be provided to enable the charts to be read without removing them from the recorders. Charts and inks sufficient for two years continuous working on each recorder shall be supplied under the Contract. Wherever possible, instruments shall be provided with a readily accessible zero adjustment. Electrical Instruments and Meters All electrical instruments and meters are to comply with IEC 60051-1 and IEC 62271-203 or equivalent national standards respectively and, unless otherwise specified, shall be of industrial grade accuracy. Three-phase power measuring instruments shall be of the three-phase unbalanced load pattern wherever the current and voltage references permit. Maximum demand indicators shall have a demand interval of 30 minutes. Where precision grade metering is specified meters are to be calibrated to precision grade accuracy and allowance is to be made for the errors of current and voltage transformers with which they are to work and whose accuracy class is to be Class 0.2, 0.5 and 1.0 respectively. Where commercial grade metering is specified the meters shall be calibrated to commercial grade accuracy. Unless otherwise stated, meters shall be single directional and fitted where required with suitable devices for the transmission of

impulses to a summation Var-hour meters shall be complete with phase shifting transformers as necessary. Front of panel test terminal blocks shall be provided for all meters. Summation meters are to be equipped where required with suitable contacts for the retransmission of impulses to a print-to-meter.

Instruments and meters other than electrical Major scale markings, should be clearly differentiated from minor marks and pointers should taper evenly to the width of the minor scale marks. The normal working range should be between 50 and 75 per cent of the full movement of the pointer.

2.21 ELECTRICAL INSULATION

All insulating materials shall be suitably finished so as to prevent deterioration of their qualities under the specified working conditions. Plastics, elastomers, resin-bonded laminates and inorganic materials shall be of suitable quality selected from the grades or types in the appropriate IEC Standard. All cut or machined surfaces and edges of resin-bonded laminates shall be cleaned and then sealed with an approved varnish as soon as possible after cutting.

Wherever practicable, instrument, apparatus and machine coil windings, including wire wound resistors, with the exception of those immersed in oil or compound, shall be thoroughly dried in a vacuum or other approved means and are then to be immediately impregnated through to the core with an insulating varnish complying with BS.2778. The coils are to be covered with impregnated cotton or other suitable synthetic material. The impregnated coils are finally to be covered with an impervious enveloping varnish. Encapsulation of windings is preferred.

2.22 EARTHING CONNECTION

All necessary studs, connectors and earth bars shall be provided to permit the connection of each switchboard, motor or other electrical equipment supplied under the Contract to the substation general earthing system. The provisions for earthing shall be such that no reliance is to be placed on the conductivity of metal to metal joints without the use of special connectors.

2.23 ELECTRIC MOTORS

All motors shall be Universal Type, in accordance with IEC: 60072 and, unless otherwise specified, shall be of the totally enclosed fan cooled type, suitable for continuous operation and direct on-line starting. They shall be suitable in all respects for service in a damp tropical climate. Main conductor and slot insulation shall be non-hygroscopic and in accordance with Classes B or E of IEC 60085. Motors to be located out of doors shall be entirely suitable for operation under the climatic conditions at Site. Motors shall be capable of operating continuously at rated output at any frequency between 48 and 51 cycles per second and at any voltage within 6 percent of the nominal value. Motors shall be designed to operate for a period of not less than 5 minutes at a voltage of 25 percent below the nominal value and at normal frequency without injurious overheating. If required by the Employer / Engineer, the Contractor is to demonstrate that the motors comply with this requirement. The starting current at full voltage is not to exceed six times the rated full load current. All bearings shall be fitted with oil or grease lubricators

complying with specification. Vertical shaft motors shall have approved thrust bearings. The ends of motor windings shall be brought out to terminal boxes and the arrangement shall be such as to permit of easy changing over of any two phase leads without disturbing the sealing compound when this is used at cable terminations. All terminals shall be of the stud type of adequate size for the particular duty, marked in accordance with an approved standard and enclosed in a weatherproof box. All terminal boxes shall be fitted with an approved sealing chamber, conduit entry or adaptor plate, as required, together with the necessary fittings to suit the type of cable specified.

2.24 STARTERS AND CONTACTORS

Where starters shall be provided under this Contract, each motor shall be equipped with two or three pole control gear as appropriate and suitable, unless otherwise specified, for direct starting by the switching of full line voltage on to a standing motor. All starters should preferably be supplied by one manufacturer. Contactors are to be of robust design and are to comply with IEC. They shall operate without undue noise or vibration. Contactors shall be mounted in ventilated metal cubicles. Unless otherwise approved, the metal surfaces of the cubicle walls adjacent to the contactors shall be protected by fire-proof insulating material. Where two or more contactors are contained in the same cubicle, they shall be separated by barriers of fire-proof insulating material. The cubicles shall be complete with all locks, cable sealing boxes, bus bars, internal wiring, terminal boards and accessories. All bare copper connection shall be taped and all secondary wiring is to be so arranged and protected as to prevent its being damaged by arcing. Starters shall be of the electrically held-in type with integral "start" and "stop" push buttons mounted externally on the door, with integral interlocked isolators. Where required, auxiliary switches shall be included for the operation of "red" and "green" indicating lights on remote instrument panels. All A,C contactor coils shall be connected between phases for 400 volt working. All motor contactors and their associated apparatus must be designed to operate for a period of not less than 5 minutes at a voltage of 25% below the nominal value and at normal frequency without injurious overheating. For circuits controlling motors of 15 kW and over, transformer operated overload and **phase failure relays** are to be provided. These shall be of approved type and be operated by saturating type current transformers. For circuits controlling motors of less than 15 kW, thermal overload trips will be accepted.

2.25 CONTROL, SWITCHES AND PUSH BUTTONS

i) General:

Control switches for electrically operated circuit breakers and motor operated isolators shall be of discrepancy type and arranged to operate clockwise when closing the circuit breakers and anti-clockwise when opening them. They shall be designed to prevent accidental operation. Operation of switches of the discrepancy type shall be effected by two independent movements.

Alternatively, control switches for circuit breakers only may have pistol grip handles.

Switches for other apparatus shall be operated by shrouded push buttons or have handles of a type other than that used for circuit breakers.

Control, reversing, selector and test switches are to be mounted, constructed and wired so as to facilitate the maintenance of contracts without the necessity for disconnecting wiring.

Where necessary control switches shall be capable of being locked in appropriate positions but control switches for circuit breakers and for motor operated setting devices shall be of the non-locking type with spring return to the "neutral" position.

All push buttons shall be of the non-retaining type made of non-hygrosopic materials, non-swelling and fitted to avoid any possibility of sticking.

The contacts of all switches and push buttons shall be strong and have a positive wiping action when operated.

Control switches for use in direct control schemes shall be rated for the substation battery voltage and in any case not lower than 110 volts.

All control switches shall be provided with labels to give clear indication as to the direction of each operation, for example, "open", "close", "raise", "lower", etc.

ii) Electrical Control Locations

Equipment may be electrically controlled from a number of different control points as specified in the appropriate sections of this Specification. The control positions shall be designated as follows:

Local Control

Located adjacent to the item of plant to facilitate maintenance, inspection and emergency operation.

Remote Control

Located at a substation control room where specified items of plant are monitored and controlled by direct wire connection.

Supervisory Control

Located at a Load Dispatch Centre where principal items of plant are remotely controlled via a tele control system.

2.26 INDICATING LAMPS AND FITTINGS

Indicating lamps fitted into the facies of switch and instrument cubicles or panels shall be adequately ventilated. Lamps shall be easily removed and replaced from the front of the panel by manual means not requiring the use of extractors. The bezel of metal or other approved material holding the lamp glass shall be easily removable from the body of the fitting so as to permit access to the lamp and lamp glass. The lamps shall be clear and must fit into an accepted standard form of lamp holder. The rated lamp voltage should be 25 percent in excess of the auxiliary supply voltage, whether a.c. or D.C alternatively, low voltage lamps with series resistors will be acceptable. The lamp glasses shall be in standard colors, red, green, blue, white and amber. The color shall be in the glass and the different colored glasses shall be

inter- changeable. Synthetic materials may be used instead of glass, provided such materials have fast colors and are completely suitable for use in tropical climates. Spare lamps shall be supplied as 300% of the number and size of each type used with a minimum of 12.

2.27 AUXILIARY SWITCHES

Where appropriate, each item of plant shall be equipped with all necessary auxiliary switches, contactors and mechanisms for indication, protection, metering, control, interlocking, supervisory and other services. All auxiliary switches, including spares, and Contractors as well as the associated coil connections and inter- connections between auxiliary switches, shall be wired up to a terminal board on the fixed portion of the plant, whether they are in use or not in the first instance. All auxiliary switches and mechanisms shall be mounted in approved accessible positions clear of the operating mechanisms and shall be protected in an approved manner, and if outdoors, housed in a substantial weatherproof enclosure. Where adjustable linkages are provided to facilitate the timing of the auxiliary switches with respect to the main equipment, approved locking devices shall be fitted. The contacts of all auxiliary switches shall be robust and have a positive wiping action when closing, and where necessary, discharge resistors shall be provided to prevent arcing when breaking inductive circuits. Banks of auxiliary switches and associated terminal boards shall be arranged to facilitate extension when required.

2.28 ANTI-CONDENSATION HEATERS AND VENTILATORS

Any major items of electrical equipment which are liable to suffer from internal condensation due to atmospheric or load variations shall be fitted with heating devices suitable for electrical operation at 220/230 volts a.c. 50 Hz. single phase of sufficient capacity to raise the internal ambient temperature by 5°C . A suitable thermostat shall be included in the heater circuit. The electrical apparatus so protected shall be designed so that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the apparatus is in operation. Where fitted, a suitable terminal box and control switch, with indicating lamp, shall be provided and mounted in an accessible position. All such equipment, whether fitted with a heating device or not, shall be provided with adequate ventilation, screened to prevent entry of vermin, suitable drainage and to be free from pockets in which moisture can collect.

2.29 OIL

The oil shall comply with the requirements of IEC 60296. Where other types of filling media are used in current transformer chambers and other parts of the equipment, they shall be of an approved type.

2.30 ELECTRICITY SUPPLIES FOR AUXILIARY PLANT

The electricity supplies available for auxiliary plant will normally be:

- i) 400V 3-phase 50 Hz 4-wire for power
- ii) 230V single phase 50 Hz for lighting and indication.

iii) 110V d.c. for essential indication controls, protection, alarms and circuit breaker closing and tripping supplies. The equipment provided under this Contract is to be capable of operating reliably at voltages down to 80% of the normal voltage except where otherwise specified.

2.31 SYSTEM IDENTIFICATION

System identification of AC circuit shall be as follows:

Phase 1 R – Red

Phase 2 Y – Yellow

Phase 3 B – Blue

Neutral – Black

Grounding - Green with yellow stripes.

Wire colors for small wiring shall be as follows:

Color of Wire and Circuit Particulars

- | | | |
|--------|---|--|
| Red | - | Red-phase connections in current and voltage transformer circuit only. |
| Yellow | - | Yellow-phase connections in current and voltage transformer circuit only. |
| Blue | - | Blue-phase connection in current and voltage transformer circuit only. |
| Green | - | Connection to earth. With yellow stripes |
| Black | - | A.C. neutral connections, earthed or unearthed, connected to the secondary circuit of current and voltage transformers. Any other AC connection other than those above and colour connection in a.c./d.c. circuit. |
| Grey | - | Connection in d.c. circuit. |

2.32 OIL OR COMPOUND FILLED CHAMBERS

All joints of fabricated oil or compound filled chambers, other than those which have to be broken, shall be welded and care shall be taken to ensure that the chambers are oil-tight. Defective welded joints are not to be caulked but may be re-welded subject to the written approval of the Engineer. Suitable provision shall be made for the expansion of the filling medium in all oil or compound filled chambers and the chambers shall be designed to avoid the trapping of air or gases during the filling process. Design shall permit the temperature of any chamber which shall be compound filled to be raised such that the compound does not solidify during the filling process. All wiring in the vicinity of oil-filled chambers shall be insulated with oil-resisting insulation of approved quality.

2.33 LUBRICATION

The Contract is to include for the supply of flushing oil for each lubrication system when the item of plant is ready for preliminary tests and the first filling of approved lubricants for the commercial operation of the plant.

A schedule of the oils and other lubricants recommended for all components of the Contract Works shall be submitted to the Engineer for approval. The number of different types of lubricants shall be kept to a

minimum. Copies of this schedule shall be included in both the draft and final copies of the operating and maintenance instructions. In the case of grease lubricated roller type bearings for electric motors a lithium based grease is preferred.

Where lubrication is effected by means of grease, preference will be given to a pressure-gun system with a separate nipple to each point. Where necessary for accessibility, the nipple shall be placed at the end of extension piping, and, when a number of such points can be grouped conveniently, the nipples shall be brought to a battery plate mounted in a convenient position. Nipples shall be of the hexagon headed type complying with the standards. The Contractor is to supply at least one grease gun equipment for each type of nipple provided. Where more than one special grease is required, a grease gun for each special type shall be supplied and permanently labeled.

2.34 INTERNAL CLEANING OF PIPES

The Contractor shall be responsible for ensuring that the internal surface of all pipe lines is thoroughly clean both during erection and before the pipe line is placed in commission. The procedure adopted by the Contractor is to include the following: i) Through cleaning of all internal surfaces prior to erection to remove accumulations of dirt, rust, scale etc., and welding slag due to site welding before erection. ii) Through cleaning of all pipe work after erection by blowing thorough to atmosphere to ensure that no extraneous matter is left in the system. The Contractor is to provide all necessary facilities for carrying out these requirements.

2.35 CONDITIONS OF OPERATION

Except where otherwise specified in this contract all materials and equipment shall be suitable for operation at the guaranteed maximum sustained rating throughout all seasons of the year. The highest operating voltage will be 123kV and 24kV. The neutral earthing condition for the system as specified in the bid specification.

2.36 CLIMATE CONDITION

In choosing materials and their finished, due regard shall be give to the climate conditions under which equipment is to work, and the recommendations under which equipment is to work.

2.37 RELIABILITY

All materials and equipment shall be designed for operation on systems where continuity of supply is the prime consideration. They shall also be satisfactory in operation under the atmospheric and climatic conditions prevailing at the site and under such variations of current, voltage and frequency as may be met under fault and surge conditions on the system.

2.38 TYPE APPROVAL

All materials and equipment shall have satisfactorily passed type approval test equal to those required in accordance with the Tests Section of the Specification or equivalent standards. The Contractor shall certify that the materials and equipment offered will be identical in all essential particulars in respect of

design, materials and workmanship with the materials and equipment for which type approval certificates are submitted.

2.39 DESIGN PARTICULARS

All materials and equipment shall comply with design details entered in the Schedule of Particulars and Guarantees hereto and except where otherwise specified, their individual components shall meet the requirement of the relevant IEC Standards. The contractor shall also ensure that all materials used will be subjected to and shall have satisfactorily withstood such tests as are customary in the manufacture of the types of equipment specified. Records of such tests shall be available for inspection, if required by the Engineer.

2.40 OUTER COVERINGS OF CABLES

Unless otherwise specified the cable outer coverings shall be provided in the form of an extruded continuous black PVC sheath which shall meet the requirements IEC standard and the Site Condition Clause. As a protection against termite attack, the outer coverings shall preferably contain an evenly dispersed mixture of aldrin and dieldrin in the ratio of 0.25 per cent aldrin and 0.25 per cent dieldrin by weight of PVC, or another suitable termite deterrent which shall be stated in the Bid for approval by the Engineer. The Contractor shall state in his Bid and on the cable test certificate the amounts of insecticide added. The Engineer reserves the right to select samples of such outer coverings for analysis to check the quantities added. The PVC outer covering of 20 kV cables shall have been subjected to abrasion, penetration and saline bath tests in accordance with BS 480/1966 during the type approval program of tests and approved. If there is any damage to the outer covering which in the opinion of the Engineer, appears to be repairable, the Contractor may, after receiving agreement, attempt to effect repair by an approved method. The agreement to attempt repair shall not bind the Engineer to accept the repaired cable length when it is re-offered for inspection and test.

2.41 CABLE LENGTH

Where applicable, cables shall be supplied in maximum drum lengths bearing in mind the transport limitations in gaining access to the site. No drum shall contain more than one length.

2.42 CABLE DRUMS

Cable drums shall be non-returnable and shall be made of timber, pressure impregnated against fungal and insect attack, or made of steel suitably protected against corrosion. They shall be lagged with closely fitting battens in accordance with IEC standard. Each cable drum shall bear a distinguishing number on the outside of one flange. Particulars of the cable, i.e. voltage, conductor size and material, number of cores, type, length, gross and net weights shall also be clearly shown on one flange. The direction of rolling shall be indicated by an arrow on both flanges. The method of drum marking shall be to the Engineer's approval. Cable maintenance lengths and spare lengths shall be wound onto steel-drums before they are handed over to the Employer's stores.

2.43 SPARE CABLE

In addition to the cable maintenance lengths supplied against the Schedule of Spares the Employer will have the option to purchase from the Contractor at the rates stated in the Schedules any spare cut lengths of cable for future maintenance purposes. Brass or other approved sealing caps of the correct size shall be supplied and fitted for all spare cut lengths of cable exceeding 10 meters in length to enable them to be properly stored for future maintenance purpose. The Contractor shall be responsible for the immediate sealing of such cut lengths and the cost thereof shall be deemed to be included in the Contract Price.

2.44 SPECIAL TOOLS

Special tools if ordered may be used for the purpose of the installation. After the taking over of the installation, they shall be re-conditioned if necessary and handed over to the Employer's stores. Prices shall be quoted in the appropriate Schedule for the supply of any Special Tools and Appliances considered necessary for the cable installation and maintenance

2.45 JOINTING ACCESSORIES

Cables shall be installed in maximum possible lengths and straight through jointing between shorter lengths will not be permitted without the prior written authority of the Engineer.

Jointing accessories shall include all necessary internal and external fittings, insulating materials, soldering and plumbing metal, plumbing glands, filling and drain plugs, armour clamps, earth bonding terminals and filling compounds. Compression type sealing glands are not permitted for use with paper insulated lead sheathed cables of any voltage.

Aluminum sheath temperatures shall be monitored during plumbing by means of a thermocouple. The temperature shall not exceed the temperature stated in the Schedule of Particulars and Guarantees.

Glands for the termination of all solid dielectric cables shall be of the compression type and shall be designed to Secure the amour or metallic layer wires and to provide electrical continuity between the armor and the threaded fixing component of the gland and to provide watertight seals between the cable outer sheath and gland and between the inner sheath and threaded fixing component. The glands shall preferably project 10 mm above the gland plate to avoid entry of moisture. Compression glands shall meet the requirements of BS6121 and shall be fitted with a substantial earth bond terminal. Where insulated entry compression glands are required to provide an insulating barrier on single core cables installed in a single point bonding system, the gland insulation shall be capable of withstanding a dry high voltage test of 10 kV d.c. for one minute. Sealing end porcelains shall be free from defects and thoroughly vitrified so that the glaze is not depended upon for insulation. The glaze shall be smooth and hard, completely cover all exposed parts of the porcelain and for outdoor types shall be a uniform shade of brown.

Porcelains must not engage directly with hard metals and, where necessary, gaskets shall be interposed between the porcelain and the fittings. All porcelain clamping surfaces in contact with gaskets shall be accurately ground and free from glaze.

Outdoor sealing ends and fittings shall be unaffected by atmospheric conditions, proximity to the coast, fumes, ozone, acids, alkalis, dust or rapid changes of air temperature between 15°C and 65°C under working conditions. The minimum creep age distances phase to ground of outdoor sealing end porcelains shall be in accordance with clause "Particulars of System".

Sealing end supporting structures shall be constructed of galvanized steel and their design shall be subject to the written approval of the Engineer.

The concrete foundation design shall, where necessary, incorporate a curved slot having a radius not less than the minimum bending radius of the cable, to allow the cable to enter the ground within the confines of the structure and its foundations. The minimum height above ground of the sealing end supporting structures shall be 2.44 meters.

2.46 CABLE JOINTING INSTRUCTIONS AND DRAWINGS

Copies of the instructions for the jointing of each type of cable terminating and jointing accessories supplied shall be submitted to the Engineer and the Employer for approval before any work is commenced at site. One copy of each instruction shall be bound into each copy of the Operating and Maintenance Instructions to be supplied to the Engineer and the Employer at the completion of the Contract for the use of the Employer. Drawings submitted by the Contractor for approval by the Engineer shall comply with specified requirements. "As erected" drawings of cable routes shall be drawn to a scale of 1/500. The route shall be dimensioned in such manner that it may be used for pinpointing accurately the cables in the future. All drawings shall be submitted for approval within the six months following the issue of the Taking-Over certificate.

2.47 CURRENT AND VOLTAGE TRANSFORMERS

Current and voltage transformers are to comply with IEC-60044-2 and IEC-60186 as appropriate. They are to be housed or accommodated to suit their particular duties specified elsewhere and are to comply with other relevant clauses of this Specification as regards rating, class etc. Secondary windings are to be wired to suitable terminal boards and earthed at one point in the circuit.

All current and voltage transformers are to be provided with an identifying label giving type, ratio, class, output and serial number. All current transformers are to have sufficient overload capacity to permit continuous operation with currents up to 120 % of rated current.

2.48 GAUGE CUBICLES AND PANELS

Gauges and instruments shall be grouped whenever possible and housed in suitable cubicles. Where circumstances do not justify cubicle accommodation, they may be secured to flat back panels but in such cases the approval of the Engineer is first to be obtained.

Cubicles shall be of sheet metal construction having a minimum thickness of 2 mm. The construction shall employ folding techniques with the use of standard rolled sections or other reinforcement where necessary. The stiffness shall be such as to prevent mal operation of relays or other apparatus by impact. The front of the panel is to have a smooth well finished surface and, if of the "desk" type, the desk is not to protrude so far as to hinder the easy reading of instruments and the operation of the controls.

2.49 GAS OIL AND COMPOUND

The Contractor shall supply the first filling of all gas, oil and compound required for the operation of the Plant. It shall be of the appropriate grade for operating conditions at Site.

2.50 CABLE TERMINATIONS

i) Cable Boxes – General

Provision shall be made for earthing the body of each cable box. Where cable boxes are provided for 3-core cables the sweating sockets on the outer phases shall be inclined towards the center to minimize bending of the cable cores.

ii) Compound Filled Cable Boxes

Compound filled cable boxes are to comply with BS.2652 Part 1 for voltages of 11 kV and below and Part 2 for voltages above 11 kV and up to and including 150 kV.

iii) Glands for Paper Insulated Cables

Paper insulated, lead covered and wire armored cables shall be fitted with universal tapered brass glands, with combined armor and earthing clamps. Glands for single core cable shall be insulated from the box. The insulation is to include a metallic "island" layer for testing purposes. In addition, removable connectors for bonding across the gland insulation shall be provided. The gland insulation shall be capable of withstanding a dry high voltage test of 2 kV RMS AC for one minute.

iv) Compression Glands for Solid Dielectric, Power and Multi-core Control Cables

Compression type glands with armor and bonding clamps for the termination of all solid dielectric multi-core cables shall be designed to secure the armor wires to provide electrical continuity between the armor and threaded fixing component of the gland and to provide watertight seals between the cable outer sheath and gland and between the inner sheath and threaded fixing component.

2.51 TERMINAL BOARDS

All terminals shall be mounted in accessible positions. Adjacent terminals shall be adequately spaced to each other and to the incoming cable gland plate. Separate studs shall be provided on each terminal strip for the cores of incoming and outgoing cables including all spare cores.

Acceptable types of terminal are:

- i) Screw or stud type used with crimped ring type termination Screws and studs shall be of not less than size M6 but stainless steel and bronze down to size M5 may be used provided that the current carrying capacity is adequate. All studs shall be provided with nuts, washers and lock washers.

ii) Insertion clamp type whereby the standard conductor or crimped termination is clamped between plates by a screw having a suitable locking device. Terminal entries shall be shrouded such that no current carrying metal is exposed. Tapped holes are to have not less than three full threads. Screws shall be of plated steel, stainless steel or phosphor bronze and size M3 or M4.

Terminal assemblies are preferably to be of the unit form suitable for mounting collectively on a standard assembly rail, secured from the front and giving the required number of ways plus ten percent spare with a minimum of three.

400/230V circuit terminals shall be segregated from other terminals and shall be fitted with non-flammable plastic covers to prevent contact with any live parts. They are to have warning labels, with red lettering, mounted thereon in a conspicuous position. All connections shall be made at the front of the terminal boards and no live metal shall be exposed at the back.

2.52 MINIATURE CIRCUIT BREAKERS, FUSES AND LINKS

Facilities shall be provided for protection and isolation of circuits associated with protection, control and instruments. They shall be of approved type and grouped, as far as possible, according to their functions. They shall be clearly labeled, both on the panels and the associated wiring diagrams. Facilities shall be provided to enable the control circuits for any circuit breaker to be individually isolated for maintenance purposes. Facilities for protection and isolation of control and tripping circuits are preferably to be mounted on the outside of control panels. All fuses are to incorporate HRC cartridges to IEC 60269. Miniature circuit breakers are to comply with BS.3871 Part 1 or other relevant standard. Spare fuses shall be supplied as 100% of the number and size of each type used with a minimum of 6 (six).

2.53 SYSTEM CONTROL CENTRE FACILITIES

General

In order to provide the tele control facilities required at the Load Dispatch Centre (LDC), the following provisions shall be made under this Contract.

All plant supplied under this Contract shall be equipped with potential free auxiliary contacts for indications and alarms. CT and VT circuits shall be fitted, where required with the appropriate shorting and fused terminals to add auxiliary CTs and VTs respectively for transducers supplied under a separate contract.

Provision shall be made for the future installation of interposing relays for supervisory control functions. Floor mounted substation plant tele-control equipment marshalling kiosks shall be provided to form an interface between the plant supplied on the Contract and the tele control equipment.

All necessary wiring and cabling from the plant control and relay panels into the tele control marshalling kiosks shall be provided under the contract. Cabling between the marshalling kiosks and the tele control equipment will form part of separate contract.

The plant/tele control equipment interface cubicle shall be located adjacent to the relay panels in order to keep cable runs to a minimum.

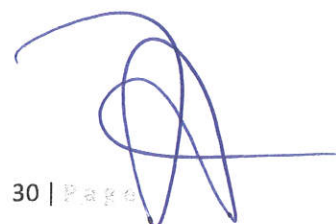
The cubicles shall be of similar construction to relay cubicles, both in size and color. The doors shall be lockable.

Removable gland plates shall be provided for the cables from the control and relay panels and for the outgoing cables to the tele control equipment.



2.3: TECHNICAL SPECIFICATION

- 1 STEEL STRUCTURES
- 2 CIRCUIT BREAKERS
- 3 DISCONNECTING AND EARTHING SWITCHES
- 4 CURRENT TRANSFORMERS
- 5 VOLTAGE TRANSFORMERS
- 6 SURGE ARRESTERS
- 7 GLASS OR CERAMIC INSULATORS
- 8 CONDUCTORS AND HARDWARE
- 9 20kV SWITCHGEARS WITH PANELS
- 10 CONTROL AND PROTECTION EQUIPMENT
- 11 NUMERICAL RELAYS
- 12 20kV CABLE AND ACCESSORIES
- 13 LOW VOLTAGE AC SUPPLY
- 14 DC SUPPLY
- 15 STATION SERVICE TRANSFORMER
- 16 SUBSTATION EARTHING SYSTEM
- 17 MINIMUM ACCEPTABLE SITE TESTS AND COMMISSIONING



1. STEEL STRUCTURES

1. GENERAL

Steel structures shall be provided under this Contract for supporting the insulators, switchgear, overhead conductors, bus bars, earth wires, and other equipment and fittings generally as shown on the drawings, and have to be designed and erected according to the relevant international recognized standards.

Existing substations to be extended have gantry steel structures of lattice tower (column) and girder (beam) construction. Extensions with similar steel work are preferred. A price shall be included for a design closely resembling the existing arrangement of the Bidder's manufacture. Drawings of the Bidder's design are to be submitted with the bid.

The structures shall include all necessary access ladders to give access to the various levels of the high-level equipment and shall incorporate all necessary screens to comply with the requirements of insulation levels and minimum clearances.

Step, ladders, handrails, guards and other facilities shall be provided on the inside of the columns near the junction of the beam and column, to facilitate safe inspection and maintenance for the structures. Step bolts are not acceptable for the steel structures.

If necessary, the gantry structures of the existing substations subject to uprating shall be checked by the Contractor and replaced or reinforced in order to correspond to the new short circuit conditions.

The design and arrangement of supporting structures shall be subject to approval by the Owner/Engineer. The structures shall be rigid and self-bracing against all dead, wind, pull-off and other applied loads. Wherever such an arrangement can be adopted, structures shall be braced by horizontal beams at intermediate or high level to provide an integrated framework. At or near ground level, all uprights shall be provided with holding down bolts provided under this Contract.

The rigidity of the structures shall be such that the alignment of the apparatus which they carry shall not be disturbed by the loads to which the structures are subjected.

Bus bar

Dead end structures shall be designed so as to be suitable for future bus bar extension.

2. DESIGN

All structures shall be designed so that no failure or permanent distortion shall occur when tested with applied forces equal to 2.5 times the maximum simultaneous working loads.

The maximum allowable stresses in tensile members shall be such as to give a factor of safety of not less than 2.5 on the elastic limit strength.

Contractor should design the steel structure considering the applied conductor tension and sag for the condition, that at the highest operating temperature of conductor (i.e 90°C for ACSR and AAC) the maximum sag of conductor is 3 percent.

Bolts and nuts shall be fitted with spring washers. Taper washers are to be added where necessary.

Threads of bolts shall be spun galvanized and the threads of nuts shall be greased. The diameter of bolts

and nuts which are mechanically stressed shall not be less than 12 mm and shall have metric screw threads. Nuts and heads of all bolts shall be of the hexagonal type. Minimum quality of for bolt shall be in accordance to the respective standards (5.6 of DIN 267).

Bolt holes are not to be more than 1.5 mm larger in diameter than the corresponding bolt diameter. The design is to be such as to keep the number of different parts as small as possible and is to facilitate transport, erection and inspection.

3. DEFORMATION – DEFLECTION CONDITIONS

Under permanent loads and with normal wind but with no short-circuit and no earthquake, deformations are never higher than the following values:

- Beam: vertically: 1/200 of the span

Horizontally: 1/200 of the span

- Column: 1/150 of the height in both directions measured at the level of the horizontal axis of the beam.

4. MATERIAL

Material for steel members and plates of towers shall be of the type and grade most suitable for the application intended and shall conform to the latest applicable standard, specifications and recommended practices of the industry. The quality of steel to be used for the fabrication on the towers shall at least correspond to SS400 and SS540 according to JIS G 3101. The steel to be used shall be of a quality that will not have its physical properties changed or become embrittled by hot dip galvanizing.

All material shall be tested at the steel mill in accordance with applicable specification and standards under which they are manufactured. The contractor shall apply all certified mill tests. Test shall be conducted in accordance with ASTM A 370. The test to be conducted shall include, but are not limited to uniformity of galvanizing coating, mechanical and chemical properties of all steel and additional embitterment testing on high strength steel.

High tensile steel, when stores in the fabricators stockyard prior to fabrication and galvanizing, shall be marked continuously throughout its length with a light blue water paint line. In addition the grade number of the steel shall be painted on and ringed round with paint.

The steel shall be free from blisters, scale and other defects.

Main members and bracings of lattice structures shall be not less than 6 mm and 5 mm thick respectively.

5. CONSTRUCTION

The compression members of steel structures shall consists of rolled steel sections and the tension members of rolled steel sections or flats.

All members shall be stamped or marked for erection purposes as specified.

All members shall be stamped or marked in an approved manner with numbers and/or letters corresponding to number and/or letter on the drawings or material lists. Drawings and material lists shall

be submitted to the Engineer for approval. The erection marks if stamped, shall be stamped before galvanizing and shall be clearly visible after galvanizing.

Pockets and depressions likely to hold water shall be avoided and all parts of the structures shall be properly drained.

Where overhead transmission lines are terminated at the substation structures, landing plates welded to the structures shall be provided for reception of the transmission line insulator fittings and earth wire clamps which will be supplied and fitted under other Contracts.

Special care shall be taken not to injure the skin on galvanized or special treated surface during erection. Care shall be taken to prevent or remove any white rust, streaks or foreign matter deposited on galvanized surfaces during storing or transport or after erection.

Approved means shall be provided for fixing and bonding copper conductors to the steel work at sufficient points to obtain efficient earthing. Earth connection shall be made to a vertical face, clear of the ground. Foundation bolts shall not be used for their attachment.

To facilitates inspection and maintenance the structures shall be provided with steps, ladders, handrails, screens, guards and other facilities. Step bolts are not acceptable for substations structures

6. WORKMANSHIP

All members shall be cut to jig and 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 can be accurately aligned before being bolted up. Drifting or reaming of holes will not be permitted. All burrs shall be removed before galvanizing.

The drilling, punching, cutting, bending and welding of all fabricated steelwork shall be carried out before galvanizing and shall be such as to prevent possibility of irregularity occurring which might cause any difficulties in the erection of steel structures on the site.

Except where specified to the contrary, all iron and steel used in the construction of the work shall be galvanized.

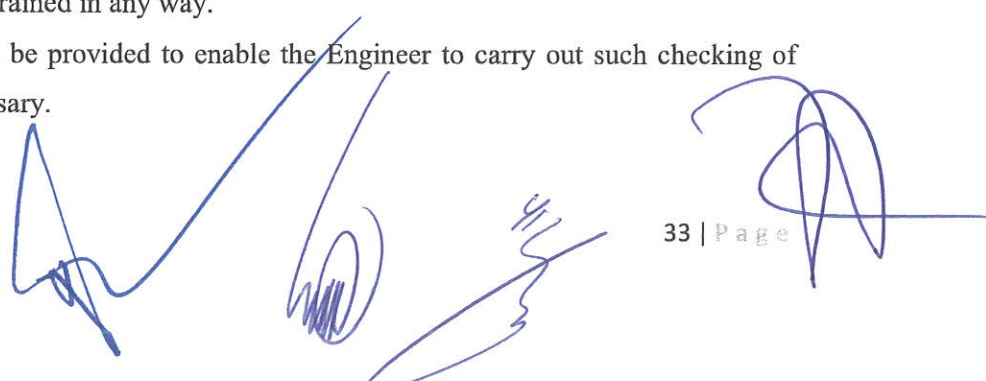
Galvanizing shall be applied by the hot dip process for all parts according with ASTM A-123, A-143 and A-153 shall be applied by the hot dip process and shall consist of a suitable thickness of zinc coating of not less than 610 grams of a zinc per square meter of surface.

The zinc coating shall be smooth, clean and of uniform thickness and free from defects. The preparation for galvanizing itself shall not adversely affect the mechanical properties of the coated materials.

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.

Steel gauges of the stud type shall be provided to enable the Engineer to carry out such checking of members as he may consider necessary.

7. OTHER MATERIALS



(1) General

All construction materials such as conduit, steel angles, steel channels, steel plate, bolts, nuts and other related items required for operation shall be provided without extra charge and shall comply with the highest grade requirements of relevant standards.

(2) Lighting fixtures

(a) LED Luminaries substituting High pressure mercury vapor Lamp 230 V, 300 W, 50 Hz, Single phase shall be mounted on the Steel structure with adequate fittings.

(b) Daylight switch (photoelectric automatic switching) 230 V, 6 A, 50 Hz, single phase.

(c) Magnet switch, 230 V, 50 A, 3-phase

(d) LED based Emergency lighting to substitute 230 V, 20 W x 2, fluorescent lamps is to be provided to inverter circuit

(e) Power distribution box. Outdoor use for housing of (b) (c) and required number of switches/wiring, to be fixed on a steel structure column. The Contractor shall submit to the Employer design drawing of item (e) for approval. Road and fence outside perimeter lighting fittings amounted on suitable columns shall be supplied and erected to give a general level of illumination of 5 lux. Special attention shall be given to access and building gates.

(3) Number Plate and Danger Plate for connection Line tower to Switchyard The number plate indicates tower number, phases and earthing resistance, and the danger plate is used for calling caution. Both the number and the danger plates shall be fixed to the tower with bolts.

The number plate and danger plate shall be supplied by the Contractor in a finished form, together with zinc coated steel bolts and nuts of 10 mm in a diameter for fixing these to the tower member. The bolt holes on tower member for fixing these plates will be instructed by the Engineer when returning the approval drawings of tower. The Contractor shall provide one (1) number plate and two (2) danger plates each for a tower.

8. TESTS

The following tests shall be carried out before shipment according to ASTM A370

(a) Mechanical strength of materials

(b) Galvanizing test (c) Shop assembly

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2. CIRCUIT BREAKERS

1. CODES AND STANDARDS

Circuit - breakers shall conform to the following standards as to material, design and tests, except as modified in this specification:

- IEC 60060-1: High-Voltage Test Techniques – Part 1: General Definitions and test requirements.
- IEC 60376: Specification of technical grade Sulphur Hexafluoride (SF6) for use in electrical equipment. u IEC 60815-1: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles
- IEC 60815-2: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 2: Ceramics and glass insulators for a.c. systems
- IEC 62155: Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V
- IEC 62271-1: High Voltage Switchgear and Control gear. Part 1: Common Specifications.
- IEC 62271-100: High Voltage Switchgear and Control gear. Part 100: High Voltage Alternating Current Circuit Breaker.
- IEC 62271-300: High Voltage Switchgear and Control gear. Part 300: Seismic Qualification of Alternating Current Circuit Breaker
- IEC 62371: Characteristics of hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V

2. GENERAL

The circuit-breakers shall be of the SF6, outdoor, single-pole and single-break unit per pole type.

The manufacturer shall guarantee the maximum value of over-voltage as high as 1,5 p.u. without restrikes.

Circuit-breakers shall be capable of interrupting their circuits for the duty cycle specified. They shall be substantially in the same mechanical and electrical condition at the termination as at the beginning of the specified duty cycle, shall have not emitted flame, oil or given other indications of failure.

Circuit-breakers shall be capable of interrupting their rated interrupting current within the specified time after the tripping coil has been energized.

The line circuit-breakers shall be suitable for single and three phase multiple rapid auto-reclosing (0.3s).

The bus-coupler and transformer circuit-breakers shall not be equipped with automatic reclosing and shall be mechanically linked to avoid any single-phase operation.

All circuit-breakers shall be able to perform an O - CO switching cycle when the auxiliary voltage is lost.

The rupturing capacity of the circuit-breakers after unsuccessful auto-reclosing should not fall below the minimum required rated breaking capacity.

The main high-voltage current carrying parts shall be able to carry the rated current continuously and the temperature rise of the main high-voltage current carrying parts, auxiliary circuits and devices shall be limited as specified in IEC 62271, however, the reference ambient- temperature shall be maximum 45 degree Celcius.

Full contact and current carrying capacity shall be maintained during reasonable over-travel and under travel of the mechanism.

All main high-voltage current carrying parts and supporting insulators shall be capable to withstand successfully without damage or injurious distortion the specified short-circuit currents for the time duration specified.

The circuit-breakers shall be designed on the buffer principle i.e. the complete installation shall employ the single-pressure principle or an equivalent design.

The contacts shall be of self-wiping and self-cleaning type.

All circuit breakers shall be of the trip-free type. Care must be taken to prevent any pumping. Should the breaker either fail to latch or should it trip during closing, due to malfunction of the protective relays, adequate measures to prevent pumping shall be taken.

The circuit breakers shall be suitable for at least 10.000 satisfactory open and close mechanical operations in accordance with IEC 62271-100.

The circuit-breaker shall be equipped with a temperature balanced remote and local SF6 gas monitoring system with two stages, indicating early the necessity of replenishing and blocking the breaker on the excessive pressure-drop. SF6 gas density monitors shall be installed on each pole. All devices required for fail-safe operation during condition of low gas pressure shall be provided.

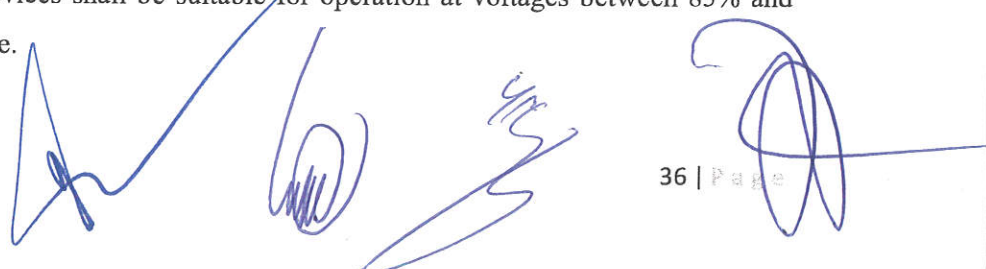
Replenishing of gas shall be possible while the circuit breaker is in service.

All circuit breakers shall be designed for closing and tripping by remote and local electrical controls. Local electrical control shall be from the outdoor control cubicle by means of a local "CLOSE" - "TRIP" control switch. The control location shall be selected by a "LOCAL"-"REMOTE" transfer switch provided within the outdoor control cubicle. The "LOCAL" operation shall be possible only during breaker maintenance, when the associated disconnecting switches are open. When the switch is under local control, this shall be indicated in the control room.

Each pole shall have a mechanical position indicator. The device shall be labelled "ON" and "OFF" and shall be clearly visible.

Operation of the breaker shall be actuated by two independent tripping coils and one closing coil. The trip circuits shall be duplicated and automatically supervised.

All electrically operated closing devices shall be suitable for operation at voltages between 85% and 110% of the nominal control voltage.

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The tripping devices shall be suitable for operation at voltages between 70% and 110% of the nominal control voltage.

Circuit breakers shall be equipped for phase discrepancy detection.

All circuit breakers shall have a sufficient number of auxiliary contacts, which shall be capable of carrying at least 10A continuously and be easily convertible from normally-open to normally-closed or vice-versa for annunciation locally and to the control room and for all necessary interlocks.

Breaker tripping must be indicated by a switch-discrepancy contact, made up of two signaling contacts. All contacts even if not used shall be wired up to the terminal blocks ready for connection to external equipment.

All circuit-breakers of the same rating and service shall be physically and functionally interchangeable. For refilling purposes, portable SF6 gas bottles including all required accessories shall be furnished.

3. RATING

The rating of circuit breakers shall comply with Technical Particular and Guarantee (TPG) attached in Bidding Document – Part 1.

Circuit-breakers shall meet the Transient Recovery Voltage requirements specified in IEC 62271 Standard (representation by four parameters) for the rated short circuit conditions.

Rated line-charging breaking current and rated cable-charging breaking currents shall be as specified in IEC 62271 Standard.

4. INSULATING MEDIUM

Circuit-breakers shall be of the SF6 single-pressure type.

Circuit-breakers shall be provided with means to ensure that moisture content, arc products and contaminants are retained and filtered to prevent loss of dielectric or internal condensation on insulating medium.

The nominal operating pressure of the SF6 insulating gas shall be as low as is compatible with the requirements for electrical insulation and space limitations to ensure there is no chance of the gas liquefying at the lowest ambient temperature.

5. SPRING CHARGED OPERATING MECHANISM

Circuit breaker operating mechanisms shall be the spring- spring type. The operating mechanism type offered shall have accumulated failure-free references at a sufficient number of circuit breakers and for at least three years in operation under similar climatic conditions. The Bidder shall give the reason for his choice.

The circuit-breaker's operating mechanism shall be capable of storing energy to perform at least three complete closing and tripping operations, without recharging.

Power closing mechanisms shall be recharged automatically for further operations as soon as the circuit-breaker has completed the closing operation.

The design of the closing mechanism shall be such that the circuit-breaker cannot be operated inadvertently due to external shock forces resulting from short-circuit, circuit-breaker operation, vibration or any other causes.

A manually operated emergency tripping device per pole shall be provided as part of the mechanism. The emergency tripping device shall be protected against accidental operation and capable of tripping the circuit-breaker during a complete loss of the AC and DC auxiliary supply.

The circuit-breaker shall be provided with indicators or targets for each operating mechanism. They shall be located so that the position of the poles, whether open or closed can easily be determined. The mechanism shall be trip free as defined in IEC Standard.

The motor device for drive mechanism shall be operated at 230 V AC.

If a circuit-breaker closing mechanism is not fully recharged for further operation within a predetermined time after a closing cycle, the mechanism shall be locked out and alarm initiated.

Each part of the operating mechanisms shall be of substantial construction utilizing such materials as stainless steel, brass or gunmetal where necessary to prevent sticking due to rust or corrosion.

If not maintenance-free the maintenance period of the driving mechanism must not be shorter than that of the circuit breaker itself.

The spring mechanism shall be fully charged before it can be released to close the circuit-breaker. It shall not be possible for the breaker to close whilst the spring is being charged.

The mechanism shall be provided with means for charging the spring by hand. This operation may be carried out with the doors of the cubicle opened. During this process no electrical or mechanical operation of the mechanism shall endanger the operator, or damage the equipment.

A mechanical indicating device shall be provided to indicate the state of charge of spring and shall also be visible with the doors of the cubicle closed.

An alarm shall be provided at the local control panel and in the control room to indicate a spring failing to be charged a pre-set time after circuit-breaker closing.

The spring mechanism shall be fitted with a manual release, preferably by a local push button shrouded to avoid inadvertent operation.

Means shall be provided for discharging the spring when the circuit-breaker is in the open position without the circuit-breaker attempting to close.

6. OPERATING CUBICLE

The cubicle enclosing the operating mechanism shall accommodate the auxiliary contacts, the shunt tripping coils for "ON" and "OFF" operation, the terminal block and control device for electrical or mechanical local operation of the circuit-breaker.

Cubicles shall be of rigid, hot dip galvanized, preferably folded but alternatively formed on a framework of standard rolled steel sections and shall include any supporting steelwork necessary for mounting on the circuit breaker.

The cubicle shall be vermin proof, weatherproof and well ventilated through louvers comprising a brass gauze screen attached to a frame and secured to inside of the cubicle. Divisions between compartments within the cubicle shall be perforated to assist air circulation.

Doors shall be rigid and fitted with waterproof sealing material suitable for the climatic conditions specified and with proper locking devices.

Access door or panels shall be glazed where necessary to enable instruments to be viewed without opening the cubicle. The arrangement of equipment within the cubicle shall be such that access for maintenance or removal of any item shall be possible with the minimum disturbance of associated apparatus.

A copper earth busbar shall be provided with tapped holes and screws and shall be connected to the earthing system.

A heating element for 230 V AC must be installed to avoid moisture in the circuit breaker cubicle. The heating element shall be temperature controlled, however a by-pass switch shall enable continuous heating.

Interior lighting operated from a door switch shall be provided within each cubicle assembly. Lamps shall be 230 V with bayonet base.

A 230 V AC, 10 A a single-phase standard power outlet along with its approved fuse to fit standard prong-plug shall be installed inside each cubicle assembly.

An approved schematic diagram of the local control system of the circuit breaker, identifying the various components within the cubicle and on the circuit breaker and referring to the appropriate drawings and maintenance instructions, shall be affixed to the inside of the cubicle access door. The diagram shall be marked on durable non-fading material suitable for the specified site conditions.

7. WIRING

All wires shall be identified at both ends according to the interconnection diagrams.

Wiring between terminals of various devices shall be point-to-point, no splicing or "T" connection shall be allowed. All internal wiring shall be neatly trunked in wiring troughs.

All groups of bundled conductors to hinged doors and panels shall use extra flexible wire arranged so that a twisting rather than a bending motion is imparted to the moving conductor bundle.

Terminal blocks shall be arranged with sufficient space for easy connections of incoming cables. Parallel rows of terminal blocks shall be spaced at least 15 cm apart. At least 20% spare terminals shall be provided in each block. Terminal studs and wires shall be numbered or otherwise marked in accordance with applicable schematic and wiring diagrams.

The DC power supply to the circuit-breaker tripping coils and the control circuit wiring shall be provided with shielded cables, like type NYCY, and all other measures of protection shall be taken in order to minimize the hazard of damage to these cables and subsequent failing of control voltage.

Auxiliary circuits shall be capable of carrying at least 10 A continuously.

8. INSTALLATION SUPERVISION

During erection, test and commissioning at site, the manufacturer's expert engineer shall supervise the work.

9. TESTING

Type test certificates or Type Test Report for the specified equipment shall be issued by an approved internationally acknowledged, reputable, independent testing laboratory as attached at Appendix-1.

9.1. Type Tests

The circuit-breaker type offered shall have passed the type tests in accordance with IEC 62271-100.

9.2. Routine Tests

Circuit-breakers of each type ordered under the contract shall be fully assembled at the manufacturer's works and subjected to routine tests in accordance with IEC 62271-100.

10. ACCESSORIES

The following items shall be provided for the circuit breaker:

- a. Name plate
- b. Position indicating signal lamp
- c. 10-stage auxiliary switch for position indication and interlocking
- d. Counter to record the number of operation
- e. Primary terminal connectors
- f. Grounding terminal(s)
- g. Supporting structure with anchor bolts and nuts
- h. SF6 gas for first filling
- i. SF6 gas leakage detector
- j. Mounting bolts and nuts
- k. Primary terminal connecting clamps, connectors, jumpers and necessary material for connection to conductors (busbar) and other equipment
- l. Other necessary accessories, even if specified elsewhere in the Bid Documents or not expressly specified but required for a continuous reliable operation.



3. DISCONNECTING AND EARTHING SWITCHES

1. CODES AND STANDARDS

Disconnecting and earthing switches shall comply with the requirements of the following standards, except as modified in this specification:

IEC 60060-1: High-Voltage Test Techniques – Part 1: General Definitions and test requirements.

IEC 60815-1: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles

IEC 60815-2: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 2: Ceramics and glass insulators for A.C systems

IEC 62155: Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V

IEC 62271-1: High Voltage Switchgear and Control gear. Part 1: Common Specifications.

IEC 62271-102: High Voltage Switchgear and Control gear. Part 102: Alternating Current Disconnectors and Earthing Switches.

IEC 62371: Characteristics of hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V

2. GENERAL

Disconnecting-switches (disconnectors) shall be outdoor, single--phase, two-column, rotary, single-throw, horizontal center-break type, motor and manually operated.

One three-phase disconnecting-switch shall consist of three units of single-phase disconnecting switches. They shall be completed with supporting steelwork and installed to permit easy maintenance and shall be so located that the minimum safety clearances are always maintained.

The single-phase disconnectors shall be mounted on three separate steel supports but operated three-phase by a common motor-operated mechanism. The disconnector poles must be so coupled as to ensure synchronism of the switching motions under all conditions.

All contact arms shall be in positive continuous control throughout the entire cycle of and in angular synchronization during the closing and opening operation. The disconnectors shall be of the slow acting type.

Disconnectors shall be designed for the specified rated currents. The contacts shall carry their rated load currents without overheating or welding. They shall be suitable for off-load isolation at the maximum permissible continuous operating voltage.

Full contact and current carrying capacity shall be maintained during reasonable over travel and under travel of the mechanism.

All main high-voltage current carrying parts and the supporting insulators shall be capable to withstand successfully without damage or injurious distortion, the short-circuit current for the time duration specified (refer to TPG). The use of stranded wire connections bridging the movable links are not allowed.

Main contacts shall be of the high pressure line type and arcing contacts, if provided, shall be subjected to the DABS/Engineer's approval.

Service conditions require that the disconnectors shall remain alive and in continuous service for periods of up to two years in the climatic conditions specified, even without operation or maintenance.

The Disconnecting Switches shall be suitable for at least 2000 operating cycles, satisfactory open and close mechanical operations in accordance with class M1 IEC 62271-102.

All line disconnectors shall be fitted with approved three-phase line earthing switches.

The line disconnectors shall be interlocked also with their associated earthing switch in such a manner as to allow the disconnectors to be closed only if the earthing switch is open and to allow the earthing switch to be closed only if the disconnector is open.

The earthing switch, when in the closed position, shall be capable of carrying the rated short time current for the specified time duration without the contacts burning or welding. The position of the earthing switch shall be indicated by a reliable indicating device.

In order to prevent the possibility of making or breaking load current, bus bar disconnectors, line disconnectors and transformer disconnectors shall be interlocked with the circuit-breaker of the respective bay so that the disconnectors can be closed or opened only if the circuit-breaker is open.

Disconnectors and earthing switches shall have the sufficient number of auxiliary contacts for the control circuits, which shall easily be convertible from normally closed to normally-open and vice-versa.

3. RATING

The rating of disconnectors shall comply with the Technical Particular Guarantee.

4. OPERATING MECHANISM

Each disconnector and earthing switch shall be three-phase group-operated, by an AC motor-driven mechanism.

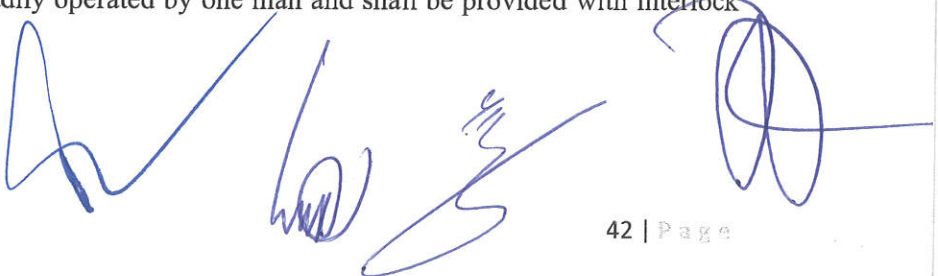
Disconnector operating mechanisms shall be of robust construction, carefully fitted to ensure free action and shall be unaffected by the climatic conditions at site. Mechanisms shall be as simple as possible and comprise a minimum of bearing and wearing parts. Approved grease lubricating devices shall be fitted to all principal bearings.

Each rotating insulator rod shall be provided with weatherproof type, sealed, ball or roller bearing.

All pin, sert screw and washers shall be of non-corroding material.

Operating rods shall be equipped with weatherproof ball or roller bearings or with brass bearings in order to avoid corrosion.

Mechanisms shall be designed to be readily operated by one man and shall be provided with interlock and auxiliary switches as specified.

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Manual operation shall be possible on all disconnectors and earthing switches, from switches located approximately 1 meter above ground. The force to open or close a single-pole or three-pole switch manually shall not exceed 15 kg on a crank not over 1.5 m in length.

The mechanism shall be housed in a weatherproofed enclosure complete with auxiliary switches, terminal blocks, heaters, cable gland plates, cable glands, etc.

All steel and malleable iron parts including the supporting steelwork shall be galvanized as specified.

5. INTERLOCKING FACILITIES

Disconnectors and earthing switches shall be provided with an interlocking system which ensures safe operation of the equipment under all service conditions.

Interlocks shall be effective at the point where hand-power is applied so that stresses cannot be transferred to parts remote from that point.

All electrical interlocks shall so function as to interrupt the operating supply, and an approved system of interlocks shall be provided which shall cover the emergency hand operation of apparatus which is normally power operated. Failure of supply (or its restoration after an outage) or of connections to any electrical interlocks shall not produce or permit faulty operation.

Electrical bolt interlocks shall be energized only when the operating handle of the mechanism is brought to the working position. Visible indication shall be provided to show whether the mechanism is locked or free. Approved means, normally inaccessible shall be provided whereby the bolt can be operated in the emergency of a failure of interlock supplies.

At existing substations where equipment is being extended, interlocking facilities, and associated equipment shall be identical with and form a comprehensive extension to the existing interlocking scheme.

Disconnectors shall be so interlocked that they cannot be operated unless the associated circuit breaker is open.

The interlocking facilities shall allow for the on-load transfer of feeder circuits from one busbar to the other busbar system, i.e. both busbar disconnectors could be closed when the bus coupler is closed.

6. LOCKING FACILITIES

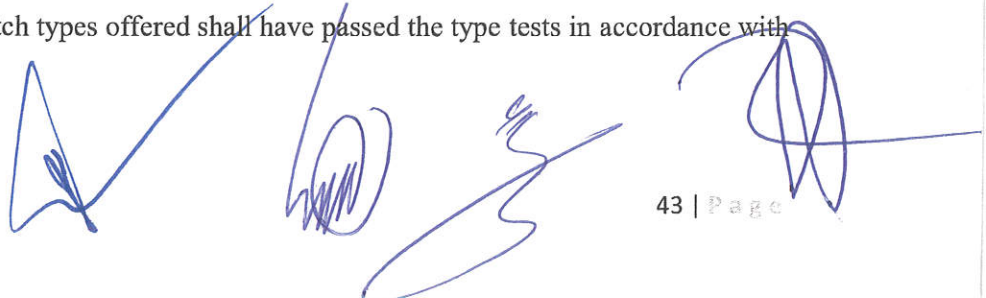
Locking facilities shall be provided on each disconnector.

Provision shall be made at that part of the mechanism where the operating power is applied and not to remote or ancillary linkages.

7. TESTING

7.1. Type Tests

The disconnecting and earthing switch types offered shall have passed the type tests in accordance with IEC Standard.



Type test certificates and Type test report for the specified equipment shall be issued by an approved internationally acknowledged, reputable, independent testing laboratory.

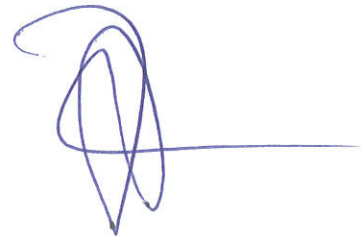
7.2. Routine Tests

Disconnectors shall be subject to routine tests according to IEC 62271-102.

8. ACCESSORIES

The following items shall be provided for each disconnecting and earthing switch:

- a. Name plate.
- b. Primary terminals
- c. Supporting structure with anchor bolts and nuts.
- d. Primary terminals connecting clamps, connectors, and other necessary material for connection to conductors, busbar and other equipment.
- e. Other necessary accessories even if specified elsewhere in the Bid Documents or not expressly specified but required for a continuous reliable operation.



4. CURRENT TRANSFORMERS

1. CODES AND STANDARDS

Current transformers shall conform to the following standards as to material, design and tests:

IEC 60296: Fluids for electro technical applications – Unused mineral insulating oils for transformers and switchgears.

IEC 60815-1: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles

IEC 60815-2: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 2: Ceramics and glass insulators for a.c. systems

IEC 61869-1: Instrument Transformers - Part 1: General requirements for instrument transformers.

IEC 61869-2: Instrument Transformers - Part 2: Additional requirements for current transformers

IEC 62155: Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V

IEC 62271-1: High Voltage Switchgear and Control gear. Part 1: Common Specifications.

IEC 62371: Characteristics of hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V

2. GENERAL

The current transformers shall be outdoor, single-phase, vertically mounted, free standing, oil immersed type, low reactance inverted type, single or multi-turn primary and shall be hermetically sealed.

Each current transformer shall be impregnated and filled with oil of grade as specified in IEC 60296. Oil level indicators shall be provided. Oil volume shall be compensated by using a corrosion-proof metallic bellow.

Current transformers shall be designed for base mounting. The secondary leads shall terminate in a weatherproof junction-box (IP54) mounted on the current transformer base and the secondary leads size shall not be smaller than 4 sqmm.

Primary winding conductors shall have the capacity of the nominal continuous current and short-time current not less than that of the associated switchgears for a duration of one second.

Except where stated in data sheets all current transformers shall have a maximum continuous primary current rating not less than the primary current rating of the bay in which they will be installed.

Star connection and earthing of the current transformer's neutral shall be performed only once for the three-phase group and located at the corresponding outdoor control cubicle.

The secondary windings shall consist of enameled insulated wire and each current transformer secondary winding circuit shall be earthed at only one point. The secondary terminals must never be opened.

Current transformers shall be supplied with the number of cores for metering and protections as specified in the Technical Particular and Guarantee (TPG).

The cores shall be constructed of the highest quality, non-aging, cold-rolled, grain oriented steel especially suitable for the purpose. The steel shall be in thin laminations and each sheet shall have an insulating surface treatment or coating resistant to the action of hot oil.

Magnetization and core-loss curves shall be provided for each type and rating of current transformers. The magnetization characteristic shall be submitted to the DABS for approval.

If the Bidder wishes to provide current transformer ratios differing from those specified he shall first obtain approval in writing from the DABS for each specific instance.

Current transformers for balanced protective schemes including neutral current transformers where appropriate, shall have identical turn's ratio and shall have their magnetization characteristic matched to each other.

The neutral current transformers, if any, shall be of the totally enclosed bushing type, complete with suitable mounting, cable box for secondary connections, etc.

Minimum knee point output voltage of current transformer for distance protection shall be:

$$V_k > I_f (1 + X/R) \times (Z_r + R_{ct} + 2R_l),$$

where I_f is the maximum fault current in secondary term, X/R the primary system ratio, Z_r the relay burden impedance, R_{ct} the current transformer's internal resistance in secondary terms, R_l the lead resistance from current transformer to relay. The lowest ratio of current transformer shall be used for determining I_f in secondary term.

Current transformers provided for protective gear purposes shall have over-current and saturation factors not less than those corresponding to the design short circuit level of the system. The output of each current transformer shall be not less than that specified and the Bidder shall ensure that the capacity of the current transformers provided is adequate for operation of the associated protective devices and instruments.

The Bidder shall provide details of their method of calculating the outputs of the current transformers for each type of protection specified and shall submit calculations for all the current transformers for approval to the DABS.

Separate cables shall be laid from each individual protection core up to the control and protection cubicle.

The screen of the cable connecting the current transformers to the outdoor control cubicle and further to the control and relay cubicle shall firmly be connected at both ends to the substation earthing system.

If double ratio secondary windings are specified, a label shall be provided at the secondary terminals of the current transformer indicating clearly the connection required for either ratio. These connections and the ratio in use shall be shown on the appropriate schematic and connection diagrams.

Where multi-ratios are specified current transformers with multiple windings are offered, it shall be possible to select either ratio for each winding without alteration to the number of primary turns.

Provision for lifting component parts or the complete assembly as required for inspection, handling and erection at site of the current transformer shall be provided. The following facilities shall be provided:

- a. Easily visible means of determining from ground the level of oil within the current transformers
- b. Oil drain cock and sampling device
- c. Earthing terminal of adequate dimensions

3. RATING

Rating of the current transformers shall comply with Technical Particular and Guarantee (TPG).

4. TESTING

4.1. Type Test

The current transformers offered shall have passed the type tests in accordance with IEC 61869-1.

Type test certificates or Type test report for the specified equipment shall be issued by an approved internationally acknowledged, reputable, independent testing laboratory.

4.2. Routine Test

Current transformers shall be subjected to routine tests as per IEC 61869-1.

5. ACCESSORIES

The following accessories shall be provided with each current transformer:

- a. Name plate
- b. Primary terminals
- c. Earthing terminal
- d. Primary winding protective device
- e. Weatherproof secondary terminal box
- f. Lifting lug
- g. Supporting structure with anchor bolts and nuts
- h. Mounting bolts
- i. Oil level indicator
- j. Drain and sampling plugs
- k. Oil filling plugs
- l. Oil adjusting unit (if necessary)
- m. Pressure relief device
- n. Cable conduit
- o. Weatherproof secondary terminal box for each 3-current transformers
- p. Primary terminal connection clamps, connectors, jumpers and other necessary material for connection to conductors (bus bar) and other equipment
- q. Other necessary accessories, even if specified elsewhere in the Tender Document or not expressly specified but required for a continuous reliable operation.



5. VOLTAGE TRANSFORMERS

1. CODES AND STANDARDS

Unless otherwise stated, voltage transformer shall comply with the following:

IEC 60270: High Voltage Test Techniques – Partial Discharge Measurements.

IEC 60296: Fluids for electro technical applications – Unused mineral insulating oils for transformers and switchgears.

IEC 60358-1: Coupling Capacitors and Capacitor Dividers – Part 1: General rules IEC 60481: Coupling Devices for Power Line Carrier Systems

IEC 60815: Guide for the selection of insulators in respect of polluted conditions

IEC 60815-1: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles

IEC 60815-2: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 2: Ceramics and glass insulators for AC systems

IEC 61869-1: Instrument Transformers - Part 1: General requirements for instrument transformers.

IEC 61869-5: Instrument Transformers - Part 5: Additional requirements for capacitive voltage transformers.

IEC 62155: Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V

IEC 62371: Characteristics of hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V

2. GENERAL

The voltage transformers shall be of the outdoor, single-phase, vertically mounted, capacitor type.

The design of capacitor voltage transformers shall be such that the accuracy shall not be affected by the presence of pollution on the external surface of the insulation.

Voltage transformers shall be suitable for use as line couplers for the operation of carrier accelerated tripping and communication systems. The material of insulators of voltage transformers shall be porcelain or silicon rubber.

Voltage transformers specified to carry line traps at the top, shall be designed and dimensioned accordingly.

Capacitor voltage transformers shall also be suitable for use as couplers for high frequency live line pulse fault-locators and measurements.

Secondary fuses shall be provided on each voltage transformer, located such that they are accessible while the primary is alive and shall be provided with labels indicating their function and their phase colours.

The voltage transformer secondary circuit shall be earthed at only one point by a separate earth link situated at each voltage transformer.

A fast damping device shall be provided at each voltage transformer in order to damp transient and Ferro resonant oscillations.

The capacitor unit shall be hermetically sealed.

A bushing shall be provided to enable a high-frequency signal to be coupled to the capacitor unit.

The bushing shall be fully protected against rain and vermin by a sealed weatherproof terminal box (IP54).

The capacitive voltage transformer's terminal box shall:

- a. have a provision for connection with a line matching unit.
- b. have an earthing-switch capable of being operated from ground level. It shall preferably include facility to enable the capacitor coupling unit to be earthed via the drain coil whilst simultaneously isolating the carrier equipment for test purposes.
- c. have a surge arrester connected between the coupling capacitor and earth to protect the matching unit, drain coil, etc.

3. CONSTRUCTION

3.1. Construction

All material and workmanship throughout shall be of best quality and in accordance with modern practices. The design shall be such that installation replacement and general maintenance may be undertaken with a minimum of time and expense.

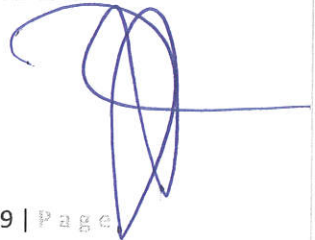
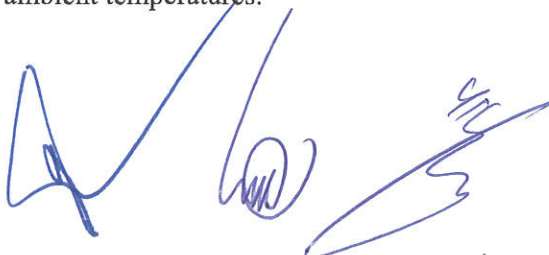
The Capacitor Voltage Transformer shall consist of a Capacitor Divider and an electromagnetic unit (Intermediate Voltage Transformer) connected between the Intermediate terminal and the earth terminal of the capacitor divider unit for providing the secondary output. The capacitive divider shall be made up of one or more coupling capacitors, each containing a large number of series connected capacitor elements impregnated with synthetic oil.

3.2. Coupling Capacitors

Coupling capacitors shall be equipped with corrosion-proof metallic bellows to accommodate the variations in oil volume due to variation of temperature.

The capacitor electrodes shall be made from aluminum foil. The dielectric shall consist of high quality paper separating layers of polypropylene film impregnated with synthetic oil. Appropriate clamping of capacitor stacks should be demonstrated by the manufacturer to ensure long term stability of the divider.

The capacitor divider unit shall offer regligible capacitance variation with temperature and shall have optimum stability of ratio for different ambient temperatures.



The stack capacitance at rated power frequency shall not differ from the nominal nameplate value by more than - 5% or +10%. After dielectric tests the capacitance at rated power frequency shall not differ from that measured prior to dielectric tests by less than the equivalent of one capacitor element.

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3.3. Electromagnetic Unit

The electromagnetic unit shall consist of an Intermediate Voltage transformer a device for suppression of Ferro resonance oscillations and a compensating reactor to ensure correct phase and ratio relationship between primary and secondary voltages. These shall be housed in a corrosion resistance base housing which is filled with mineral oil. A drain screw, oil filling screw and oil level indicator shall also be provided. The intermediate transformer shall operate at low magnetic flux. If ground switch for the intermediate transformer is provided, it shall be lockable in "open" position.

The intermediate transformer shall be provided with an electrostatic earth screen between the primary and secondary windings to reduce inter winding capacitance. The screen shall be solidly connected to the tank of the CVT.

The base housing may be constructed of corrosion resistant die cast aluminum, galvanized steel or painted steel.

A high frequency power line carrier terminal shall be provided (in between the earth terminal of capacitive divider unit and earth) for connection of carrier communication and metering apparatus.

4. ACCURACY REQUIREMENTS

The measuring and protective accuracy clauses specified in the schedule of technical particular and guarantee shall be met without having to make adjustment for changes of power factor, burden or voltage.

The ratio of the voltage transformers shall not be affected by changes in ambient temperature.

The standard reference range of frequency shall be from 99 to 101% of rated frequency for accuracy classes for measurement and from 96 to 102% for accuracy class for protection. The ratio error and phase displacement shall remain within accuracy limits as required by IEC 61869-5.

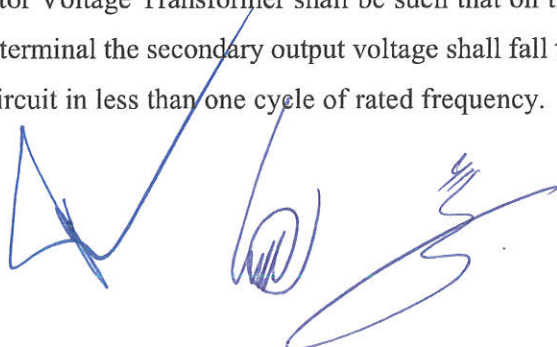
The voltage error and phase displacement at rated frequency at any voltage between 80% and 120% of rated voltage and with burdens of between 25% and 100% of rated burden, at power factor of a 0.8 lagging, shall not exceed the prescribed value for measuring accuracy class.

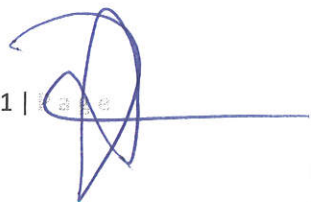
The voltage error and phase displacement at rated frequency at 5% rated voltage and at rated voltage multiplied by rated voltage factor with burdens as between 25% and 100% of rated burden at a power factor of 0.8 lagging, shall not exceed the prescribed value for protective accuracy class. At 2% of rated voltage the limit of error and phase displacement with burdens between 25% and 100% of rated burden at a power factor of 0.8 lagging will be not more than twice as high as that prescribed for the accuracy class.

5. EFFECTS OF TRANSIENTS

5.1. Transient Response

The transient response of the Capacitor Voltage Transformer shall be such that on the application of a short circuit to the primary and earth terminal the secondary output voltage shall fall to a value less than 10% of the peak value before short circuit in less than one cycle of rated frequency.



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5.2. Ferro resonance Suppression Performance

When a Capacitor Voltage Transformer supplied at 120% of rated voltage and with substantially zero burden has its secondary terminal short circuited and the short circuit is suddenly removed, the peak of the secondary voltage shall revert to a value which does not differ from its nominal value by more than 10% after 10 cycles of rated frequency.

All CVT's shall be tested on a Routine Test with a minimum of 10 secondary short circuit operations to ensure conformance with this requirement. Secondary waveforms shall be included in the test report.

5.3. Short Circuit Characteristics

Capacitor Voltage Transformer shall be capable of withstanding for one second the mechanical and thermal stresses resulting from short circuit on secondary terminal with maximum rated voltage maintenance on primary terminal.

6. SECONDARY TERMINAL BOXES

The secondary terminals of the Capacitor Voltage Transformer shall be brought out into a weatherproof terminal box attached to the transformer tank. Mini circuit breakers of suitable rating shall be connected to the polarity end of each secondary winding for protection of the CVT.

Note: Mini circuit breakers can be omitted provided the CVT when energized to 120% of rated voltage withstands without damage a secondary short circuit applied on each secondary winding separately for a minimum duration of one hour.

7. BUSHINGS

Bushings shall be made of silicon rubber or wet process porcelain which shall be homogeneous free from laminations, cavities or other physical flaws and shall be well verified tough and impervious to moisture. Bushing shall have a glaze of brown colour. Bushings shall be made of alternating sheds and shall possess good self-cleaning properties. Minimum inclination of top shed shall be greater than 5° as per IEC Standard.

8. TESTS

8.1. Type Tests

110 kV Capacitor Voltage Transformers The type tests shall be performed in accordance with IEC 61869-5.

Type test certificates or type test report for the specified equipment shall be issued by an approved internationally acknowledged, reputable, independent testing laboratory.

1) Short Time Withstand Current Test

2) Dielectric Tests as follows:

a) Dry Lightning Impulse Test This test shall be performed at the level specified in IEC 61869-5 for Dry Lightning Impulse Test.

b) Wet Power Frequency Voltage Test

c) Partial Discharge Test Partial Discharge Test is not required for completed Capacitor Voltage Transformer. However evidence shall be produced by the manufacturer showing that the insulator bushings have passed the Partial Discharge test.

- 3) Test for Accuracy
- 4) Temperature Rise Test on complete CVT unit
- 5) Ferro resonance Test on complete CVT unit
- 6) Transient Response Test
- 7) Insulation Endurance Test

8.2. Routine Tests

8.2.1 On the capacitor divider:

a) Capacitance and dissipation factor measurement before and after power frequency withstand voltage (dry) test

b) Dry Impulse Test of each capacitor section

(This test is required in order to provide a more searching test for capacitor element flaws on a routine basis [all units] than would otherwise be achieved with only the Power Frequency Withstand and Partial Discharge Tests). The test may be performed on individual capacitor sections only, at the rated lightning impulse level multiplied by a factor equal to the percentage of the unit's power frequency voltage tap which is borne by the individual capacitor section under test.

c) Power frequency withstand voltage (dry) test

d) Partial discharge measurement according to IEC standard (for Bushing)

8.2.2 On the electromagnetic unit:

a) Induced potential test on the primary circuit

b) Applied potential test on the secondary circuit

8.2.3 On the complete CVT:

a) Accuracy tests

b) Polarity check

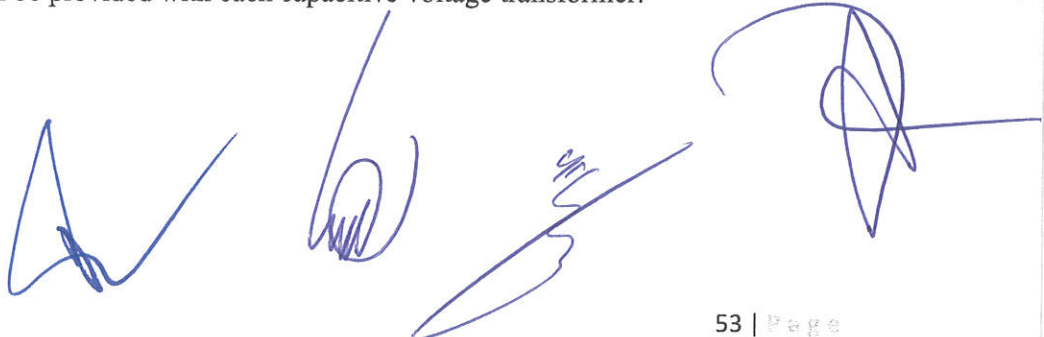
9. RATING

The rating of the Voltage Transformers shall comply with Technical Particular and Guarantee (TPG).

10. ACCESSORIES

The following accessories shall be provided with each capacitive voltage transformer:

- a. Name plate
- b. Primary terminal
- c. Secondary terminal box
- d. Earthing terminal
- e. Lifting lug



- f. Cable conduit
- g. Supporting structure with anchor bolts and nuts
- h. Carrier earth switch
- i. Carrier surge arrester
- j. Weatherproof secondary terminal box
- k. Primary terminal connection clamps, connectors, jumpers and other necessary material for connection to conductors (busbar) and other equipment
- l. Other necessary accessories, even if specified elsewhere in the Bid Documents or not expressly specified but required for a continuous reliable operation.

6. SURGE ARRESTERS

1. SCOPE OF WORKS

This Specification covers design, manufacture, testing at manufacturer's Works, packing, supply, delivery to site, install of gapless Surge Arresters complete with fittings and accessories.

2. STANDARDS

Surge arresters shall comply with IEC and/or all other equivalent or better relevant standards:

IEC 60137: Insulating bushings for alternating voltages above 1000 V

IEC 61463: Bushing - Seismic qualification

IEC 62271-300: High-voltage switchgear and control gear. Part 2: Seismic qualification for rated voltages of 72,5 kV and above

IEC 60099-3: Surge Arresters. Part 3: Artificial pollution testing of surge arresters

IEC 60099-4: Surge Arresters. Part 4 : Metal-oxide surge arresters without gaps for a.c. systems

IEC 60099-5: Surge Arresters. Part 5: Selection and application recommendations

IEC 60270: High Voltage Test Techniques – Partial Discharge Measurements.

3. OPERATIONAL CONDITIONS

The surge arresters shall be designed to ensure satisfactory operation under the atmospheric conditions prevailing at site, and under such sudden variation of voltage as may be met with under working conditions of the system.

4. GENERAL REQUIREMENTS

4.1. Design and Manufacturing Requirements

Surge arresters shall be outdoor, vertically mounted, self-standing type on supporting base or structures. These surge arresters shall be metal-oxide type, gapless discharge devices, having non-linear characteristic, explosion proof, heavy duty, Station Class and shall be hermetically sealed to ensure a permanently reliable performance, irrespective of the surrounding atmosphere.

Surge arresters shall consist of zinc-oxide disc stacks housed inside the sealed insulator body.

The insulator body housing the active parts of the arrester shall be of silicon rubber or porcelain with alternating size in order to attain a low sensitivity to pollution and fitted with proper grading rings. The color shall be brown.

The surge arresters shall be capable of diverting the impulse voltage caused by lightning strikes and over voltage due to switching and temporary power frequency over voltages, and shall be designed for a nominal discharge-current as specified at the rated high voltage.

The surge arresters shall be capable of discharging over voltages occurring during switching of unloaded transformers and long lines.

The surge arresters shall be capable of withstanding Continuous Operating Voltages (C.O.V) as stated at the Technical Particular and Guarantee (TPG).

The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltages.

In case of overloading, a pressure-relief device must discharge the dangerous pressure.

Internal components shall be designed to minimize internal corona and also to ensure minimal capacitive-coupling with any conducting layer of pollutant on the outside of the porcelain housing.

Each surge arresters shall be provided with high voltage terminals suitable to connect aluminum connectors and earth terminals shall be of tinned copper suitable to connect copper connectors.

The construction of surge arresters shall ensure proof against ageing and shall be of the maintenance free type.

4.2. Surge Counter and Leakage Current Meter

One surge-counter and leakage current meter shall be provided for each phase. The surge-counter shall be of the electromechanical type and designed for continuous service, operated by the discharge current passed by the surge arrester.

The leakage current meters shall be provided for installation in the earth connection of surge arresters and shall be designed for continuous service, suitable leakage current monitor on each pole of the arresters and measure leakage currents. The internal parts shall be fully weatherproofed with a transparent cover to provide on unobstructed view of the milli-ammeter. The reading of surge-counter and leakage current meter shall be visible through an inspection glass panel. Internal parts shall be hermetically sealed in a weather-proof housing and shall allow the recording device to be read without exposing the internal parts to the atmosphere.

The surge-counter and leakage current meter shall be connected in the main earth lead from the arrester in such a manner that the direction of the earth lead is not changed or its surge impedance materially altered. Earthing surge arrester should be separated from the mesh grounding system of substation. Bolted links shall be provided so that the surge-counter and leakage current meter may be short-circuited and removed without taking the arrester out of service.

5. RATING

Rating of the surge arrester shall comply with Technical Particular and Guarantee (TPG).

6. PERFORMANCE

6.1. Operating duty

The surge arrester shall interrupt the follow-current after each of ten applications of an 8/20 microsecond impulse current having the peak value equal to the nominal discharge current of the arrester, while the arrester is connected to a power supply at the rated voltage, the interval between successive impulse current applications being about 60 seconds and the polarity of the impulse current being positive for five applications and negative for five applications.

6.2. Durability

No puncture or no external flashover of the arrester shall occur at the nominal discharge current, and the performance of the arrester shall not be deteriorated for a long time of service even if exposed to successive operations.

7. TESTS

7.1. Type tests

Type test certificates or type test report for the specified equipment shall be issued by an approved internationally acknowledged, reputable, independent testing laboratory.

7.2. Routine tests

Before delivery surge arresters shall be subjected routine tests made by the manufacturer in accordance with IEC 60099-4.

Failure of a test specimen to comply with any one of the requirements of this standard shall be rejected.

8. ACCESSORIES

Each surge arrester shall be supplied complete with the following accessories:

- a. Name plate
- b. Pressure-relief device
- c. Two primary terminals, one for connection to the power line and the other for connection to earth insulating base
- d. Surge-counter and leakage current meter
- e. Porcelain or composite Insulator base
- f. Supporting structure with anchor bolts and nuts
- g. Primary terminal connection clamps, connectors, jumpers and other necessary material for connection to conductors and other equipment.
- h. Bolted links shall be provided so that the surge counter and leakage current meter may be short circuited and removed without taking the arrester out of service.

i. Other necessary accessories, even if specified elsewhere in the Tender Documents or not expressly specified but required for a continuous reliable operation.

7. GLASS OR CERAMIC INSULATORS

1.0 GENERAL

1.1 WORK INCLUDED

This specification covers the requirements for design, manufacturing, testing, packing, furnishing and delivery of insulators to be used for 150 kV Substation: cap and pin type.

1.2 QUALITY STANDARDS

1.2.1 General

The supplier and/or manufacturer shall control the quality of items (and services) to meet the requirements of this specification, applicable codes, standards and other applicable documents.

1.2.2 Standards

Unless otherwise stated in this technical specification, the following standards (the latest edition) are specifically applicable to the design, manufacturing and testing of the equipment and materials included in this specification.

IEC 60071-1: Insulation co-ordination – Part 1: Definitions, principles and rules

IEC 60120: Dimensions of ball and socket couplings of string insulator units

IEC 60305: Characteristics of string insulator units of the cap and pin type

IEC 60372: Locking devices for ball and socket couplings of string insulator units - Dimensions and tests

IEC 60383-1: Insulators for overhead lines with a nominal voltage above 1000 V, Part 1: Glass or ceramic insulator units for a.c. systems - Definitions, test methods and acceptance criteria

IEC 60383-2: Insulators for overhead lines with a nominal voltage above 1000 V, Part 2: Insulator strings and insulator sets for a.c. systems - Definitions, test methods and acceptance criteria

IEC 60815-1: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles

IEC 60815-2: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 2: Ceramics and glass insulators for a.c. systems

IEC 61211: Insulators of ceramic material or glass for overhead lines with a nominal voltage greater than 1000 V – Impulse puncture testing in air

IEC/TR 61467: AC power arc tests for insulator sets

1.3 SITE CONDITIONS

Pollution Level: 1. Heavy or 2. Very Heavy (according to condition of location)

1.4 SERVICE CONDITIONS

1.4.1 Nominal system voltage: 110 kV.

1.4.2 Highest system voltage: 123 kV

1.4.3 Rated frequency: 50 Hz.

1.4.4 Rated fault level: 12.5 kA up to 40 kA for 1 s.

1.4.5 Standard lightning impulse withstand voltage: 550 kV

1.4.6 Standard rated short-duration power frequency withstand voltage: 325 kV

1.5 SUBMITTALS

1.5.1 Language

All documents are to be in the English language.

1.5.2 Documents to be submitted with the Bid

Each bidder shall submit with its bid the following documents, data and information in addition to any other information called for elsewhere in the Bidding Documents to enable DABS to fully evaluate the proposal of the Bidder.

a. Type test certification for single insulators units.

The Bidder shall include with its bid the recent type test certificates and test data for the offered insulator units. The document shall have been issued by an approved internationally acknowledged, reputable, independent testing laboratory.

b. Certification that the same type of insulators units with the same mechanical rating have been sold to foreign customers for at least 350.000 units and a record of past successful operation for use on transmission line at a voltage level 150 kV or above for a period of at least five years.

c. A list of at least five foreign purchasers of the offered insulator units giving date of delivery, quantities supplied, and full name and address of these purchasers.

d. Outline drawings of insulator units showing all dimensions, main characteristics, description of materials, unit weight, etc.

e. General description of the factory, giving information concerning the capacity of production, manufacturing techniques used and quality system of the manufacturer.

f. Technical particulars, catalogs, leaflets, and other identifying and descriptive literature to clearly demonstrate that the insulators offered meet all the requirements of the Bidding Documents. Failure to comply with the above requirements a., b. and c. may be considered sufficient reason for rejection of the Bid.

1.5.3 Document to be submitted After Award of Contract

a. Confirmation of data provided in the Bid.

b. Technical particulars.

- c. Outline drawings of insulator units.
- d. Type test certificates of insulators to be supplied.
- e. Inspection Quality and Testing Procedure
- f. Quality control procedure.

1.6 TESTING AND INSPECTION

The following tests shall be carried out in order to determine whether the materials and equipment comply with this Specification.

Not less than three weeks' notice of all tests shall be given to DABS. As many tests as in the opinion of DABS are possible shall be arranged together. Four copies of the records of all tests shall be furnished to DABS. All instruments shall be approved and shall, if required by DABS, be calibrated at the expense of the Bidder by an approved authority.

With the exception of the manufacturer's routine and sample tests all type tests may, at the option of DABS, be waived providing satisfactory previous type testing records, issued by an approved internationally acknowledged reputable independent testing laboratory, are available and are approved by the Engineer.

The cost of tests including the provision of the necessary test equipment shall be deemed to be included in the Contract Price.

Testing shall be in accordance with the relevant clauses of the standards as mentioned in this Specification with the additions stated in below:

1.6.1 Type Tests of Insulator Units

The type tests are as follows:

- a. Verification of the dimensions.
- b. Dry lightning impulse withstand voltage test.
- c. Wet power-frequency withstand voltage test.
- d. Electro-mechanical failing load test or mechanical failing load test
- e. Thermal-mechanical performance test.
- f. Residual strength test. g. Impulse puncture testing in air

1.6.2 Routine Tests of Insulator Units

Routine tests of insulator units shall be carried out in accordance with IEC 60383-1.

1.6.3 Sample Tests of Insulator Units

Sample tests shall be carried out in accordance with IEC 60383-1.

1.6.4 Type Tests of Complete Insulator Sets

- a. Dry lightning impulse withstand voltage test, according to IEC 60383-2.
- b. Wet power-frequency withstand voltage test, according to IEC 60383-2.
- c. AC power arc test, according to IEC 61467.



1.7 PACKING, MARKING AND DELIVERY

The insulators shall be packed in wire bound wooden crates. The packing shall be suitable for transport by sea, rail and road, as separate crates or pelletized. It is preferred that each separate crate contain five or six units and shall contain only insulator units of the same type.

Each crate shall be clearly marked with the following information:

- a. Contents.
- b. Quantity.
- c. Net weight and gross weight.
- d. Name of DABS and name of the Bidder.
- e. Contract number.
- f. Project name.
- g. Destination.
- h. Any other identification required by DABS.

2.0 SPECIFIC REQUIREMENTS

2.1 TYPE OF INSULATORS

The insulator units shall be of the cap and pin type and shall be of aluminous ceramic or toughened glass;

2.2 MATERIALS, DESIGN AND QUALITY

2.2.1 Ceramic

Where ceramic insulators are used, they shall be made of the highest grade, dense, homogeneous, wet-process ceramic. The ceramic shall be free from warping, roughness, cracks, blisters, laminations, projecting points, foreign matter and other defects, except those within the limits of standard accepted practice.

2.2.2 Glass

Where glass insulators are used, they shall be made of the highest grade, dense, homogeneous, toughened glass possessing uniform mechanical and electrical strength and long life service. The glass shall be free from warping, roughness, cracks, blisters, laminations, projecting points, foreign matter and other defects, except those within the limits of standard accepted practice.

2.2.3 Cap and pin insulators

Cap and pin insulators shall comply with IEC 60305 and shall be provided with ball and socket couplings in accordance with IEC 60120 and split-pin type locking devices for the insulator units themselves, in accordance with IEC 60372.

The caps shall be made of good commercial grade malleable cast iron or ductile/cast iron and shall be hot dip galvanized after all necessary marking. The cap shall be truly circular, with the inner and outer surface concentric, and shall be free from cracks, shrinks, air holes, burrs, and rough edges to minimized field concentrations and radio disturbances.

The insulator pins shall be made of forged carbon steel or high tension steel and free from cracks and air-holes. Pins shall be provided with zinc anti-corrosion sleeve and the materials of the sleeve shall be pure zinc with the purity not less than 99.7 per cent. Total fused area of the interface should be more than 80 per cent of the total interfacial area between the zinc sleeve and the pin.

The metal of cap and pin insulators shall be hot-dip galvanized in accordance with ASTM A 153 or equivalent and shall consist of a coating of at least:

- For iron and steel castings and forgings:

610 g/m² for all samples, with 500 g/m² on any individual sample;

- For bolt, nuts and washers:

375 g/m² for all samples, with 300 g/m² on any individual sample;

The zinc coating shall be smooth, clean, free from defects, and of uniform thickness, satisfying the prescribed test procedure.

The locking devices shall be of austenitic stainless steel or phosphor bronze. Locking device shall be so formed that when set and under any conditions there shall be no risk of the locking device being displaced accidentally and that nothing but extreme deformation of the locking device shall allow separation of the insulator units. Locking device design shall be such as to allow easy removal or replacement of the insulator units under live line conditions. Locking devices when in position shall be independent of rotation, and the efficiency of the locking shall be independent of the degree of opening applied to the locking device after insertion.

2.2.4 Glaze

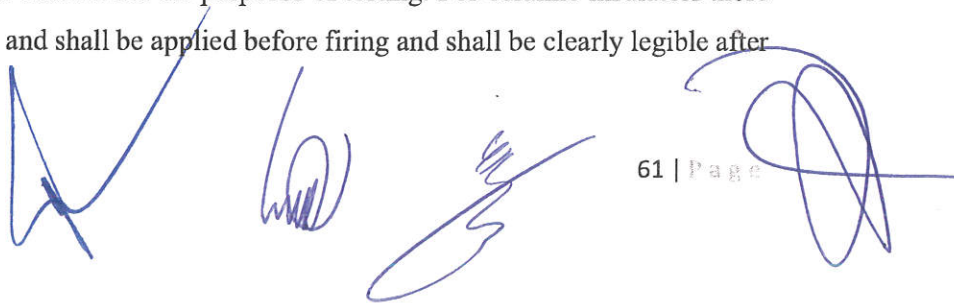
All ceramic surfaces exposed to the weather shall be glazed with reasonably uniform brown color. The glaze shall be smooth, hard, dense, and properly fitted to the ceramic and shall be unaffected by the weather, ozone, nitric acid, nitric oxides, alkali, dust, or sudden change in temperature within the atmospheric range.

2.2.5 Cementing

Extra high quality cement shall be used for cementing the insulator body to the cap and pin. The cement shall have minimum expansion to avoid thermal stress between joints. Cement thicknesses shall be as small and even as possible and proper care shall be taken to correctly center and locate the individual parts during cementing.

2.3 MARKING

Each insulator shall be legibly and indelibly marked with the manufacturer's name or trade mark, the year of manufacture, a mark indicating the minimum failing load and such other mark as may be approved to assist in the representative selection of batches for the purposes of testing. For ceramic insulators these marks shall be printed, not impressed, and shall be applied before firing and shall be clearly legible after firing the glazing.



For glass insulators these marks may be applied by sand blasting. If these indications are stamped on the insulator socket, they shall not affect the quality of galvanization.



2.4 COORDINATION WITH MANUFACTURER OF FITTINGS

It is the Bidder's responsibility that a close and constant liaison be maintained between the manufacturer of insulators and the manufacturer of fittings so that all component parts of an insulator assembly are perfectly adapted to one another.

8. CONDUCTORS AND HARDWARE

1. CODES AND STANDARDS

Conductors for bus bars and all electrical connections in the outdoor substation bays shall be in accordance with IEC 61089 or equivalent national standards in respect of current rating and material analysis.

Type of conductor shall be Hard Drawn Aluminum (HAL) or Aluminum Alloy (AAC) or Thermal Aluminum Conductor (TAL). Size of bus bar conductor and current rating shall be calculated by the Bidder to meet the substation requirements. Bus bars shall be strung in continuous conductor lengths for each span.

Conductors and connectors provided for extending existing connections at each substation shall be identical with the existing equipment except where otherwise specified.

2. GENERAL

Materials used for bus bars and bay conductors shall be stressed to not more than two-fifths of their elastic limit. Provision shall be made for expansion and contraction with variation in conductor temperature.

Bus bars shall be arranged so that they may be readily extended in length with a minimum of disturbance to existing equipment.

All necessary clamps and connectors for connections between the bus bars, bay conductors and equipment for the complete the scope of work shall be provided under this Contract.

Clamps and connectors shall be of an approved type, preferably type tested. Connections dependent upon site welding techniques will not be permitted.

Bus bars and bay conductors shall be so arranged and supported that under no circumstances, including short circuit conditions, can the clearances between live metal and earth or earthed metal work or between conductors be less than the specified distances.

When dissimilar metals are in contact, approved means shall be provided to prevent electro-chemical action and corrosion. Unless otherwise approved, joints and surfaces of copper or copper alloy fittings shall be tinned.

Suspension and tension clamps shall be of approved types and shall be as light as possible. Those for the bus bar conductor shall be compression type. Suspension and tension clamps shall be designed to avoid any possibility of deforming the stranded conductor and separating the individual strands.

Tension conductor clamps shall not permit slipping of, or damage to, or failure of the complete conductor or any part thereof at a load less than 95 per cent of the ultimate strength of the conductor.

Clamps and fittings made of steel or malleable iron shall be galvanized.

The Bidder shall supply all bus bars, jumpers, necessary connectors and clamps for connection between the bus bars and all apparatus/equipment even if not specifically mentioned in the tender specification, bill of quantities and drawings, but necessary for the proper completion of the work.

9. 20kV SWITCHGEARS WITH PANELS

1. GENERAL

1.1. Work Included

1.1.1. This specification covers the design, manufacture, supply, factory test and inspection, installation, site test and commissioning, 12 months guarantee after taking over offer or 18 months after last delivery.

1.1.2. Bus duct shall be furnished for interconnection between two rows of M.V. cubicles.

1.2. Quality Standard

1.2.1. General

The Contractor shall control the quality of equipment, material testing, cleaning, services and reports to meet the requirement of this specification, applicable standards, codes and other applicable standards.

1.2.2. Standards

The equipment and materials shall conform to the latest applicable standards of sponsor organization as follows:

1.2.2.1 Basic Standards

Unless otherwise specified or modified herein, all IEC Standards directly or indirectly applicable, including parts and addenda. Specific Standards include, but not limited to the following:

- IEC 60056 - High voltage alternating current circuit breaker.
- IEC 60060 - High Voltage test techniques
- IEC 60068 - Basic Environmental Testing Procedures
- IEC 60129 - Alternating current disconnectors (Isolators) & earthing switches.
- IEC 6068 - Test on indoor and outdoor post insulators of ceramic material of glass for systems with nominal voltage greater than 1000 V.
- IEC 60185 - Current Transformer
- IEC 60186 - Voltage Transformer
- IEC 60265 - High Voltage Switches for rated voltages above 1 kV and less than 52 kV
- IEC 60282 - Current limiting fuses
- IEC 60298 - A.C. metal enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV.

- IEC 60420 - High voltage alternating current switch-fuses combination
- IEC 60466 - High voltage insulation enclosed switchgear and control gear
- IEC 60529 - Classification of degree of Protection Provided by Enclosures
- IEC 60660 - Test on indoor post insulators of organic material for systems with nominal voltages greater than 1000 V up to but not including 300 kV

1.2.2.2. Supplement Standard

- N F C Standards (French)
- VDE / DIN Standards (German)
- B S Standards (British)
- N E M A Standards (USA)
- J I S Standards (Japanese)

1.2.2.3. Conflicts

- a) If conflicting requirements between applicable standards exist, the more stringent requirement shall govern.
- b) If this specification conflicts in any way with applicable standards, this specification shall take precedence and shall govern.
- c) The parts, sections, subsections, paragraphs or clauses of supplemental standards replace and take precedence over the requirements of the corresponding parts, sections, subsections, clauses or paragraphs of the basic standard to the extent of the scope covered by the part, section, subsection, paragraph or clauses listed supplemental standard.

1.3. Site Condition

The equipment shall be suitable for operation under site condition including Climatic Conditions and Seismic Conditions

1.4. Service Condition

- 1.4.1. The equipment will be installed indoors and will be subject to the minimum and maximum environmental conditions as specified.
- 1.4.2. The equipment shall be suitable for operation under the ambient conditions specific to their respective location while in service.
- 1.4.3. The equipment shall fulfill the electrical characteristic below:

- * Nominal System Voltage 20 kV
- * Rated Voltage 24 kV
- * Rated Frequency 50 Hz
- * One-minute power frequency withstands
voltage, dry (r.m.s):
- type test 50kV

- routine test

50kV

* Withstand voltage across isolating

Isolating distance

- Impulse voltage (peak) 145kV
- One-minute power frequency voltage 50 kV
- Bus bar nominal current 2000 A

Circuit Breaker

- Incoming 1250 A
- Outgoing 2000 A
- Rated short time withstand current (1 sec) 16kA
- Test voltage of auxiliary circuits (1 minute) 2kV

1.5. Submittals

1.5.1. Language

All document are to be in English

1.5.2. Document to be furnished by the Contractor / Supplier

1. When Bidding

The following data shall be submitted:

- a. Outline drawings for the equipment will be supplied
- b. Technical particulars and guarantee
- c. Type test certificate of MV circuit breaker, load break switch, MV enclosure/ cubicle.
- d. Technical literature of the equipment
- e. Quality control manual for review and acceptance
- f. Other data if requested during evaluation

2. after the award of the contract

- a. Foundation guide drawings
- b. Technical particular and guarantee
- c. Outline and detail drawings for approval
- d. As built drawing
- e. Method of inspection and testing
- f. Inspection / test report before delivery
- g. Quality control procedure

1.6. Test, Inspection and Guarantee of Medium Voltage Switchgear

The switchboards and switchgear units will be inspected either at manufacturer's premises or at the place where they are assembled. In any case, the final inspection shall be carried out on completely assembled switchboard.

Inspection will be made by an authorized representative of DABS to be appointed later.

1.6.1. Type Test

Tenderer shall include with their offers that certificate, including test carried out in accordance with IEC 60298.

The test must include:

1.6.1.1. For 20 kV Switchgear

- Test of mechanical strength
- Check of degree of protection
- Impulse voltage dry test
- Power frequency voltage dry test
- Temperature rise test
- Short time current test on main circuits
- Short time current test on earthing circuits
- checking of making and breaking capacity
- test resistance to environmental conditions
- Internal arc test

1.6.1.2. For the Circuit - Breaker

- Mechanical strength
- breaking and making capacity
- Permissible over current
- Temperature rise
- Operation
- Power frequency test.

1.6.2. Routine Test

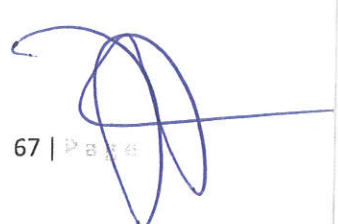
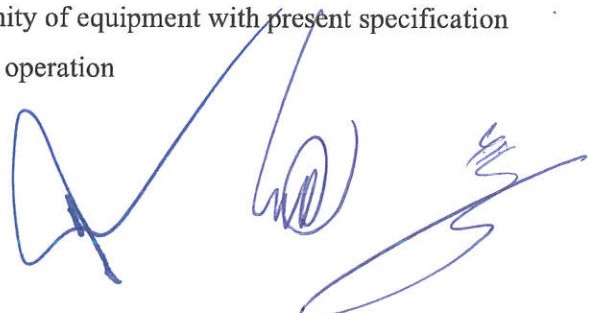
1.6.2.1. For 20 kV Switchgear

These tests shall be made on all assemblies and shall include:

- Power frequency voltage dry test
- Voltage test on auxiliary circuits
- Mechanical operation test on control and interlocking
- Verification of wiring
- Verification of earth continuity
- checking of conformity to specification

1.6.2.2. For the Circuit Breakers

- checking the conformity of equipment with present specification
- checking mechanical operation



- checking operation of releases
- Dielectric test.

1.6.3. Guarantee

The manufacturer shall be required to provide test certificates.

In the event that the equipment delivered fails to pass the required tests, the manufacturer will be responsible for the equipment until such time that the equipment is retested and proved satisfactory and the required test certificates are accepted by the DABS prior to dispatching the equipment.

2. SPECIFIC REQUIREMENT

2.1 General

- 2.1.1. The M.V Metal clad shall be of single busbar type and housed in specially provided buildings (indoor installation).
- 2.1.2. Switchgear shall be metal clad, prefabricated, withdraw able type. Switchgear assemblies which will be called hereafter switchboards are made up of compartment or units. Partitions of metal clad switchgear and control gear shall be metallic, earthed and no phase barriers may be installed. Switchgear shall be suitable for operation in a hot and damp climate. All components shall be made to receive a tropical finish.
- 2.1.3. Control and indication for the supervision at Distribution Control Centre (DCC), as required, shall be brought out to terminal blocks on each 20 kV Switchgear Panel.

2.2. Arrangement and Construction

2.2.1. Design of Switchboard

2.2.1.1 Construction

The medium voltage switchboards shall be made up in compartments completely enclosed in metal enclosure including the bottom face. The switchboards are to be fabricated from rolled steel sheets composed of interchangeable cells having standardized dimensions and easily joined together.

The sheet steel used in the construction of panels shall be perfectly planned and not less than 2.50 mm thick for front panel and 2.0 mm for other sections. However the covers and partition shall be so stiffened that a mechanical impact of 2 joule (equivalent to a 0.5 kg ball falling from 0.4 m) shall not render ineffective the control gear or alter the specified degree of protection or reduce the creep age distance or clearances below the specified values.

The switchboards should be provided with the cable support with fixing clamps for nut and screw. In case duplex type will be supplied, front cover for the second switchboard shall be provided. The cover shall be designed such that they can easily remove and installed to the first switchboard or other switchboard.

The first switchboard is the switchboard with circuit breaker and the second switchboard is the switchboard without circuit breaker in the duplex system.

2.2.1.2. Degree of Protection

Complete protection shall be provided against approach to live or contact with internal moving parts to category IP 41 to IEC - 60529

2.2.1.3. Access to Compartments

Switchgear compartments:

Each switchgear shall house the following components:

- Busbar(s) compartment
- Current Transformer and HV connection compartment
- Circuit Breaker compartment
- LV compartment

These compartments are to be fully segregated by metallic earthed partitions.

The cover and partitions of these compartments are fixed. They cannot be removed unless tools are used (e.g. fixation by hexagonal head screws).

Access to equipment fitted in these compartments is by opening a door or cover. Complete or partial access into a switchgear compartment by operators shall only be possible if all the equipment contained in that compartment is "dead" or connected to earth if it remains connected to circuits outside that compartment.

Mechanical type interlocks shall forbid access to switchgear compartment if the following conditions are not fulfilled:

- The switching device (load break switch, isolator, etc) is in the open position.
- The earthing switch is in the closed position,
- Any conducting parts which extend outside the compartment are earthed.

Closing of door or cover shall not be possible unless the earthing switch is closed. However the earthing switch may be open once the door is opened.

Modification or replacement of part of the bus bars will required the whole switchgears be dead.

2.2.1.4. Internal fault in the cubicles

All constructional arrangements of cubicles shall be taken to minimize the risk of consequences of internal faults in the cubicles.

2.2.1.5. Control Levers

The control levers of switching devices shall preferably be in the high position when the device is in the "closed" position and in the low position when the device is in the "open" position. End position of the lever shall be indicated on the panel.

The effort to be exerted on a lever by operators shall not exceed 250 N. The direction of rotation of levers shall be such that they do not knock against the opened door of an adjacent compartment or a wall.

Position of all switching device shall be clearly and automatically indicated on a mimic diagram which shall be fitted on the front face of the switchboard.

2.2.1.6. Control Mechanism

Control mechanism of switching devices shall be of the independent manual operation type.

Operation of switching devices shall be carried out without entering into the switchgear compartment.

The component of the control mechanism or locking devices their linkages are to be designed and constructed so as to provide a safety factor of 3 in relation of permanent deformation or rupture (depending upon the material) for the transmission in the most unfavorable condition of an effort of 250 N applied to the handle of the control lever.

The interlocking devices shall have a higher safety factor than the control mechanisms.

Position of any switching devices, including isolators, shall be eye checked by one of the following means:

- The movable contact tips in the open position are visible through portholes located in the enclosure.
- A clearly visible screen can be inserted between the fixed contacts and the movable contacts.
- Sectionalizing is made by withdrawing a device,
- Opening of contact is shown by an indicating device either for each pole or for the 3 pole together depending upon the construction. The indicating devices shall be directly connected to the movable contacts by means of a strong linkage which cannot be put out of adjustment of forced.
- Electromagnetic indicators enclosed on the mimic diagram for earthing switch position.

2.2.1.7. Isolating Facilities

2.2.1.7.1. General

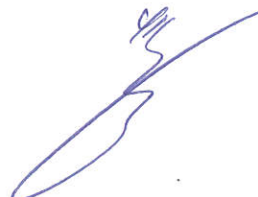
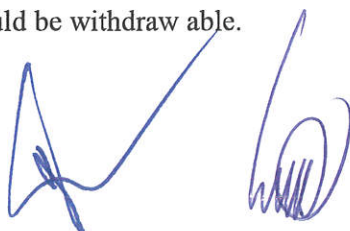
Mechanical indicators visible at the front of the cubicle shall be provided to show the position of isolators and earthing switches.

Padlocking facilities shall be fitted to enable isolator and earthing switches to be locked in the 'on', 'off' and 'earthed' positions.

Facilities shall be provided for high voltage test on cables and primary injection of current transformers. Where windows are provided for observation of position of isolators and earthing switches, these shall comply with IEC. 60289 in respect of internal arc test and 150% power frequency dielectric test.

2.2.1.7.2 Withdraw able circuit-breakers

All circuit breaker(s) should be withdraw able.



The circuit breakers shall be connected to the bus bars and feeder circuits through plug and socket type isolating devices. The devices shall be of an off load type but shall suitable for operation whilst the bus bars or feeder circuits are live. It shall be impossible to operate the isolating device if the circuit-breaker is in the closed position.

The main circuit isolating devices and all auxiliary circuit isolating devices shall be self-aligning and accessible for maintenance. The main isolating contacts shall be silver plate, self-cleaning and shall be mounted in porcelain or cast resin bushings.

It shall be possible for circuit-breakers to be withdraw able from the fixed portion of the cubicle by either horizontal or vertical isolation from the fixed bus bars and outgoing circuit connections or by some other approved procedures.

It shall be possible to remove the circuit-breaker completely from the panel within the distance stated in the Schedule of Particulars.

Automatic shutters shall be provided to IEC Standards to prevent access to live equipment when the circuit-breaker is withdrawn. These shall provide degree of protection IP-31 and shall be so designed as to be individually locked over bus bar or circuit orifices independently of the other except that simultaneous operation of shutters is permitted where other means of access to cable terminations is provided.

Shutter shall be metallic except that insulating material may be employed subject to compliance with test in accordance with IEC 60298. Orifice shutter shall be clearly labelled and shall be warning symbols.

Two (2) rollers shall be provided for each substation for carrying withdraw able part in case truck mounted is not applied.

2.2.1.8. Earthing Facilities

Means shall be provided to earth both the outgoing circuit and the bus bars, but not both simultaneously. Both bus bars for double bus bar type may be earthed simultaneously.

The means of earthing shall from an integral part of the design of the switchboard. The earths shall be made either through circuit-breakers or by the use of fault making switches. It shall not be possible to select an integral position or connect a portable earthing device unless the circuit-breaker is in the open position.

When the circuit-breaker is being used for earthing, a locking facility shall be provided to prevent the breaker being opened closed. It shall be impossible to return to the normal service position without having first removed the same locking facility. Fault making switches shall be capable of making on to a 3 phase fault whose is equal to the specified short circuit level for the time specified in system and fault levels. The operating mechanism shall be a spring-operated manual device designed so that the closing speed of the switch is independent of the operator.

It shall not be possible to have the switch in a partially open or closed position and it shall be possible to closed and immediately open the switch.

2.2.1.9. Earthing of Metal Parts

All metal parts including any relays, instrument, etc., mounted on the switchboard, shall be connected to a copper earth bar which runs along the full length of the switchboard.

The cross-section of the bar shall be sufficient to carry the rated short-time withstand current of the switchgear for the time specified.

The frame and the tank of the draw-out circuit- breakers shall be connected to the earth bar through a substantial plug type contact or sliding type contact arranged to make and maintain contact before the main isolating contacts make.

The earthing contacts of all earthing switches and the earthing connections for any earthing device shall be connected directly to the earth bar.

2.2.1.10. Interlocking Facilities

The switchboards shall be provided with an interlocking system which ensure safe operating of the equipment under all service condition.

Mechanical interlocking shall be effective at the point where hand is applied so that stresses cannot be transferred to parts remote from that point.

When remote control facilities are required, electrical interlocking shall also be provided to prevent closure of the circuit by interrupting of the operating supply to the solenoid operating contractor or the spring release coil in the case of spring closing mechanism.

Interlocks shall be provided on Incoming Feeder, Bus Section and Bus Coupler equipment to prevent the paralleling of switchboards and sections of switchboards.

Where mechanical keys are used to private interlocking and attempt to release a key when the circuit-breaker is closed shall not trip the circuit-breaker.

Facilities shall be provided for live uninterrupted transfer of circuits form one bus bar to the other bus bar. Interlocks shall be provided to prevent to the closure of the circuit disconnectors unless the bus coupler is closed.

2.2.1.11. Information Labels

Information plates indicating the functions of equipment contained in the various compartments are to be fitted on the front face of the switchgear panel.

Additional, clearly designed information plates indicating the open/closed position and direction of rotation for opening/closing the circuit breakers, on-load isolators and earthing switches are to be fitted adjacent to each switch, in position where they will be easily visible to the operator.

Identification plates 100 x 40 mm are to be screw fixed to the front of each cell.

These plates shall be supplied blank.

2.2.2. Composition of 20 kV Switchboard

2.2.2.1. Arrangement of Switchboard

The switchboard shall be:

Single bus bar system (current carrying capacity of 2000 A)

2.2.2.2. Composition of 20 kV Switchboard

2.2.2.2.1a). Operation system

All switchgear are connected on the same bus bar. Both incomings are normally closed while bus tie (bus section) switchgears are normally open.

In case of under voltage on one incoming, opening of this incoming will close the bus tie switchgear automatically.

b). List of equipment

20 kV switchgear Incoming feeder

Each of the incoming feeders shall include the equipment in the following lists & typical arrangement is shown on drawing.

The following equipment shall be furnished, mounted and connected within the switchgear unit compartments:

- One three phase 20 kV draw out power circuit breaker rated 1250 amperes continuous, 25 kA, with a single trip coil and with a nominal control voltage of 110 volts D.C, complete with auxiliary switches, operating mechanism.
- One three phase rated 1250 A (continuous) bus bar, 25 kA, insulated with non-ignitable materials, MV and LV isolating plug and sockets.
- One set of provisions for termination of 1 or more power cables per phase.
- 20 kV current transformers as follows:
 - * 200-400-800/1-1A, class X
For Transformer differential protection & Ref.
 - * 200-400-800/1A, 15 VA class
5P20 for o/c and e/f protection.
 - * 200-400-800/1A, 15 VA class 0.2
For Instrument & metering.

The following equipment shall be furnished mounted, and connected on the front panel of the switchgear unit.

- 1 - Set of mimic diagram for 20 kV Switchgear
- 1 - Set of alarm annunciator for tripping relays and monitoring AC/DC supply failure with minimum 4 windows. The function as follow:

- 1 window for CB fault common trip
- 1 window for supply DC failure
- 1 window for supply AC failure
- 1 - Set of push button lamp test, accept, reset and horn off
- 1 - Set of circuit breaker local control switch
- 1 - Set of Local/Remote Supervisory switch with indication and key
- 1 - Set of indication for the position of circuit breaker and earthing switch
- 3 - Pcs of indicating AC ammeters, 0 to 5 ampere input, 0 to 1200 A and 0-2400 A scale (double scale)
- 1 - Pc of indicating AC Voltmeter with selector switch, 0-100 V or 0-110V input, 0-25 kV scale
- 1 - Pc of kilowatt hour meter, class 0.2, 4 wire, three element, double tariff with maximum demand indicator, and non-reverse ratchet
- 1 - Set of 3 phase overcurrent relay and 1 (one) ground over current relay with time delay and instantaneous element, having 4 inverse and 3 definite time characteristic
- 1 - Under frequency relay with trips set at 49; 48.5 and 48 Hertz for load shedding shall be wired to trip circuit of each outgoing circuit breaker
- 1 - Set of trip circuit supervision relay with lamp indication and alarm
- 1 - Set of under voltage relay
- 1 - Set of visual check of the position of earthing switch
- 1 - Set of auxiliary relay
- 1 - Lot of terminal block with switches for connection to DCC

20 kV Switchgear Station Service Feeder.

Station service feeders shall include the equipment in the following lists, and typical arrangement is shown on drawing.

The following equipment shall be furnished mounted and connected within the switchgear unit compartments.

- One three phase rated 1250A (continuous) busbars, 25 kA, insulated with non-ignitable material, MV and LV isolating plug and socket.
- One set of provisions for termination of 1 power cable per phase.
- Three gang operated load break switches designed to open upon the sensing of unbalanced voltage due to the interruption of any fuse.
- One three phase fault making earthing switch.
- Three fuses 24 kV, 45 A.

The following equipment shall be furnished, mounted and connected on the switchgear unit front instrument panel.

- 1 - Set of mimic diagram
- 1 - Set of alarm annunciator for monitoring AC/DC supply failure
- 1 - Set of mechanical/electrical operator for load break switch
- 1 - Set of indicator of the position of load break switch and earthing switch
- 1 - Set of visual check of the position of load break switch and earthing switch
- 1 - Set of low voltage voltmeter with selector switch, scale 0-250 volt and 0-500 volt

20 kV Switchgear Outgoing Feeder

Each of the outgoing feeders shall include the equipment in the following list, and typical arrangement is showing on Drawing.

The following equipment shall be furnished mounted and connected within the switchgear unit compartments.

- One three phase 20 kV draw out power circuit breaker, rated 2000 amperes continuous, 25 kA, with single trip coil and with a nominal control voltage of 110 volts dc. Complete with auxiliary switches, operating mechanism etc.
- One three phase rated 2000 A (continuous) bus bar, 25 kA, insulated with non-ignitable material, MV and LV isolating plug and sockets.
- One set provisions for termination of two power cables per phase.
- 20 kV current transformers as follows:
 - 200-400-800/1 A, 15 VA class 5P20 for o/c and e/f protection.
 - 200-400-800/1 A, 15 VA class 1 for metering and Instrument.
- One three phase fault making earthing switch.

The following equipment shall be furnished, mounted and connected on the front panel of the switchgear unit.

- 1 - Set of mimic diagram for 20 kV Switchgear
- 1 - Set of alarm annunciator for tripping relays and monitoring AC/DC supply failure
- 1 - Set of push button lamp test, accept, reset and horn off
- 1 - Set of circuit breaker local control switch
- 1 - Set of Local/Remote Supervisory switch with indication and key
- 1 - Set of indication for the position of circuit breaker and earthing switch
- 3 - Pcs of indicating AC ammeters, 0 to 1 ampere input, 0 to 250 ampere and to 500 ampere scale (double scale)
- 1 - Pc(s) of kilowatt hour meter, class 1, 4 wire, three element, double tariff with maximum demand indicator, and non-reverse ratchet

- 1 - Set of 3 phase overcurrent relay and 1 (one) ground overcurrent relay with time delay and instantaneous element, having 4 inverse and 3 definite time characteristic
- 1 - Set of three phase, two shot auto reclose relay with in/out switch
- 1 - Set of trip circuit supervision relay with lamp indication and alarm
- 1 - Set of auxiliary relay
- 1 - Set of visual check of the position of earthing switch
- 1 - Selector switch for load shedding scheme
- 1 - Lot of terminal block with switches for connection to DCC

20 kV PT's and Earth Switch Cubicles.

20 kV PT's and Earth Switch Cubicles shall include the equipment in the following lists, and typical arrangement is shown on drawing.

The following equipment shall be furnished mounted and connected within the switchgear unit compartments.

- Three phase voltage transformer ratio $20,000/\sqrt{3}:110/\sqrt{3}$ Volt, 30 VA class 3P for protection and 100 VA, class 0,2 for Instrument & Metering.
- One three phase fault making earthing switch.
- One three phase rated 2000 A (continuous) busbars, 25kA, insulated with non-ignitable material, MV and LV isolating plug and socket.
- One set of provisions for termination of 1 power cable per phase.
- Three fuses 24 kV, 45 A.

2.3. Technical Specification of MV Switchboard Equipment

2.3.1. Bus

2.3.1.1. The switchgear main bus shall be copper bar designed to carry continuously current minimum 2000 A and temperature rise requirement specified in IEEE, IEC and NEMA standard.

Type a switchgear shall have three phase-bus bars.

Type B switchgear shall have three phase-bus bars and one neutral-bus bar with suitable required current rating.

2.3.1.2. Main bus shall be insulated with non-ignitable insulating materials.

2.3.1.3. The bus shall be installed with rigid, non-tracking, fire resistance and non-hygroscopic epoxy insulating supports capable of withstanding the mechanical momentary current rating of the circuit breakers.

2.3.1.4. The bus shall be supplied in unit length which will permit rearrangement of the units in the field.

2.3.1.5. All load current carrying connection shall be flat bar or acceptable equal. All power current carrying connection shall be completed by bolting together flat bar.

- 2.3.1.6. All joints shall have some material contact surfaces with minimum contact resistance.
- 2.3.1.7. Instrument transformer primary connections shall be designed to permit removal and replacement of the transformer without damage to the connections.
- 2.3.1.8. Provisions shall be made for bays expansion to prevent undesirable or destructive mechanical strains in the bus support and connections, through a full ambient temperature to +50deg.C.

Expansion joints shall be furnished where required.

- 2.3.1.9. Except at bolted termination and connections points, all buses which are specified to be insulated shall be coated with epoxy type insulating material or acceptable equal molded around and bonded of the bus.
- 2.3.1.10. All bolted joints, expansion joints, bus connection, factory or field and all terminals, cable connector for attachment of conductor of terminals, cable connector for attachment of conductor of instrument transformer circuit and external circuits shall be insulated with removable boots. Removable boots shall be designed to overlap permanent bus or cable insulation a minimum of one inch upon each conductor in the connection insulated by the boot.
- 2.3.1.11. The insulating rating of bus, joint, connection and termination insulation shall be not less than the voltage rating of the equipment. Epoxy coating for 20 kV bus shall be coloured red for phase R, yellow for phase S, black for phase T and blue for neutral.
- 2.3.1.12. The Contractor shall furnish all material required for filled connections and insulating of switchgear bus and terminals.

2.3.2. Ground Bus

If required under the specification, an uninsulated copper bus with a momentary rating at least equal to the momentary rating of the circuit breakers shall be furnished through the entire length of the switchgear.

All switchgear equipment requiring grounding shall be connected to this ground bus. Set of ground bus is required only for 20 kV switchgear and shall be designed as so to be suitable for ground fault current.

2.3.3. Post Insulator

Post insulators can be made of porcelain or synthetic material. Porcelain insulators shall be in accordance with IEC recommendation no. 168.

Synthetic resin insulator shall be free from surface defects such as folds blowholes, etc., prejudicial to satisfactory performance in service and shall be in accordance with IEC recommendation no. 660.

2.3.4. Circuit Breaker

The image shows three handwritten signatures in blue ink. The first signature on the left is a stylized 'V' shape. The middle signature is a more complex, cursive script. The third signature on the right is a large, bold, circular mark with a horizontal line through it, resembling a stylized 'O' or a checkmark.

2.3.4.1. Each circuit breaker shall be of SF6 or vacuum type and three pole, single-throw, draw out type, electrical and mechanical trip free, motor charged spring closing and shunt tripping by DC 110 V battery, with draw out wheels.

2.3.4.2. Power circuit breakers shall be cooled by natural conduction, convection and radiation.

2.3.4.3. Circuit breaker shall be designated and manufactured so as to avoid switching overvoltage exceeding the withstand voltage of the related switchgear equipment and compartment.

2.3.4.4. Removable circuit breaker elements of the same type and ampere capacity shall be wired a like and shall be mechanically and electrically interchangeable.

2.3.4.5. Rating of circuit breaker shall be as follows :

	Incoming breaker	Outgoing breaker
Nominal voltage	20 kV	20 kV
Rated voltage	24 kV	24 kV
Rated insulation withstand		
- Power frequency	50 kV	50 kV
- Impulse	125 kV	125 kV
Rated current		
- Continuous	1250 A	2000A
- Short time withstand		
Current (3 sec.)	25 kA	25 kA
Rated breaking time	5 cycle	5 cycle
Control circuit voltage	110 V DC	110 V DC
Rated frequency	50 Hz	50 Hz
Rated Operating sequence	0-0.3 sec - CO - 15 S. - CO - 15 S - CO	
Making current	40 kA	40 kA
Spring charging motor voltage	230V AC	230 V AC

2.3.4.6. The operating mechanism shall be of the stored energy spring type with a closing coil and a shunt trip coil. The closing devices, tripping device, and charging motor shall be designed and rated for operation on the nominal control voltage specified. The charging motor shall be designed to permit mechanical uncoupling and emergency charging by manual operation. The operating mechanism shall be trip-free in any position and shall be anti-pump.

2.3.4.7. The circuit-breaker main contacts shall not touch or arc cross into a faulted circuit when a close signal is received while a trip signal is being applied.

2.3.4.8. Each circuit-breaker element shall be furnished with a manual trip button which mechanically trips the breaker. The manual trip push button and its associated breaker trip linkage shall have

no common components with the electrical trip mechanism, except the final breaker release device.

2.3.4.9. Each breaker element shall be furnish with an operation counter which shall be readable from the front of the switchgear unit with the breaker in the connected position.

2.3.5 Load Break Switch

2.3.5.1. The three pole SF6 or vacuum load break switches for station service transformer shall be manually operating mechanism:

- Rated voltage : 24 kV
- Rated current : 400 A
- Short time withstand Current (1 sec.) : 25 kA
- Rated short circuit duration : 3 sec.
- HV fuse : 45 A
- Activating of switching "OFF" : -O/C Protection via 45 A fuse
- Max. Temp. Rise of station transformer oil

2.3.5.2. The HV fuses shall be of enclosed type, the over voltages caused by interruption must in every case remain below double the peak value of the rated voltage. The fusible conductor, the arc quenching means etc. shall be housed inside a porcelain tube which is closed at either end by a contact making ferrule cap. A device must be provided to indicate when a fuse has blown and for tripping the load break switch.

2.3.6. Current Transformer

2.3.6.1. The transformer shall comply with the requirements of IEC 60185: 1987 and relevant British standard.

2.3.6.2. Current transformers, including primary winding conductors, shall have a short-time current rating and duration not less than that corresponding to the design short circuit level of the associated switchgear.

2.3.6.3. Current transformers shall have a maximum continuous primary current rating not less than the primary equipment rating of the bay in which they are installed.

2.3.6.4. Specification of current transformer as follow :

- Secondary current : 1 A
- Short time withstand current (3 sec) : 25 kA
- Rated burden and class : 20VA
- Measurement Class : 0.2
- Protection : 5P20

Should be matched with the required power for the relay and/or measurement equipment.

2.3.6.5. The secondary windings of each current transformer shall be earthed at one point only.

- 2.3.6.6. Magnetization curves shall be provided for each type and rating of current transformer.
- 2.3.6.7. Where the Contractor wishes to provide current transformer ratio differing from those specified, he shall first obtain approval in writing from the Engineer for each specific instance.
- 2.3.6.8. The output of each current transformer shall not be less than specified, but the Contractor shall ensure that the capacity is adequate for operation of the equipment being supplied.
The current transformer shall be installed on the circuit side of the circuit-breaker remote from the busbars except on busbar and sectionalizing equipment.
- 2.3.6.9. Each current transformer shall be individually labelled and serial plates are to be provided for fitting to the outside of current transformer chambers, etc. Where double ratio of secondary windings are specified, a label shall be provided at the secondary terminals of the current transformer indicating clearly the connection required for each ratio. These connections shall be shown on the appropriate schematic and connection diagrams.

2.3.7. Voltage Transformer

2.3.7.1. Voltage transformer shall comply with IEC 60186: 1987 (BS. 3941). They shall have secondary voltage of $100/\sqrt{3}$ volt when the rated nominal voltage is applied to the primary winding.

2.3.7.2. Specification voltage transformers as follow:

System voltage (kV)	20
Highest voltage equipment	24
Rated primary voltage (V)	$\frac{20000}{\sqrt{3}}$ or $\frac{110000}{\sqrt{3}}$
Rated secondary voltage (V)	$100/\sqrt{3}$; $110/\sqrt{3}$
Accuracy class:	3P; 0.2
Rated burden (VA)	30; 100

- 2.3.7.3. Voltage transformer shall be epoxy resin clad or where paper insulation is employed shall be immersed in low flammability dielectric fluid.
- 2.3.7.4. The primary windings shall be connected to the busbars through renewable fuses of adequate breaking capacity with current limiting features. HRC type secondary fuses shall be provided. These shall be so placed as not to be accessible to unauthorized persons.

2.3.8. Cable Terminations

Indoor/outdoor termination shall be heat shrinkable and suitable for XPLE insulated cables with Copper stranded conductors, up to 630 sqmm. Sufficient space shall be provided to house cable terminations.

2.3.9. Earthing Switches

- 2.3.9.1. The position of the three blades of the earthing switches shall be eye-checked in either the closed position or the open position through portholes provided in the enclosure.

2.3.9.2. As an alternative the earthing blades can be fitted with a position indicator. The indication must always be concordant with the actual position of the blades.

2.3.9.3. In case earthing switch is immersed in a dielectric medium other than air at atmospheric pressure or if the position of the blades cannot be checked as indicated above, than the earthing switch shall have a making capacity of 62.5 KA (peak).

Earthing switch shall be provided with independent manual operation, operated from the front face.

2.3.10. Interlocking

2.3.10.1. Switch Interlocking

In addition to the interlocking that prevent access into compartments, the following interlocking shall be provided:

- Operation of an isolating switch cannot be performed when the:
 1. Switchgear cell door is open
 2. Associated load switch or circuit breaker is in "closed" position
 3. Earthing switch of the cell is in the "closed" position
- Operation of an earthing switch cannot be performed when the switch device mounted in the cell is in the "closed" position.

2.3.10.2. Padlocking

Provisions shall be made for padlocking the load break, switches, and the isolating switches, the earthing switches in either open or closed position.

Circuit breaker can be padlocking in the open the position. Provision shall be also made for padlocking the access door to the cell.

2.3.11. Voltage Control Device

A voltage control device shall be installed in each unit/compartament provided with an earthing switch to shown if the cable is energized or not.

This device shall comprise three capacitors provided with low phase voltage output and connected to three neon lamps. The neon lamps shall commence to light when the phase to phase voltage reaches 13 KV.

All necessary precautions are to be taken to insure that at points where access is possible the effective voltage is not dangerous for the operations at any time.

2.3.12. Breaker Control Device

2.3.12.1. Each circuit breaker shall be furnished with a local control switch and breaker position switch arranged to provide the following control of breaker position.

Breaker Operation

<u>Breaker</u>	<u>Remote control</u>		<u>Local control</u>	
<u>Position</u>	<u>Close</u>	<u>Trip</u>	<u>Close</u>	<u>Trip</u>
Connected	x	x	x	x
Test		-	-	x
Disconnected	--	-	-	

2.3.12.2. Each circuit-breaker local control switch shall have a trip close escutcheon; shall have a center normal position; shall be spring return to normal from close and trip; shall have red and green targets to indicate the latest operation of the switch; and shall be furnished with red and green indicating lights.

10. CONTROL AND PROTECTION EQUIPMENT

1. CODES AND STANDARDS

Equipment furnished under these specifications shall be in accordance with applicable standards of or other equivalent internationally recognized standards.

2. GENERAL

The cubicles provided under these specifications shall match and line up with the Owner's existing cubicles. The Contractor may use any source of available information but shall verify design details by sufficient field surveys and comparisons to assure accurate match of dimensions, locations, materials, shapes, colors, and other pertinent details.

3. CONSTRUCTION DETAILS

3.1 Control and Relay Cubicles

The structure of the Control and Relay Cubicles shall be completely enclosed.

Control and relay cubicles shall have both the front and rear panel hinged with concealed hinges that are not visible from the outside of the panel.

Standard control and relay cubicles for extended substations shall be similar, match and line up with the existing cubicles.

Steel sheets and formed steel members shall be welded or bolted together to form a rigid self-supporting structure. The boards shall be provided complete with mimic diagram, measuring, control and protection equipment, terminal blocks, panel heating, bottom sheets, wiring auxiliary and accessory equipment and nameplates.

The measuring equipment and the control devices, including the mimic diagram and the alarm indication panels, shall be installed on the front of the cubicle.

The front of the cubicle shall also carry all equipment concerning transformer control and protection circuits like: Buchholz protection, temperature measuring, tap changer protection, pertaining interposing and tripping relays, etc.

The protection relays and kWh-meters shall be installed on the rear of the cubicle.

The arrangement of the equipment mounted on the control panels is shown on the drawings contained in Tender Document.

Degree of protection for the cubicles for indoor application in accordance to IEC 60529 is IP 54.

Equipment cut outs, mounting studs and brackets shall be accurately located. Welds on exposed surfaces of the structure shall be ground smooth.

The control and measuring and relay cubicles shall be 800 mm wide, 2,200 mm high, and 800 mm deep. Finished panel surfaces shall be free of waves, bellies, and other imperfections.

Mounting brackets, as required, shall be arranged inside the cubicle for mounting and wiring auxiliary devices and terminal blocks. They shall be located to allow access to the back of the equipment mounted on the front of the hinged panel.

Panel space not utilized by equipment shall remain clear for addition of possible future equipment. An approved receptacle shall be furnished, mounted, and wired in a convenient location near the front and rear hinged doors of the cubicle to be used for portable tools and drop lights and shall be connected to the 230 V AC single-phase source.

The interior of each cubicle shall be illuminated with a light, mounted inside the top of the cubicle and controlled by a door switch.

Each panel shall be equipped with a 230 V AC heating device with thermostat and ON-OFF switch to prevent the formation of moisture. Each heating device and switch shall be wired to common terminals on one cubicle unit to facilitate connection to the power source.

3.2 Auxiliary Marshalling Cubicles

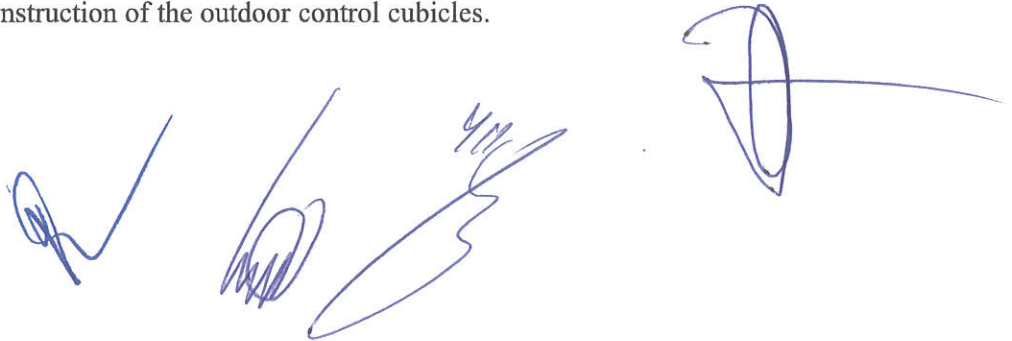
In several substation bays subjected to uprating i.e. where major electrical equipment (circuit breaker, disconnecting switches, instrument transformers, etc.) will be replaced by new equipment, the space in the existing Outdoor Control Cubicle available for circuit interfacing purposes might be very limited or even not sufficient. In such cases the Contractor shall deliver and install Auxiliary Marshalling Cubicles to serve as an interface between the circuits of the new equipment and the existing circuits leading to the control room.

The Auxiliary Marshalling Cubicle(s) shall be installed outdoors in the substation bay closed to the existing Outdoor Control Cubicle.

The Contractor shall provide sufficient terminal blocks as required for connecting all items of the new equipment to the existing auxiliary circuits. The cubicle shall contain 20 percent spare terminal blocks in addition. The terminal blocks shall be segregated by plant, control, inter-

tripping, indication, analogue, and by voltage. Terminal blocks subject to induced voltages shall be segregated and clearly indicated with warning labels.

The cubicles shall be free standing and of weatherproof and verminous of aluminum construction matched to the construction of the outdoor control cubicles.



4. CUBICLE PAINT AND NAMEPLATES

Except as otherwise specified, cubicle surfaces shall be completely factory painted before shipment to the job site. This includes painting of the inside and outside surfaces of all equipment. The painting shall consist of suitable primers and one burnt finishing coat as required to produce a smooth, hard, durable finish. The color of the exterior finish coats shall be light grey (RAL 7032 or similar) and has to match with the existing equipment. Interior surfaces shall be primed and finished in a similar manner.

All surface shall be carefully cleaned to bare metal before application of paint. Rust and scale shall be removed by sandblasting, power sanding, power grinding, or power wire brushing.

Shafts, pins, bushings, and other operating mechanism parts whose operation would be impaired by painting shall be protected by application of an easily removable rust preventive compound and shall not be painted.

Paint films which show sags, checks, blister, teardrops, or fat edges will not be acceptable and if any such defects appear, they shall be repaired by and at the expense of the Contractor.

Engraved nameplates shall be delivered in accordance with the requirements of these specifications including nameplates for each relay. Nameplate inscriptions, will be furnished by the Owner.

5. WIRING AND WIRING DIAGRAMS

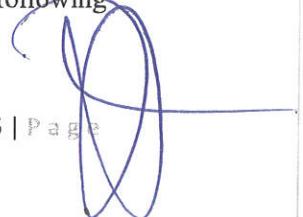
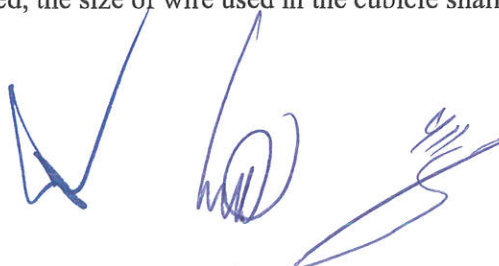
The Contractor shall provide internal cubicle wiring, connections, and diagrams in accordance with the requirements of the following paragraphs.

All wiring shall be neatly and carefully installed in wiring gutters or raceways. Instrument wiring on the panels shall be numbered sequentially from the source to the final instrument, and the number of the source equipment shall be used as a prefix for the individual wire numbers such as 1R1 being the phase one lead from current transformer 1R to the first instruments on that circuit. Wiring shall be terminated at terminal blocks plainly lettered or marked in accordance with manufacturer's connection diagrams.

Sufficient clearance shall be provided for all leads. All leads for external circuit wiring shall be connected to grouped terminal blocks located for convenient connection of external circuits. Splices will not be permitted in cubicle wiring.

Arrangement of circuits on terminal blocks shall be such that all connections for one circuit, plus any spare conductors, shall be on adjacent terminals. Cubicles that are split for shipment shall have terminal blocks adjacent to the split and shall be provided with wiring required to interconnect the split units.

Except as otherwise specified, the size of wire used in the cubicle shall conform to the following requirements.



Min. wire size (sqmm)

- | | |
|---|-------------|
| - Power supplies and packaged Control systems | as required |
| - Current transf. secondary circuits | 4.0 |
| - Control-switch wiring | 4.0 |
| - Voltage circuits | 2.5 |
| - Indicating lights and annunciators | 1.5 |

Extra flexible wire shall be furnished at hinge points.

The Contractors shall prepare control and protection diagrams, schematic (elementary), connection, and interconnection diagrams.

The complete connection diagram of each switchgear unit shall be on an individual sheet. Information on each connection diagram sheet shall include point-to-point wiring of the entire panel as it would appear to a person wiring the cubicle panel. Elementary diagrams of control and instrument circuits, contact arrangement of switches, and internal wiring of relays and instruments for each switchgear unit shall be on additional sheets, Interconnection diagrams shall be on separate sheets.

Each type of switchgear mounted equipment indicated on the diagrams shall be identified by item number and name.

6. BUSES

Control, potential, and alarm buses of 4 sqmm (12 AWG) or larger cubicle wire shall be furnished and installed as required.

A continuous 6 mm by 25 mm cross-section bare copper ground bus, with compression or clamp type connectors at each end, shall be provided in the cubicle. The end connectors for connection to the stranded copper ground cable shall be provided.

All cubicle equipment requiring grounding shall be connected to this ground bus.

7. POWER SUPPLY

Facilities shall be provided for the protection and isolation of power supply circuits associated with electrical instruments, protection and control. They shall be of approved type and grouped, as far as possible, according to their functions.

They shall be clearly labeled, both on the panels and the associated wiring diagrams.

Power supplies for recording instrument devices and other special devices shall be wired to a separate supply circuit for connection to the uninterrupted power supply. Isolation fuses, as specified above, shall be furnished for each power supply branch circuit.

8. TERMINAL BLOCKS

Terminal blocks shall be provided with white marking strips. Circuit designations shall be applied to the marking strips by use of black paint. Extra terminals, in a quantity of not less than 20 % of the active terminals, shall be provided on each terminal block for circuit modifications and for termination of spare conductors and multi conductor cables.

Shorting-type terminal blocks shall be used on current transformer leads.

Terminal blocks shall be located so that the accessibility to them will not be lessened by interference from structural members or panel instruments. The arrangement of connections on the terminal blocks shall be as approved by the Owner/Engineer.

Ample space shall be provided at terminal block termination of all external circuits for an adequate raceway system.

9. CABLE ENTRIES AND RACEWAYS

Adequate openings shall be furnished for all conductors entering the cubicles. Cable entrance to the cubicles for both power and control cable shall be from the bottom.

Cable entries to the cubicles shall be provided with approved cable glands preferably of metal, well matched to the diameter of the cable leading through. An additional 20 % spare cable glands shall be installed in each cubicle. After installation of the cables, as circular gap between cable gland and cable shall be permitted.

An adequate raceway system shall be provided for all wiring on each side of each panel as well as a horizontal raceway for front-to-rear panel wiring.

10. MEASURING INSTRUMENTS AND DEVICES

All indicating instruments shall be of the cubicle type with 1 % accuracy classification, shall be designed for semi-flush mounting and unless otherwise specified, shall be approximately 96 mm x 96 mm square with black frame. Scales shall consist of black 90 degree scales on a white background.

Indicating instruments shall comply with the related CT and VT ratio to avoid any multiplied reading.

All coils of the equipment specified shall be suitably impregnated to withstand the high humidity conditions existing in Afghanistan. All resistors shall have moisture resisting vitreous enameled coating.

All ammeters shall be designed for operation through 1A or 5A current transformer secondary as per specified requirements.

11. METERING DEVICES

The kWh and kVArh integrating meters are to be of the induction disc three-phase unbalanced load type, shall consist of three elements and shall be mounted in robust flush mounting metal

cases. Cases shall be finished in bright black enamel. Each meter shall be equipped with a single rate cyclometer register having at least 7 (6 plus 1 digit).

12. CONTROL DEVICES

12.1 General

Control devices shall be installed in the Control and Relay Cubicles as well or in the Outdoor Control Cubicles.

Control discrepancy switches shall be used for the control of circuit breakers and of motor operated disconnecting switches and earthing switches from the control room.

The control discrepancy switches shall indicated also the position of the circuit breaker or disconnecting/earthing switch.

The control discrepancy switch shall be of the cam switch type with red switch knob on a transparent white illuminated base. It shall have two normal positions at 90° from each other and two operating positions a further 30° from each normal position.

In the normal positions the on- or off-position of the circuit breaker or disconnecter shall be selected. The commands for "on" or "off" to the circuit breaker or disconnecting switch shall be initiated by turning the knob a further 30°. The knob shall turn back automatically from the operating position to the normal position. The c.d.s. shall be illuminated whenever its position does not correspond with the position of the c.b. or disconnecter.

Position indicators shall be of the electro-mechanical type. Different forms are preferred for disconnecting switches (preferably round front plates) and for circuit breakers (preferably square front plates). Position indicators shall be installed in the control room for the manually operated disconnectors if any. Position indicators for all disconnectors and circuit breakers shall be installed in the outdoor control cubicle.

All discrepancy lamps shall be arranged to flash and give an audible alarm when the position of the circuit-breaker or disconnecting switch is at variance with that of the indicator and shall be arranged to extinguish when the indicator is set to the correct position.

12.2 Voltage Control Device

The voltage control device shall be provided in the transformer control panel. The device shall operate automatically or manually. A corresponding selector switch shall be provided mounted on the front panel.

Automatic voltage control shall be initiated by a voltage regulating relay of an approved type and suitable for flush mounting. The relay shall operate from the nominal reference voltage derived from a voltage transformer in the transformer secondary having accuracy class 0.5 to IEC 60186.

Relay bandwidth shall preferably be adjustable to any value between 1.5 times and 2.5 times the transformer tap step percentage, the nominal setting being twice the transformer tap step percentage.

The relay shall be insensitive to frequency variation between the limits of 47 Hz and 51 Hz and shall be completed with a time delay element adjustable between 10 - 120 seconds. The relay shall also incorporate an under-voltage blocking facility which renders the control inoperative if the reference voltage falls below 80% of the nominal value with automatic restoration of control when the reference voltage rises to 85 % of the nominal value.

12.3 Synchronizing Facilities

Manual and automatic synchronizing facilities are required for all circuit-breakers controlling overhead line feeder and bus-coupler circuits.

The manual facilities shall include a swiveling synchronizing panel installed on the front of the control and protection cubicle with a double-voltmeter, a double frequency-meter and a synchrony scope.

The system is to be completed by adequate synchrocheck relays and is to be such that synchronizing must be established before the circuit-breaker can be closed.

Automatic synchronizing facilities and corresponding relays are described in detail under para 12.2

13. MIMIC BUS

The mimic bus shall perfectly be matched with the existing control panels.

Mimic bus material shall be one of the following:

- Brass, bronze, or copper with baked enamel finish.
- anodized aluminum.

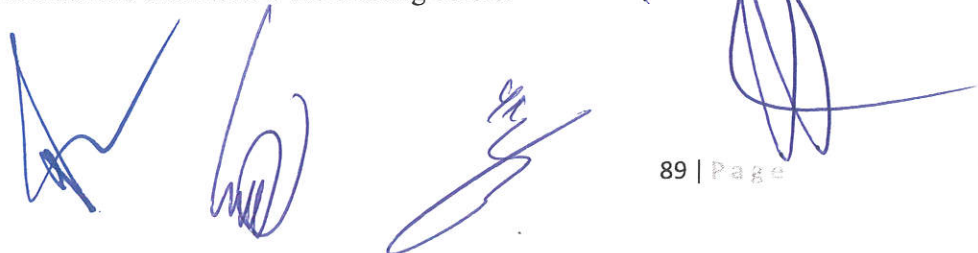
The mimic bus shall be attached to the cubicle by mechanical devices, not with adhesive. Attachments shall be closely spaced to hold all parts of the mimic bus firmly to the panel face and shall be concealed when the panel is viewed from the front.

Except as otherwise specified, mimic bus shall be provided with the following dimensions and colour :

Voltage	Bus Color	Thickness	Width
20 kV	Brown	3 mm	10 mm
70 kV	Yellow	3 mm	10 mm
110 kV	Red	3 mm	10 mm

The colour code for existing substations shall follow the existing colors.

14. ANNUNCIATORS



Annunciators shall be self-contained utilizing solid state electronic components for all logic circuitry. The front of the device shall contain the lamp windows; front covers shall be removable for replacing lamps. Static components shall be in the rear with access from the rear. The entire assembly shall be dust-tight, and equipment shall be suitable to operate under the local atmospheric conditions. Annunciators shall have lamp windows of approximately 25 by 38 mm area with translucent plexiglass windows and black, engraved lettering.

The annunciator operation shall be such that any supervised abnormal condition will cause the assigned annunciator point lamp to flash and the audible alarm to sound continuously.

Operation of the "HORN OFF" pushbutton shall silence the audible alarm. Operation of the "ACKNOWLEDGE" pushbutton shall cause the lamp to remain steady on. Operation of the "RESET" pushbutton shall extinguish the lamp only if the abnormal condition has been cleared. If the abnormal condition has cleared prior to acknowledgement, the lamp shall turn to slow remain flashing and the audible alarm shall remain on until the indication has been acknowledged, after which both the lamp and the audible alarm shall be de-energized. Operation of the "LAMP TEST" pushbutton shall cause all lamps to light.

Annunciator resetting devices to be furnished with the switchboards shall be either pushbuttons or rotary type switches. The annunciator design shall include full operational test features. Solid-state components shall be mounted in plug-in modules.

Annunciators and alarm contacts shall be suitable for operation at 110 V DC.

Complete external cable connections between alarm - initiating contacts and the annunciators shall be provided.

Means shall be provided in the annunciator equipment for suppressing induced voltages which may cause spurious alarms.

15 TEST AND EARTHING FACILITIES

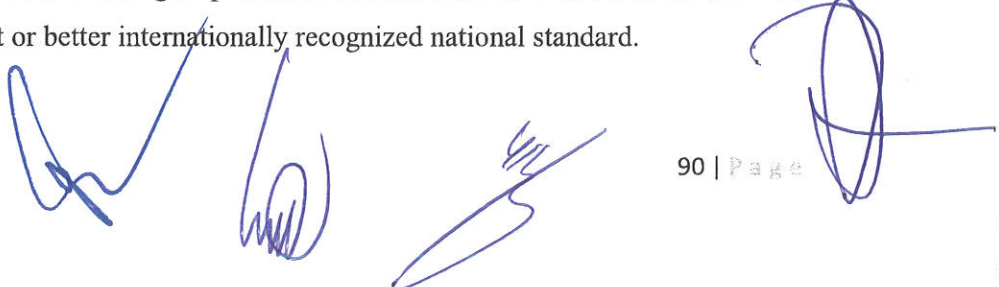
Test facilities shall be provided for each current and voltage transformer secondary circuit so as to give access for testing of protection relays and associated circuits. The facilities shall comprise test terminals of approved type for front of panel mounting with provision for automatic short-circuiting of current transformer secondary circuits by means of test-sockets and plugs.

Each current transformer circuit shall be earthed through a removable link at one point only, located in the outdoor control cubicle.

Links shall be provided for isolation of protection trip circuits.

16. PROTECTION DEVICES

The application, performance and testing of protective devices shall be in accordance with IEC 60255 and/or an equivalent or better internationally recognized national standard.



Protection equipment shall be designed and applied to provide maximum discrimination between faulty and healthy circuits. All equipment shall remain inoperative during transient phenomena which may arise during switching or other disturbances to the system.

The Contractor is responsible for a proper coordination of the protection system included in the scope of work and the protection system of the existing substations.

The relay types offered shall have references of at least 5 years of successful operation.

Relays shall be of approved types and be flush mounted in dust and moisture proof cases of preferably withdraw able type as per IEC 60068.

Relays shall be arranged so that adjustments, testing and replacement can be effected with the minimum of time and labor. Relays of the hand reset type shall be capable of being reset without opening the case.

Electrically reset tripping relays shall be provided for all those circuits which may be subject to supervisory control.

Relay contacts shall be suitable for making and breaking the maximum current which they may be required to control in normal service but where contacts of the protective relays are unable to deal directly with the tripping currents, approved auxiliary contactors, relays or auxiliary switches shall be provided.

Separate contacts shall be provided for alarm and tripping functions. Relay contacts shall make firmly without bounce and the whole of the relay mechanisms shall be unaffected by vibration or external magnetic fields.

Relays, where appropriate, shall be provided with flag or LED indicators, phase colored where applicable. Indicators shall be easy to reset without opening the case. Where two or more phase elements are included in one case separate indicators shall be provided for each element.

The external d.c. supply of relays shall be monitored and an alarm provided in the event of failure.

Trip circuit supervision relays shall supervise the trip circuit of a circuit-breaker, initiating audible alarm and visual indication if the trip circuit fails or the mechanism does not operate.

It shall be provided to detect failure in the trip circuit and shall be able to detect open circuit trip coil or trip circuit wiring and failure of circuit-breaker tripping mechanism.

Trip circuit supervision relays shall give supervision with the circuit-breaker in either state (open or closed).

Series resistances shall be provided as necessary to ensure that the trip coil will not operate in the event of short-circuit of any component of each monitoring circuit.

Duplicate monitoring relays shall be provided for all circuit-breakers fitted with a second trip coil.

Relays shall be provided with clearly inscribed labels describing their application and rating in addition to the general purpose labels.

Attention is particularly drawn to the tropical climate conditions.

17. AUTOMATIC RECLOSING

The automatic reclosing relay supplied shall be able to carry out high-speed multi-shot single and three-phase [to be removed] auto reclosure.

The relay shall be easily adjustable from the relay front panel for every mode of operation.

It shall be provided for:

- Single phase auto-reclose
- Single or 3 phase [to be removed] auto-reclose depending on fault type
- 3 phase for all fault types
- Selectable single or 2-shot auto reclose
- Independently adjustable dead time, close pulse and reclaim times
- Built in test facilities.

The relay shall provide test facilities as follows:

- To read the state (i.e. on or off) of each input to, and output off, the relay.
- To monitor the operation of all timers via a dedicated input and output.
- With the relay out of service, the state of each relay can be changed

18. SYNCHROCHECK RELAYS

Synchro check relays shall be provided to match with the three pole delayed auto reclosing scheme.

The synchro check relay shall monitor the magnitude of the two voltages on both sides of the open circuit breaker and the phase angle and frequency between these voltages. Closing shall only be permitted when these are within prescribed limits. The voltage setting shall be adjustable between 80 and 90 % of rated voltage and the phase angle setting adjustable between 5 and 40 degrees. The maximum permissible slip frequency shall be 4.4 % of rated system frequency.

Synchro check relays shall be used to monitor manual and supervisory closing as well as auto-reclosing and shall be provided for all circuit-breakers.

Synchro check relays shall check the phase and magnitude of the voltage-difference at synchronizing as well as frequency-difference, with contacts connected to prevent inadvertent manual synchronizing or auto-reclosing outside acceptable limits.

A guard feature shall be provided to monitor the contacts of the check synchronizing relays to ensure that these are not welded together or otherwise permanently closed. Should the latter condition be detected, closing of the circuit-breaker shall be blocked.

Synchro check relays shall be suitable for use with the remote supervisory control scheme, if required, without further modification.

All necessary relays (including voltage selector relays) and other equipment are deemed to be included in the prices.

19. OVERCURRENT PROTECTION

The overcurrent protection shall be suitable to cope with all phase phase and earth faults occurring in the line they are protecting.

The overcurrent protection shall be equipped with three-phase instantaneous and definite time overcurrent relays.

It shall have standard inverse characteristic and be provided with adjustable settings for both operating current and time, the design being such that the adjustment can be carried out on load. The relays shall be thermally rated such that the operating time of the relay, at the highest practical current levels on any combination of current and time multiplier settings shall not exceed the thermal withstand time of the relay.

Separate output contacts, capable of circuit-breaker tripping for time delayed phase fault, instantaneous phase fault, time delayed earth fault and instantaneous earth fault operation shall be provided.

Preferably flush mounted plug in relay units shall be offered with automatic short-circuiting facilities, when the relay is withdrawn.

Additionally the following features shall be provided:

- self monitoring function
- short reset time/high reset ratio
- reduced consumption
- front panel signal lamps for start and trip condition
- reset button at front panel

20. TRANSFORMER DIFFERENTIAL PROTECTION

The transformer differential protection shall be of the instantaneous biased differential type providing protection for phase and earth fault.

The necessary interposing current transformers associated with this relay are to be provided under this contract.

The relays shall have magnetizing inrush current restraint of the harmonic type and shall have individual adjustment of operation and bias settings.

The minimum operating settings shall be not more than 30 % of the current transformers secondary rating.

All systems shall remain stable under maximum through fault conditions corresponding to rated system short-circuit level on any tap position.

21. NEUTRAL EARTH FAULT OVERCURRENT PROTECTION

Where required, secondary transformers shall be provided with earth fault overcurrent protection for neutral grounding resistors.

Neutral current transformer associated with this relay shall be provided.

22. RESTRICTED EARTH FAULT PROTECTION (REF)

Transformer's HV and LV windings shall be provided with restricted earth fault protection.

Relays shall preferably be of the high impedance type with necessary protection against over voltages.

Relays shall have maximum sensitivity and minimum operating times consistent with stability for faults outside the protected zone and on magnetizing inrush surges.

Line and neutral current transformers associated with the REF protection shall be provided.

The Contractor shall ensure that line and neutral current transformers have identical turns ratio and magnetization characteristics.

23. SYSTEM CONTROL CENTRE FACILITIES

For the tele control facilities required at the Area Control Centre (ACC), the following provisions shall be made available under this Contract:

a. Status Indications

- Circuit breakers, bus and line disconnecting switches and earthing switches
- Local/remote switch position for circuit breakers and disconnecting switches
- synchro check in progress

b. Load Flows, System Voltages and Frequencies (analogues)

- Power flow (MW and MVAR) on all 110 kV feeders
- Busbar I and II voltages and frequencies

c. Alarms

- Circuit breaker auto reclosing
- 110 kV feeder main protection operated
- 110 kV feeder back-up protection operated
- Circuit breaker fault

d. Remote Control

- Circuit breakers
- Bus and line disconnecting switches

Therefore all plant supplied under this Contract shall be equipped with sufficient potential free auxiliary contacts. CT and VT circuits shall be fitted with the appropriate terminals in sufficient number to connect auxiliary CTs and VTs respectively transducers supplied under a separate contract.

Provision shall also be made for the future installation of interposing relays for supervisory control functions.

In the control and relay panels tele control interface marshalling terminals shall be provided to form the interface between the plants supplied on the Contract and the tele control equipment (see attached drawings).

All necessary wiring and cabling from the plant's control, alarm and measuring circuits to the tele control interface marshalling terminals shall be provided under this Contract.

Cabling between the interface marshalling terminals and the tele control equipment will form part of a separate contract.

Remark:

In case a special tele control interface cubicle is specified, this shall be located adjacent to the relay panels in order to keep cable runs to a minimum.

The cubicle shall be of similar construction to the control and relay cubicles, both in size and colour and with lockable doors.

Removable gland plates shall be provided for the cable from the control and relay panels and for the outgoing cables to the tele-control equipment's.

24. MAINTENANCE AND OPERATING EQUIPMENT

The Bidder shall include with his proposal a complete list of necessary special tools, maintenance and operation equipment which are required to perform all the works concerning maintenance, operation and repair to be done by the owner.

25. SPARE PARTS LIST

The Bidder shall include in the "Schedule of recommended spare parts" a complete list of spare parts or special tools which in his opinion are additionally required for his equipment, to the spare parts listed as a minimum in the Bill of Quantities.

26. INSPECTION AND TESTS

26.1 Type Tests

Type test may be waived at the Owner's/Engineer's discretion if adequate type tests have already been performed and copies of the type test reports are supplied giving detailed test information, including test results.

Additional tests shall be performed on each type of relay supplied under the contract as follows:

All equipment containing semi-conductors shall be subjected to:

a. Transient over voltage tests.

The transient over voltage test shall be performed by applying 8.5 kV 1/50 microsecond's impulse from an approved generator to the relay terminals as the following:

- Between any terminal not normally connected to earth
- Between terminals not normally connected together, between terminals of the same circuit, each circuit being tested in turn.

The relay shall withstand this test without damage or risk or mal-operation.

- b. High frequency disturbance tests.

The high frequency disturbance test shall be performed by applying a wave of high frequency signals as described in IEC Recommendation 60255 Appendix E. The equipment shall suffer no damage, shall not operate incorrectly or fail to operate when required to do so.

- c. Test to prove that the relay will not mal-operate or that its performance is unaffected when the d.c supply is interrupted and/or reduced, irrespective of the duration of interruption and magnitude of the DC and irrespective of the magnitude of the a.c measuring quantities.

26.2 Routine Tests

After the cubicles have been fabricated and all parts assembled, the complete gear, including instruments and devices, all relays and associated equipment shall be routine tested to prove the quality and accuracy.

Routine tests shall be effected in accordance with the relevant IEC Recommendations, supplemented by additional tests as is considered necessary by the Engineer/Owner.

Conjunctive type tests shall be performed on each type of protective scheme simulating service conditions as closely as possible to prove sensitivity, stability, operating times and correct operation.

Routine test reports shall be submitted for each relay and piece of equipment. The reports shall record all measurements taken during the tests together with standard values which should be reached.

11. NUMERICAL RELAYS

1. GENERAL RELAY REQUIREMENTS

Protective relays shall conform to the latest IEC/ANSI/BS standards and be of a totally digital modular design.

The manufacturer of relays shall have at least 15 years' experience in manufacturing the relays continuously.

The proposed relays shall have been installed and successfully operated for at least 2 (two) years in tropical countries similar to Afghanistan and Protection Relay have capable to install the existing SCADA the new Transformer Bay System.

Dynamic test shall be performed on numerical relays and the test shall be in accordance with "CIGRE Working Group 04 of Study committee 34" concerning "Evaluation of Characteristic and Performance Power System Protective Relays and Protective System".

In addition to the relays protective function the following features shall be available as standard on all products.

- Serial communication facilities to allow relays to be connected to a multi-drop network and accessed via a single multi-function software package. The accessories of communication interface for each individual relay to form the communication network shall be stated and

provided with each relay. The guideline of the communication network installation shall also be provided.

- By an interface unit or other means, the whole protection system shall be able to communicate with the master station via a single IEC 60870-5 link.
- Comprehensive self-monitoring with indication on the front of the relay and watchdog contacts for alarm annunciation.
- Fault information for at least the last five faults. This shall be available for display via the front of the relay or via the access software.
- Event recording, including change of state of input/output and fault information, time tagged to one millisecond accessible via the serial communication port.
- Disturbance recording facilities for all measured analogue quantities, control inputs and relay outputs accessible via the serial communication port.
- A minimum of eight programmable op to-isolated inputs for control functions, as well as a minimum of eight programmable output contacts for system flexibility.
- Measured analogue quantities shall be available to be selectivity displayed on the front of the relay or via the access software.
- The relay shall accept both ac and dc auxiliary voltage input at rating 24-125 V or 48-250 V.

3. TRANSFORMER DIFFERENTIAL RELAY

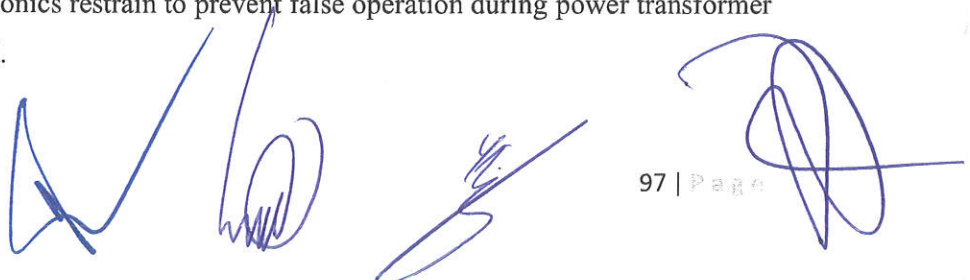
The microprocessor based protection relay shall consist of the following standard transformer differential protection features:

The transformer differential protection relay shall be a three phase unit with internal vector group compensation, CT ratio correction and zero sequence traps there by eliminating the need for external interposing transformers. The CT ratio mismatch correction shall be 0.05-2 or 0.1-30 in 0.01 steps.

The relay shall have dual slope bias differential characteristic in effective bias current vs differential current group. The initial slope shall be 20% or 25% for bias current of zero up to rated current. The bias slope is there after increased to 80% or 100%. The minimum differential current required for operation shall be adjustable from 10% to 50% of the rated secondary current in 10% steps.

The relay shall be able to provide with 1A CTs input on the high voltage winding side and 1A CTs input on the low voltage winding side if necessary.

The relay shall have magnetizing inrush current restraint by using waveform or second harmonic recognition technique. The fifth harmonics restrain to prevent false operation during power transformer over-excitation shall be also provided.



An additional unrestrained instantaneous high-set shall be provided to ensure rapid clearance of terminal faults. The setting range shall be 500%-2000% of rated secondary current in 50% steps.

The relay shall provide restricted earth fault protection for each of the power transformer winding. The REF protection shall work on the high impedance circulating current principle. The current setting range shall be 5%-100% of rated secondary current in 0.5% steps.

The relay shall provide v/f over flux protection against prolonged over fluxing conditions. Two independently adjustable V/f elements are available for over fluxing protection. The alarm element shall be definite time characteristic with a time setting range of 0.1-60 sec in 0.1s steps. The protection element shall be IDMT or definite time characteristics. The IDMT characteristic shall follow the equation below:

$$T = 0.18 + \left[\frac{0.18K}{\frac{v}{f} - 1} \right]^2$$

Where K = time multiplier (1 to 63 in steps of 1)

Setting = 1.5-3 V/Hz in steps of 0.01 V/Hz

For definite time characteristic, the time setting range shall be 0.1-60 sec in 0.1s steps.

The feature of the relay shall be assessable through the front panel or via the remote communication facility. The relay shall provide RS-485 or RS-232 port for multi-drop mode communication.

The relay shall provide at least two setting groups. The setting groups shall be selective via the logic input or remote control.

The relay shall store at least 50 event records and the latest fault disturbance record.

The relay shall have 8 programmable opto-input for monitoring the status of contacts of external plant such as Buchholz protection and temperature measuring devices. Each input can be routed to any number of the output relays via a variable time delay if required. The timers setting range shall be 0 to 14.4 ks (4 hrs).

The relay shall accept IRIG-B signal for time synchronization. The accuracy of the internal real time clock when not synchronized be better than 1s per day.

4. OVERCURRENT AND EARTH FAULT PROTECTION

The microprocessor based protection relay shall consist of the following standard overcurrent and earth fault features:

Relay shall be of the numerical type with three overcurrent stages per pole. The settings for each stage shall be completely independent of each other. The first measurement stage shall have selectable characteristics of the definite time or normal inverse, very inverse, extremely inverse and long-time inverse of the four inverse time (IDMT) type characteristics conforming to IEC 60255-4 and the BS 142 be standards. The characteristic that will be used by the overcurrent and earth fault shall be individually selectable. The second and third measurement stages shall be definite time characteristic.

The first stage phase overcurrent setting shall be 10%-320% of the rated secondary current in 1% steps. The time setting multiplier shall be 0.025-1.2 in steps of 0.025 for IDMT. The definite time setting shall be 0-100s in 0.01s steps. The second and third stage phase overcurrent settings shall be 10%-1600% or 80%-3200% of the rated secondary current in 1% steps. The definite time settings shall be 0-10s respectively 0.01s steps.

The first stage earth fault setting shall be 2%-80% or 10%-300% of the rated secondary current in 0.25% steps. The time setting multiplier shall be 0.025-1.2 in steps of 0.025 for IDMT. The definite time setting shall be 0-100s in 0.01s steps.

The second and third stage earth fault setting shall be 2%-80% or 10%-300% of the rated secondary current in 1% steps. The definite time settings shall be 0-100s and 0-10s respectively in 0.01s steps.

The feature of the relay shall be assessable through the front panel or via the remote communication facility. The relay shall provide RS-485 or RS-232 port for multi-drop mode communication.

The relay shall provide at least two setting groups. The setting groups shall be selective via the logic input or remote control.

The relay shall store at least 50 event records and the latest fault disturbance record.

The relay shall accept IRIG-B signal for time synchronization. The accuracy of the internal real time clock when not synchronized be better than 1s per day.

The relay shall provide broken conductor(s) detection logic to protect against single phasing condition. The logic shall base on measurement of no current in the broken conductor(s) (up to 2 conductors) and measurement of load current in the remaining healthy conductor(s). The logic shall use two measurement elements to prevent mal-operation in light load condition: one element to confirm no current flowing in the broken conductor(s) and the other element to confirm load current flowing in the healthy conductor(s). The logic shall provide sensitivity of no current measurement of 2%. The logic shall provide option to detect single conductor broken condition.

The relay shall provide circuit breaker fail protection. The protection shall be selectively initiated via the internal timer and undercurrent element, or external contact.

Where the application requires the use of directional over-current relays these shall have the facility for selecting individual elements to be directional or non-directional. The relay shall also be provided with some method to ensure correct directional decisions if the polarizing voltage collapses below the minimum required operating voltage.

Note: Contractor responsible for interfacing the New Transformer Bay with local existing SCADA system

And BCU which Contractor consider as per IEC 60870-5-104 IEC 61850, energy analyzer should be supporting TCP Modbus and RTU Modbus.



12. 20 KV CABLE AND ACCESSORIES

1. STANDARDS

The cables and cable accessories are to be designed and manufactured in accordance with the latest edition of the relevant I.E.C publication and where applicable supplemented by the latest addition of the following:

	NF.C	Standards	(French)
or	VDE	Standards	(German)
or	BS	Standards	(British)
or	NEMA	Standards	(U.S.A.)
or	JIS	Standards	(Japanese)

And the current edition of this specification.

Equipment meeting other authoritative standards, which ensure and equal or higher quality than the standards mentioned in this specification, will also be accepted.

The IEC and International Recommendation concerned by the present specification are indicated but not limited by the following list.

- IEC 60060 - High voltage test techniques
- IEC 60121 - Commercial annealed aluminum electronic conductor wire
- IEC 60228 - Conductors of insulated cables
- IEC 60230 - Impulse test on cables accessories
- IEC 60287 - Calculation of continuous current rating of cables
- IEC 60446 - Identification of insulated and bare conductors by colors
- IEC 60502 - Extruded solid dielectric insulated power cables
- IEC 60811 - Test for insulation and sheets of electric cables
- BS 6360 - Copper conductors in insulated cables
- ICEA S.66 542 - Cross linked thermo setting polyethylene insulated wire and cable
- ES I 09-13 - HV Heat shrink components for solid dielectric cables up to 33 kV
- ASTM D2303 - Inclined plane non-tracking test method

2. CABLE CHARACTERISTICS

2.1. GENERAL

The minimum voltage cables shall be of the single core type, cross-linked polyethylene insulated, screened and PVC sheathed. The rated voltage U_0/U is : 12/20 kV.

The cables will be laid directly in the soil at an average depth of 0.8 meters in trefoil formation.

The continuous current rating of cables (100% load factor) given for a ground temperature of 20°C (flat formation) will be not less than

The maximum temperature of the conductor under continuous loading shall not exceed 90 °C.

Bidder shall also indicate the short time currents that the cable may carry for 0.1, 0.2, 0.5 and 1 second.

The maximum temperature under short time current shall not exceed 25°C.

Cables shall be delivered on non-returnable drums.

2.2. Constructional Details

The cable composition will comprise:

(a) A circular, stranded aluminum conductor

(b) A semi-conducting screen over the core.

The thickness of the screen shall not less than 0.8 mm

(c) An extruded insulation layer made of cross-linked polyethylene (hereinafter called XLPE).

The nominal insulation thickness is 5.5 mm

The insulation layer shall be homogeneous, free from gas bubbles or impurities, without residual internal stresses.

Mechanical properties of the XLPE shall be as follows:

- Minimum breaking stress: 12,2 N/mm²

- Minimum elongation at breaking: 200%

(d) A semi-conducting coating over the insulation entire surface area of an easy strip ability.

(e) A metallic screen comprising two copper tapes or copper wire screen. It shall be applied to form a complete screen over the insulation. Joints between successive tapes shall be made by brazing. The thickness of the metallic screen shall be such that it can withstand 1000 A current for one second.

(f) An outer polyvinyl chloride (PVC) protection sheath. The material shall be compatible with the maximum permissible temperature of the conductor as defined. The nominal thickness of the outer sheath shall not be less than:

2.1 mm for 150 sqmm cable

2.4 mm for 400 sqmm cable

3. CABLES ACCESSORIES CHARACTERISTIC

3.1. General

All 20 kV straight through joints and termination shall be of the heat recoverable polymeric type. They shall be factory engineered kits containing all the necessary components to restore the cable insulation metallic shielding and earthing system of each core, together where applicable with the reinstatement of the sheath and armor, equivalent to the cable being jointed or terminated. They shall be generally as shown in drawings.

The Contractor shall supply complete illustrated instruction describing the methods for jointing or terminating each type and size of cable.

Each terminating or jointing kit shall be in a separate package and a list of materials indicating quantities in the kit, and instruction sheet shall be included in the package.

Kits shall contain sufficient cleaning solvents and cleaning cloth for the proper making of the joint or termination.

Voltage stress relief shall be inherent in the heat recoverable polymeric material.

The joints or terminations shall be easily adapted to accommodate XLPE cable type. The joints or termination shall be capable of tolerating any variance in the manufactured dimension of the cable such as oval, out of round, sector or oversized cable cores.

The joint or termination shall be capable of immediate energization once all components have been installed. The jointing or materials shall not be subject to storage such limitations such as controlled temperature or humidity restriction, nor have shelf life limitations.

3.2. Composition

The straight through joint kits shall comprise:

- Compression connectors suitable for aluminum
- Black stress control modified extruded polyolefin tubing
- Red insulation modified extruded polyolefin tubing dual-layer insulating and conductive modified extruded polyolefin tubing
- Outer thick-wall adhesive-coated protective tubing
- earthing system
- All other items necessary to complete the kit

The termination kits shall comprise:

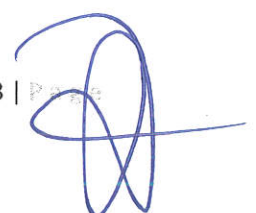
- Bimetallic lugs of the water blocked compression type
- Red non-tracking weather resistant modified silicone base exterior tubing
 - Black modified polyolefin extruded impedance layer stress control tubing
- Red non-tracking modified silicone base weather skirts (not more than 1 pc for indoor and 4 pcs for outdoor)
- Red sealant tape (optional)
- Copper braid for earthing onto screen
- Earth clamp assembly
- All other items necessary to complete the kit

3.3. Heat Recoverable Material Polymeric Materials

Heat recoverable material for 20 kV power cables shall consist of a heat shrinkable polymeric system providing high permittivity electrical stress control, non-tracking exterior surface and complete environmental sealing.

Heat recoverable polymeric materials shall comply with requirements of IEC 60060 sub clause 3.3, IEC 60071 and IEC 60507 section 3.

The material and the completed jointed or terminations shall be for the appropriate type of service, size and voltage and shall include ferrules, lugs and other materials necessary for the jointing or terminating



of the aluminum conductor and clamps, braid, etc. necessary for the through jointing or terminating of armour and sheath for earth continuity.

Electrical stresses shall be controlled by an high permittivity high resistivity heat shrinkable polymeric tubing.

All heat shrinkable polymeric tubing shall be ultra violet stable, non-tracking (per ASTM D2303 and SI 019-13) and suitable for operation in the presence of severe external contaminating and environment pollution.

The entire termination or joint shall be environmentally sealed with heat activated adhesive and capable of preventing the ingress of external moisture and contamination.

Internal terminations shall fully insulate all bare metal adjacent to the termination, except at the exposed lug.

3.4. Tools

The following tools of well proven design and performance shall be supplied for cable jointing and laying.

- * Cable pulling sock-flexible steel wire woven with swivel for all cable types and sizes.
- * Cable pulling sock-flexible steel wire woven with swivel split type for the required cable types and sizes.
- * Manually operated hydraulic 12 tons compressors complete with dies to fit all compression connectors or terminals as supplied with the jointing and terminating kits.

One tool shall be suitable for all die sizes, and shall completed with:

- Recommended kit of spares, each kit to include at least three sets of seals other items required during normal servicing.
- Pressure test gauge including test blank dies.
- Complete set of repair and service tools.
- Maintenance and operating instructions.
- Service and repair manual
- Strong metal box for protection of hydraulic compressor unit when not in use.
- Gas regulation outlet of sufficient flow to operate gas torch, with spare tips, jets, gaskets, etc. and gas hose including coupling and fittings 6 meter length.
- Tools for cutting cable sheath and armor.

4. INSPECTION AND TESTING

4.1. Cable

The cables will be commissioned at the manufacturer's premises by a representative of an inspection organization approved by DABS and who be designated at some later date.

The test listed hereafter shall be carried out in accordance with the provisions of the relevant IEC standards supplemented by the specific requirements indicated hereafter.

In the absence of IEC recommendations, the test must be equivalent at least to conditions, provisions and definitions set out in one of the standards as mentioned in Clause 2.1.

4.1.1. Routine Test

These tests shall be carried out on all finished cable length (each drum of cable) ready for deliveries.

These tests include:

- a. Visual inspection of the cable
- b. Dimension measurement
- c. Measurement of the electrical resistance of conductor
- d. Measurement of the electrical resistance of insulation
- e. High voltage test
- f. Partial discharge test
- g. Capacitance measurement

4.1.2. Special Test

These tests shall be carried out for every manufactured cable length on sample taken at random on the basis of one sample for every 10 km of manufactured cable with a minimum of one sample.

These tests include:

- a. Conductor examination and check of dimensions.
- b. Inspection/verification of construction and dimensions of the complete cable
- c. High voltage test of 36 kV for 4 hours
- d. Hot set test for XLPE insulation and PVC sheath

4.1.3. Type Tests

Bidder shall include with their offer test certificates in accordance with IEC 60502.

The type test described hereinafter will be carried out on sample cut from the supply length.

These tests need only be carried out if the manufacturer is not in a position to produce "Compliance Certificates" duly approved by an independent authority of international repute stating the cables, having same cross-section as required in the Specification, were manufactured and tested completely in accordance with the present applicable standards.

These tests include:

- a. Measurement of the electrical resistance of conductor
- b. Measurement of the electrical resistance of insulation
- c. High voltage test
- d. Partial discharge test
- e. Bending test followed by partial discharge test
- f. Tang delta measurement as a function of the voltage

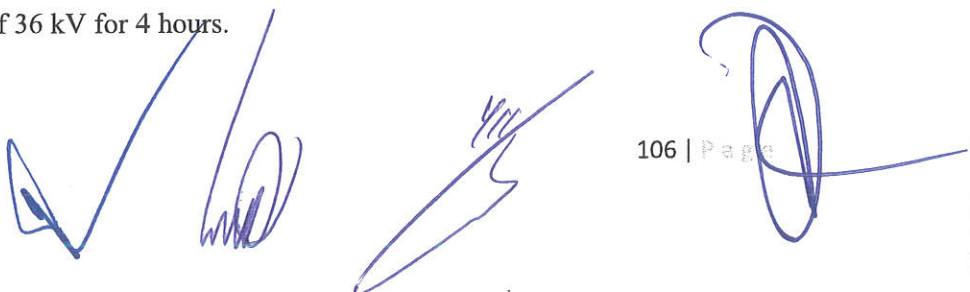
- g. Capacitance measurement
- h. Tan delta measurement as a function of the temperature
- i. Insulation resistance measurement at maximum rated temperature conductor
- j. Heating cycle test followed by partial discharge test
- k. Impulse withstand test followed power frequency voltage test
- l. High voltage test at 36 kV for 4 hours
- m. Visual inspection of the complete cable
- n. Dimension measurement of each cable component part
- o. Test for determining mechanical properties (tensile strength and elongation) of insulation before and after ageing.
- p. Test for determining mechanical properties (tensile strength and elongation) of insulation before and after ageing.
- q. Additional ageing test on pieces of complete cable.
- r. Loss of mass test on PVC sheath
- s. Heat shock test (cracking) of PVC sheath
- t. Hot pressure test PVC sheath
- u. Shrinkable test for XLPE insulation
- v. Hot set test
- w. Flame retardance test of PVC sheath
- x. Water absorption test on insulation
- y. Watertightness test

4.1.4. Acceptance Test

The acceptance procedure for any delivery of the cable is as follows:

1. Inspection of the complete cable
2. Study of the result of the routine test, and eventual repeat of some of these tests.
3. Carrying out, on samples taken at different intervals, of all or part these mentioned in the routine test and special test at least:
 - a) Measurement of the electrical resistance of conductor
 - b) Measurement of the electrical resistance of insulation
 - c) High voltage test
 - d) Partial discharge test
 - e) Tang delta measurement as a function of the voltage
 - f) Capacitance measurement
 - g) High voltage test of 36 kV for 4 hours.

4.1.5. Test after Installation



When the installation of the cable and its accessories has been completed, the following test will be carried out. A test voltage (cable) be gradually applied between conductor and screen and maintained for 15 minutes. No breakdown should occur. The test voltage shall be in accordance with IEC 60502. A dielectric test will be carried out on accessories.

4.2. Accessories

4.2.1. Routine Test

20 kV cable Accessories are to be checked for compliance with specification here if and with the Schedule quantity.

4.2.2. Type Tests

Bidder shall include with their offers test certificates including test carried out in accordance with the appropriate IEC standards for cable accessories, which are issued by an approved internationally acknowledged reputable independent testing laboratory. At all times partial discharge value shall not exceed 3pc at 24 kV.

4.2.3. Test after Installation

When the installation of the cable and its accessories have been completed, the following test will be carried out. A test voltage (cable) will be gradually applied between conductors and screen and maintained for 15 minutes. No break-down should occur. The test voltage shall be in accordance with IEC 60502. A dielectric test will be carried out on cable accessories.

5. GUARANTEE

The manufacturer of the cable accessories will be required to supply the test certificates (certifying conformity with the standards applicable).

In the event that the equipment to be supplied fails to pass the required tests, the manufacturer will be responsible for the equipment until such time that the equipment is retested and proved satisfactory and the required test certificates are accepted by DABS, prior to dispatching the equipment.

13. LOW VOLTAGE AC AUXILIARY SUPPLY

1. CODES AND STANDARDS

The LV AC switchboards shall be designed and manufactured in accordance with the latest edition of all relevant IEC recommendations like IEC 60044, IEC 60947, IEC 60269, IEC 60439, etc., and where applicable, supplemented by the latest edition of one of the internationally recognized national standards.

2. GENERAL

The LV AC switchboards for supplies to substation auxiliary services shall be of the single busbar, air insulated cubicle type according to IEC 60947 incorporating air break manually operated switch fuse units, suitable for a 400/230 V, 3-phase 4-wire 50 Hz system having the neutral solidly earthed, for substation auxiliary transformers of minimum 200 kVA.

All switchboards shall have a short circuit rating of 16 kA, degree of protection of IP 54, and will be installed in the substation building in rooms which are not air conditioned.

3. CONSTRUCTION OF SWITCHBOARDS

3.1 General

Cubicle type switchboards shall be provided able to supply all LV AC auxiliaries of the substation.

The compartments of the switchboard shall be so arranged that those housing the control/switching units are grouped separately from further compartments housing the bus bars, terminal boards, cable boxes and glands.

LV AC switchboards shall be of metal enclosed free-standing type with protective insulating barriers between the phases and between phase and neutral.

Neutral connections for each circuit shall be made directly to the neutral bus bar in each fuse board via removable links.

Special attention shall be paid to the proper selectivity between the MCB installed at the switchboard and those at the end of the supply cable in the control and relay cubicle, the local control cubicle, etc.

3.2 Framework

The switchboard frames are constructed from angle-iron, or U-bars, or steel plate.

The minimum size of components used in construction of switchboard framework are as follows:

- Sheet steel (plate or folded) (mm) 3
- Angle iron (mm) 50x50x5
- Channel iron (mm) 50x38x5

The unit shall be rigid enough to withstand handling, operation and maneuvering, without strain, notably when the main switch is thrown or fuse cartridges connecting links are inserted.

The feeder panels shall be extendable type, by adding an additional frame bolted on to the initial panel.

This addition must be carried out without major modification to the original equipment.

The arrangement must be such that neither leakage currents flow in the vertical or horizontal struts by induction from service currents, nor any undue heating occurs in the frame.

4. SWITCHBOARD PARTS AND FITTINGS

4.1 Bus bars

The switchboards shall each include 3-phase bus bars and one neutral bus bars of high conductivity copper supported to withstand all normal and fault condition stresses. The neutral bus bars shall have a rating not less than that of the associated phase bus bars.

Protective insulating barriers shall be provided between the phases and between phase and neutral and adequate insulating partitions between compartments.

4.2 Circuit Breakers

The infeed circuit breakers shall be of the three-pole, single-throw, trip-free in any position, complete with controls and wirings and other accessories needed for operation. The feeders shall be provided with manually operated miniature circuit breakers (MCBs) suitable for the 400/230 V 3-phase 50 Hz system.

They shall be equipped with instantaneous electromagnetic and delayed thermal release respectively with potential free auxiliary contacts to be used for remote trip signaling.

4.3 Interlocks

Substation auxiliary services switchboards shall be provided with mechanical/electrical interlocks in order to prevent the two normal incoming supplies being paralleled.

4.4 Instrument

Low voltage AC switchboards shall be provided with the following instruments:

- a. One AC voltmeter with selector switch.
- b. Three maximum demand ammeters, one for each phase of the incoming feeder connected through a current transformer. The ammeter is to comprise an auxiliary pointer carried forward by the main pointer and an externally operated resetting device.
- c. One three-phase kWh-meter.
- d. Current transformer set located before the main switch to supply ammeter and kWh meter.

5. EARTH CONNECTION

The frame shall include an earth terminal in the form of a 14 mm threaded stud-bolt made of copper and fitted with 2 nuts and 3 washers.

This connection will be located on the front surface of one of the vertical frame struts, at a height of 30 cm from the base of the board. Earth connection shall have a short circuit rating not less than 12.5 kA.

6. PROTECTION AGAINST CORROSION

The frame shall be by hot dip galvanized. The zinc coating should have a minimum covering power of 5 g/sqmm, i.e. an even thickness of 70 microns approximately. All copper fittings in the electrical gear will be tinned to minimum thickness of 8 microns.

All nuts and bolts, together with other steel parts, for the electrical gear, will be cadmium plated to a minimum thickness of 8 microns.

7. TEST AND INSPECTION

The switchboards will be inspected at the manufacturer's premises by DABS or a representative of an inspection organization, approved by DABS.



14. DC EQUIPMENT

1. CODES AND STANDARDS

Batteries, battery chargers and accessories furnished under these specifications shall conform to the applicable requirements of the IEC, IEEE, and NEC.

The switchboards shall be designed and manufactured in accordance with the latest edition of all relevant IEC recommendation like IEC 60947, IEC 60269, IEC 60439, etc. and where applicable, supplemented by the latest edition of one of the internationally recognized national standards.

2. GENERAL

The DC equipment in the substations shall include the battery set, the battery charger, the distribution switchboard and all pertaining DC cables and auxiliary circuits separately for 110 V and 48 V DC.

In the event of power failure the DC supply facilities shall provide reliable and continuous current supply from the battery necessary and sufficient for the operation of the substation during a minimum period of 8 hours.

3. BATTERIES

3.1 Type and Rating

The battery shall be lead acid sealed type with nickel alloy positive plate grids and cadmium alloy negative plate grids designed to comply with the ratings based on the calculation by the Bidder.

Cell containers shall be sealed, heat resistant, clear, non-ageing high impact strength plastic with electrolyte level markers and flame arresting vents.

The battery shall have sufficient plates per cell and ample ampere-hour capacity to supply all loads for the period of specified with the chargers out of service.

Battery sizing calculations, discharge curves, and temperature correction factor shall be included in the Tenderer's proposal.

3.2 Battery Mounting, Connections and Accessories

Batteries shall be arranged in several rows on one level and mounted on steel racks of robust construction.

The stand shall be mounted on insulators and be so dimensioned that the bottom of the tier is not less than 300 mm above the floor.

All steel shall have not less than two finish coats of alkaline resistant Grey paint. Before application of paint, all surfaces shall be carefully cleaned of all dirt, moisture, rust, scale, lubricants and other substances. Lubricants shall be removed by suitable solvents. Rust and scale shall be removed by sandblasting, power sanding, power grinding or power wire brushing. Paint films which show sags, checks, blisters, tear drops or fat edges will not be acceptable and, if any such defects appear, they shall be repaired by the Contractor. Battery supporting rails shall be covered with a protective PVC runner plate not less than 1.5 mm thick.

Each cell shall be shipped dry and fully discharged. The first filling electrolyte has to be performed at site.

Batteries shall be supplied and erected complete with all necessary connections and cabling. Connections between tiers, between end cells and between porcelain wall bushings shall be by PVC cables arranged on suitable racking or supports.

Before jointing, joint faces shall be bright metal, free from dirt and shall be protected by a coating of petroleum jelly.

The Contractor shall include on his erection and assembly drawings complete information for tightening of all electrical connections secured with bolts or studs. The information furnished shall include torque wrench settings or complete details of other tightening procedures recommended for bus joints, connector attachments, and contact attachments.

The battery shall be complete, including the following equipment and material:

- a. Inter cell connectors to provide not less than 125 mm between cells.
- b. Connector bolts with alkaline resistant nuts.
- c. Terminal lugs for two cables per polarity.
- d. PVC connector covers.
- e. Cell lifting facilities.
- f. Dry flake electrolyte suitable for two complete fillings.
- g. Vent plug thermometer.
- h. Corrosion preventive grease.
- i. One set of numerals (one numeral per cell) suitable for permanent attachment to cells.
- j. Assembly wrenches.
- k. Other necessary accessories to complete the scope of work even if not expressly mentioned.

3.3 Spare Parts and Tools

Each battery set shall be provided with 10 % spare cells and a durable instruction card with a full set of test accessories, mounted in a strong wooden box, including one syringe hydrometer.

The Bidder shall include in recommended sheet of spare parts with his proposal a complete list of other spare parts and/or special tools which are deemed necessary to be furnished with the equipment including them into the price stated in the proposal.

4 BATTERY CHARGERS

4.1 Type and Rating

Battery chargers shall be self-regulating, solid state thyristor controlled, full wave rectifier type, designed for single and parallel operation with the batteries specified under these specifications.

Chargers need not be designed for automatic load sharing during parallel operation.

The chargers will be supplied from a 400/230V+10-15%, 3-phase, 50 Hz system.

Solid-state electronic circuits shall have A.C and D.C transient voltage protection and shall be designed to recharge a totally discharged battery without overloading and without interruption of a.c or d.c circuits.

The battery chargers shall be equipped with an automatic changeover relay and manually operated changeover switch for continuous and quick charging. It shall be adjustable for different continuous loading currents.

A battery earth fault and a battery low voltage detecting device for both the 48 and the 110 V system shall be incorporated in the respective switchboard. The voltage setting shall be adjustable over an approved range.

Battery earth-fault relays and low-voltage detecting devices shall each have three alarm contacts, one for local visual annunciation, one for the station control panel and one for audible alarm.

An over-voltage detection device shall be included to give local indication and remote alarm and to isolate the A.C supply to the chargers when the D.C voltage exceeds a specified value when connected to the load. A time delay shall be incorporated to prevent operation when a battery with high open circuit voltage is switched from the boost to float condition.

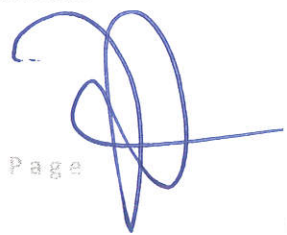
Each 48 volts and 110 volts battery charger shall have a continuous output capacity based on the calculation by the Bidder.

4.2 Accessories

Each battery charger shall be housed in a wall mounted steel cabinet, shall not require forced ventilation, and shall include the following features:

- 1 Voltmeter, indicating D.C. output voltage, 96 mm, 96 x accuracy class 1.5
- 1 Ammeter, indicating D.C. output current, 96 x 96 mm square, accuracy class 1.5
 - 1 Ammeter, battery charge & discharge current.
- 1 Circuit breaker, charger output.
- 1 Timer, high-rate charge, manual reset, 0-72 hour range.
- 1 Circuit breaker, charger input, 14 kA interrupting capacity at 400/230 volts.
- 1 Voltmeter, indicating, input a.c. voltage, 96 x 96 mm square, accuracy class 1.5
- 3 Indicating lights, one ac pilot light, one float charge indicator light and one high-rate charge indicator light
- 1 Charger failure alarm relay assembly, including under voltage relays for monitoring input and output voltages. Each relay shall be provided with two sets of contacts wired to terminal blocks for connection to external circuits
- 2 Potentiometers, one "Float Voltage Adjust" and one "High-Rate Voltage Adjust"
- 1 lot of nameplates as required to identify the function of each item mounted on the charger control panel.

The battery charger cabinet shall consist of a steel framework with top, bottom, front, back, and sides of sheet steel. Louvers shall be provided for ventilation as required for operation in the specified ambient but the cabinet top shall be solid.



Bolts, clamps, connectors and other necessary accessories to complete the scope of work shall be supplied by the Contractor.

4.3 Painting

All galvanized steel surfaces shall be completely factory painted before shipment. This includes painting of the inside and outside surfaces of all equipment.

The painting shall consist of application of suitable primers and two or more finish coats of alkyd resin machinery enamel or lacquer as required to produce a smooth, hard, durable finish. The colour of the outside finish coats shall be grey RAL 7032 interior surfaces shall be primed and finished in a similar manner.

All surfaces shall be carefully cleaned to bare metal before application of paint. Rust and scale shall be removed by sandblasting, power sanding, power grinding, or power wire brushing.

Shafts, pins, bushings, and other operating mechanism parts whose operation would be impaired by painting shall be protected by application of an easily removable rust preventative compound and shall not be painted.

Paint films which show sags, checks, blisters, teardrops, or fat edges will not be acceptable and if any such defects appear, they shall be repaired by and at the expense of the Contractor.

4.4 Spare Parts

The Tenderer shall include with his proposal a complete list of other spare parts or special tools which will be furnished with the equipment and are included in the lump sum price stated in the Proposal. The Tenderer shall also list, as required by the Proposal Data section, additional recommended spare parts which will be furnished for the spare parts option price stated in the Proposal.

5. DC SWITCHBOARDS

5.1 General

The DC distribution switchboard shall be included for each type of battery set. Distribution switchboards shall be of the cubicle type.

Two-pole miniature circuit-breakers shall be fitted to the DC switchboard as required by the substation auxiliary supply requirements, however with a minimum of 6 or 10 A rating.

Special attention shall be paid to the proper selectivity between the mobs' installed at the switchboard and those at the end of the supply cable in the control and relay cubicle, the local control cubicle, etc.

The 110 V DC distribution switchboard shall feed the control, signaling and protection circuits under normal operation as well as the emergency lighting and all other auxiliaries which have to be supplied during power failure.

The 48 V DC distribution switchboard shall feed all facilities of the SCADA and telecommunication equipment.

A battery earth fault detecting relay which will center tap the 48 respectively 110 V system via high resistance shall be incorporated in the switchboard. The earth fault detecting scheme shall be completed with two indicating lamps (one for each busbar section when grounded) complete with test lamp facilities. All switchboards shall have a short circuit rating of 16 kA, degree of protection of at least IP 54, and shall be able to be operated in rooms which are not air-conditioned.

5.2 Construction of Switchboards

Cubicle type switchboards shall be so arranged that the cubicles housing the respective control units are grouped to form a multitier arrangement and a further part shall where possible constitute a cabling and wiring chamber of ample dimensions in which terminal boards, cable boxes and gland plates shall be located.

D.C distribution boards shall be of metal enclosed free- standing type with protective insulating barriers between the poles.

The metal casing of the fuse boards shall be provided with knock-out or other approved cable entries for accommodation of the cables and cable glands.

The switchboard frames are constructed from angle-iron, or U-bars, or steel plate.

The minimum size of components used in construction of switchboard framework are as follows:

- Sheet steel (plate or folded) (mm) 3
- Angle iron (mm) 50x50x5
- Channel iron (mm) 50x38x5

The unit will be rigid enough to withstand handling, operation and maneuvering, without strain, notably when the main switch is thrown or fuse cartridges connecting links are inserted.

The feeder panels shall be extendable type, by adding an additional frame bolted on to the initial panel.

This addition must be carried out without major modification to the original equipment.

The arrangement must be such that neither leakage currents flow in the vertical or horizontal struts by induction from service currents, nor any undue heating occurs in the frame.

Note: The manufacturer may freely choose any systems preventing closed magnetic loops such as use of anti-magnetic materials or insulator inserts between steel components.

The insulating cross-strut at the bottom of the frame will be used to carry the output cable ends.

The switchboards shall include:

- a. Bus bars with suitable capacity made of high conductivity copper supported to withstand all normal and fault condition stresses.
- b. Two pole circuit breakers which shall be electrically remote controlled from main control board and locally by manual control.
- c. Instrument: voltmeter, ammeter and other equipment to complete the switchboard ready for operation.

The frame shall include an earth terminal in the form of a 14 mm threaded stud-bolt and fitted with 2 nuts and 3 washers.

5.3 Protection against Corrosion

The frame shall be hot-dip galvanized. The zinc coating should have a minimum covering power of 5 g/sqdm, i.e. an even thickness of 70 microns approximately.

All copper fittings in the electrical gear will be tinned to minimum thickness of 8 microns.

All nuts and bolts, together with other steel parts, for the electrical gear, will be cadmium plated to a minimum thickness of 8 microns.

5.4 Test and Inspection

The switchboards will be inspected at the manufacturer's premises by DABS or a representative of an inspection organization, approved by DABS.

15. POWER TRANSFORMER

Specification for 20/110 kV Step-up Power Transformer

Item	Description/Details	Unit	
1	Transformer 20/110 kV Step up		
1.1	Windings(Pri/Sec)		Bidder To be specified
1.2	Type		Two winding Type
1.3	Rated power(at Substation location)	MVA	40
1.4	Rated voltage, primary winding	KV	20
1.5	Rated voltage, secondary winding	KV	110
1.6	Number required		1
1.7	No Load losses at rated voltage and power*	KW	Bidder To be specified
1.8	Load losses at rated voltage and power*	kW	Bidder To be specified
1.9	Impedance voltage	%	10
1.10	Magnetic flux density	Tesla	1.55
1.11	Top oil temperature	°C	55
1.12	Hotspot/ winding	°C	60
1.13	Impulse with stand voltage, primary winding	KV	125
1.14	Impulse with stand voltage, secondary winding	KV	550
1.15	Cooling Type		ONAN, ONAF
1.16	Power frequency withstand voltage, primary winding	KV	55
1.17	Power frequency withstand voltage, secondary winding	KV	230
1.18	Vector Group		Bidder To be specified
2	On-load tap changer(110 KV)		
2.1	Number of Steps-		Bidder to be specified
2.2	Taps		+2.5%Each
3	Bushings-Primary		
3.1	Type		IEC60137
3.2	Lightning impulse level (1.2/50)	KV	550
4	Bushings-Secondary		
	Lightning Impulse level	KV	Bidder To be specified
4.1	Type		IEC60137
4.2	Minimum creepage distance	mm/KV	31

These technical requirements shall be considered together with the specified attached Technical Data Sheets.

Magnetic cores

The flux density in the core shall not exceed 1.55 Tesla during normal operation at rated primary voltage on nominal tap and at rated frequency with no over-fluxing occurring.

The core shall be made of high grade, un-aging, cold rolled grain oriented steel. Laminations shall have low losses and high permeability. Insulated packets of the core are to be connected so that no potential differences will exist between them. Flux distortion shall be minimized to reduce noise level.

The cores, framework, and clamping arrangements shall be capable of withstanding any shocks to which the equipment may be subjected during transport and operation.

Both the core and frames shall be earthed via a single point earthing design where each connection to either the frame or core is brought out through separate 2KV bushings complete with removable bolted shorting links that connect them to an earth stud on the transformer tank lid.

All components shall be rated for the maximum possible circulating current should the core or frame becomes inadvertently earthed. The bushings located on the transformer lid shall be protected from inadvertent physical damage by a removable cover or similar.

Windings

Copper windings shall be used. Insulation material shall be of excellent quality.

The transformer shall be supplied according to IEC insulation class A. The insulation shall be provided against attack by moulds and other tropical effects and shall be tropical according with DIN 40040 or an equivalent standard.

The winding shall be thoroughly seasoned during manufacture by the application of axial pressure at a high temperature for such a time as will ensure that further shrinkage is unlikely to occur in service.

The windings and lead of the transformer shall be braced to withstand the shocks, which may occur through rough handling and vibration during transport, switching and other transient service conditions. Coil clamping rings shall be of steel or of a suitable insulating material built up from flat laminations.

Internal earthing of the magnetic circuit shall be made to the core clamping device at one point only through a removable link placed in an accessible position just beneath an inspection opening in the tank cover and which, by disconnection, will enable the insulation between the core and clamping plated. The connection to the link shall be on the same side of the core as the main earth connection.

All windings 110KV and above connected in star shall have graded insulation; and all windings rated less than 110KV shall be fully insulated.

Tank

The transformer tank shall be designed for a vacuum of less than 1 Torr. The tank shall have four (4) jacking points for the use of hydraulic jacks. They must be rated for the most unfavorable load distribution on two diagonals. Underneath the upper tank edge, four (4) lifting hooks shall be arranged to enable the entire transformer to be lifted by a crane. The transformer shall be equipped with 4 transport rollers (flanged wheels). Each of the rollers shall rotate 90° (for longitudinal and transversal movement of the transformer) without dismantling and shall have a roller bearing (with lubricator). The device for fastening the rollers on the rails is part of the delivery.

The tank cover shall be of adequate strength, must not distort when lifted and shall be provided with suitable flanges having sufficient and properly spaced bolts. Inspection openings shall be provided to give access to the internal connections of bushings, windings and earthing links. The tank and cover shall be designed in such a manner as to leave no external pockets in which water can lodge, nor internal pockets in which

air can be trapped when filling the tank, and to provide easy access to all external surfaces for painting. The interior surface of the tanks shall be painted with an oil resistant coat, the exterior surface with a primer and two finish coats.

Pockets shall be provided for a dial type thermometer. These pockets shall be located in the position of maximum oil temperature. Caps shall be provided to prevent the ingress of water to the thermometer pockets when they are not in use.

Two earthing screws shall be placed at the lower tank frame one either side of the transformer in such a way that a low-resistance connecting to the local earthing system is guaranteed.

The conservator tanks shall be arranged above the highest point of the circulating system. Connections to the main tank shall be at the highest point to prevent the trapping of air or gas under the main tank cover. The capacity of the conservator tanks shall be adequate for the expansion and contraction

Of oil in the transformer under the specified operation conditions. Conservator tanks shall also be provided with a filling cap, drain valve with captive cap

And oil level gauge.

A silica gel air dehydrator shall be fitted to the conservator with a size considering the climate.

The necessary filter and drain valves for filling and drainage of oil as well as air vents shall be provided for the tanks (main, conservator, radiators) and they shall have provisions for locking in the closed and open positions. All devices fitted to the transformer shall be designated visibly with respective alphanumerical designations.

Rails

For supporting the power transformers rails are required. The steel quality shall be at least St 37 according to DIN 17100 or an equivalent standard.

Bushings

Bushings shall be of type stated in IEC60137.

The transformer shall be equipped with top quality bushings on both the primary, secondary side and tertiary side in compliance with relevant IEC standard. The bushings shall be arranged on the tank cover in an upright position and must be easily exchangeable without lifting of the cover plate.

The star point of the winding shall be separately brought out through the tank lid by means of an outdoor bushing, located so that it cannot be associated with the main phase bushings. All bushings shall have permanent phase markings adjacent to the bushing flange.

Cooling System

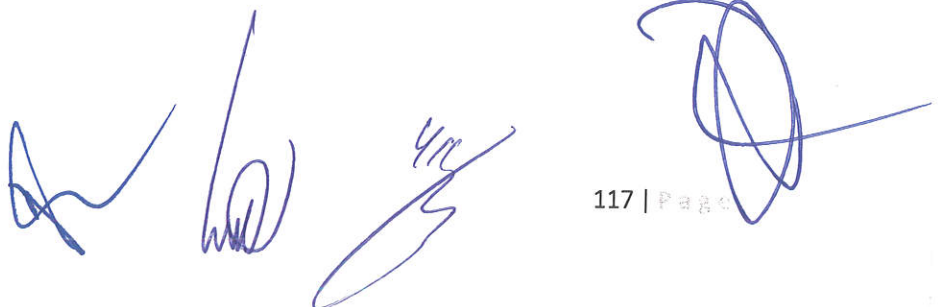
Transformers shall be capable of operating continuously at full load utilizing ONAN/ONAF type cooling. The transformer shall be capable of operation at 80% of rated capacity with the cooling fans out-of-service.

The coolers shall be of the fin type, fully hot-dip galvanized, detachable and equipped with lifting eyes, vent holes with plugs, plugs for filling and draining and with shutoff valves to permit the removal of any cooler without draining the oil from the transformer tank. The coolers shall be removable during operation of the transformer. All radiator isolating valves shall be fully oil tight and vacuum capable and shall be mounted to the transformer and radiator by bolted flanges.

Only transformers less than 10MVA shall have radiators mounted directly to the transformer tank, all other transformers shall be mounted via a manifold.

On-load tap changing

General



On-load tap changers (OLTC) for automatic control, manual control, and electrical remote control shall be provided. The OLTC shall comprise a tap selector with changeover switch and a rotary diverter switch of high-speed transition resistor type. The OLTC shall be in conformity with IEC 60214 and IEC 60542. Only designs that have been type tested in accordance with the relevant IEC standards will be accepted. The OLTC shall be equipped with all devices necessary to automatically control secondary voltage regulation. Controls shall have provisions for (as a minimum):

- Automatic/Local Manual/Remote Manual Operation
- Return to neutral tap
- Set-point Regulating Voltage
- Resistive voltage drop compensator (current sensing)
- Inductive voltage drop compensator (current sensing)

The OLTC shall be mounted from the cover into the transformer tank at narrow sides of the transformer tank. The diverter switches and/or selector switches shall have oil compartments separate from the transformer oil as well as their own closed sub-sections in the oil conservator.

The tap changer head shall be equipped with a bleeding duct to be connected to Buchholz relay of main tank to avoid any gas collection underneath the tap changer head outside the diverter switch compartments. No piping or other equipment shall be arranged beyond the tap changer head to allow lifting of the diverter switches and/or selector switches without removing (dismantling) of any other equipment.

An oil-flow operated protection relay and a sudden-pressure operated protection relay shall be provided for internal failure protection. In addition a spring-loaded pressure relief device with trip contact shall be mounted directly onto the tap changer head.

The power of the transformers shall remain constant at all tap positions, and the OLTC shall be capable of successful tap changes for the maximum current to which the transformer can be loaded.

The permissible continuous through current of each tap changer unit at rated switching capacity shall cover all cyclic loading duties as per IEC 60354 at highest current tap and at rated system operation voltage applied on the transformer terminals.

The OLTC shall withstand all kinds of through-fault currents for at least 3 (three) seconds without damage.

The motor drive, plus all auxiliary equipment for operation of the tap changer, shall be incorporated in a control cabinet made, protection class IP65, and shall be mounted onto the transformer tank in a convenient floor height.

The complete wiring shall be of highly flexible stranded copper and furnished with slip-over ferrules at both ends. Wiring shall also have crimped termination. The minimum cross-section of the wiring other than for step-position transmitters shall be 2.5mm^2 .

An electrical supply of 400/230VAC, 3-phase, will be available from the substation for operation of electric motors required for the proper operation of the power transformer. The AC supply of the motor drive cabinet shall occur via the control cabinet for cooling equipment or marshalling box and an appropriate MCB with trip contact shall be provided in the concerned cabinet for the outgoing auxiliary supply cable.

The cabinet shall be mounted on a narrow side of the transformer and the following main equipment shall be installed:

- Driving motor with complete motor protection equipment
- Operation counter

- Control switch or push buttons for local raise/lower operations (properly protected against unauthorized operation)
- Electrical limit switches
- Mechanical stops in end positions
- Step position indicator ("1" related to the position with the maximum high voltage)
- Local/remote switch
- Voltage supervisory relays for all phases of supply voltage and main circuits of control voltage
- MCBs for driving motor and each auxiliary supply circuit
- Hand lamp (controlled via door contact)
- One heater, thermostatically controlled
- Minimum one conventional position transmitter of the resistor type
- Additional end position contacts
- Spare plug socket LV, AC (BS) with MCB 10A
- Terminal blocks with terminals of single insertion type with isolating facilities and test connectors and being universally suitable for connection of solid conductors from 0.5 mm² up to a cross-section of at least 10 mm² (Phoenix or equivalent), with ten percent spare terminals on each terminal block
- Crank handle for manual operation
- Padlock facilities for front door
- All equipment installed in the cabinet shall be designed for a cubicle inside temperature of at least 70°C
- A rigid pocket for storing the related paper drawings shall be securely fixed on the inner side of the door of this cabinet

The motor drive shall meet the following requirements:

- Mechanical indication of step position at the motor drive cabinet
- Transmission of step positions of the transformers to the local control room
- Manual operation in the case of a failure in the electrical supply system
- Step-by-step operation with automatic stop after each step
- Automatic restart of tap changing operation in the case of a failure in the electrical supply system, interlocking to be provided against simultaneous raise/lower operation
- Blocking of end positions by means of limit switches
- Provisions to be made for parallel running and automatic operation controlled by a voltage regulating device and parallel control unit

Parallel Operation and Voltage Regulation

The power transformers shall be able to be operated in parallel, if manually placed on common tap.
Performance Characteristics of Motors

- The motor shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following supply conditions:
- Variation of supply voltage from rated motor voltage $\pm 10\%$.
- Variation of frequency $\pm 1\%$.
- Combined over or under excitation $\pm 10\%$.

- The motor shall be capable of starting and maintaining the load with the applicable method of starting without exceeding acceptable winding temperature when the supply
- Voltage is in the range of 85% of the rated supply voltage.
- The motor shall be suitable for full voltage direct on line starting.
- AC motors shall be of the three-phase type, 400VAC.
- Motors less than 3.7kW may be single phase, 230VAC.
- The vibrations of motors shall be within the limits specified in applicable standards.
- Insulation shall be given fungicide treatment suitable for extremes of hot and cold climate.

Temperature Rise

In continuous service, at the specified ratings, the rise in temperature above the ambient air shall not exceed 60°C for the windings and 55°C for the top oil.

For cores and other parts the rise in temperature shall, in no case, reach a value that will damage the core itself, metallic parts or adjacent materials.

Short-Circuit Withstand Capability

The transformer shall be designed and constructed to withstand, on any tapping, without damage:

- Thermal and mechanical effects of any short-circuit (three-phase short-circuits and solid line-to-ground short circuits, etc.) that can appear at the terminal of any winding

Transformer oil

The transformer oil shall be pure mineral oil, free from additives; it shall be acid refined. All oil used during the manufacture of the transformer shall be free of all additives. Oil supplied for the filling of the transformer shall be new and shall contain at least 0.3 per cent by weight oxidation inhibitor of type di-tert-butyl-para cresol (DBPC) according to IEC 60296.

The oil shall not contain PCB. If oil samples taken from the transformer on delivery contain 2ppm or more PCB, the Employer shall have the right to refuse the delivery of the transformer.

Vibration and Noise limits

The transformer shall be so designed and constructed that harmful vibrations are eliminated and that minimum noise will occur at any operating conditions. The transformer shall pass the specified noise level test.

Transformer neutral

The neutrals of the power transformer have to be brought out to bushings.

Transformer losses

A guarantee must be given that the transformer losses to be indicated in the Schedule of technical data are not exceeded.

For the guarantee data mentioned hereinafter the tolerances in accordance with specified IEC 60076 shall apply and only if these tolerances are exceeded a penalty shall be applied as follows:

Losses

- If, the no-load losses of the power transformer exceed the guaranteed value, the no-load losses in excess of the tolerances will be considered and an amount of US\$ 6,500.00 for each full kW in excess will be deducted from the Contract Price.
- If the load losses of the power transformer exceed the guaranteed value, the load losses in excess of the tolerances will be considered and an amount of US\$ 1,500.00 for each full kW in excess will be deducted from the Contract Price.

It is thereby understood that values of 0.5 kW and above will be rounded up to the next full kW.

Rated power

If the test of temperature rise carried out on any transformer should reveal that the temperature rise of the transformer exceeds the values guaranteed, the rated power of the transformer will have to be down-rated to such a degree as to obtain the temperature rise guaranteed. For each kVA of the actual transformer rating below the guaranteed output, an amount of US\$ 2,500.00 will be deducted from the Contract Price of this transformer and all those transformers of the same design unless the Contractor, at his own expense, gives evidence that those transformers fulfill the guaranteed values.

Rejection

The Employer shall have the right to reject any transformer if, the actual Values are in excess of the guaranteed values, including the tolerances according to IEC 60076, by more than the margins specified hereunder:

- no-load losses: + 15%
- load losses + 15%
- total losses +10%
- rated power: - 5%
- impedance voltage on main tapping +/- 5%
- Impedance voltage on extreme taps +/- 10%.

All values in excess of the guaranteed values including the tolerances will be penalized.

Indicating plates

The following plates shall be mounted on the low voltage side of the transformer tank at a height of about 1.5 m above ground:

- rating plate as specified in IEC 60076, including also a space for the Employer's serial number,
- diagram plate with the internal connections of the windings and the voltage ratios for each tap,
- General plan of the transformer covering the locations of terminals, control devices, lifting points and valves.

Inscription shall be written in English language.

Piping and valves

The piping required for the connection/filling of the various parts of the transformer as well as the valves required for oil sampling, draining, filtering, vent plugs, etc. are to be included. Drain valves shall be equipped with suitable adapters for direct connection of oil sampling hoses.

Cabling and wiring

All cables from supervisory equipment to terminal boxes shall be heat resistant, steel-armored and rigidly fastened to the tank. The complete wiring shall be of stranded copper and furnished with slip-over ferrules at both ends. Wiring shall also have crimped termination. The minimum cross section of the wiring shall be 2.5 mm^2 . Terminations of two conductors at on terminal point shall be made by suitable bridges and links of the terminal.

All wiring to alarm and trip devices shall include an insulated separate protection earth conductor („green/yellow “colored) of at least the same cross-section as the line conductor. Suitable grounding conductors shall be provided between terminal box and related cover. The cross-section shall not be less than 16 mm^2 . Insulated grounding conductors shall be „Green/yellow “colored.

External cabling

Cables from the control room to the control boxes of the transformer shall also be steel armored or special heat resistant cables in metal pipes have to be used and fixed to the transformer.

Marking and labeling

All parts of the transformer shall be provided with complete labeling. The labels shall provide the operating personnel with easily understood and unmistakable information and shall be clearly legible at all times.

Terminals shall be marked in accordance with VDE 0532 or similar standard. Labels attached to transformer exposed to the weather must be in the form of

Enamel labels. Labels fitted in control and terminal cabinets and not exposed directly to the influence of weather may also be made of different materials. However, they must be light-resistant, must not fade and must be scratch-resistant.

All labels and markings must be in English language.

The labels must be secured by means of corrosion-resistant materials or a weather-resistant plastic material with spacers.

Corrosion-protection, painting

The main tank shall be spray galvanized and painted as already mentioned above. Conservator tank, radiators, control and monitoring cabinets shall be hot-dip galvanized and shall be treated externally and internally provided with an oil-resistant coat of paint. The external paint shall consist of 4 - 5 painting layers with a total minimum thickness of 200 micrometer. The equipment

Must be so designed that any features, which may encourage the formation of rust, are avoided.

Parallel operation and voltage regulation

For automatic voltage regulation, an electronic voltage regulator (AVR) shall be supplied for each transformer suitable for voltage regulation without hunting. The regulators shall be installed in the control board and meet the following minimum requirements:

Sensitivity 0.4% to 6% of transformer voltage

Response time 0 - 15 sec to 4 min. referred to 1%

Deviation from desired value

Range of set point adjustment 90 to 115% U_N

Current-responsive raising of set point 0 to 16% U_N

Limitation of current effect 0 to 16% U_N Overvoltage U_{max} . 100 to 135% U_N Under voltage, U_{min} 50 to 100% U_N Over Current I_{min} 60 to 120 I_N

The voltage regulator shall contain at least the following main items: Matching transformer, r.m.s. converter with integrator, limiter stages for

Higher and lower, set point adjuster, timing stages for command duration, amplifier, current compensation, compensation limiting, max. And min. limiter states, auxiliary voltage transformer.

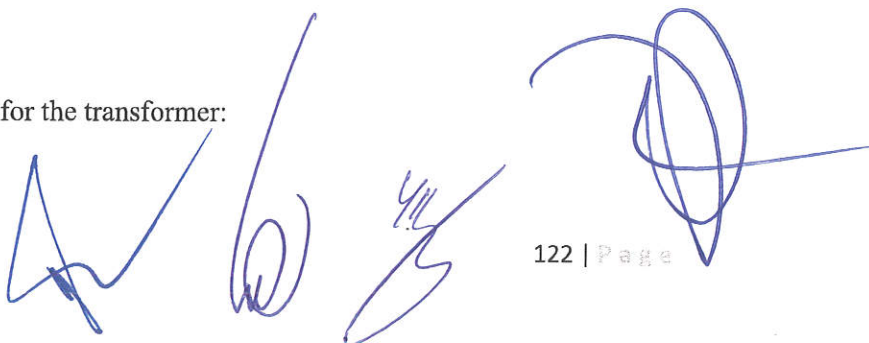
Voltage drop compensation for the active and reactive voltage component shall be provided. In addition, the voltage regulators shall be provided with a manual/auto selector.

The power transformer shall be able to be operated in parallel.

For parallel operation the AVR of one transformer shall be the master and the AVR of the other two transformers will follow.

15.24 Accessories

The following accessories shall be provided for the transformer:



- Oil temperature indicator for the top oil equipped with a maximum reading device individually insulated and a minimum of two separately adjustable contacts for alarm and tripping, with all immersed parts able to be removed without the need to interfere with the tank
- Winding temperature indicator shall be equipped with a maximum reading device individually insulated and a minimum of two separately adjustable contacts for alarm and tripping, with all immersed parts able to be removed without the need to interfere with the tank
- An aseismic Buchholtz relay for gas protection with a minimum of two non-mercury separate contacts for signal and tripping. A gas capture and test device shall be connected to the Buchholtz and located adjacent to the control cubicle
- Oil level indicator equipped with a minimum of two separately adjustable contacts for alarm and tripping
- Oil drying device, type Silica Gel breather
- Terminal box equipped with disconnect able terminals for signal cables to the auxiliary cubicle
- The on-load-circuit tap changer shall be provided with a mechanism for automatic operation. The operating mechanism shall be provided with a tap position indicator.

Transport

The transformer shall be transported either empty or partly filled up and in both cases provided with nitrogen gas charged from bottles fixed at the transformer tank. Nitrogen bottles, reduction valves, pressure gauges and humidity control equipment are to provide maintaining a constant monitored gas pressure in the transformer tank during transportation. The Contractor has to take care that during transport and storage at site a sufficient and monitored nitrogen overpressure will be inside the tank to avoid access of moisture. At each intermediate step of the transport, both at arrival and departure, the pressure of the nitrogen, has to be recorded, i. e. in factory, port of departure, port of arrival and site. In order to facilitate handling and shipping, external accessories shall be removed if necessary and replaced with special shipping covers. Bushing, radiators and other accessories, which may be affected by moisture shall be moisture-proof packed in seaworthy packing.

Packing material, including oil drums, shall remain the propriety of the Seller.

Vibration sensors including vibration recording devices shall be installed and shall record the vibrations of the transformer from the factory to site.

FATs and Type Tests Reports

15.26.1 General

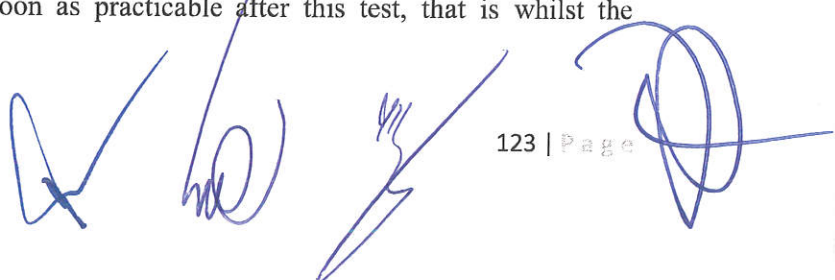
Full and complete testing of the transformer with accessories shall be carried out according to the relevant IEC Standards. The more important tests are listed below.

The Seller shall give a complete description of the proposed test methods. The test methods and the performance of the test shall be subject to the approval of the Employer / Engineer. All instruments and equipment necessary for the testing shall be provided by the Seller.

15.26.2 Test Particulars

Testing shall include but not be limited to the following:

- When a transformer is to be subject to a temperature rise test, dielectric test including an impulse test shall be carried out as soon as practicable after this test, that is whilst the transformer is still hot



- The no-load losses and the current of the transformer shall be measured at 90%, 100% and 110% of rated voltage before commencement of the dielectric test. The no-load losses and current measured after completion of the dielectric test shall be the values used in determining the performance of the transformer
- Impulse test shall be applied on all transformer terminals, including neutrals. Impulse test oscillography records shall be made
- Noise level measurements shall be carried out according to IEC 60076
- Bushings shall be fully tested according to IEC 60137
- Insulation power factor tests shall be performed with bushings in place

15.26.3 Test requirements

The test requirements for the power transformers are specified in the following:

15.26.4 Type Tests

The following type tests Report shall be carried out. The tests shall be according to IEC 60076, except where otherwise specified.

1. Temperature rise test
2. Zero sequence impedance
3. Noise level
4. Examination of harmonics
5. Tests on bushings

15.26.5 FATs Tests

The following FATs shall be carried out. These tests shall be according to IEC 60076.

6. Check phase displacement and vector group
7. Magnetic balance & magnetizing Current test measurement.
8. Measurement of voltage ratio Test
9. Measurements Winding resistance on all windings
10. Measurement insulation resistance of windings & Core
11. Measurement of Tan Delta and Capacitance and of windings & Bushing
12. Measurement of No Load Current and no Load losses
13. Measurement of Load Losses and Impedance Voltage Between (HV/LV)
14. Test of OLTC
15. Measurement of auxiliary losses
16. Separate source withstand tests
17. Full wave Lightning Impulse voltage withstand tests on HV terminals
18. Full wave Lightning Impulse voltage withstand tests on LV terminals
19. Long duration induced AC Voltage Test (ACLD) with PD Measurement
20. Functional Test on Marshalling Box
21. Oil leakage Test
22. Testing equipment's calibration Summary
23. Polarity tests
24. Impedance and load loss at rated current
25. Exciting current at 90%, 100% and 110% of rated voltage
26. No-load loss at 90%, 100% and 110% of rated voltage
27. Induced voltage tests
28. Operational tests of all devices and wiring

29. Insulation tests on auxiliary devices and wiring

30. Pressure tests on tank and coolers for oil tightness. If a temperature test is made, the pressure test shall

15.2.1. AUXILIARY TRANSFORMER

2.1.1. GENERAL SPECIFICATION

The following transformer specification is to be supplied and installed in the substation as required for this project:

- System Voltage 20 kV
- Rated Power 100 kVA
- Phase 3
- Frequency 50 Hz
- Type oil immersed, outdoor
- Cooling ONAN
- BIL at high voltage side 125 kV
- Voltage at high voltage side 50 kV
- Impedance 4 %
- Connection Dyn 5
- Highest voltage winding 24kV
- Rated 24,000 v
- Nominal 20,000 v
- Off circuit tap 0%, $\pm 2.5\%$, $\pm 5\%$
- Low voltage winding (Rated) 400/230
- Short time withstand current for 3 seconds 25 KA
- Standard IEC - 60076

2.1.2 TERMINALS

2.1a Medium Voltage Terminals

Terminals shall be of the ELBOW Connector type terminals. The terminals shall be delivered with below type connectors and other necessary accessory such as dead end receptacles. Fitting of conventional bushing in withdraw able plugs place shall be possible without modifying the cover.

2.1b Low voltage terminals

Low voltage terminals of the station service transformer may be one of the following types:

* Porcelain bushing with threaded stud. Bronze stud connectors similar to the model shown on the annexes drawing shall be supplied.

* Flat bar bush suitable for use with sealed type transformers. Insulating material and gasket shall be impervious to action of hot transformer oil. Bar conductor shall be made of copper.

Distance between adjacent voltage terminals shall not be less than 120 mm.

2.1.3 PRIMARY TAPPING

Voltage tapping shall be provided on the primary side of each transformer, as follows:

21 kV, 20.5 kV, 20 kV, 19.5 kV, 19 kV

The tapping are to be selected by an off - load tapping switch with an external hand wheel with provision for locking on to selected tapping.

The tap change positions are to be marked clearly and indelibly.

The tap change switch shall have a positive action designed to eliminate the possibility of stoooping in and intermediate position.

The tap change switch shaft which passes through the transformer tank shall be so designed as to completely prevent the leakage of oil under all condition of service.

2.1.4 IMPEDANCE

The impedance voltage shall be 4 % at a temperature of 75 °C. The admissible tolerance is ± 10 %.

2.1.5 LOSSES

The Contractor shall state in Form of Transformer Losses and Schedules of Technical Particulars & Guarantee values for components of losses comprising no-load loss, load loss at continuous maximum rating (C.M.R.) and auxiliary loss if any.

The total losses shall be as low as is consistent with transport restrictions, reliability and economic use of materials.

Should the losses determined on test exceed the guaranteed values, then the Contract Price for the transformer shall be reduced in proportion to the amount by which the losses determined on tests exceed the guaranteed total losses.

Any transformer may be rejected if the losses exceed the guaranteed value by an amount in excess of the followings:

Total losses	10 %
Component losses	15 % (unless the total loss exceed 10 %)

2.1.6 RATING PLATE

All information to be clearly and indelibly marked or engraved as follows:

- * Kind of transformer
- * Manufacturer name
- * Serial number
- * Year of manufacturer
- * Number of phases
- * Rated power
- * Rated frequency

- * Rated voltages
- * Rated currents
- * Connection symbol according to I.E.C
- * Impedance voltage
- * Type of cooling
- * Total mass
- * Volume of oil
- * Connection diagram
- * Insulation level
- * Detail tapping

2.1.7 ACCESSORIES

The transformer shall be provided with the following accessories:

- * Lifting lugs be provided on the top cover
- * Oil filling plug (21 mm min. dia.) at the top
- * Oil drain plug (21 mm min. dia.) at the bottom
- * Two earthing terminals which shall be clearly indicated by and adjacent indelibly marked or engraved symbol
- * Rating and diagram plate
- * Four flat rollers which can be oriented in two perpendicular directions with provision for locking in the selected direction.
- * Thermometer and oil Gauge.

2.1.8 FINISHING

The transformer including accessories shall be suitable for operation under a hot and damp climate with frequent showers.

All parts exposed to atmospheric agents shall be protected. Metal surfaces shall be thoroughly cleaned by sand blasting before painting. The exterior surfaces shall be given two primer coats and one finishing coat of paint of an approved color. The paint shall be resistant to hot oil action and weather. The interior surfaces shall be treated in accordance with manufacturer's practice.

Special attention shall be given to the parts located at the level if any.

All bolts and nuts shall be cadmium plated.

2.1.9 Transformer Oil

2.1.9a filling with oil level

Before filling with oil, the transformer coil assembly tank radiators and all internal parts shall be thoroughly cleaned of all dirt, grease and loose items. The tank shall be filled under vacuum conditions

with new Shell Diala-B or mixable type with the Shell Diala-B complying with IEC 60296 for acceptance test.

2.1.9b Supply of transformer Oil

The Bidder shall include for the supply of new Shell Diala-B or mixable type with the Shell Diala-B complying with IEC 60296. Oil shall be supplied in the transformer (total weight filled with oil does not exceed 5 tons).

16. SUBSTATION EARTHING SYSTEM

1. GENERAL

The equipment/materials shall conform to the latest applicable standards of sponsor organizations not limited to the followings:

General regulation of electrical installation Afghanistan:

Relevant standards of: DABS.

Guide for safety in AC S/S grounding: IEEE 80-1986.

Guide for measuring earth resistivity. Ground impedance, and earth surface potentials of a ground syst.: IEEE 81-1983.

Recommended practice for grounding of industrial and commercial power systems: IEEE 142-1991.

Electrical measurement of the subsoil at various depths, shall be made at the site of the substation from which the ground resistivity and hence the expected resistance of the proposed earth grid system may be predicted.

The earthing system shall comprise a mesh grid, formed by copper strip or flexible conductor buried directly in the ground, and arranged so as to utilize fully the available site area. A continuous conductor shall be laid outside the periphery of the substation site at a distance of 1.5 to 2.0 meters from the boundary fence, and at a depth of between 0.3 to 0.8 meters below the surface. A mesh system shall be formed by interconnection of various points of the perimeter conductor. The spacing between conductors forming the mesh system shall be such as to limit the maximum mesh potential to a value not greater than the maximum tolerable touch potential assuming a fault clearance time equal to that of the main protective gear being provided. (See definition of terms at end of section).

The earth system shall be designed so as to include all overhead line terminal steel structures, which shall be earthed. The metal substation fence immediately below any overhead line entering or leaving the site should be bonded to the earth system at that location.

The design of earth grid over the area occupied by switchgears and associated apparatus shall be based on a maximum grid spacing of 10 m x 5 m.

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.

Measurements of ground resistivity shall be made by the appointed Contractor. For tendering purposes, a value of 100 ohm meters should be assumed.

The current density of the earth conductor shall be not greater than 200 A/mm² for a 1 second short time current rating and 100 A/mm² for a 3 second duration.

Single connections between equipment and system can 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 % shall be assumed for this purpose, i.e. the cross sectional area of branch connections may be reduced to 60 % of the corresponding single conductor. The design of the substation earthing system shall be based on a fault rating of 31.5 kA (3 second).

NOTE:

The use of earth plates as current carrying electrodes is not acceptable).

Metal parts of all equipment, other than those forming part of an electrical circuit shall be connected directly to the main earth system via a single conductor. The arrangement of the mesh earth system shall be such that it minimizes the length of these single connections.

Earthing for high frequency coupling equipment and surge diverters shall be via a copper rod driven directly into the ground at a position immediately adjacent to the equipment being earthed in addition to the normal earth connection.


All main members of structural steelwork shall be earthed by copper connections bonded to the steelwork. Connections to apparatus and structures shall be made clear of ground level, preferably to a vertical face and protected against electrolytic 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. Joints in earth bars shall be brazed.

Where bolted joints are used in copper connections they shall have the joint faces tinned.

A facility shall be provided on the earth bar run between, the equipment and the base of the structure, comprising a looped copper strip, 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 megger will be acceptable in the event of a local supply being unavailable.

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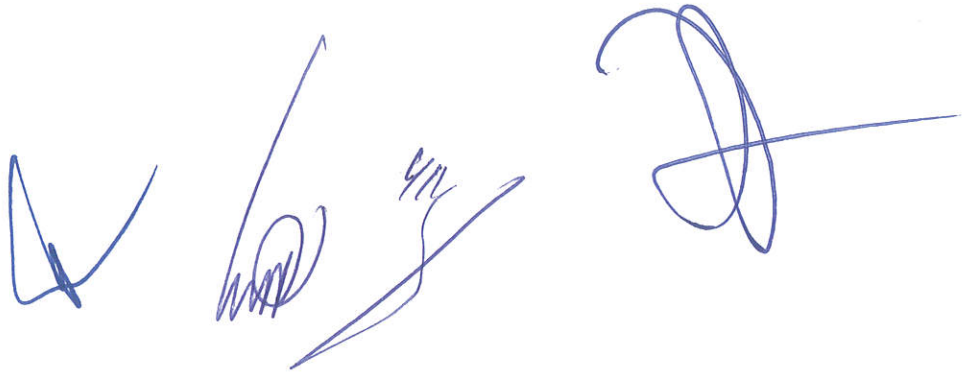
2. DEFINITION

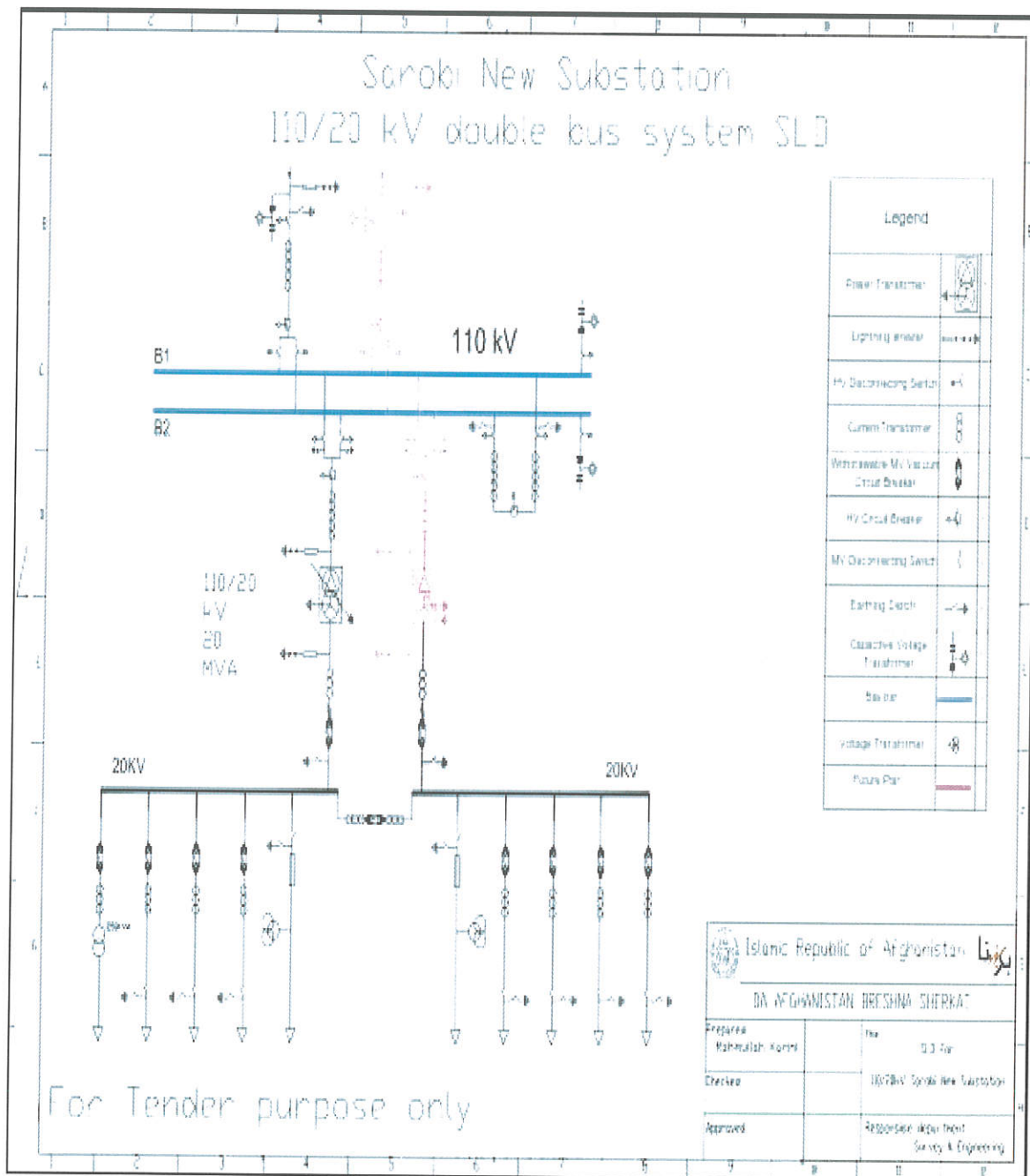
Mesh Potential

The potential existing between a point on the edge of a rectangular grid and a point at the center of that grid.

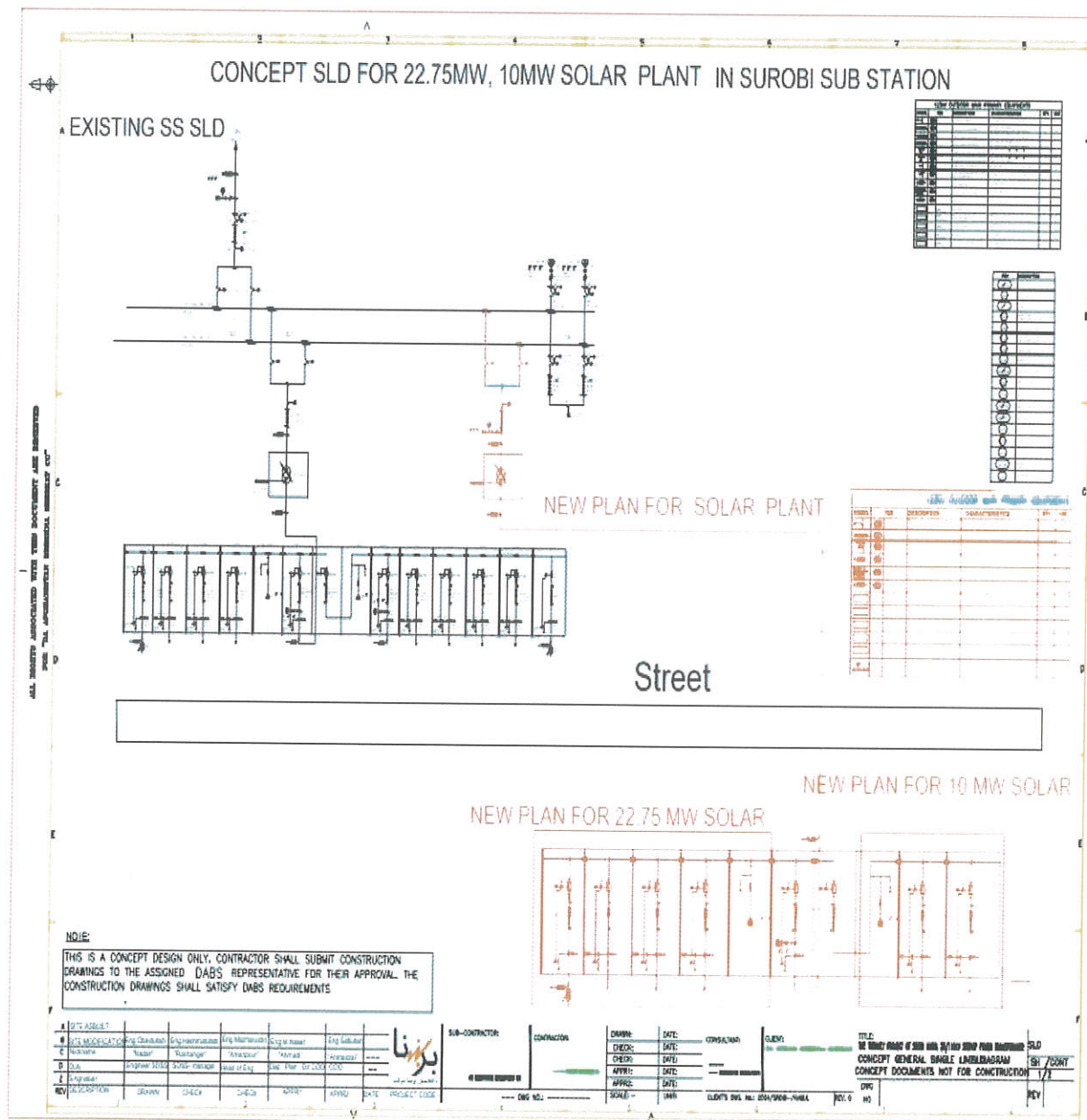
Maximum Tolerable Touch Potential

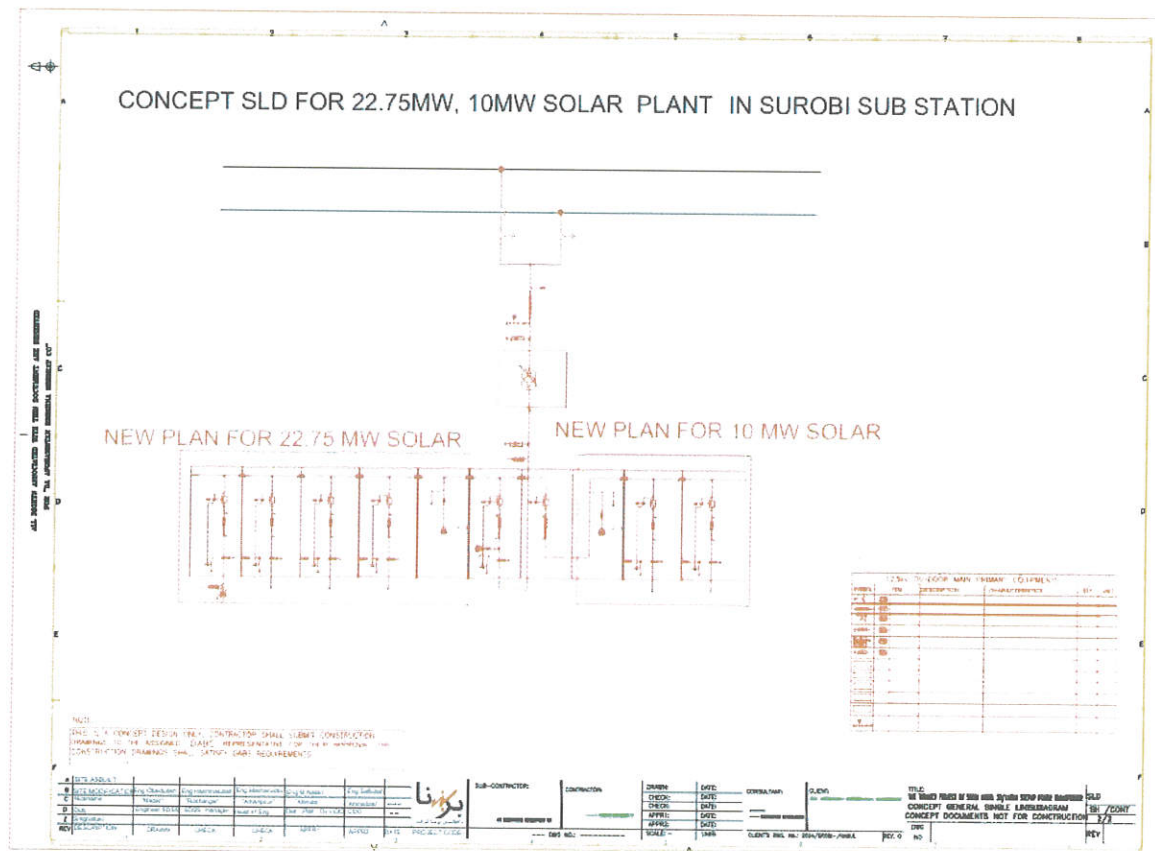
The maximum potential that can be tolerated between the hand and the foot of a person without the current flow through the body exceeding the threshold of ventricular fibrillation.





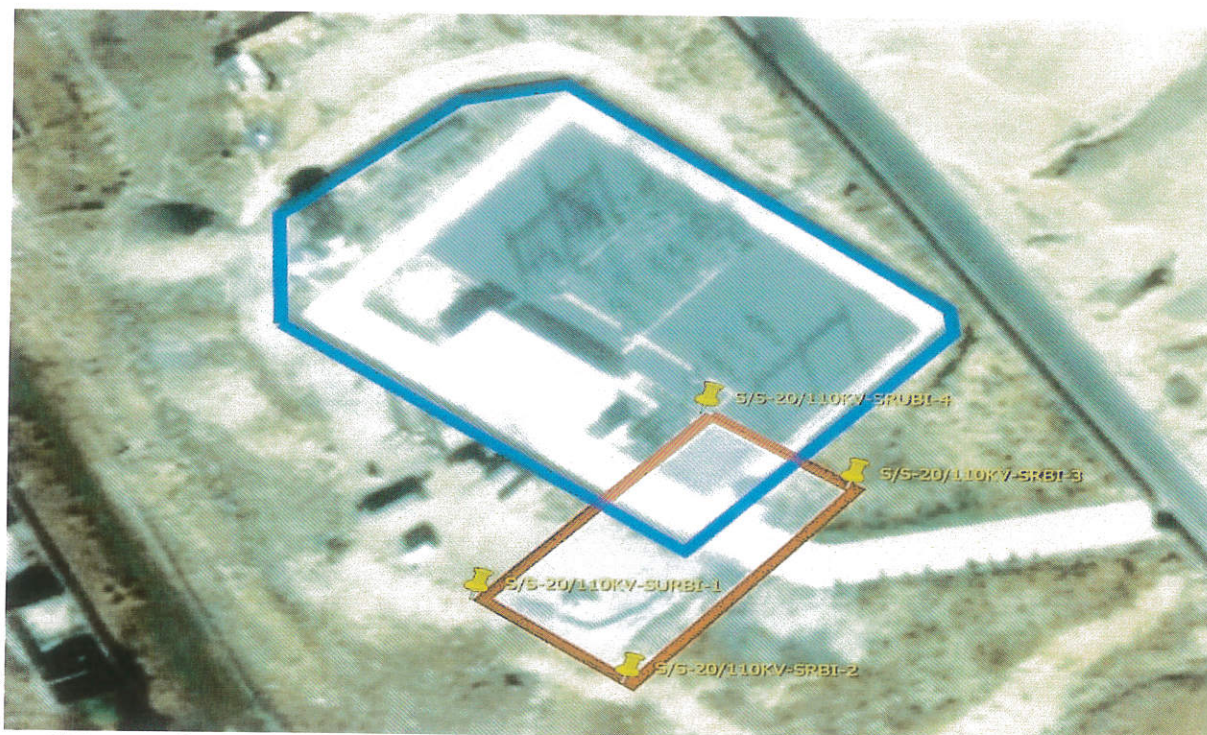
Drawings 20/110KV Step Up Power Transformer New Plan





نقشه گوگلی سب استیشن سروبی وساحه پلانی نصب ترانسفارمر افزایشی

رنگ آبی ساحه موجوده سب استیشن سروبی
رنگ سرخ ساحه توسعه وی ترانسفارمر بی



A) Proposed Areas for construction of new 20/110 kV Step-up Power Transformer in Srobi Substation for absorption of Solar energy in national grid of Afghanistan

P1 N34 37 54.90	E69 43 17.90
P2 N34 37 54.25	E69 43 18.91
P3 N34 37 55.78	E69 43 20.39
P4 N34 37 56.36	E69 43 19.41

The Site is at the Altitude as 1020 meters above mean sea level. The max ambient temperature is about 45°C and minimum is about -10°C.

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TECHNICAL REQUIREMENT FOR CIVIL WORK

1. General Description of the Project

This section covers design, construction and supply of all civil works including heating, ventilation and air conditioning of the specified new 20/110kV Transformer bay at:

- **Srobi Extension TR bay substation.**

It is describing quality standards, required functions but is not a detailed specification. Therefore, the requirements are not limited to the descriptions hereafter; items not explicitly mentioned shall be in the same best quality range as for the entire works of the project.

The civil works must be performed in such a manner that the high standards of quality and function required are fully achieved.

Special attention must be paid to the aspects which are specific to climate and local conditions.

The buildings and structures shall be designed with due regard to the need for inspection, maintenance, cleaning and repair, and must be good to operate on long-time periods with the minimum of inspection, adjustment and repair.

All material shall be new and of best quality suitable for working under the conditions, variations in temperature and load encountered in service

without undue distortion or deterioration or the occurrence of undue stresses in any part, such as to affect the efficiency and reliability of the plant.

1.It is worth mentioning that the scope is general. 2.If any work described in the scope and specifications conflicts with the BOQ, consult with DABS. 3.Civil work is not limited to the tasks described in this scope document. 4.If infrastructure such as roads, trenches, and boundary walls needs to be extended, it shall be done according to the specifications of the existing facilities, including material and dimensions. 5.A firewall shall be constructed between the two transformers. 6. If any work is unclear, consult with DABS.

2. Scope of Supply and Services

2.1 General

The services to be provided within the framework of this specification comprise the planning and complete supply and execution in every respect including all the necessary calculations and documentation, prefabrication, delivery, erection and acceptance of all civil works required for faultless operation of the new 20/110 kV Transformer bay at Srobi substation.

The civil works consist basically of, but are not limited to the following main services:

detailed design and engineering

supply of all labor; materials; equipment; temporary work; tools; etc necessary for the execution of the civil works

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site related investigations

earth works including also all leveling and grading works in the project area as well as the necessary soil improvements as required

foundations

structural and nonstructural steelwork

building works

containers

roads and parking including access road

fencing and gates

storm water drainage and sewage systems

civil works for cable, routing, ducts, trenches, tunnels, crossings etc.

earthing system

outdoor lighting system

2.2 THE 20/110 KV TRANSFORMER BAY AT Srobi SS

The civil works in the Transformer bay are:

All civil works necessary for the complete erection of the new Transformer bay.

The access roads to the site are also included in the project, from locations informed by the Employer.

The discharge of the rain water from the sites is also included in the scope of works of the Contractor; the limits will be informed by the Employer.

2.3 Instructions Related to the Scope of Works

The Contractor will be fully responsible for ensuring that all materials used in the work and temporary works comply with the approved standards, and that all processes of workmanship are carried out with a high degree of efficiency, in accordance with an approved program and in compliance with the



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requirements of the specification. Solely virgin materials shall be used which have been approved by the Employer/ Employer's Representative.

While the civil works are in progress the Contractor shall provide suitably qualified competent civil Engineers to be full time on the site to verify the work, quality and progress of the subcontractors.

To ensure proper quality assurance the Contractor shall submit for approval a Civil Works Quality Plan.

All work shall be constructed to the lines and levels shown on the drawings prepared by the Contractor and approved by the Employer.

The Contractor shall employ competent design engineers to prepare civil design. All designs shall be prepared in accordance with the best current engineering practice and with the requirements of the Project Specifications and the appropriate Codes of Practice and Standards approved by the Employer. Any deviation from the Project Specifications must be duly requested and justified in writing from the Employer's with formal Design Change Authorizations. The building, structures and roads within the site and their design and detailing shall comply with and satisfy the fundamental technical and operational requirements of the electrical equipment to be accommodated therein and with the requirements of the specification.

Building and structures shall be earthed as specified in the Electrical part of the documents.

Ducts, trenches and/or tunnels shall be provided with suitable permanent pumps and sump pits to enable the easy removal of water spillages and firefighting water collected in these areas.

If a culvert(s), and /or tunnel(s), trench(s) or any other underground services are crossing roads and railways, other ducts and channels, etc these shall be constructed as bridges calculated for heavy truck loading.

Where sizes and/or dimensions are given in the Bidding Package, those shall be considered as informative and for guidance only.

The Contractor shall be responsible to finalize all such sizes and dimensions during his detailed engineering to fulfill all functional and specified requirements.

2.4 Design and Engineering

Preparation and submission of design calculations and construction drawings by the Employer to the Contractor for the implementation, as follow:

piling calculations (if any)

structural calculations for buildings, structures and foundations



general arrangement and reinforcement drawings for concrete works, including bar bending schedules
architectural arrangement drawings and details for the substation building layout with details of outdoor facilities

general arrangement and manufacturing drawings for steel structures

preparation and submission of drawings for statutory approvals of local authorities and of the agencies, if applicable

calculations for HVAC works, drainage and sewage systems

2.5 Site Related Surveys

Topographic survey

A topographical survey shall be made by the Contractor concerning the sites
of the project. The Contractor shall carry out all the necessary surveying works in order to:

obtain topographic survey maps

ensure that the position and elevation of all works constructed by him are correct

Updating of survey maps in the zone of the extended substation

The existing benchmarks (if available) shall be used as basis for the surveying works.

2.6 Soil investigations

The extent of the investigations done by the Contractor shall be such as to permit the satisfactory determination of all necessary subsoil characteristics, to exclude any unacceptable settlement and to determine reliable type, size and execution of foundations. These investigations have to be completed before the works start. A detailed specification of the investigations is given in Section 6.

2.7 Site Development Works

- site clearance including diversion of existing services, if any
- site leveling and grading
- roads, drains, surfacing
- temporary constructions works and services enabling the works of the Project
- temporary and permanent security fences around the new transformer bay works



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2.8 Site Installation and Temporary Works

- The Contractor shall supply on all sites temporary offices, laboratories, sanitary conveniences, stores, equipment, workshop, compounds, parking, areas, etc, necessary for the completion of the works.

2.8.1 Contractor's organization

- The Contractor shall set up an organization as to enable to perform the design, construction, tests and completion at the target days according to the detailed program of works.
- The Contractor shall submit an organization chart including the key personnel for the period of design, construction and tests on completion.
- The Contractor shall revise periodically the organization chart and shall be subjected to the approval of the Employer/ Project Manager.

2.8.2 Documents for the construction site

- The Contractor shall prepare and provide in due time, prior to commencement of construction works the following documents which require the approval of the Employer/ Engineer:
 - All necessary general and detailed construction drawings
 - Detailed construction time schedule
 - Site facilities plans
 - Construction site Regulations
 - Environmental protection plan
 - Quality assurance plan
 - Fire fighting and fire protection plan

2.8.3 Site store

- Site storage area shall have sufficient surface so that process of works is not jeopardized. It shall be fenced and guarded 24 hours in a day.
- All materials shall be stored in tiers, shall be stacked, racked, interlocked secured to prevent sliding, deterioration or collapse
- Maximum safe load limits shall not be exceeded.
- Aisles and passenger ways shall be kept clear to provide the free movements of materials and equipment.



- Each employee working on stored materials in silos, hoppers, tanks and similar areas shall be equipped with personal fall arrest equipment.
- Non compatible materials shall be eliminated from the storage.
- Bagged materials shall be stocked by stepping back the layers and cross keying the bags at least every 10 bags high.
- Materials shall not be stored on scaffolds.
- Vegetation control shall be exercised when necessary.

2.8.4 Construction supervision personnel

- The Contractor shall provide his own construction supervisory team consisting of:
- Senior Construction Manager
- Construction Managers for section of works.
- Construction site Engineers of various disciplines
- Construction inspectors.
- The Senior Construction Manager shall be highly qualified and experienced and will represent the Contractor in all contractual, organizational and technical matters.
- All members of the construction supervisory team shall be nominated in writing. Only approved persons will be accepted to perform the site activities.

2.8.5 Final construction checks

- At the end of the construction works or of sections, the Contractor shall perform his inspections, tests with regard to:
- Completeness
- Defects
- Compliance with the Contract requirements.
- The Contractor shall notify the Employer/ Engineer in writing of his readiness. Final construction checks shall be conducted jointly. The results will be recorded, if necessary deficiency lists shall be prepared.
- The Contractor has to remedy without delay all deficiencies.
- After successful completion of the works the Contractor shall submit a final report.
- Depending on the results, the Employer/ Engineer may grant or withhold his approval for the commencement of the test completion, of a section or part
- of the works.
- The Contractor has to remedy without delay all deficiencies.



2.9 Main Civil Works

2.9.1 General layout

- The limits of the new transformer bay and extension works are shown in the conceptual draft general layouts.
- Based on the attached draft layout plans the Contractor shall propose a detailed arrangement with the various components for the final configuration of the transformer bay, subject to the approval of the Employer or his Representative. In doing so, adequate safety clearances and fire protection system.
- compartments, favorable layout of the plant components for monitoring and maintenance, possibility for extension and any other requirements of up to date transformer bay construction shall be taken into account.
- The final position of the entrance in the transformer bay areas will be proposed by the Contractor and agreed by the Employer or his Representative.

2.9.2 Switchgear Room

- The switchgear building in one story first floor just for cables and second floor for service and it will be designed and constructed by the Contractor according to the basic design indicated in Annexes.
- Battery room
- AC/DC rooms
- Medium voltage room
- Auxiliary equipment room
- Corridors
- The proposed arrangement of the buildings can be modified by the Contractor according to the specific conditions (i.e. transport ways, arrangement of the equipment, partition of the building, etc.), subject to the Employer's/ Engineer's approval.



2.9.4 Bay control kiosks

The control and protection equipment for the 110 kV bays shall be installed in local kiosks in the immediate neighborhood to the respective bay of the switchyard.

2.9.6 Outdoor foundations

Transformer foundations

The main oil-filled transformer in the 220 kV switchyard areas shall be supported on a reinforced concrete foundation (see Laout). An oil/ water separator shall be provided.

Outdoor foundations

The following foundations are included:

Foundations for outdoor switchgear equipment, supports and gantries

foundations for kiosks, lighting arresters and poles, etc.

Cable ducts, reinforced concrete trenches and ducts shall be provided

Special attention and security measures have to be taken in the extension areas where part of installations is under operation. The existing disturbed roads and surfaces damaged during the execution works will be repaired by the Contractor to the fully satisfaction of the Employer.

2.9.7 Roads, paving's and surfacing

The proposed roads and paving's are indicated in the layout plans

The road system must be arranged by the Contractor in such a way that non obstructed traffic is guaranteed main roads should be 5 m width and sub roads 3.5 m both with 1.5 m shoulders



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The connection portion of the access roads, outside of the site areas belongs also to the scope of works of the Contractor. Connections to the existing roads shall be provided in the extension areas.

Special attention has to be paid to the roads in the transformer bay where coordination with the roads of the 20/220 kV transformer bay has to be made.

2.9.8 Boundary wall & Fencing

If required as per design.

2.9.9 Drainage and sewage system

Storm water drainage system

The storm water drainage system collects only clean storm water which should be discharged into the storm water system of the zone. For the new transformer bay, complete storm water drainage system is required. Substantially maintenance-free and operationally safe installation must be guaranteed. The surface water drainage shall include all necessary gutters, down pipes, gullies, traps, catch pits, manholes, etc. In the extended substation only Coordination of the new drainage with the existing system has to be realized.

Sanitary sewage drainage

The sanitary water from the WC, urinals, shower, washes basins and kitchen shall be discharged to a three-chamber treatment plant made of reinforced concrete. The pre-cleaned water shall be led to a soak-away pit.

2.9.10 Landscaping

The free area of land inside of the transformer bay, where no roads or gravel is provided, shall be landscaped using low to medium-high growing plants and grass. Plantations shall be provided along the main roads and the building. The landscaping is subject to the approval of the Employer/Engineer.

3. Design Requirements

3.1 Instructions for the Basic Design

- The civil works are governed by the conditions of the electromechanical part and the conditions or specifications stipulated hereafter.



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- This document shall represent the basic specification information for calculating the lump sum price of the works concerned, but they should not be considered to be a complete description in every respect. Bidding drawings indicate the intended layout of the works, but are not to be taken as a final and dimensional reference.
- The price offered shall be understood as the total sum for the complete civil and finishing works to suit the requirements and the functions of the works concerned.
- Design and choice of construction materials shall consider and ensure the reduction of future maintenance works, and therefore, all civil elements shall be designed to minimize maintenance and to result in a durable construction with a minimum design life of 40 years.
- The Contractor shall prepare all necessary design and detail drawings in accordance with the project requirements.
- The design of all structures under this Contract shall be such that differential and total settlements or other movements shall not exceed acceptable limits and full provision shall be made for all expansion and other joints. The design shall be to the approval of the Employer.
- Structural members subjected to flexure shall be designed to have adequate stiffness to limit deflections or any deformations that affect strength or serviceability of a structure adversely. The maximum allowable deflections of structural members shall be in accordance with the relevant design standards and/or the limits prescribed by the machinery manufacturers.
- The dimensions of all buildings and containers shall be such as to provide adequate space for the safe installation and proper operation, maintenance and repair of all plant and equipment.
- In order to save energy for air conditioning adequate thermal insulation of buildings has to be provided. The general transmission coefficient, including walls, roof and doors shall be $K \leq 0.7$.
- Suitable access to the roofs of the buildings shall be provided for maintenance and repair of any installation.
- All rooms with fire hazard shall be provided with suitable emergency exits.
- Safe, convenient and straight forward accesses and means are to be provided to take equipment in and out of all rooms.
- If a culvert(s), and/or tunnel(s), trenches or any other underground services are crossing roads, these shall be designed as bridges for truck loading without affecting the underground structures.
- All civil designs and drawings must be approved by the Employer/Engineer before start of manufacturing/construction.
- Proper access roads shall be provided to bring in all the equipment and to take it out in case of maintenance. These access roads shall be suitable for the vehicles which will be used (cars, forklifts, trucks/trailers, etc.) to reach up to the point of unloading of the equipment.

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- Safe, convenient and straight forward accesses and means are to be provided to take equipment in and out of all rooms, at all levels using suitable stair wells and suitable electric hoists. The dimensions of rooms, stair , doors, etc. shall be designed to suit the transport concept mentioned above.

3.2 Particular Architectural Requirements

- The external aspects and finishing of buildings will be made in harmonic combination of the elevation types, with the local conditions, subject to the approval of the Employer or his Representative.

3.3 Responsibilities of the Contractor

- The Contractor shall be solely responsible in all respects for the suitability and stability of the buildings, structures and foundations.
- In the extended substation special attention and care has to be given by the Contractor to the special situation of works in an area where a part of the equipment is under operation. All necessary safety measures have to be realized by the Contractor.

3.4 Codes and Standards

- The civil/architectural works for buildings and structures shall be designed and constructed according to the highest quality codes/standards specified and good engineering practice.
- All relevant laws, directives, codes, regulations and ordinances must be complied with, in the latest version in each case. In particular these include (the list is not exhaustive):
 - EN standards/guidelines
 - Afghanistan State building regulations (if any)
 - Water Management Regulations
 - Workplace ordinance/guidelines VDE guidelines
 - VGB directives
 - Accident Prevention Regulations
 - Other standards which have the status of EN standards
 - Conditions, requirements and recommendations from the permits/licenses

3.5 Design Loads

- The following design loads shall be considered for the design of buildings and structures:
- Dead load:

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- Dead load is defined as the weight of all permanent construction including walls, foundations, floors, roofs, ceilings, partitions, stairways, and fixed service equipment and shall be calculated according to DIN 1055-1 or equivalent.
- For substations this would include equipment, pipes and accessories, electrical and lighting conduits, switchgear, instrumentation, fireproofing, insulation, ladders, platforms, and other similar items.
- Equipment and piping should be considered filled by product load when calculating dead load. The gravity weight of soil overburden shall be considered as dead load.
- Erection dead load:
- The erection dead load is the weight of the equipment at time of erection plus the weight of the footing, pedestal, and overburden soil.
- Live load:
- Live load is defined as the weight superimposed by the use and occupancy of the building or other structure, but not permanently attached to it. For industrial design, live load can be defined as the load produced by personnel, moveable equipment, tools, and other items
- placed on the structure, but not permanently attached to it.
- Crane loads shall be considered as live load. Unless specified otherwise, the minimum live load values given in Table 1 below shall be considered.
- The loads assumptions quoted in Table 1 have proved useful in the construction of numerous substations and are to be regarded as minimum requirements.
- The Engineer's consent is required in all cases for reductions of load carrying capacities and for exceeding the permissible stresses.

Recommendations for assumed live loads (kN/m²)

	Slabs and Subsidiary supports	Gratings ¹⁾	Main girders	Supports and walls	Founda tions
Reinforced concrete structures					
At road level in areas used by large vehicles in areas of major assembly work at their access roads	15 SLW 30 ²⁾ SLW 60 ²⁾	5	15 SLW 30 ²⁾ SLW 60 ²⁾	10	10
Heavy intermediate floor slabs (electrical)	10	5	10	7.5	7.5
Medium intermediate floor slabs	7.5	5	7.5	5	5
Light intermediate floor slabs	5	5	5	5	5
Roofs	1.5		1.5	1.5	1
Steel structures					
Heavy platforms	15	10			
Medium platforms	5	5	5	5	5
Light platforms and walkways	2.5	2.5	2.5	2.5	2.5

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- Truck loads according DIN 1072 or equivalent.
- Areas designated for different loadings on the same floor shall be clearly and permanently marked.
- Thermal load:
 - Thermal loads shall be defined as forces caused by changes in temperature. The primary source of thermal loads in an industrial plant is the expansion or contraction of vessels and piping. Another source of thermal loads in a structure is the expansion or contraction of the entire structure or individual structural components.
- Truck load:
 - Structures accessible to trucks shall be designed to withstand the gravity, lateral and impact effects of truck loading. Truck loading shall be SLW 60 as defined by DIN 1072.
- Soil load:
 - Soil loads shall consist of lateral earth pressures. Active and passive coefficients for lateral pressures shall be obtained from the project soils report. The weight of soil shall be considered as dead load.
- Hydrostatic load and buoyancy:
 - Hydrostatic load is the load due to water pressure. The design of structures shall include hydrostatic loads when applicable. The buoyancy load is equal to the weight of the volume of displaced water.
- Wind and snow load:
 - The actual wind load for the calculation of buildings and structures shall be taken from local Georgian codes.
- Wind zone 1
- Wind speed 35 m/s
- Earthquake load:
 - The seismic calculations of buildings and structures shall be prepared in accordance with the requirements of the relevant local standards, using data for the location of the project (Richter scale 8). If no local Standards are available, the provisions of the United Building Codes shall be applied.
- Dynamic loads:
 - Each structure shall be designed to withstand the effects of vibration and impact to which it may be subjected. Each structure and foundation supporting machinery having significant dynamic unbalance shall be designed to resist the peak loads specified by the manufacturer. Vibration amplitudes of the supporting structure or foundation shall be kept within acceptable limits for dynamic forces that occur



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during normal machine operation. In the case of a tall and slender structure, there may be a need to investigate the dynamic effects of wind gusts.

- The following impact loads shall be considered:
- Shaft or motor driven machinery: 20% of machinery weight
- Reciprocating machinery: 50% of machinery weight
- Overhead travelling Crane
- Crane load shall be considered as live load according to DIN.
- vertical force: 25% of maximum wheel loads for the cabin operated crane.
- 10% of maximum wheel loads for pendant operated crane.
- lateral force: 20% of the weight of trolley and lifted load
- Longitudinal force 10% of maximum wheel loads.
- Truck loads: Impact effects of truck loading shall be considered according to
- DIN 1072.
- Hoist:
- Vertical force: 20% of lifted loads.

3.6 Foundation Design

- The foundations shall serve to support all loads from the equipment, buildings and associated equipment. For existing subsoil conditions the following foundation types can be applied to the buildings and structures of the transformer bays:

Piled foundations (If necessary)

End bearing piles i.e. bored piles down into a deep stratum shall be used for heavy constructions.

Friction piles i.e. driven piles can be used for usually buildings.

Direct foundations

Direct foundations can be used when the allowable bearing capacity shall reach values of approx. between 1.0 – 2.5 kg/cm² under acceptable settlement conditions.

Settlement tolerances

The following are the acceptable limits of settlements for foundations:

buildings/structures: 25 mm differential settlements: 10 to 20 mm

Stability of foundations



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Stability against overturning erection shall be 1.5. For normal operating load conditions, it shall be 2.0 and for cases of transient loads, such as earthquake or wind it shall be 1.5.

Stability against sliding

The minimum safety factor against sliding shall be 1.5. The coefficient of friction used in computing the safety factor against sliding for the cast-in- place foundations shall be 0.50, unless specified otherwise in a detailed soil investigation. Passive earth pressure from backfill shall not be considered in computing these safety factors.

Stability against flotation

All foundations subject to buoyant forces shall be designed to resist a uniformly distributed uplift equal to the full hydrostatic pressure. The minimum safety factor against flotation shall be 1.10, considering the highest anticipated water level.

Increase in allowable bearing pressures

Allowable bearing pressures under foundations shall be increased by one third for load cases considering extreme loads like wind or seismic forces, either acting alone or when combined with vertical loads.

3.7 Special Civil Design Requirements

Introduction

The civil works are governed by the conditions of the electromechanical part and the conditions or specifications stipulated hereafter.

Detailed execution features of the civil work are described in the relevant sections of the Specifications.

This document shall represent the basic specification information for calculating the lump sum price of the works concerned, but they should not be considered to be a complete description in every respect. Bidding drawings indicate the intended layout of the works, but are not to be taken as a final and dimensional reference.

The price offered shall be understood as the total sum for the complete civil and finishing works to suit the requirements and the functions of the works concerned.



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Design and choice of construction materials shall consider and ensure the reduction of future maintenance works, and therefore, all civil elements shall be designed to minimize maintenance and to result in a durable construction with a minimum design life of 40 years.

The Contractor shall prepare all necessary design and detail drawings in accordance with the Project requirements.

Design guidelines

Buildings

Foundations shall be designed according to the findings of the soil investigations and shall consider the requirements of the buildings. Total settlements shall not exceed 2 cm and differential settlement must be smaller than 1 cm.

Cable trench/channels respective cable tunnels (ease of access) shall be considered under all rooms.

Raised modular flooring shall at least be foreseen for containers and switchgear rooms.

Provisions for heating, cooling and ventilation shall be made for every individual converted space. To be fully supported by design (demand, losses and resulting facility capacities requirements).

An adequate number of doors/emergency exits to comply with means of egress requirements and sufficient loading spaces have to be provided as per related fire fighting code requirements.

All cable trenches to be executed with at least 1% slope towards drainage points or pump sumps, which shall be provided for each section or at least at both ends of the trench. Normally a recessed/flush installation shall be foreseen for all wall cabinets and panels, e.g. for indoor fire hose reels, breathing apparatus, fire extinguishers, annunciator/repeater panels, CO2 off units, alarm/detection equipment, etc.

External walls, roofs, aluminum or metal clad walls and roofs, as well as all doors and windows of all containers shall provide adequate thermal insulation and shall be approved by the Employer / Employer's Representative. The thermal transmission coefficient of walls, including all windows and doors, shall be in compliance with the applicable standards.

Unless local regulation require differently, all fire rated doors shall be designed in accordance with NFPA, and all reinforced concrete structure members (slabs, beams, frames, columns, etc) shall be designed in accordance with EN norms.

Buildings and each substation has to be equipped with fire alarm and fire fighting systems, which meet local regulations.



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Foundations and floor slabs shall have projecting galvanized earthing flags to enable connection to the earthing grid of the Station.

All substation metalwork including transformer tank, cable screens, feeder pillar, doors and any internal structural steel work shall be securely bonded together so that a firm metallic connection existing between each of them and the substation earthing terminal.

The application of windows and glass panels as well as the general architectural concept of the building and container are subject to the approval of the Engineer. The observations and requirements of the Employer's Representative are no reason for additional claims by the Contractor.

The following fundamental design criteria shall be strictly followed and applied in view of the proposed equipment:

results of soil investigations

codes and standards to be adopted in the design

loading to be adopted for the various elements of the structure load factors and load combinations

description of the design method and theories to be adopted

base calculation of the structural design and general arrangement drawings shall include the principle framing and loading calculations, architectural scheme design as well as the information concerning the expected forces in the relevant elements of the structure

to guarantee the security of the equipment in operation during the extension works of existing substations.

Architectural detail drawings covering the electrical equipment requirements shall include the following:

plans, elevations and sections detailed enough to enable construction

without difficulties

stair case details

roofing and water proofing detail . doors and windows schedules

finishing schedules

Particular space requirements

Dimension of switchgear rooms, switchgear room and any other shall be determined under full consideration of the equipment requirements and listed in the relevant part of the Specification.



Pipes, lighting installations, air conditioning ducts have to be located in a way that sufficient (shadow-free) lighting is provided after completion of all installations.

3.8 switchgear room

The story switchgear building will be designed and constructed

Under the responsibility of the Contractor along the basic design indicated in Concept layout

All auxiliary, control, protection, telecommunication equipment for the

110 kV switchyard, which is not accommodated directly at the equipment or in one of bay control kiosks shall be accommodated within the appropriate rooms of the station switchgear building.

The proposed arrangement of the building can be modified by the Contractor according to the specific conditions (i.e. transport ways, arrangement of the equipment, partition of the building, etc.), subject to the Employer's approval.

Description of the switchgear building

structure: modular system of reinforced concrete frames with block work infill

foundations: According to the soil report to be prepared by the Contractor

roof: reinforced concrete + steel structure or wooden structure is subject to the fire resistance description

doors: double skin insulated metal doors with the required fire resistance, large enough to pass the equipment for , staff and office timber doors

floor finishes: epoxy screed (minimum 5 mm thick), epoxy seal coat for all electrical rooms without raised floor, including also the acid resistant for battery and charger room.

Internal walls: brick work, plastered, emulsion paint

Exterior walls: cavity masonry or double-twin wall with thermal insulation; plastered and painted inside; rendered and weatherproof painted outside

windows: The building shall receive aluminum-framed, windows with double glazing to provide natural light in the rooms



Access: For access in the building, a concrete platform with two steps or ramps shall be provided in the front of the building. For access to the roof, there is an external steel service ladder, with safety cage after 2.20 m

heating: electric system

air conditioning: split units (central system is also possible) ventilation: in the switch gear and battery charger rooms,

Description of the building

Structure:

Modular system of reinforced concrete frames with block work in-fill.

Roof:

Reinforced concrete + steel structure.

Doors:

1 access door at least 2.00 m wide.



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Floor finish:

Epoxy coated screed.

3.11 Bay Control Kiosks/Container type

The control and protection equipment for the 110 kV bays shall be installed in local Container in the immediate neighborhood to the respective diameter or bay of the switchyard. The control and protection equipment will then be linked with a redundant optic fiber to the Central switchgear Room in the station.

New bay control kiosks shall be constructed to accommodate the bay control and protection panels for the new switchyards:

110 kV switchyard

The kiosks shall be designed in such a way that it offers sufficient spare space and shall be equipped with air conditioning and heating equipment. The overall space and design should also take into consideration that batteries have to be included in the kiosks.

The structure of these bay control kiosks can either be of conventional civil design or of a prefabricated cabin/container type design. It shall be self- supporting.

The construction shall be designed in such a way that the bay control and protection panels can be safely installed and spare space still is available.

The outer skin shall be UV-stabilized with special admixtures. The frame shall be consisting of welded galvanized sectional steel. Air conditioning and ventilation shall be sufficient for the required capacity of the bay control and protection panels and other equipment installed.

The construction shall be obligatory waterproofed. Floor openings for the

MV and LV cables must be sealed so that no water can enter into the cabin. Monolith or prefabricated concrete foundations shall be foreseen.

The Contractor is free to propose another type of housing bearing in mind cost optimization, transport and installation.

Separate cable entries for LV power and control cables shall be foreseen. The floor shall withstand a static load of 500 N/m² and a dynamic load of

3000 N/m². All metallic structures, fastening devices, fittings, etc. shall be either of non- corrosive material or galvanized steel.

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All fittings (e.g. doors, louvers, windows, etc.) shall be mounted from the inside of the cabin in order to prevent any vandalism.

The internal side of the walls and the ceiling shall be painted with a white tincture from synthetic resin base.

The external sides shall be treated with plastic waterproof layer made of synthetic resin, quartz powdered oxide to withstand the atmospheric and ambient condition.

The colors of the walls shall be beige and the cover shall be of grey color.

3.12 Outdoor Foundations and Structures

3.12.1 Transformer foundations

The main, oil-filled transformers foreseen for the project shall be supported on reinforced concrete foundations installed on concrete tray. The provisions of the relevant VDE prescriptions shall be respected.

The foundation supporting the transformer shall incorporate transformer transport rails. Bollards to give haulage points for the transformers shall be provided at suitable locations.

Provision shall be made for the catchment of oil spillage, rain and fire extinguishing water. Appropriate measures to be made to prevent pollution of the environment by discharging of ejected oil. Each transformer foundation tray shall be provided with slope and raised borders, enclosing an oil pit in which the oil content of one transformer can be discharged in the event of an oil leak.

Each transformer compound shall be designed to retain 1.25 times its volume of oil by means of oil retaining walls in the event of failure or spillage and provision should be made for the catchment and drainage to an underground oil sump tank and subsequent removal of the oil.

The transformer compounds shall be of sufficient size to permit safe working and provide adequate space for installation, maintenance, removal and cooling of the transformers.

The oil pits inside the transformer foundation compound shall drain into one central underground oil collecting pit with integrated oil separator.

The oil collecting pit shall be sized to accommodate at least 150% of oil of the transformer to allow for firefighting materials externally applied by the fire fighting services.

The area within the transformer enclosure shall be designed as a water retaining structure to BS 8007 and be coated with 2 coats of bituminous paint. The tray shall be covered with steel grating and gravel



layer. The bottom of the tray shall be sloped in order to drain the oil spillage to the pump sump foreseen into the slab.

The area within the transformer enclosure shall be designed as a water retaining structure to BS 8007 and all internal concrete surfaces of the transformer trays supposed to get in contact with oil shall be painted with oil resistant paint. The area within the transformer enclosure shall be coated with 2 coats of bituminous paint. It shall be surfaced with a 100 mm thick layer of gravel on steel grating as specified in Annex 85.

The road immediately adjacent to transformer used by oil handling equipment for maintenance will also drain to the containment facility to prevent ground pollution in the event of accidental spillage.

If there is more than one power transformer on site, it may be economic to link the oil containment drainage areas of these to a single underground tank with a capacity for largest transformer alone, thus reducing the excavation required.

Connection pipe work shall be designed to ensure rapid discharge of oil to the underground facility that together with pipe works shall be resistant to transformer oil at a temperature of up to 80°C.

3.12.2 Oil separator

The water collected in the tray underneath the transformer will flow through a drainage pipe to an oil separator of cast in place reinforced concrete.

The oil separator consists of three chambers having the following functions:

The reception chamber in which the inflowing liquid is being settled. In this chamber water/oil emulsions start to separate.

The collecting and oil separation chamber where the liquid is being collected and the separation of oil from water is taking place. The dimension of this chamber must be at least equal with 150% of the oil content of the largest transformer allowing for the water discharge of the fire deluge system and volume of the collecting chamber for storm water.

This chamber shall be equipped with an indicator/alarm system, which signalizes the oil content in the chamber. As needed the oil shall be extracted by means of pumps.

The outlet chamber, which receives the cleaned water without oil content. From here the water is drained through a pipe of minimum 150 mm diameter to the storm water system.

The oil separator shall be provided with openings in the cover slab and step irons into the walls for easy access into each of the three chambers. The inner surface of the structure shall be painted with oil



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resistant coating. The top slab as well the cover the openings into the slab shall be adequate for the traffic load occurring on the structure.

The design and size of the oil separator shall be in accordance with VDE (AGI J21-1)

3.12.3 Other outdoor foundations

The following foundations shall be included under this clause:

for supporting structures of pipes / cables, etc.

for outdoor switchgear equipment supports and gantries

for supporting units:

inside the 110 kV switchyard

foundations for other outdoor structures not explicitly specified above.

The foundations for structures and equipment, like e.g. transformers, containers, kiosks, gantries, HV switchgear, lightning arresters, lighting poles, etc. shall be of reinforced concrete designed and constructed according to the recommendations of the soil investigation report and the respective equipment and wind loads.

The foundations shall be designed so that the upper structures are securely supported. The foundations will have adequate dimensions to prevent settlement, overturning, or other displacement and shall withstand the loading calculated.

The overload factors for stability of the foundations (overturning, sliding, bearing and uplift) shall not be less than 2.5 for normal loading conditions and shall not be less than 1.5 for exceptional loads.

The foundations shall be performed according to the requirements of the soil investigation.

The soil conditions met during the foundation works are to be checked by the Contractor's soil engineer, recorded and compared with previous results. If essential differences occur, the Contractor has to inform the Employer/Engineer and to propose further measures.

Immediately prior to concreting, the Contractor has to verify the specified soil conditions below the foundation level by a sounding method.



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3.13 Cable Trenches

All electrical trenches shall be of reinforced concrete. For outdoor trenches exposed to heavy loads (trucks), reinforced concrete covers, calculated for $1,000 \text{ kg/m}^2$, shall be provided. At road crossings the truck loads imposed by SLW 60 shall be considered.

The trenches shall be provided with sumps, to collect the storm water inside the trenches and from here to be discharged to the storm water drainage system.

Reinforced concrete cable trenches, pulling pits and duct banks shall be cast in C30 concrete and to suit the requirements of the cable arrangements, all to the approval of the Engineer. Reinforced concrete duct banks shall be provided at all road crossings with transition chambers at each end. The ducts shall be sloped to a low point and drained. The duct banks shall consist of transite or equivalent approved pipes with sufficient concrete cover to pipes and shall be designed safely to carry all loads to be transported over the roads. All necessary fittings and inserts shall be cast in place and slots shall be provided in the centre walls of cable trenches to suit the cable arrangement requirements. Reinforced concrete pulling pits shall be constructed where required to facilitate pulling cables. They shall be covered with suitable covers, designed to accommodate their likely loading, and be suitable for ease and safe removal. The pre-cast concrete covers shall be designed to support a concentrated live load of 10 kN placed anywhere on the span. Maximum deflection shall be $1/500$ of span.

The Contractor shall provide additional protection for concrete from the action of sulphates in the soil by the application, to the satisfaction of the Engineer, of a protective coating of bitumen not less than two millimeters thick to contact surfaces.

The bitumen coating on vertical faces shall be applied in more than one layer to ensure the complete absence of pinholes and bare patches.

3.14 Storm Water Drainage System

General

The work covered by this section of the Specification consists of:



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3.15 a drainage system for the evacuation of rainwater from the switchyard areas generally, of roads and paved areas, of cable trenches and roof of building, shall be provided.

a sewage drainage system for the connection and discharge of water closets.

The storm water system shall consist of piped drains back filled with broken stone or gravel (French drains) as well as reinforced concrete drainage ditches and channels. The connection of the drainage systems to the outdoor existing facilities is also included in the project. The system shall discharge the storm water outside of the switchyard areas, as agreed with the Employer.

For the design of the storm water drainage system, the following data have to be considered:

The average annual precipitation is 2,016 l/m² and as confirmed by local meteorological authorities.

Drain ditches shall be built in reinforced concrete. The sloping of open drains shall be of min. 0.2%.

The regulations and recommendations of the relevant local drainage standards shall be observed as agreed with the Employer.

The Contractor shall execute temporary channels which may be necessary to prevent flooding of the site, until permanent drains have been completed.

Design features

For design purposes a precipitation prescribed by the local rules and meteorological conditions has to be considered for the design of drainage systems.

The various drains within the plant shall be arranged in such a way as to avoid, as far as possible, auxiliary lifting pumps.

The arrangement of all drain lines, discharge headers and collectors shall suit the operational requirements, simplicity and reliability to be of utmost importance, and shall have checking facilities to make sure that every drain emission component of the plant is working properly.

The sewage system shall be dimensioned to handle the worst conditions of the blow-down system and the water discharged in the construction zone from the neighboring hilly zones.

The pipe-work for the effluent water shall be designed to withstand all adverse effects such as corrosion attacks, thermo-shocks, sand and sludge which are likely to occur under normal and emergency conditions. The material of the pipes shall be subject to approval of the Employer / Employer's Representative.

The Contractor shall supply sump pumps including discharge pipes for all pits, culverts, channels, etc. if drainage by gravity cannot be carried out. The sump pumps shall be equipped with all switch and control devices as well as audible and optical alarms to prevent over-flooding in the case of failures.

Materials

Quality and standards

Materials and components which the Contractor shall supply and install and which therefore will be incorporated in the work or structure shall be of selected quality which is subject to approval. They shall comply with the requirements and standards acceptable to the Employer/Employer / Employer's Representative.

Unplasticized Polyvinyl Chloride (UPVC) Pipes

UPVC pipes are to be used for water supply and storm water sewerage purposes.

The minimum quality requirements of UPVC shall be as follows:

Pipes of unplasticized PVC (polyvinylchloride) shall be used for water supply purposes.

Pipe, couplings and pipe fittings must meet the requirements of approved standards. Pipes and fittings or plasticized polyethylene shall not be used.

All materials shall comply with the regulations regarding quality and dimensions and shall be adequate for the required work.

All pipes and joints shall be marked indelibly immediately after taking from the moulds.

The marking shall include:

name of manufacturer

date of manufacturing and serial number

nominal diameter and pipe class

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Vitrified clay pipes

Vitrified clay pipes are to be used for domestic sewerage, oily water system and chemical contaminated water drains.

Tolerances

The tolerance of the nominal diameter of pipes shall be 5 mm for 250–500 nominal diameter; 10 mm for 600-1000 diameter and 15 mm for 1200-2000 nominal diameters.

For wall thickness at the base, at the side and at the top, tolerance of 20 -10 mm shall be allowed. Consideration shall always be given to the required clearance between spigot and socket for proper joining.

The tolerance on the nominal length shall be 20 mm.

Requirements

The storm water drainage system collects only clean storm water which can be discharged into the storm water system of the zone. For the extension of substation, a complete storm water drainage system is required. Substantially maintenance-free and operationally safe installation must be guaranteed. The surface water drainage shall include all necessary gutters, down pipes, gullies, traps, catch pits, manholes and exit as approved by the Employer or his Representative.

The boundaries of the substations shall be protected against over flooding of the site.

The work to be carried out under these technical requirements comprises various types of drainage culverts and pipes including all accessories such as inspection shafts, etc.

All work shall also include supply, loading, transportation, unloading and storage at site and placing according to drawings and requirements of all materials and components connected therewith.

The pipes and structures of the drainage system shall be placed such to withstand buoyancy.

3.15 Fencing and Gates

Fencing shall be provided around the substation area. Exception is only the substation where the external fences are included in Contract. The fences shall be at least 3.00 m high above the ground level and shall be topped with additional rows of barbed wire.

The plain surface area made of concrete or plastered masonry will be strengthened by means of reinforced concrete columns (20 x 20 cm) every 4 m max.



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The internal security fences shall be of galvanized steel posts and robust solid mesh panels. Minimum height shall be 2.00 m.

3.16 Substation Boundary Walls

If required as per design.

3.17 Roads, Paving and Surfacing

The road system must be arranged in such a way that a non obstructed traffic is guaranteed.

The following types of as per Site roads shall be provided:

The main road access shall be min. as per site wide, the internal roads may be 5 m wide. The minimum radius of main roads has to be designed for heavy vehicles and trailers, not less than as per site.

The road connections to the buildings and kiosks are to be provided by the Contractor even if they are not shown on the general layout drawing. The road connections from the municipality roads to the site and the main station roads are part of the scope of civil works.

If necessary, the roads shall be provided with slopes, not exceeding 5%.

Footpaths of 1.0 m width shall be provided around the switchgear building. The areas around the buildings and outdoor areas which can be used infrequently as lay down areas for small loads, parking areas, etc. shall be paved with interlocking concrete blocks.

The area of each switchyard not covered by buildings, foundations, structures, roads, paving, plants, etc. shall be leveled and covered by a gravel strata of min. 15 cm thickness. The effective substation equipment area shall be filled to the final elevation by a 200 mm thick layer of gravel or stone pitching.

Road signs, traffic signs and road surface marking shall be provided as per authority requirements for traffic in industrial areas.

The roads and paving shall be provided with slopes to lead the storm water to gullies and to the discharge system.

The Employer's instructions regarding the addition of water to improve compacting of fill must be adhered to. For fill under roads and foundations every effort shall be made to compact the fill material at its optimum moisture content for compacting. In any case, the dry density of the compacted soil shall not be less than 95% of the maximum density according to ASSHTO T180.

The complete substation area shall be surfaced with a 100 mm layer of crushed aggregate, size 32mm-64mm.

The allowable tolerances are as specified as per site:

Concerning the wearing course, the Contractor may propose a double seal coat or premixed asphaltic concrete. The proposal shall account for rates and types of bitumen and aggregates, plant and method of application.

For dimensioning the roads the actual heavy traffic loads will have to be considered, however, as minimum the specific standard load of the truck SLW 60 (according to ISO TR 9492) shall be considered for dimensioning of roads.

3.18 Landscaping

The free area of land inside of the substation, where no roads or gravel is provided, shall be landscaped using low to medium-high growing plants and grass. Plantations shall be provided along the main roads and the building. The landscaping is subject to the approval of the Employer.

3.19 HVAC and Heating System Works

The HVAC and electric heating systems to be installed under this Project within the bay control kiosks and in the substation Switchgear building shall be designed for cooling in summer and heating in winter.

The split a.c. units shall be equipped with electrically operated air heaters to heat the supply air in winter time.

Condensate shall be drained into the drainage system.

Room conditions to be considered for the design of the equipment:

Inside	Min. °C	Max. °C
Switchgear rooms	+10	+28

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3.20 Water supply system

The complete water supply systems belong to the scope of works of the Contractor. The works include:

Contractor shall install a complete and functioning water supply system.

The water supply system inside of the substation.

3.21 Fire detection and fire protection system (if required)

3.21.1 General

This Section covers the technical requirements for the fire detection, alarm and fire protection system for transformer bay complete in every respect including the design, manufacturing and supply of the complete fire protection and fire detection systems of the transformer bays. Thereby only minimum requirements are stated.

The Contractor shall classify all plant areas according to specific fire hazards and fire areas and shall clearly define and provide the most suitable fire protection and fire detection systems.

The design, installation and testing of the systems shall be according to local standards and NFPA standards (especially NFPA 850), whatever is more stringent. Furthermore, requirements from international insurance companies shall be taken into account.

3.21.2 Technical Requirements

3.21.2.1 Fire risk assessment

A fire risk assessment according NFPA 850 shall be performed by the Contractor to analyze the likelihood of fires, their consequences and recommend mitigation measures. Special attention shall be drawn to:

fire prevention
control of ignition sources
definition of hazardous areas
construction precautions
fire detection and alarm systems
fire water supply
portable fire extinguisher
escape ways
others.

3.21.2.2 Fire detection

The fire detection and fire alarm system shall comprise an automatic fire detection system to be installed in each room of the switchgear room.

The signals from the detectors shall be collected in the fire alarm control panel. (MCFA)

Also temporary fire protection and fire detection measures shall be considered.

All necessary electrical instrumentation and control equipment and all measures as required by the permitting authorities shall be included.

Automatic fire detection systems

The switchgear room shall be furnished with an automatic fire detection system including an alarm control panel.

The fire detection system shall be connected to an fire alarm control panel at the switchgear room.

Surveillance with fire detectors shall be provided for all areas.

Details of the arrangements and types of fire detectors shall be fixed in the fire protection design basis document.

Manual call points

Manual call points shall be of the break-glass type and shall be established in the switchgear room area at emergency exits.

Alarm and warning systems

If the push button of a manual call point will be pressed, an alarm shall be released and indicated immediately on the fire alarm panel in the switchgear room.

If the alarm is triggered by one of the installed automatic fire detectors, the alarm shall be indicated first in the switchgear room and on the fire control panel.

Push-button actuation must be provided for manually operated fire alarms next by exits and on all escape routes.

Sirens for indoor and outdoor installation must be provided for warning the operating personnel.

In the central switchgear room, the necessary automatic fire detectors are to be incorporated in the luminous ceiling.

The whole of the substation area to be monitored is to be divided into individual alarm sections, the latter being so arranged as to enable rapid and positive identification of fires.

Detectors installed in false floors, suspended ceilings, cable ducts, air-conditioning or ventilation systems are also to be combined to form separate alarm sections.

Detectors belonging to a particular alarm section shall be incorporated in alarm lines, the automatic and manual fire alarms being connected via separate alarm lines to the common fire alarm control panel in the switchgear room.

The arrangement and number of detectors is determined by the type of fire detector used, by the room configuration (size, height, form of floor and roofing, etc.) as well as by the ambient conditions in the rooms to be monitored.

Detectors installed in inaccessible points such as cable ducts, false floors, cable basements, etc. shall be connected in parallel to external optical alarm indicators installed close by and in readily visible positions.

No restrictions on the proper functioning of fire alarm by reason of movement of air, optical radiation, smoke, dust, vibration, high humidity, etc. are acceptable. Moreover, fire alarms shall be located in the outgoing airflows of air-conditioning and ventilation systems.

The alarm signal receiving units must be so designed that by use of a standardized alarm unit socket, any of the types of detector may be used with equal facility on any of the fire alarm circuits. The fire alarm control panel must be housed in sheet-steel enclosed cabinets and located in the switchgear room or

nearby in an appropriate location. Both optical and audible signals must be given when a fire alarm or fault alarm occurs.

Power supply for the fire alarm system shall be taken from the station battery.

Fire alarm control panel

The fire alarm control panel shall be implemented in all-electronic technology using plug-in units and assemblies on the modular construction principle, and shall be accommodated in metal-clad enclosed panel with type IP 32 enclosure for wall-mounted/free standing installation.

The arrangement and functioning of the fire alarm control panel shall be such as to permit as a minimum the following:

The fire alarm and fault annunciation system shall be designed with optical and audible alarms. Whereas the audible alarm must be resettable, the optical indication shall persist until the annunciation is finally extinguished or the fault cleared. If a fault warning is followed by a fire alarm annunciation, the fault indication must be stored and suppressed until the fire alarm condition has been cancelled. Provision shall be made for clear audible identification of the alarm/fault signal. Furthermore, fire alarm signals and fault signals shall be strictly segregated.

The individual fire alarm lines and function lines of the fire-fighting equipment and facilities, as well as important functional groups of the fire alarm control panel shall be continuously monitored for faults and breakdowns e.g. for

wire breakage of each alarm line

short-circuit of each alarm line

earth fault of the fire alarm system

power supply system faulty

main fuses and MCB's failure

alarm modules disconnected from plug-in frame.

All fault signals shall be optically and audibly indicated.

For checking out the functioning of the complete fire alarm system including the fire alarm lines and fire alarm devices, testing facilities shall be provided. When testing a circuit, initiation of fire alarm warnings in external facilities shall be prevented. After testing, the tested circuit shall automatically reset to normal operation.

Simulation (e.g. test pins) of all relevant fault signals as listed above as

Well as of all fire alarms shall be possible.

Layout Display Board

For indicating fire alarm and fault annunciations from the fire alarm system, a layout display board shall be provided in the control panel. This board shall include a graphic display to show a simplified ground plan of the substation and shall feature signal lamps for the separate optical indication of the alarm line, and shall include the annunciator with alarm test, reset and acknowledge buttons.

Detection system elements

The fire detector system elements and the associated mountings are to be provided with sturdy, corrosion-proof plastic housings.

The fire alarm detectors are to be provided with optical means for signaling their activation (e.g. light-emitting diode), and are to be suitable for the connection of an additional optical external alarm indication.

The fire alarm detectors shall reset ready for operation following each alarm, without outside intervention, and shall plug-in and be provided with suitable means to prevent unauthorized removal.

The following detector types as a minimum shall be used for fulfilling the requirements for the power plant as a whole:

Ionization detectors

For the early identification of visible and invisible fire aerosols, consisting of ionization chamber, alarm electronics, optical alarm indication, response delay pre-settable to suit ambient conditions, detector socket, variable response sensitivity.

Optical smoke detector

For early identification of visible smoke generation, consisting of photoelectric unit, alarm electronics, optical alarm indication, detector socket.

Flame detector

For early identification of fire outbreaks and open flames, consisting of optical unit, alarm electronics, optical alarm indication, detector socket, variable response sensitivity.

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Manually operated push buttons

Consisting of push-button, only operable after smashing the replaceable glass window fitted in the housing, painted red, interlocking mechanism, to be reset by key.

Sirens

The protection degree of the sirens for indoor and outdoor installation must be at least IP 54. The outdoor sirens are to be arranged in the transformer area. The arrangement of the indoor sirens must meet the requirements at site for satisfactory warning of the operating personnel. The control of the sirens shall be performed automatically by the fire alarm system, but manual operation from the fire control panel must also be possible.

3.21.2.3 Fire protection

Fire protection system shall consist mainly of structural measures transform water spray system mobile fire extinguishers temporary fire protection measures.

3.21.2.4 Structural protection

Material

Materials used for fire protection shall have test certificates to certify their specific application and their protective function. Wherever a fire risk is possible non-combustible building materials shall be used.

Fire barriers and fire compartments

Fire barriers separating fire areas shall have a minimum of two (2) hour fire resistance rating. All openings in fire barriers should be provided with fire door assemblies, through penetration seals (fire stops), or other approved means having a fire protection rating consistent with the designated fire resistance rating of the barrier.

Fire door assemblies used in 2-hour-rated fire barriers should be listed and approved for a minimum 90 min fire rating.

All wall penetrations for piping, cables etc. shall be refilled with non- combustible construction material.

Outdoor oil-insulated transformers shall be separated from adjacent structures and from each other by firewalls, spatial separation, or other approved means for the purpose of limiting the damage and potential spread of fire from a transformer failure.

Walls and ceilings



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For walls and ceilings of the buildings as mentioned in this section only construction and insulating material of non-combustible material shall be applied.

Roofs

The roof cladding of the buildings shall be resistant against flying sparks and heat radiation. Roof insulation material shall be of non-combustible material.

Cable ducts, cable trenches

Non-accessible cable ducts or cable trenches inside buildings shall consist of non-combustible material.

Accessible cable ducts and cable trenches shall be considered as a fire fighting compartment and shall meet fire resistance rating requirements according to applicable standard. No self locking doors shall be installed in cable ducts.

Penetrations and fire retarding sealing to buildings shall be designed with a fire resistance rating according to applicable standard.

Air ducts

Air ducts shall consist of non-combustible construction material. Air ducts penetrating firewalls or ceilings shall be equipped with fire dampers in the fire resistance class of the penetrated construction.

3.21.2.5 Fire protection for the power transformers (not in scope)

For the power transformers manual/automatic water spray systems shall be installed.

The water spray system shall include as a minimum:

fire water supply system including

1 x 100% electrically driven pump,

hydro- pneumatic tank with compressors

firefighting equipment including

transformer spray water deluge system

All necessary electrical instrumentation and control equipment and all measures as required by the permitting authorities shall be included.

Each transformer shall be provided with one valve station and one control and monitoring cabinet for the deluge system.

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The deluge system shall be designed for manual, automatic or electrical remote operation and shall be provided in free-standing and self-supporting design, with the following basic equipment:

air pressurized tank (filled with service water) for maintaining a reserve of fire-fighting water according to applicable standards but at least for minimum of 10 minutes (including compressors).

required number of triggering and fire extinguishing nozzles, with galvanized pipes and mountings,

necessary galvanized connecting lines from the appropriate valve station to the nozzle pipe network,

necessary drainage valves, struts, diaphragm sleeve valves, single chamber valve stations with all fittings and connections, pressure- sensitive switches for signaling and air pressure drop,

one monitoring cabinet with local control and remote control from the switchgear room,

all auxiliary equipment for are fully functional deluge system (including all piping, valves, cabling).

3.21.2.6 Portable fire extinguishers

Portable fire extinguishers shall be placed in the switchgear building and an on each floor or stage of the buildings as well in the switchgear room. Generally only standardized fire extinguishers complying local standards and NFPA shall be used.

The number, volumes and installation locations of the fire extinguishers shall be evaluated during detail engineering, following the recommendations of local standards and NFPA. In case that hose reel stations are installed, the number and volume of required fire extinguishers can be reduced.

CO₂-fire extinguishers shall be preferred in the switchgear stations.

The necessity for the provision of mobile fire extinguishers (50 kg – 100 kg) shall be evaluated during detail engineering. Criteria for the provision and use and of mobile fire extinguishers are:

experienced personal in the use and handling of fire fighting devices

automatic fire detection systems

short fire attack routes.

high fire load

3.21.2.7 Temporary fire protection measures

All necessary fire protection measures shall be provided according to

general and local rules and shall be maintained by the Contractor throughout the erection/construction phase, especially the rules and directives for construction sites.

The Contractor is responsible for the realization of all necessary fire protection measures prior to commencement of all construction works, which includes:

an alarm plan with all ways of information and responsible persons, authorities and duties to be informed in case of a fire or other incidents and accidents has to be established,

Evacuation plans for the construction site have to be established.

mobile fire extinguishers shall be provided

a fire protection order has to be established and to be published to all parties participating at the construction,

an alarm plan with all ways of information and responsible persons, authorities and duties to be informed in case of a fire or other incidents and accidents has to be established, evacuation plans for the construction site have to be established. Mobile fire extinguishers shall be provided

A safety coordinator has to be nominated by the Contractor, responsible for all safety relevant aspects of the construction works to be coordinated by him. The coordinator has to execute a fire risk assessment for the construction site, to evaluate the fire risks of the construction works and to set up suitable measures of fire protection e.g. to establish portable fire extinguishers, manual call points and other fire protection equipment as far as necessary.

3.21.3 Technical data

The technical data of the system to be implemented are specified in the attached schedule of technical data

3.21.4 Test requirements

Test requirements shall be followed as specified.

3.21.5 Proof of compliance

As proof of compliance the Bidder shall submit with its bid the following: The bidder shall provide a description of the fire detection and alarm system as well as the fire protection system to be implemented in the substations.



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Block diagrams of the fire detection and transformer water spray system.

4. Requirements for the Execution of Civil Works

4.1 General Stipulations

The specifications and methods of construction for civil works are given hereinafter. The Contractor has to follow these specifications and shall conform thereto. The Contractor shall submit their own specifications which they propose to use for methods not covered by these specifications.

The quoted costs given in the lump sum price shall cover any subsidiary or incidental works that may be found necessary

No work will be regarded as complete, until the Contractor has removed from the site all rubbish and unused materials and has properly dressed and finished all the grounds to the final approved levels, to the full satisfaction of the Employer.

4.2 Site Facilities for the Employer's Representative

For the use by Employer/Engineer's site personnel the Contractor shall provide on all sites a complete and fully equipped, temporary accommodation container for two engineers and a meeting room container either in containerized or hard block construction at a location to be indicated by Employer/Engineer, as follows:

Employer/Engineer's accommodation containers, incl. furniture

Employer/Engineer's meeting room containers, incl. furniture

Air-conditioning, telephone- and Internet connection for Employer/Engineer's offices

These containers shall be installed at locations to be indicated by Employer/ Engineer and the Contractor shall be maintaining them throughout the project period and shall upon request remove these after the completion of work.

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The temporary site facilities for the Employer's Representative shall be structurally sound and compatible with the weather conditions on the site including at least the following rooms:

Accommodation container:

- one (1) room for 1 engineer each (min. 3 x 4 m²)
- one (1) toilet room one
- (1) shower room
- one (1) kitchen

Meeting room container:

one (1) room for holding meetings for at least 10 – 12 persons (min. 8 x 4 m²)

one (1) toilet room ,

one (1) kitchen

The accommodation rooms shall be fully furnished to the satisfaction of Employer/ Engineer with air-condition (heating & cooling), wardrobe cabinets, tables, chairs, etc. They shall have sanitary facilities and a kitchen, which shall be equipped with one sufficiently sized refrigerator, microwave oven and a 2-plate cooker.

The meeting room shall be furnished with big table, chairs, a desk, filing cabinets, air-condition (heating & cooling) and be provided with a telephone system and a facsimile machine, which shall be connected to the Georgian telephone-system for international and local calls. It shall be fully furnished to the satisfaction of Employer/ Engineer.

The facilities shall be provided with the services necessary for their operation, such as electrical energy, potable water supply, sewers, drainage system with soak pit, fire extinguishing system, etc. The Contractor shall install an independent communication system to his, to the Employer's/ Employer's Representative's offices.

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The Contractor has to submit for approval to the Employer/ Employer's Representative all drawings and details for the temporary buildings, services, and equipment intended to be used before starting with the execution works on the site.

4.3 Communication System

The Contractor shall install an independent communication system to the Employer's and the Employer's Representatives offices and facilities, comprising at least two international telephone connections, internet access etc.

4.4 Responsibilities of the Contractor

The Contractor shall be solely responsible in all respects for the suitability and stability of the buildings and foundations.

The Contractor shall also be the solely responsible for verifying the suitability of his designed foundations to the effective ground conditions. When the soil has been excavated according to the approved design and the type of ground requires modifications in the design, these modifications shall be carried out by the Contractor without extra charge and have to be approved by the Employer.

The construction work referred hereto shall be performed in such a manner that the high standards of quality and function are achieved.

All materials shall be new and of the best quality, suitable for working under the climatic conditions without any distortion or deterioration.

Setting out of the work

The Contractor shall set out the work and shall be solely responsible for the accuracy of the setting out work. He is also responsible for the maintenance of existing and provision of all necessary new survey marks.

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Materials

All material used in the works shall be new and of best quality of their respective kinds. They shall comply with the requirements of the latest edition of the relevant standards.

Workmanship

All workmanship shall be of the highest standard and shall be performed by competent personnel skilled in their respective jobs.

Samples

Samples, when approved, shall be regarded as the acceptable standard, any material or workmanship subsequently not complying with the samples shall be rejected and replaced by the Contractor. Sample storage boxes shall be provided by the Contractor free of cost.

Tests

(a) Whenever considered necessary by the Contractor / Employer /

Employer's Representative, Inspectors may be sent to manufacturer's or sub-contractor's facilities to test materials or supervise their manufacture.

(b) Where specified or requested, the Contractor shall obtain from the manufacturer certificates of test, showing that the materials have been tested in accordance with this Specification and standards.

Prevention of damage

The Contractor shall take all necessary and reasonable precaution during the execution of the works to prevent damage to existing land, fences, channels, roads, buildings, services on and/or adjacent to the site.

Safety precautions

Wherever works are to be constructed in the vicinity of existing electrical installations, overhead power lines, power cables or any other electrical equipment in operation, the Contractor shall be responsible for ascertaining the necessary precautions and safety measures as required by the rules and Authorities.

Cleanliness of site

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The Contractor shall at all times maintain the site in a clean condition, and all rubbish, debris, etc. shall be collected and shall be disposed as requested.

Contractor's area

Offices, stores, etc.

The areas to be used by the Contractor for offices, stores, accommodation, workshops, etc. shall be agreed with the Employer / Employer's Representative. Spaces for offices, workshops, and etc. as well as free outdoor plot areas for storage of materials will be given by the Employer to the disposal of the Contractor.

Temporary sanitary facilities

The Contractor shall be responsible for providing suitable and adequate sanitary facilities for his site staff, at a position agreed with the Employer / Employer's Representative.

Health

The Contractor shall take for his staff all necessary health measures, as may be required by the works and by the statutory provisions of the Local Health authorities.

Water, electricity and other power

The Contractor shall be responsible for supplying of all temporary water, electricity and other power required for the execution of his works from a source indicated by the Employer. He should give notice and pay all fees as required by the authorities for such supplies and services. The Employer will give necessary assistance for electricity connections.

Temporary roads and fences

The Contractor shall provide the temporary roads outside and inside of the site and temporary security fences around the site.

Program

Overall and detailed programs

The Contractor shall prepare general overall and detailed programs also for civil works and submit them for approval. The detailed program for civil works shall be in accordance with the general and special conditions of the Contract.

Supervision

The Contractor shall provide adequate and qualified supervision for all civil works and his subcontractors.

Inclement weather

No payment will be made to the Contractor for works due to inclement weather conditions.

4.5 Site Services during Construction

Site services such as Contractor's temporary site buildings, site fire protection site access control and security, temporary latrines and ablutions as well as temporary electricity and water supplies, site access control and security are the responsibility of this contract, but need to be coordinated with the Employer or his Representative.

Site preparatory works

The Contractor shall clear all materials, debris, etc., from the areas required for the temporary and permanent works and accesses. All trees and vegetation, including rubbish and objectionable materials shall be felled, stumped, stacked, burned or disposed of. Unless otherwise stated, holes and cavities resulting from the clearing, grubbing, removal of stumps and roots shall be backfilled with acceptable materials and compacted to the density of the adjacent areas.

Materials removed during clearing operations shall be burned, buried in disposal areas or otherwise disposed of as approved by the Employer.

Any excavation of cable trenches or foundations near existing services shall be made by hand and not by excavator.

Site clearance and demolition works

Site clearance and demolition works consist of the removal and disposal of bushes, existing structures and foundations and of all other obstructions on the transformer bay sites, access roads, as well as the back filling of existing pits, trenches, channels etc.

Before submitting his Bid, the Contractor is given the opportunity to visit the site and inspect and examine the extent and nature of the various works which are included in this section of civil works. All these works have to be included in the lump sum price offered by the Contractor.

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Clearing and grubbing

Clearing and grubbing shall consist of clearing of all trees, bushes and other vegetation and rubbish, over the site area generally, as shown on the drawings or as directed by the Employer. Where the drawings or the Employer prescribe that items have to remain undisturbed, the Contractor shall take all necessary precautions to prevent damage to them.

The Contractor shall clear all materials, debris, etc. from the areas required for the temporary and permanent works and accesses, but shall take all reasonable precautions to prevent damage to existing roads and paved areas, buildings and other facilities in the zone which do not need to be cleared.

All trees and vegetation, including rubbish and objectionable materials not designated to remain, shall be felled, stumped, stacked, burned or disposed of. Unless otherwise stated, holes and cavities resulting from the clearing, grubbing, and uprooting shall be filled with acceptable materials and compacted to the density of the adjacent areas.

Demolition of existing structures

Demolishing, taking away and storage of existing structures to be removed will be performed by the Contractor. It is within the scope of the Contractor to plan, follow-up, execute and supervise these demolishing works.

4.6 Earthworks and Excavation

This section covers all the necessary work of the excavating, importing, placing, disposal and compaction of earth, as required by the drawings and specifications for the proper execution of the works.

4.6.1 General

The Contractor shall be expected, before submitting their Bid, to visit the site and inform themselves about the ground conditions on the site, the nature of the soil to be excavated, obstructions which may be encountered within the limits of the excavation, etc.

No claims will be accepted after award of the Contract.

The site shall be excavated, filled and graded to a general level which shall be established by the Contractor taking into account:

the results of the topographical surveys performed by the Contractor

the imposed levels due to the level of existing structures in the site areas

the quantity of imported filling from borrow pits shall be kept to a minimum

4.6.2 Water removal

The lump sum prices shall include the costs of control and removal of water during and/or after excavation. The Contractor shall provide all facilities and take whatever action is necessary to keep the excavation clear of water at all times of the execution.

4.6.3 Topsoil removal

The first earthworks operation shall be the removal of topsoil to a depth as agreed with the Employer. The topsoil shall be kept separate from other material and stock-piled for re-use on the site in the landscaped areas, as indicated by the Employer.

4.6.4 Execution of excavations

The works shall be excavated either by hand or by use of mechanical excavating equipment.

Excavation by hand may be required close to existing installations and/or underground services, but subject to special instruction of the Employer / Employer's Representative.

The contractor shall carry out earth- and rockwork for the works defined hereafter:

Clearing and grubbing

Excavation of top soil

Open cut excavation

Backfilling

Safety precaution during earthwork

Underground excavation (if required)

Grading

Replacement of material

Trench excavation for service lines

Embankments

Safety precaution

The Contractor shall be responsible for all necessary safety measures.

Proper strutting, sheeting and bracing, including re-arrangement of the installations when necessary, stabilization and protection of slopes, methods of excavation to reduce risks of slides, etc. shall be considered by the Contractor.

Over excavation

If somewhere, and for any reason, excavations are executed beyond the established lines and without the Employer's / Employer's Representative's previous approval, the Contractor shall at his own expenses backfill with approved material (including required compaction) or with lean concrete to Employer's / Employer's Representative's approval, the volume corresponding to over-excavation. He shall not receive payment for over- excavation not ordered.

Stockpiles and disposal

Excavated material from the Works selected by the Employer / Employer's Representative for re-use shall be placed immediately in its final position, if possible, or otherwise may be stockpiled or deposited on Site as directed by the Employer / Employer's Representative.

The Contractor shall not have the right either to additional payment or to claim because of work involved in stockpiling materials, re-use of for carting to the waste disposal areas. Soil unfit for re-use shall be removed to sites approved by the Employer. The excavated material which will not be used for backfilling works shall be removed from the site by the Contractor at a storage area indicated by the Employer at a distance of max. 10 km. This clause is valid also for the rubbish obtained from various demolishing works.

Back filling

The material for filling shall be made with natural material free from mud, silt, vegetable or other soft or injurious matter. The Contractor shall inform the Employer of the source or borrow pit from which he proposes to obtain the material.

Fill materials

The fill materials used are to be examined by the Contractor and approved by the Employer / Employer's Representative.

Select fill

Select fill shall have the following properties:

Well graded, non-cohesive and nearly silt free, salt free soils free of organic matter.

The material shall be of such nature and character that it can be compacted to the specified densities. It shall be free of plastic clays, of all materials subject to decay, decomposition or dissolution or other materials which will corrode piping or other metal.

The intention is to use select fill below structure, roads, etc. Ordinary fill

Ordinary fill shall have the following properties:

Natural inorganic soils: salt content not greater than 5%, organic matter less than 3%.

The intention is to use ordinary fill for non-built areas. Special fill

Special fill material shall be gravel or crushed rock.

The intention is to use special fill e.g. as sub-base material for open-air switchgear areas and roads.

Density requirements shall be as follows by tests per modified AASHTO (American Association of State Highway and Transportation Officials)

180 Method D or equivalent, at optimum moisture content

Under buildings and structure foundations and slabs	97%
Under roadways and parking areas	95%
Under transformers and other major foundations	97%
Embankment	95%

Placing and compacting

The filling shall be placed in layers not exceeding two hundred (200) millimeters in depth and the surface of each layer shall be given a slight fall to allow natural drainage.

Each layer shall be compacted at optimum moisture content by eight (8) tone smooth wheel rollers, or equivalent vibrating roller, or other approved means.

Subsequent layers shall not be placed and compacted until the previous layer has been compacted as specified and accepted by the Employer. Filling material that does not contain sufficient moisture to achieve the required degree of compaction shall be sprayed with water until compaction can proceed at optimum moisture content.

Excavation for pits and trenches for foundations, drainage, electrical, etc. Excavation shall be taken out to the minimum sizes necessary for the proper construction of the works. The excavation shall not be kept open for periods longer as necessary and reasonably required for the construction of the works.

The Contractor shall take all precaution necessary to ensure that the bottoms of excavation are protected from deterioration and contamination and that the excavation are carried out in such a manner that adjacent foundations, pipes, etc. are not undermined, damaged or weakened. Any excavation taken out below the proper level without approval shall be made good at the expense of the Contractor using lean concrete.

The Contractor shall be responsible for the stability of the steep sides of excavations, and shall provide and install all timbering and shoring necessary to ensure stability.

Shoring shall not be removed until the possibility of damaging of the works by earth pressure has asset. The bottoms of all excavations shall be properly trimmed and leveled, inspected and approved by the Employer before placing of concrete.

Backfilling

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

If during the execution of the excavation, by reason of delay or the effect of floods, bad weather, slips, etc., any sand, mud, weeds or other materials will be deposited or accumulated on the excavated areas, such materials shall be removed by the Contractor at his own cost. The Contractor shall provide pumping to keep the whole of the works, including the deepest foundations, free from water.

The positions of all temporary sumps shall be approved by the Employer. No sumps shall be permitted within the area of the foundations of the permanent work.

Due notice shall be given by the Contractor when he considers that any excavation beds have been properly and finally prepared, so that the Employer may arrange to make the necessary inspection.

4.7 Site Finishing

Weed killer

Weed-killer of an approved type suitable for local conditions shall be spread over areas to be covered by site surfacing before such surfacing is laid. The weed-killer shall be of type which does not cause corrosion of metals and shall be used strictly in accordance with the manufacturer's instructions.

Switchyard surfacing

Site surfacing shall consist of 200 mm clean, hard, natural, gravel or crushed stone graded from 10 to 30 mm. It shall be spread after installation of service and cable earth strips, electrical equipment, etc.

4.8 Road Works and Surfacing

4.8.1 General

This section contains the requirements for the construction of the roads and path ways, as shown on the General Layout.



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Culverts, pipe drains, ditches and other services shall be completed under and alongside roads. The Contractor shall take all necessary precautions to prevent damage to completed or partially completed services until the roads and paths have been completed.

Ditches, drainage channels, discharge structures, etc. shall be suitably designed and executed ensure the drainage of all storm water and to avoid possible damages to the road foundations.

4.8.2 Sub-Base

Sub-base material shall be crushed rock or other approved local material having suitable properties and conforming to the following grading:

BS (British Standard) Sieve	Percentage by Weight
75	100
37.5	85-100
10	45-100
5	25-85
0.6	8-45
0.075	0-10

The sub-base shall be compacted by approved plant to a dry density which shall not be less than 98% relative compaction until movement of the surface ceases and the surface is closed.

4.8.3 Wet Mix Road Base

Wet Mix road base material shall consist of crushed gravel or crushed rock and shall be suitably proportioned to conform to the following grading as approved by the Employer / Employer's Representative.

BS (British Standard) Sieve	Percentage by Weight
50	100
37.5	90-100
20	60-80



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10	40-60
5.00	25-40
2.36	15-30
0.600	8-22
0.075	0-8

Material constituents shall comply with the following maximum limits:

For material passing the 0.425 mm sieve:

Liquid limit	25%
Linear shrinkage	3%
Plasticity index	6%

For coarse material:

Stone Size Aggregate	50 mm
Aggregate crushing value	25%
Water absorption	2%
Flakiness index	35%
Elongation index	35%

The base shall be compacted by approved plant to a dry density which shall be not less than 98% relative compaction and until movement of the surface ceases and the surface is closed.

The final surface shall be shaped and finished true to line and level within a tolerance of ± 10 mm to the levels shown on the drawings.

4.8.4 Placing of Road Base

Wet mix road base material shall be crushed and mixed by approved mechanical placing plant. Water for adjusting the moisture content shall be added at the mixer. If required, the moisture content shall be adjusted to allow for evaporation road base loss during transportation. After mixing, the material shall be removed from the mixer and transported to the placing location without delay.

The compaction procedure and plant shall be proved by trials at the commencement of the Works. The weight, type and number of passes of compaction plant shall be varied to determine the optimum compaction effort.



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The road base shall achieve a minimum dry density of 98% of the maximum laboratory dry density and an in-situ CBR (California Bearing Ratio according to BS 1377) value of not less than 80% or modified Proctor density of 97% according to DIN 1821-2.

4.8.5 Hard Shoulders

The material used for any hard shoulders shall comply with the General Technical Requirements/Particular Technical Requirements for wet-mix road base.

4.8.6 Bitumen Macadam (if required)

Aggregate shall be hard, clean, durable crushed rock or gravel, and sand all in accordance with approved standards and shall be obtained from approved source which shall not include quarries containing significant proportions of weathered, decomposed or extensively fractured materials. The Contractor shall propose a suitable source, or sources, and samples shall be obtained for specified testing before arrangements for obtaining aggregate are approved. Laboratory tests shall be made at regular intervals to confirm the suitability of aggregate.

Coarse aggregate is defined as that fraction retained on a 3.5mm BS sieve. It shall have physical properties which do not exceed the following test values when tested:

	Wearing Course	Base Course
Aggregate crushing value	20%	25%
Flakiness index	25%	30%
Elongation index	25%	30%
Water absorption	2%	2%

Coarse aggregate may contain up to 15% of pieces with one uncrushed face in each grading size.

Wearing course shall be of 40mm finished thickness, the aggregate grading shall be as follows:

Test Sieve (mm)	Grading (20mm nominal size)
28	100
20	95-100
14	70-90
10	55-75

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6.3	40-60
3.35	25-40
1.18	15-30
0.075	2-6

Bitumen shall be of Grade 60/70 penetration.

4.8.7 Final surfacing

The Bitumen Macadam binder course shall be kept clean and uncontaminated so long as it remains uncovered by a wearing course. Should the binder course become contaminated the Contractor shall make good by cleaning to the satisfaction of the Employer / Employer's Representative and if this is impracticable by removing the layer and replacing it to specification.

4.8.8 Interlocking paving blocks

Roads and areas to be paved with interlocking concrete blocks shall be excavated and placed with 300 mm depth of compacted material at the exact levels and falls required for the finished work.

If parts of the base are found to be unstable the Contractor shall excavate further to a firm bed and fill with layers of fine crushed rock or aggregate, thoroughly compacted. The upper surface of the base shall reflect the exact profile, fall or contour of the final paving as irregularities shall not be compensated for by varying the depth of sand bedding.

A stable edge shall be provided to retain the paving units and sand bedding by means of precast concrete edging unit or curbs set in-situ concrete. The sand bedding shall be a fine, well graded sand in a dry to moist condition and laid to an un-compacted thickness of 50 mm.

The paving blocks shall be laid in accordance with the manufacturer's instructions and shall be compacted at completion of each day's work.

The interlocking block shall be a minimum of 80 mm thick and the concrete quality must be approved by the Employer / Employer's Representative.



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4.9 Foundations

4.9.1 General

The foundations shall be performed according to the requirements of the specific loads and soil investigation's report. Special measures have to be taken if the results of soil and laboratory tests prove chemical aggressive conditions.

The soil conditions met during the foundation works are to be checked by the Contractor's soil engineer, recorded and compared with the previous results of the investigations. If essential differences occur, the Contractor has to inform the Employer and to propose further measures.

Prior to pouring of concrete, the Contractor has to verify the specified soil conditions below the foundation level by a sounding.

4.9.2 Drainage of foundation pits

During the foundation works the excavated areas, foundation levels and pits are to be kept free of water down to at least 0.5 m below the foundation level.

4.9.3 Waterproofing

The necessary measures are to be taken to protect the structure against water action e.g. in accordance with EC2, ENV 1992-1-1.

4.9.4 Pit-wall stability

The excavated pit sides, walls or slopes have to be stable and established with respect to safety regulations.

4.9.5 Settlement and expansion joints

Joints are to be arranged in such a way that stresses and strains caused by settlements, temperature, differential settlement, etc. do not adversely affect the structures. The settlement joints shall run through the complete structure down to foundation level, the expansion joints however shall stop on the top level of foundations. The joint width shall be at least 2 cm. Settlements of all relevant structures shall be measured, recorded and shown in diagrams according to recognized standards.

4.9.6 Foundations at different depths

Foundations at different levels should be based beyond a load spread angle of 30° (against the horizontal).

4.9.7 Safety against uplift

For all parts of the structures extending into the ground water, safety against uplift has to be guaranteed during all execution stages.

4.9.8 Shallow foundations

For this kind of foundations, the following standard is to be applied: EC2, ENV 1992-3, EC7, and ENV 1997-1-1.

The excavation for the foundations shall be done by machines, if the underground is not disturbed by this procedure. In every case the last 20 cm above the foundation level are to be excavated by hand.

4.9.9 Soil replacement

If unsuitable soils are encountered below the foundation level or basement floor, they are to be replaced by suitable layer-wise compacted material down to the bearing soil.

4.9.10 piling works (if any)

These specifications cover the requirements for the materials, the installation and the realization of bored cast-in-place concrete piles with grouting at the base and driven cast-in-place piles.

The piling works and design shall be in accordance with the latest editions of internationally accepted standards such as EN 1536 or EN 12699.

Other international or local standards which ensure a quality equal to or higher than the standards mentioned above, if these are submitted in the English language.

4.9.11 Waterproofing systems

The civil works include all necessary waterproofing works, including but not limited to, tanking systems, treatment of horizontal and vertical surfaces, including roofs, together with the related protection works of the water proofing. The waterproofing systems are subject to the Employer/ Engineer approval.

4.10 Concrete Works

General

In general, the concrete works shall be based on EUROCODE 1, 2 and 4, the provisions of the EN DIN standards or equivalent local rules, standards and regulations, including also the provisions of the SNIP code of practice.

Materials for concrete

All materials used for concrete and reinforced concrete structures shall be of the best quality, free from defects likely to undermine the strength and duration of service of the works. The materials furnished must at least comply with the agreed standards, and with all requirements described in these technical requirements.

All materials shall be stored and handled in a manner that will prevent contamination and/or deterioration. Deteriorated and/or contaminated material shall not be used for the concrete and shall be removed from the site at the expense of the Contractor.

Cement

The cement used for concrete, reinforced concrete, mortar, grout and plaster works shall be a moderate sulfate resisting Portland cement in accordance with DIN 1164 or equivalent.

All deliveries of cement to the concrete supplier shall be accompanied by a certified mill test report and shall include all of the physical and chemical properties.

The manufacturer's test certificate will normally be accepted as proof of compliance with the General Technical Requirements/Particular Technical Requirements. If required, confirmatory tests are to be conducted by a recognized quality control organization.

The following information shall be provided for the cement (either whole or part) which are intended for delivery to site: date of manufacture, date of original loading, destinations en-route, date of unloading, intended date of delivery to site.

Cement which has been manufactured for longer than 6 months on the proposed date of delivery to the site shall be inspected, sampled and tested for approval purposes before delivery to the site. The Contractor shall obtain and provide to the Employer / Engineer the manufacturer's Bulk Average Test Certificate for each consignment of cement to the works.

Samples shall be taken from each consignment of cement and tested as directed by the Employer / Engineer in an approved independent laboratory.

All bagged cement shall be stored in a weatherproof building which shall be kept swept clean at all times.

Cement shall be adequately protected against rain, humidity and dewfall, and all charging and discharging points shall be properly sealed.

Water

Water for preparing concrete and mortar shall be clean, fresh and free from organic and/or inorganic matter in solution or suspension in such amounts that may impair the strength or durability of the concrete. Water may be obtained from local sources, after comprehensive testing and analysis of samples. No seawater or water from excavations shall be used. Water shall be stored in clean containers.

Aggregates

Materials used as aggregate shall be obtained from a source known to produce aggregate satisfactory for concrete and shall be chemically inert, strong, hard, durable, of limited porosity and free from adhering coats, clay lumps, organic impurities that may impair the strength or durability of the concrete. Aggregate may comply with and be tested in accordance with the requirements of standards.

Concrete additives

Concrete additives approved by the Employer / Engineer shall be used to improve consistency, workability, quality and strength of the concrete. Unless otherwise agreed, an additive may comply with an approved standard.

Plasticizers and air entrainers are intended to reduce bleeding of free water at the surface. It shall only be used after the written approval of the Employer / Engineer and in accordance with the manufacturer's instructions.

Concrete mixes

General description and proportions and mixing

The mix proportions are to be determined by proper mix design based on the requirements for strength, workability and the particular site in which the concrete is to be placed. The mix design shall be carried out by the Contractor's responsible specialist and approved by Employer / Employer's Representative.

Concrete Classification

Concrete	Cube	Maximum free	Max. nominal	Min. cement
	days in MPa	ratio	in mm	Kg/m3
L	20	-	25	280
S1	35	0.40	20	380
S2	40	0.40	20	400
P1	40	0.40	20	400
P2	40	0.40	20	400

Classes of Concrete:

L - Plain concrete used for lean concrete, blinding, screeds, backfill etc. S1 - Reinforced concrete for general use

S2 - Reinforced concrete in contact with groundwater

P1 - Reinforced concrete for piles

P2 - Precast concrete

Concrete aggregates and cement shall be proportioned and batched by weight. Water and liquid additives shall be proportioned.

Trial mixes

Before concreting commences, the Contractor shall, at his own expense, make trial mixes to determine the mix proportions required to produce the strengths specified for each class of concrete and for each degree of workability required to allow placing, transporting and compacting of the concrete with the equipment he proposes to use in any particular situation. Only materials which the Contractor intends to use for concreting (including all admixtures) shall be used in the trial mixes.

Test cubes from trial mixes shall be made and tested in accordance with approved standards.

The appropriate strength requirements may be considered to be satisfied if none of the strengths of the cubes is below the required characteristic strength and if the average strength of the nine cubes is not less than recommended by the standards.

Consistency of concrete

The amount of water used in the concrete shall be adjusted as required to ensure such a consistency that it can be readily transported placed and compacted without segregation of the materials or bleeding of free water at the surface. Addition of water to compensate for stiffening of the concrete before placing shall not be permitted. Consistency of the concrete shall be checked by slump tests.

Mixing of concrete

The cement and aggregate shall be thoroughly mixed in a batch-type pull mill mixer. The capacity of the mixer shall not be less than 1 (one) cubic meter and the total capacity of the batching mixing plant shall be such to accommodate the various concrete quantities to be cast in a continuous way.

The water shall not be added until all the aggregate and cement are in the drum. Mixing shall continue until the concrete is uniform in color and for not less than 1 (one) minute after all the materials and water are in the drum.

Partly set or excessively wet concrete shall not be used. No concrete shall be mixed by hand.

Strength of concrete

Testing of fresh concrete by means of test cubes

All test cubes shall be made and tested for compressive strength in accordance with - Method of testing concrete or DIN EN 12350-1, DIN EN

12350-6, or equivalent - Test methods for concrete.

The minimum required strength for different classes of concrete is as shown in clause "General description and proportions and mixing" here above.

A minimum of seven test cubes shall be made on each concreting day (from the same mix) and for at least each 40 m³ of concrete mixed.

For columns, beams and cantilevers seven (7) cubes for every 15 m³ of concrete poured shall be taken. The moulds for the test cubes shall be made of steel. Tests shall be carried out in an approved laboratory.

The strength level of each type concrete will be evaluated separately and the concrete strength will be considered satisfactory if:

Any individual strength test result as defined above is greater than 85% of the specific minimum cube strength (characteristic strength).

If the results are less than those specified, the Employer/Engineer must suspend all concreting work and order further tests.

Any concrete found not to comply with the General Technical Requirements/Particular Technical Requirements shall be broken out and replaced to the satisfaction of the Employer/Engineer.

The Contractor shall pay all costs incurred in making, curing, delivering and testing of concrete cubes.

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Transport of concrete

Immediately after mixing, the concrete shall be conveyed to the place of use as rapidly as possible using methods which will prevent the segregation, loss or contamination of materials. The concrete shall be placed and compacted within 90 minutes of the addition of water to the mix. Any concrete left unplaced after this time shall be rejected and removed from the site.

Concreting operations

Inspection prior to concreting

All concreting methods shall be subject to the approval of the Employer/Engineer.

Concrete placing shall not be started until the Employer/Engineer has approved all preparation of forms, reinforcement, joints and all mixing, conveying, spreading, curing, finishing and protection equipment.

Placing of concrete

Concrete shall be placed in the forms as close as possible to its final position in a single operation to the full thickness of slabs and beams and shall be placed in horizontal layers, not exceeding 2.5 m height in a single pour in walls, columns and similar members.

The Contractor shall organize the pouring of concrete in such a manner that once concreting of a section has started the operation shall be continuous and each operation shall be completed prior to a stoppage.

The temperature of concrete shall not exceed 30°C measured at discharge into the works. Concrete shall not be placed when the ambient temperature is 40°C or above, or is above 37°C and is rising.

Where specified on the drawings, construction, expansion or contraction joints shall be provided and the concrete shall be poured continuously between two adjacent joints. No other joints than shown on the drawings shall be permitted. Stoppage (cold) joints formed between two concreting operations separated by more than 6 hours time shall be subject to the same treatment as the construction joints.

Concrete shall not be dropped into place from a height exceeding 2 meters. Trunking and chutes to Employer/Engineer's approval shall be used for any concrete to be fed from a height exceeding 2 m.

Concrete which has partially hardened shall not be exposed to injurious vibration or shock, except for controlled re-vibration where specified. When concreting of a certain large structural element is specified strictly as to be poured continuously, then the concreting operations shall be organized for day and night working, in long shifts, as necessary.

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Compaction and mechanical vibration of concrete

As concrete is being placed it shall be compacted by mechanical vibrators, to obtain a dense material free from honeycombing, free from water and air holes. For compacting the concrete, internal vibrators shall be used operating within a range of 5,000 to 10,000 cycles per minute.

The Contractor shall ensure that the vibrators are used in such a manner that the reinforcement is not displaced, the formwork not damaged and no segregation caused, but complete compaction of the concrete is achieved.

Finish of concrete

The concrete face shall have the finishes indicated on the drawings or in the present General Technical Requirements/Particular Technical

Requirements. The finished surface of the concrete shall be sound, solid and free from honeycombing, protuberances, air holes or exposed aggregate. No plastering, cement wash, mortar or paint shall be applied to cover defective concrete surfaces.

Construction joints

The number of construction joints should be kept as low as possible consistent with reasonable precautions against shrinkage. Concreting should be carried out continuously up to construction joints.

Where it is necessary to introduce construction joints, careful consideration should be given to their exact location, which should be indicated on the drawings. Alternatively, the location of joints should be subject to agreement between the Employer and the Contractor before any work commences.

Construction joints should be at right angles to the general direction of the member and should take due account of shear and other stresses.

Immediately prior to recommencement of concreting on a joint, the surface of the concrete against which new concrete will be cast should be free from laitance and should be roughened to the extent that the largest aggregate is exposed but not disturbed. Care should be taken that the joint surface is clean immediately before the fresh concrete is placed against it.

Particular care should be taken in the placing of the new concrete close to the joint. This concrete should be particularly well compacted and if possible a vibrator should be used.

A record shall be kept on site of the time and date of placing the concrete in each section of the work.

Expansion and contraction joints

The expansion joints, contraction joints and other permanent structure joints shall be provided in positions as shown in the drawings. Joints shall be straight and vertical, except where otherwise specified and concrete surfaces on both sides of the joint shall be flush. Where necessary, water stops of a type approved by the Employer/Engineer shall be embedded in the concrete. The water stop should be made of high-quality material which must obtain its resilience through the service life of the structure for the double function of movement and sealing.

To ensure a good tightness with or without movement of the joints the water stop should be provided with anchor parts. The complete works of fixed and welded connections must be carried out strictly in accordance with the manufacturer's instructions.

Concreting at night

When approval is given to carry out concreting operations (under control of the Employer/Engineer) at night or in places where daylight is excluded, the Contractor has to provide adequate lighting at all points of mixing, transportation and placing of concrete.

Concreting in high ambient temperature

The temperature of the mixed concrete shall not exceed 30°C. The Contractor shall take special measures in the mixing, placing and curing of concrete. These measures shall include the shading of aggregates, spraying of aggregates with water, cooling of the mix constituents (introduction of ice to the mixing water) and reduction of transportation time to the minimum. During placing suitable measures shall be provided to prevent premature setting of concrete placed in contact with hot surfaces. All concreting areas, formwork and reinforcement shall be shielded from the direct rays of the sun and sprayed with water when necessary.

Protective measures for concrete

The minimum concrete cover shall be as follows:

concrete parts above ground (external surface)	50 mm
concrete exposed to underground and groundwater	75 mm
slabs (internal)	30 mm
beams and coils (internal)	40 mm

Immediately after the compaction of the concrete has been finished, the Contractor shall ensure adequate protection from the weather. The concrete surface shall be covered with a layer of sacking,

canvas, straw mats or similar absorbent material, special protection sprays kept constantly moist for at least 7 days.

Curing compounds or other methods of preventing evaporation may be used if approved by the Employer/Engineer. Where formwork cannot be removed within 24 hours after placing the concrete, the formwork shall be kept shaded from the direct rays of the sun and shall be sprayed with water. Where large sections of concrete are poured, special precautions to the approval of the Employer/Engineer shall be taken to reduce and dissipate the heat generated by the setting and hardening of the concrete (e.g. built-in cooling water pipe system).

The minimum amount of reinforcement shall be present to prevent shrinking cracks.

No load of any kind shall be allowed on concrete which has not properly set and the Contractor shall prevent any load to be imposed on the concrete structures until it has been declared by the Employer/Engineer to be ready to carry loads.

Repair of damaged or defective concrete

Concrete which has completed its final setting shall be inspected by the Employer/Engineer and any cracks, honeycomb areas, segregations, etc. shall be marked. No repairs shall be carried out until directed by the Employer/Engineer.

Finishing of concrete surfaces

The concrete face shall have the finish indicated on the drawings or in the General Technical Requirements/Particular Technical Requirements.

All surfaces which may come into contact with oil or oily water will have to be adequately protected (paint, etc.). The finished surface of all concrete work shall be sound and free from defects. No plastering, cement wash or mortar shall be applied to cover defective concrete faces. The repair works shall be executed to the approval of the Employer/Engineer.

All concrete surfaces of cable basements and the like which are endangered by ground water shall receive a water proofing membrane of approved type with protection board against the soil.

All concrete in contact with soil shall receive a bituminous coating of at least two layers.

The striking period for cast in situ concrete under certain conditions may be taken as follows:

Soffit formwork to slabs 8 days

Soffit formwork to beams 10 days

Vertical formwork to columns,

walls and large beams	24 hours
Props to slabs	14 days
Props to beams	21 days

Extreme care shall be taken to avoid chipping of corners during removal of formwork.

Reinforcing steel

General

Reinforcing steel used in reinforced concrete shall comply with EC 3 or equivalent:

Reinforcement supports

Reinforcement supports shall include all spacers, chairs, ties, slab bolster, clips, chair bars, and other devices for properly assembling, placing, spacing; supporting, and fastening the reinforcement.

Spacers shall be cast from concrete of the same quality as that in which they will be embedded.

Concrete block spacers shall be cast in metal moulds with an approved means of separating blocks and of ensuring that the blocks are of the proper size.

Certificates

Each consignment of steel reinforcement shall be accompanied by a test certificate from the manufacturer showing that the steel has been tested and analyzed and the date of such tests and analyses and that such tests and analyses comply in all respects with the standards.

Rejection

The Employer/Engineer will reject any reinforcement steel as the result of any failed test therefore not withstanding the manufacturer's certificates.

Finishing of concrete

All exterior corners (angles of 90° or less) of reinforced concrete shall be chamfered (25 mm x 25 mm).

The top or final surface of all concrete works shall be finished by screeding, or floating, or troweling or grinding, or tooling as approved by the Employer/Engineer.

Dry cement or cement and sand shall not be used to dry excess water on the concrete surface.

Floors and slabs, which are required to be finished smooth, shall be trowelled just before the setting of the concrete.

Screeding: shall be executed by moving a straight edge or template by hand or by mechanical means immediately after compaction of the concrete.

Floating: shall follow screeding, but shall not be started until some stiffening of the concrete has taken place.

Trowelling: Where specified as necessary, the floating shall be followed by finishing until a smooth surface free from defects is obtained.

Grinding and tooling: Where specified, the methods to produce the desired surface shall be approved by the Employer/Engineer. The grinding and/or tooling shall not start until the concrete has hardened sufficiently to prevent dislodgment of the aggregate.

Chiseling: Wherever possible all chiseling works shall be carried out with mechanical devices.

Formwork

Design and construction

For stability and type of formwork and support framing used, DIN 4420 or equivalent are to be observed.

The formwork and the supporting structure are to be so dimensioned as to be able to withstand all vertical and horizontal forces safely.

Supporting structures shall be sufficiently rigid to maintain the forms in their correct position and to be true to shape and dimensions so that the final concrete is within the limits of the dimensional tolerances.

Materials for formwork

Forms shall be constructed from steel or from sound timber well seasoned and free from shakes.

Plywood lining for forms shall be of timber which is resin bonded and water repellent.

Formwork surfaces in contact with concrete shall be free from adhering grout, projecting nails, splits or other defects.

Joints shall be sufficiently tight to prevent the leakage of cement grout. Connections shall be constructed to permit easy removal of the shuttering and shall be either nailed, screwed, bolted, or otherwise secured so as to be strong enough to retain the correct shape during consolidation of the concrete.

The fair faced concrete facades have to be to the satisfaction of the Employer/Engineer. The concrete surface for facades has to be absolutely stainless and all efforts have to be taken to achieve this.

Preparation and inspection of formwork

Before concrete is placed, all formwork shall be inspected to see if it is built according to the approved plans and to see if it has been cleaned and is free from sawdust, shavings, dust, mud, earth or other contamination and properly oiled. Contact surfaces of panels shall be treated with a suitable release agent (e.g. non staining mineral oil) where applicable. Surfaces which are not oiled shall be wetted thoroughly to prevent warping.

Erection and placing of formwork

All formwork shall be erected and placed in accordance with the construction drawings approved by the Employer/Engineer. Shuttering shall be true to line and braced and strutted to prevent deformation under weight and pressure of the wet concrete, live loads, wind and other forces. The deflections shall not exceed 3 mm.

Formwork for walls and elsewhere shall be arranged for a maximum concreting height of 2.5 m in a single pour. Where necessary, panel openings are to be provided in the forms for cleaning, inspection, access of vibrators, etc.

All formwork will be inspected and approved by the Employer/Engineer before concrete placing commences but this shall not relieve the Contractor of any of his responsibilities under the contract.

Striking of formwork

Formwork shall not be removed until the concrete has sufficient strength to carry its own weight plus any constructional or designed loads likely to be applied with a normal factor of safety. It shall be removed in such a manner that no shock or injury shall result to the concrete.

Before removal of the formwork the concrete shall be examined and removal shall proceed only on the instructions and under the supervision of a competent person.

4.11 Fences and Gates (if required)

Fences around the perimeter of the substation sites shall be provided. The fence will be of robust reinforced concrete structure. Heavy mesh shall be used only for internal fences.

The fences shall be provided with anti climbing devices positioned on the top and approved by Employer. The fence shall be connected to the earthing system.



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The total height of the fence about the ground shall be as per site. Internal chain link fences with height of approx. as per site made of plastic coated galvanized steel wire shall be erected on 0.20 m high perimeter beam made in reinforced concrete, provided with adequate steel posts, reinforced concrete foundations according the Contractor's design. The total height of the fence about the ground shall be at least

4.12 Drainage

4.12.1 Execution of work

General

For trench excavation, slope safety and stability and refilling, see Section "Earthworks" here above.

For pipe laying and backfilling the requirements of the pipe manufacturer; DIN EN 1610, or equivalent shall be considered.

The design of the pipes shall be based on the max. combination of loadings (external and internal) and shall be applied systematically for the whole pipeline. This program is to be approved by the Employer/Engineer prior to execution of the works.

Independently of any groundwater lowering measures which may be necessary, the bottom of the trench shall be kept free of water to permit satisfactory excavation, placing and compaction. Buoyancy effects on the pipes are strictly to be avoided during the construction period. Appropriate precautions (e.g. filters) shall be taken to prevent earth from entering the drain pipe. Mechanical filter stability is to be ensured for all adjacent layers.

The below mentioned activities are subject to approval of the Employer approved by the Employer/Engineer.

Preparation of the trench bottom

The dimensions and shape of the trench bottom shall be designed to suit the required working space and type of pipe bedding. Trench bottom material must not be loosened. It must be protected against digging up, washing and scouring. Any cohesive bottom soil which becomes loosened must be removed down to the depth of disturbance before pipes are laid and must be replaced by non-cohesive soil or special approved pipe bedding. Non-cohesive soil shall be compacted by layer wise tamping or vibrating.

Bedding of pipes

The pipes may be bedded on:

- Type A existing soil
- Type B a bed of placed sand or gravel sand
- Type C concrete support
- Type D concrete enclosure
- Type E special forms of construction

In detail these five possibilities shall be designed and executed as follows:

Type A of bedding on existing soil

Assuming that the soil encountered at the pipe bottom is suitable, is workable by hand, has a minimum bearing capacity of 15 N/cm² and has at least medium to stiff consistency or medium density, then the following instructions must be observed:

he bedding in the natural soil has to be performed so that it corresponds to the surface of the pipe. In the cross-sectional area this applies for a supported segment of the circumference of the pipe corresponding at least to a bearing angle of 90° (related to the center line of the pipe and in accordance with the design and calculation).

The natural density of the subsoil shall not be disturbed (loosened).

The bedding must be executed in such a way that the pipe is completely and uniformly supported throughout its length.

Where the trench bottom is of sand, the bearing surface shall be contoured from the undisturbed soil to suit the shape of the outside of the pipe before the pipe is laid, so as to ensure that when laid the pipe is firmly supported over its entire length.

For pipes of cast iron, plastics and steel of all nominal bores and or pipes of concrete, reinforced concrete, stoneware and reinforced concrete pressure pipes up to and including nominal DN 600, a firm support can be obtained by placing the pipe on the carefully leveled bottom of the trench, provided that material is packed and made dense beneath the pipe to ensure uniform load-bearing support. If these requirements cannot be satisfied the following methods of bedding shall be executed.

Type B, Bedding on a sand or gravel layer

If the soil encountered is not suitable as an immediate pipe bedding a layer of "select fill" has to be placed under the pipe. This layer has to satisfy the following conditions:

The sand or fine gravel used must be well graded. In the case of natural material the maximum particle size is 30 mm. In the case of crushed stone material the maximum particle size is 15 mm.

The thickness of the bedding below the lowest point of the pipe must be at least 10 cm + 1/10 of the pipe nominal bore.

After placing, the bedding must be compacted by suitable equipment (as select fill in the clause 6.7 'Earth and Rockwork' so that the pipe rests firmly on the bedding over the entire prescribed bearing angle (90°).

Type C, Concrete Support

If the material of the trench bottom is unsuitable for forming a sand or fine gravel bedding, if the bottom is steeply inclined or if there is a risk of sand being washed out by drainage effects or if local loads require it, the pipes shall be fully bedded on concrete.

The minimum thickness of concrete bedding shall be 5 cm + 1/10 of the pipe nominal bore, with a minimum value of 10 cm.

The surface of the concrete bedding shall be shaped to suit the outside of the pipe so that when laid the pipe rests firmly over the prescribed bearing angle. Bedding concrete can be placed after aligning of the pipe. If it is placed before the pipe is installed, the pipes must be laid in a fresh layer of mortar.

Type D, Concrete Enclosure

In order to increase the load-bearing capacity of pipes, a full concrete enclosure may be provided. In designing the cover (static calculation), it is important to consider whether the concrete will be cast against the undisturbed soil or, for example, against sheet piling; the later extraction of sheet piling has an adverse effect upon the relieving action of the horizontal earth pressure.

The minimum concrete quality for pipe enclosure is B15. Construction joints should be bridged by short reinforcing bars.

It may be advantageous to subdivide the concrete enclosure by suitably spaced concrete joints at the pipe connections.

Penetration of pipes through buildings and structures

The penetration of pipes through buildings, shafts, thrust blocks and other structures or the transition from the pipes to any structure must be designed in such a way that differential settlements do not occur or cannot cause leakage or damage. Such penetrations or transitions shall be designed to be flexible if not otherwise approved by the Employer/Engineer.

Supporting and anchoring

Pipes laid in groundwater shall be secured against uplift by anchoring or additional loads, if their dead-weight is not sufficient. If branches, bends, transition pieces, closures and the like are incorporated in pressure pipelines in such a way that they do not transmit longitudinal force, they shall be so secured that these forces are resisted.

Thrust blocks and other fixing structures are to be arranged in such a way that the ends of the reinforced/pre-stressed concrete or other pipelines remain without being subject to all forces and displacement.

Bend structures are to be calculated as gravity structures. The pipeline forces have to be transmitted by bottom friction from this gravity structure into the ground. Horizontal active and passive earth pressure may not be taken into consideration.

Special measures for aggressive water and soils

In the presence of aggressive water or soils, in addition to the use of pipes made from especially resistant materials, it is important that the surfaces of pipes and joints are protected by special precautions.

Test for water resistance

The pipes shall be tested for water resistance before being backfilled. The regulations of the manufacturer or referred to in this technical requirements shall be used as the basis for the test.

Embedding and backfilling of pipes

Until final acceptance and fill, the Contractor shall protect pipes, trench and inspection pits from damage and obstructions.

Embedding of pipes and backfilling shall not be commenced until pipe joints and supports are capable of being loaded by overburden and other forces which occur during backfilling. Embedding and backfilling shall be done in accordance with clause "Earth and Rockwork" here above. This especially applies to the suitability of fill materials, compaction requirements and quality assurance (internal control and independent spot check). The number of independent spot checks is limited to one check per 3 km trench length, at least three checks, being performed.

The number of tests can be increased by the Employer/Engineer if the results are doubtful. The costs for this are to be included in the lump sum price.

For embedding of the pipes cohesion less material according to clause "Earth and Rockwork" "Select fill" here above shall be used. The maximum particle size is limited to 30 mm for embedding. Bedding material is deposited on both sides of the pipe up to a height of 30 cm above the pipe crown in layers and shall be compacted as requested for 'select fill'.

Under-packing and compaction shall be carried out with the greatest possible care; only hand tamping using flat tampers or light mechanical compaction equipment shall be employed. Under-packing shall be carried out simultaneously from both sides, in order to prevent displacement of the pipe. Any external protection (coating) provided on the pipeline shall not be damaged. Backfilling and placing of fill over pipes must be carried out in layers, materials used and compaction to be chosen in conformity with the drawings or to correspond to the subsequent use of the areas above the pipeline. The thickness of the layers and the compaction equipment shall be such that the stability of the pipeline is not prejudiced. In addition, the compaction equipment shall be selected to suit the ground conditions and trench supports. The fill material and fill procedure shall be as defined for "select fill" if not explicitly specified otherwise.

The use of heavy tamping and vibrating appliances where the pipe cover is less than 1m is not permitted.

Flexible pipes, as e.g. glass fiber reinforced plastic pipes, shall be designed taking into account soil mechanical and foundation engineering aspects. All relevant checks and calculations have to be made following at least two different internationally recognized design methods/standards.

The pipe bedding and pipe zone shall be compacted to at least 90% of modified proctor density (or 80% relative density if proctor density cannot be determined).

4.12.2 Structures of the drainage system

Shafts and manholes

Manholes shall be provided at each inlet to the drainage system at each change in gradient or direction, and at maximum intervals of 30 m. The diameter of manhole should be chosen as a function of the pipe cross-section. Either prefabricated or cast-in-situ concrete manholes may be used.

Cast-in-situ concrete shafts shall meet the requirements set out in clause "Concrete Works" specified herein.

Manholes on foul water, oily water and chemically contaminated water drains shall be rendered internally on all faces using anti-corrosive resin mastic. All manholes shall have step irons.

Manhole covers and frames shall be heavy duty type, except where flush with paved surfaces, where they shall be ductile iron and be of sufficient strength for the duty to which they will be subjected.

Oil-separator and mud trap

Oil polluted sewage shall be led through mud traps and oil separators installed immediately outside the building before entering the sanitary sewage system.

The oil-separators shall comply with approved standards. The oil-separators shall be equipped with automatic closing acoustical and optical alarm, and local indication of oil to be separated. The materials shall be of cast iron and precast concrete pipes.

Pump stations

Pump stations may be required for collection of clean drain, storm-water from building roofs and paved areas and cleaned sanitary sewage. They shall be constructed of cast-in-situ concrete and mainly buried into the soil. The top slabs shall not be subject to traffic loads and therefore be surrounded by steel railing.

Open channels

Open channels may be required for collection of drain, storm water. They shall be constructed of cast-in-situ concrete and mainly buried into the soil. The top slabs shall not be subject to traffic loads and therefore be surrounded by steel railing.

4.12.3 Accessories

Covers, trash gratings

Shaft and manhole covers shall be made from cast iron and reinforced concrete, of watertight construction, with and without dirt traps, to suit local requirements. Shaft and pit covers shall have a test load suited to the traffic conditions. The dimensions of trash gratings shall be those determined by proper structural design. Trash gratings shall be of cast steel.

Step irons

Only corrosion-protected or stainless steel materials may be used. Where shafts are constructed of reinforced concrete, the step spacing shall be 33.3 cm. Climbing irons shall be staggered, maintaining a horizontal axial spacing of 30 cm.

Pumps and valves

Drainage and storm-water can be very corrosive and abrasive in certain cases. This must be taken into consideration when selecting the appropriate construction material.

Furthermore, the design of the pump must be taken into consideration so that the pumps are able to operate with the minimum of maintenance due to their location and the operating procedure.

For basement and low points drainage the pumps shall be effluent sump pumps with submersible motor in wet installation.

Workshop and site tests shall be carried out as laid down in the appropriate section and in the accordance with the relevant standards and codes.

Any other standards can be accepted provided they are equal or better than the specified codes and standards.

4.12.4 Tests

Main test

The main test shall be carried out at a test pressure which is greater than nominal pressure. If a line cannot be tested under pressure in one operation, then it shall be tested by lengths (partial length testing).

The value of test pressure shall be determined as follows:

For pipes with a permissible operating pressure of up to 10 bar (10 kN/cm²): 1.5 x nominal pressure.

For lines with a permissible operating pressure above 10 bar (10 kN/cm²): nominal pressure + 5 bar (5 kN/cm²).

Testing shall not be repeated until all defects have been rectified. When the pipeline, anchorage and pipe joints are inspected, it should not be possible to detect any evidence of lack of water resistance and/or changes in position.

Before backfilling of the trench, the agreement of the Employer shall be obtained.

Pressure lines for water supply purposes shall be carefully cleaned, vented, washed out and sterilized before being brought into service.

For the pressure test of drainage lines, the requirements of the British Standard referred to in the relevant section shall be complied with.

A test report on each internal pressure test shall be supplied to the Employer/Engineer without special request.

4.13 Cable Trenching

Trenching is required for installation of all buried cables.

4.13.1 Outdoor trenches

The network of switchyard trenches consists of:

Intermediary cable trenches with free dimensions of 1,000 x 500 mm terminal trenches with free dimensions of 500 x 500 mm, to distribute the cables into the equipment foundations

Outdoor trenches shall have concrete covers with maximal weight of 50 kg.

4.13.2 INDOOR TRENCHES

Trenches inside of building shall be of the open type covered by checkered steel plates (6 mm thick).

4.13.3 MATERIALS

All cable trenches shall be constructed of cast-in-situ reinforced concrete in accordance with the specifications of concrete works.

4.14 Structural Steel

Structural steel shall conform to EUROCODE IC-3, ISO/DIS 10721 or equivalent.

The specified steel structures, except where otherwise required, shall be hot- dip galvanized.

The minimum weight of galvanizing coat shall be:

900 g/m² on steel sections 5 mm thick and over

600 g/m² on steel sections 2 – 5 mm thick.

Bolts and nuts shall conform to approved standards.

All welding joints shall conform to approved standards.

Deflections

Allowable deflections for steel structures shall not exceed the following values:

1. Deflection on beams and girders due to live load

Length / 240: for cantilevers

Span / 360: for beams carrying plaster or other brittle finish

Span / 300: for all other beams

2. Horizontal deflection of columns due to live and wind loads

height / 500: for tops of columns in single-story buildings

height of story / 500: in each story of a building with more than one story

3. Crane gantry girders

span / 1000: for vertical deflection due to static wheel loads

span / 500: for horizontal deflection due to crane surge calculated using the top flange properties alone, unless more strict criteria is requested by the manufacturer.

4. Monorail and hoist beams

Span / 600 for vertical deflection, unless more strict criteria is requested by the manufacturer.

5. Grating and floor plate under live load

span / 300 nor 6 mm: measured with respect of the support elements

Steel stairs

tread width = minimum 250 mm

riser height = maximum 190 mm

where a stair height exceeds 16 risers, each flight shall be equal and separated by a landing.

stair tread width = minimum 1,000 mm for secondary stairs and 1,100 mm for main stairs.

Minimum headroom of stairs shall be 2,300 mm.

4.15 Grouting Works

Non-shrinking grout will be used for the heavy steel structure base plates.

Technical requirements

In general all types of grout to be used in these works shall be according to applicable standards.

For the purpose of this General Technical Requirements/Particular Technical Requirements, a grout is regarded as "non-shrinking" if, after hardening over a period of 28 days during which the test specimens have been completely protected against drying, evaporation, and carbonation, and exposure to temperatures outside the range of $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$, its volume is still not less than the initial volume.

Mixing

Grout shall comprise only ready-to-use grouting material and water.

Materials shall be mixed in accordance with the manufacturer's requirements, using paddle type mortar mixers.

Preparation

All defective concrete, laitance, dirt, oil, grease and loose material shall be removed from the concrete foundation by bush hammering, chipping, or other approved means until sound, clean concrete is obtained. The surface of the concrete shall be left reasonably rough but not so rough as to interfere with proper placing of the grout.

4.16 Finishing Works

Floor and wall finishes



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The following table of buildings, rooms and finishes is not necessarily comprehensive as it is dependent on the Plant Contractor's layout. Any buildings or rooms not included, or special items must be agreed with the Employer/Engineer but should fall into the same categories as used elsewhere for standardization.

Floor finishes (typical)

switchgear rooms epoxy screed (trowel applied minimum 5 mm thick) and epoxy seal coat

glazed non-slip fully vitrified ceramic tiles 9 mm non-slip fully vitrified ceramic

tiles (floor tiles with epoxy grout)

battery rooms acid resistant ceramic tiles

heavy duty PVC sheeting on false floor

instrument/electrical workrooms heavy duty PVC / rubber backed tiles basements Carborundum and non-slip 3 mm self

levelling epoxy screed



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stores workshop, mechanical work room and store room

transformer pits dust-proof hard-wearing epoxy coating

Internal wall finishes (typical)

Plaster (or similar approved) and paint

Control rooms, MV/ LV switchgear rooms, LVAC rooms, computer rooms, restroom, administration areas, offices and similar rooms, corridors, instrument and electrical workrooms, mechanical workroom and store room.

Skirting shall be provided from the same material as the floor finish.

Fair faced block work, cement wash, paint

Switchgear rooms, HVAC mechanical plant rooms, stores and workshop.

Glazed ceramic tiles plaster and paint above

Glazed ceramic tiles up to a level of 2.3 m and plaster and paint above this level shall be applied in toilets, washrooms, locker rooms, kitchen and cooled drinking water alcoves.

Acid / lye resistant tiles, plaster and acid / lye resistant paint

Acid / Lye resistant tiles, (plaster and acid / lye resistant paint) up to a level of 1.2 m shall be applied in battery room. Suitably approved skirting shall be provided at the base of all tiled or plaster finished walls.

4.17 Masonry

General

The scope covered by this Article comprises the performance of all kind of masonry work in accordance with the static analysis and as shown on the approved working drawings. The requirements of EUROCODE 6 or equivalent shall be observed.

Particular attention shall be paid to the surface protection measures specified hereafter.

Material

The material to be used for masonry work comprises the following:

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clay bricks and sand / lime stone solid or hollow concrete blocks

blocks, stones and wall boards made of cellular concrete blocks light weight concrete blocks and wall boards

gypsum plaster boards natural stones

any other type of blocks and stone artificially produced insulating and filling material

binding agents metal accessories

The material above shall be generally standardized as specified hereafter.

Execution

Masonry work, arranging and bedding bricks, blocks and boards, etc. shall be executed in mortar to form a homogeneous mass and to bond them in such a manner that point or other loads and stresses are dispersed and distributed through the mass without the structure tending to disintegrate.

Block work partitions less than 200 mm in thickness shall be solid block and strengthen around all openings by reinforced concrete frame of 200 mm width (as a minimum) and in the same thickness of the wall

Block work more than 3 m in height shall be reinforced with reinforced concrete stiffening frame work comprising of 200 x 300 mm verticals at

4.00 meter centers and 200 x 300 mm horizontals at mid-height or at every 3.00 meters incase wall height is bigger than 6.00 meters.

Solid block works shall be provided wherever service pipes, cables, etc. are passing in wall (e.g. auxiliary electrical rooms, bath rooms, kitchens, etc.)

Exterior and interior walls, facing brick walls, pointing, cement mortar, gauges mortar, etc. shall be arranged as specified hereafter.

Construction during hot weather and cold weather

The presence of water in mortar is necessary for the setting action to take place. Precaution shall therefore be taken to prevent the work drying too quickly, especially in hot weather. All bricks, blocks and boards shall be saturated before bedding, except during frost, to prevent them absorbing



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the moisture from the mortar, and also to remove all loose dust from the surface in contact with the mortar.

Brickwork and/or block/board work which has not been thoroughly wetted can be detected by a thin crack between the brick/block/board and the mortar joint. Such work shall be pulled down and rebuilt. All masonry work shall be suspended during extreme weather unless adequately protected.

Block work under the ground slab, retaining walls and around foundations shall be min. 200 mm thick.

Auxiliary work

Unless specified otherwise, all and any kind of work, materials, services, safety measures, etc. as well as all tests and samples required for the completion of the work shall be included in the offer. Among others they also have to include the following services:

- a) provision and walling-up of all scaffolding holes and supports for beams, girders and ceilings
- b) walling-in or grouting of girder and beam heads and other structural members
- c) provision of slots, grooves, small openings and the like.
- d) provision of the scaffolding also for use by others and of the covers / enclosures of openings beyond the period during which these are required for Contractor's own use
- e) design calculations and drawings as far as required

Tests and properties

The minimum number of tests shall be as follows:

- a) two compressive test of soil block for load bearing walls per 200 m² of bearing block walls
- b) three compressive tests of each type of material as mentioned above c) three compressive tests of each kind of mortar to be used

Quality assurance

Blocks and stones shall be hard, of selected quality, reasonable in size and

shape. The strength of the blocks and stones shall be according to the static requirements, but not less than:

fill in block work	5 N/mm ²
fill in bricks	10 N/mm ²
non bearing wall blocks (Hollow type) (average)	5 N/mm ²
non bearing wall bricks	10 N/mm ²
load-bearing wall blocks (Solid blocks)	8 N/mm ²
load-bearing wall bricks	15 N/mm ²
face bricks	15 N/mm ²
sand lime bricks	15 N/mm ²

Mortar

Mortar for block work shall be cement mortar in the proportions 1:3 to 1:4 (cement to sand). All mortar shall be mixed in a power-driven mixer and in addition, all materials shall be screened before mixing to remove lumps. Mortar whether with or without plasticizer shall be mixed only in sufficient quantity for the work immediately in hand and no partly set mortar shall be used.

Reinforcement / fixing accessories for brick and block work

Reinforcement

Horizontal reinforcement to brick or block work is called for. It shall be in high tensile galvanized steel mesh 6 cm wide for 10 cm walls and 12 cm wide for 20 cm walls. The reinforcement shall be laid in as long lengths as practicable without laps. But where joints are necessary, the lengths shall be lapped not less than 30 cm, except at corners or junctions where the lap shall be equal to the width of the reinforcement and the reinforcement in one wall bent over that in the other.

Application: every second layer.

Damp courses

Damp-courses shall be laid on and bedded in a bed of 1:4 cement mortar in as long lengths as practicable. Where joints have to be made, they must be lapped at least 20 cm in the runs and for full width on corners and the meeting surfaces sealed with an adequate application of black bituminous water-proofing paste.

At ground floor levels, the damp-proof course for a wall shall extend to the full width. The vertical damp-proof course at reveals shall extend the full width of the return. Damp-proofing under floor slab shall be one layer self adhesive bituminous membrane, 3 mm thickness, polyester reinforced applied on bituminous primer over the blinding concrete and protected from top by minimum of 50 mm thickness cement sand screed.

Dimensions of masonry walls

The thickness of walls, all exclusively to be constructed as double skin walls, shall be designed and constructed including the insulation boards to meet at least a heat transmission coefficient of $U = 0.65 \text{ W}/(\text{m}^2 \cdot \text{K})$.

4.18 Non-Structural Steelwork

4.18.1 Description

Work include all labor, materials, equipment and services required to complete all steel work shown on drawings and as specified herein, including, but not limited to the following items, comprising at least:

anchor bolts, leveling plates and slim packs with complete instructions and templates to facilitate installation

base plates, columns, beams, girders, bracing, hangers, and related connections (bolted and welded).

floor plating

supports for equipment or elements from other supplies

corrosion, protection

temporary erection bracings and supports

miscellaneous steel structures (like ladders, rails, etc.).



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unless specifically excluded, furnishing and installing of all structural steel work indicated on the drawings, specified or obviously needed to make the work of transformer bay complete

4.18.2 Quality assurance

Codes and standards:

except as otherwise specified herein, the work shall be in accordance with the approved Standards and Regulations.

4.18.3 Material

All ferrous materials, their dimensions, forms, weights, tolerances chemical and mechanical properties, shall comply with the relevant standards or approved equivalents.

All work shall be carried out in accordance with the requirements of the drawings and the specification. All parts in the assembly shall fit accurately together and corresponding parts should preferably be interchangeable. Forced correction to fit the member together will not be allowed.

The Contractor shall submit to the Employer for approval the country of origin and manufacturer of the steel he proposes to supply.

All steel shall be carefully stored and handled so that pieces are not subjected to excessive stress or damage. Steelwork shall be stored on site such that it will be free from earth and dirt and will be properly drained.

The Contractor shall be responsible for the correctness of his shop details and site connections.

All steelwork shall be smooth, undeformed, straight and free from cracks, twists and burrs.

In the event of damage, immediately all repairs and replacement necessary shall be undertaken by the Contractor, subject to the approval by the Employer and at no additional cost to the Employer.

Technical requirements

Design characteristics

Site joints for the structure shall be bolted, unless site-welding is approved by the Employer. The construction methods shall be such as to permit easy erection, and shall conform to the stipulation given in other parts of these specifications.

Maximum dimensions and weight of the structure elements will be limited by the local transport conditions which should be investigated and verified by Contractor.

Materials

Structural steel primer paints shall be those of a recognized manufacturer experienced in coatings. The type of paint shall be submitted to the Employer for approval prior to use.

All other materials not specifically described but required for a complete and proper installation of structural steel, shall be new, free from rust, first quality and subject to review and approval by the Employer.

Surface conditions

Prior to installation of the work of this subsection, installed work of all other subsections must be carefully inspected and it must be verified that all such work is complete up to the point where this installation may properly be initiated.

It shall be verified that structural steel may be fabricated and erected in strict agreement with the original design, the approved drawings and related standards.

4.19 Wall Covering

Wall coverings are to match function of the rooms and wall areas concerned.

A high standard shall be applied to the choice of materials in particular for the control room.

Reference is made again at this point to the importance of the cleanliness aspect with a view to removal of dirt.

4.20 Rendering

All rendering work shall be protected from direct sunlight during execution and curing.

The Contractor shall ensure that all surrounding building work and paving is protected from cement splashes.

All electrical conduits and other services shall be fixed in position, and when necessary securely fixed in chases and recesses, before the execution of any rendering or other similar work.

4.21 Corrosion Protection of Steel and Ironwork Generally

Galvanizing

All steel and ironwork is to be galvanized or painted. Site drilling or cutting of steel will generally not be permitted.

Shop painting

With the exception of steelworks which is to be encased in concrete or galvanized, all surfaces of steelworks shall be shot blasted to a commercial gray finish to a profile height of 40 microns minimum.

All surfaces of steelworks shall then be painted with one Epoxy metallic zinc holding primer of an approved type and make, within one hour after shot-blasting.

All surfaces of steelworks which will be not accessible after fabrication of the steelwork, such as back angles etc., shall then be painted with two coats of red lead and two coats of micaceous Iron Oxide paint.

All areas of painted surfaces shall be made good of any damage occurred during stockpiling and delivery to site prior to erection.

Site painting

All materials shall be the best of their respective and shall be supplied from an approved Manufacturer and suitable for the climatic conditions of site.

All materials shall be delivered direct from the manufacturer on to the site in sealed containers on which maker's name and brand are clearly displayed, and shall be stored to comply with all requirements for the preservation of the paints.

If any of the painting work deteriorates from any cause other than by mechanical damage by others the Contractor shall thoroughly remove the damaged paint work and repaint the area affected in accordance with the Specification and to the satisfaction of the Employer.

A color schedule for all painting works will be made available to the Contractor prior to commencement of the works.

4.22 Raised Modular Floors

Full access raised easily removable, modular floor comprised of 800mm x 800mm (or 600x600 mm) panels, shall be used. The props shall be of rust proof material, with screw device for level adjustment. The panels shall be of galvanized steel with a core of processed timber. The surface covering of the panels shall be PVC tiles. The underside and edges of the panels shall be fire resistant meeting the requirements of BS 6266 or equivalent. Panel lifting devices belong to the scope of supply of the Contractor.

4.23 Floor Coverings

Floor coverings are to be constructed with the desired slope or completely level. All pretreatment of the base, e.g. application of damp-proof membranes of insulating coats and adherent coatings is to be carried out in such a way as to avoid any deficiencies or damage. Openings are to be edged with suitable sections.

Screeds

Screeds must be constructed in the necessary quality for the application concerned. All necessary measures are to be taken to guard against over- rapid drying out. The minimum thickness is 30 mm. Edgings are to be made with properly fixed steel angles.

4.24 Roofs

Construction

The roof construction is to be such that, with due allowance for the climatic conditions and with the intended use of the rooms taken into account, no damp will penetrate into the materials used. All roofs must have a minimum. Sound absorbing index of 20 dB (A) and a maximum heat transmission coefficient of 0.57 W/m² °C. Appropriate insulation materials will have to be used to achieve these figures.

The sequence of layers forming the roof and their dimensioning are to be correlated with the type of substructure and the intended use of the building concerned.

Roof surface is to be designed with a slope of 30°. Sloping layers below the vapor barrier shall not be constructed of lightweight concrete.

All roof penetrations are to be made with metal surrounds and bonded flanges and are to be sealed.

For covering corrugated steel plates are preferred. 4.25 Doors and Windows

Doors

Aluminum frames shall be provided for exterior doors.

All doors shall be installed by manufacturer or his authorized representative, and shall be set plumb, square, level and true to line. Frames shall be set and securely anchored to the structure. Aluminum surfaces in contact with mortar, concrete or other masonry materials shall be provided with one heavy brush coat of bituminous paint.

Hardware for all doors shall be furnished and installed by the door manufacturer. All locks shall require different keys, and three keys shall be furnished for each lock. Hardware for aluminum fittings shall, as a rule, be stainless steel.

Windows

Window frames shall be of aluminum.

All windows shall be installed by the manufacturer or his authorized representative, and shall be set plumb, square, level and true to line. Frames shall be set and securely anchored to the structure. Aluminum surfaces in contact with mortar, concrete or other masonry materials shall be provided with one heavy brush coat of bituminous paint.

Hardware for all windows shall be furnished and installed by the window manufacturer.

The windows strips in the switchgear room shall be installed on the level of + 2.0 m. The same principle is valid for all other areas where cabinets are installed.

4.26 Glazing

Clear safety toughened glass 8 mm thick of an approved manufacturer shall be used for doors.

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For windows only double glazing shall be used.

4.27 Water Supply System and Plumbing If Required

The water supply system required for the substations shall include:

A main storage tank with capacity of min. 2,000 l shall be installed in the ground-floor of the control building. The main tank shall be provided with a water inlet to allow refill of the tank from outside of the building. A smaller tank (250 l) shall be installed on the top of the control building (under the roof). The tank has to be protected and insulated against sunshine heating effects. The smaller tank shall be automatically filled by a pump from the main tank. The pump motor shall be controlled by a water level controlled switch in the smaller tank. The same system with reduced dimensions will be provided for the guard house.

All pipelines, connections pumps and associated works for the satisfactory operation of the water supply system.

Internal connections for the sanitary installations.

The main pipe supplying water to control building shall be PVC lining carbon steel pipe ($\varnothing \frac{1}{2}$ "). All valves shall be made of cast iron or bronze.

The fittings shall include toilet paper roll holders, soap dispensers, etc.

The following points shall be supplied by drinking water:

toilet and battery room wash basins

toilet's urinal

closet

showers

kitchen

Water pipes within buildings will generally be of cooper or galvanized steel or Unplasticised PVC pipes may be used for cold water lines only, subject to approval of the Employer. Unplasticised PVC pipes shall conform to approved class and manufacture and shall be jointed and fixed to walls using the correct fittings and fixings as supplied or specified by the manufacturer.

Lavatory basins

Lavatory basins in the sanitary and battery rooms shall be white ceramic, with mirrors, to be approved by the Employer before purchase or fixing in the works.

WCs and cisterns (if Required)

Unless otherwise agreed or directed, water closet pans shall be of western type, white ceramic or metal. Flushing cisterns of white ceramic metal or plastic. All materials shall be approved by the Employer before fixing in the works.

Urinals (if Required)

The urinal shall be white ceramic provided with automatic flushing cisterns.

Waste water system

The waste water from kitchen, sink, battery room wash basin, urinal, exterior tips, and all rainwater pipes shall be connected by drain pipes to septic tanks outside of the transformer bay buildings.

Cupboard with lavatory basin and electric cooker for the kitchen has to be provided.

4.28 Painting (Except Steel Surface)

Paints

The Contractor shall submit for approval the name of the manufacturer proposed to be used. Only paints suitable for the climatic conditions of the site shall be used.

All materials shall be delivered to site in sealed containers on which the maker's name, specification and date of manufacture are clearly displayed and shall be stored to comply with the requirements for the preservation of the paints. Only colors and undercoats approved by the Employer shall be used.

Application

Application of paint shall be by brush or roller, as a roved or directed the

Employer. The treatment to be given to the different surfaces shall be specified by the Contractor.

All paint shall be applied in accordance with the manufacturer's instructions and shall not be diluted in any way unless specifically stated or agreed by the Employer. No external paint work shall be carried out during high winds and rains or other unfavorable weather conditions.

All rubbish and debris shall be removed and floors swept and dampened before painting commences. Door, furniture, light switch covers and the like shall be removed and surrounding surfaces covered with canvas or other approved protection.

Newly painted surfaces shall be protected against contamination by dust or other causes.

5. Topographic Survey

5.1 *Scope of Topographic Survey*

The Contractor shall carry out all the necessary surveying works in order to:

obtain (if available) maps of the construction and surrounding areas Setting out the Contractor shall propose and install new transferred benchmarks (TBM). Their level and grid coordinates shall be related to the existing reference system

conduct spot level topographic survey of the development area and adjacent prominent surface boundaries

acquire all survey data in digital format for processing and detailed maps development

produce CAD adaptable and editable maps, natural ground profiles and survey data files of all surveyed items

produce a survey report of resources, procedures, site and office works and data acquisition, data processing and presentation.

The survey shall include all buildings and structures in the substation area (e.g. foundations, fences, overhead power lines, roads, tracks, finished grade, paving, buried services etc.). Furthermore, all pipelines and cables shall be taken up together with any location of equipment installed.

The required accuracy in Northing, Easting and elevations shall be ± 10 mm relative to the existing benchmarks.

The benchmarks shall be secured and marked in such a manner as to ensure that they can be found at any time, that they will not be destroyed by the ongoing construction activities and can be constantly used for reference and check measurements.

The results of the survey shall be reported as follows: Preliminary site survey report with an executive summary stating the objectives of the survey and containing a brief description of the work undertaken as well as the major conclusions
description of the survey work, referring to the method applied, equipment used, work organization, field operation, data processing, interpretation and presentation of the results
a site survey plan on a scale of 1:500.

Within 2 weeks after the receipt of Employer's Representatives comments the Contractor shall submit the Final site survey report having all those comments incorporated into it.

For the final report the Contractor shall also provide all the survey data in a digital format. The Contractor shall also provide the software necessary to gain access to the data in digital format as well as the specifications for the computer workstation to be used.

6. Geotechnical Investigations

6.1 General

The extent of the subsoil investigations done by the Contractor shall be such as to permit the satisfactory determination of the geotechnical conditions and to allow reasonable foundation proposals.

6.2 Scope of Works for Geotechnical Investigations

The purpose of the Site Investigation is to accurately capture, sample and in- situ test within the substation area including site reconnaissance, site geology and site previous utilization history and, above ground and subsurface conditions.

The Contractor shall comply with all local laws, rules and regulations applicable to the works. The investigation procedure shall be governed by recognized international standards and codes, in the latest edition

Anticipated work activities breakdown is summarized in, but not limited to, the following:

Conduct site reconnaissance, in-situ geophysical and geotechnical exploration including open trial pits, boring, in-situ borehole and open pit testing, piezometer installation as per planned exploration program

Collect disturbed and undisturbed soil samples and extract water samples from boreholes and open trial pits

Select proper collected samples and perform geotechnical lab tests to classify soils and assess their geotechnical behavior

Compile in-situ data collection, in-situ test results, lab test results and desk studies accounts

Produce a comprehensive factual report of resources, procedures, acquired data, site works and lab tests, desk study, data processing and conclusions

Liaise with topographic survey for interchange of information to be superposed on topographic survey maps or to obtain topographic survey information useful in setting out Site Investigation works.

6.3 Field Works

Boreholes

Exploratory boreholes shall be sunk at the locations approved by the Employer's Representative. The boreholes shall be 12 cm in diameter.

The depth of boreholes shall not be less than 10 m unless rock is encountered, in which case the thickness shall be proved to be greater than 1.5 m. Where weak soils are encountered, boreholes shall be continued down to a load bearing stratum with a minimum thickness of 3 m proved.

The boreholes shall be drilled by local trained drillers under the direct supervision of the Contractor, according to the established instructions and specifications. Casing shall be used where necessary to prevent the collapse of the borehole wall.

An appropriate boring method with continuous recovery of soil samples shall be used. Disturbed and undisturbed samples shall be collected for visual examination and laboratory testing.

The soil stratifications encountered in the boreholes shall be logged during drilling and the borehole logs shall include at least the following information:

the soil stratification

the number, depth and type of soil samples

the corrected penetration resistance

the groundwater level

the grain size distribution

the index and engineering properties of representative samples collected from different strata

the SPT values

the drilling method, coring, casing.

Standard penetration tests (SPT)

Down to the depth of drilling, SPT shall be performed in the boreholes at 1.5m intervals, in both cohesive and non-cohesive soils.

Sampling

During SPT at 1.5 m intervals, disturbed samples shall be collected and submitted in polyethylene bags with proper identification.

Undisturbed samples shall be collected for cohesive soils at 1.5 m intervals. A thin-walled sample tube of 63.5 mm ID and 610 mm in length shall be pressed into the cohesive soils by means of hydraulic pressure produced by the drilling rig. The undisturbed samples shall be trimmed and sealed with non-shrinkage wax at both ends and clearly labeled.

Disturbed and undisturbed soil samples shall be sent for laboratory tests.

Groundwater level measurement

The water level in each borehole shall be recorded before commencement and after completion of drilling when the water level has settled. The depth of the borehole and the casing (if any) shall be also recorded.

Cone penetration tests (CPT)

CPT shall also be carried out as a second method of soil investigation (after borehole sinking) at the locations approved by the Employer's Representative.

CPT shall be carried out using static penetrometers (Dutch core apparatus) for determination of the soil type, density and consistency. The results of the CPT shall be presented in CPT format.

Test (trial) pits (TP)

Test or trial pits down to 1.5 m shall be used as a third method of soil investigation in order to visually identify the top strata and its sequence as well as to proof suitability of dredgers. The Contractor shall obtain at least one disturbed and one undisturbed sample of each stratum encountered.

The description of the encountered strata and of the strata sequence, accompanied by colored photographs, shall be specified in the soil investigation report.

General soil characteristics

A general soil/subsoil description shall be made for the investigation, comprising:

soil conditions at the surface

expected soil conditions below the surface (slopes, etc.)

inclination of the ground surface, inclination and orientation of cracks and fissures as well as their stratification, evaluation of slope stability, in case there is a potential for sliding.

This information shall be provided to the Employer's Representative through intermediate reports, to enable him to give instructions for more ensive or additional investigations, if necessary.

Minimum number of boreholes /soundings /trial pits

	Borings	Cone Penetration Tests (CPT)	Trial Pits (TP)
110 kV Substations	2-3	2-3	2-3

Building Zones	2	2	2
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The final number of boreholes will be agreed between the Contractor and the Employer or his Representative. This remark is especially valid for the extended substation.

6.4 Laboratory Tests

Natural moisture content

Tests to determine that natural moisture content (natural water content) and the in-situ wet and dry densities shall be performed on undisturbed samples. Atterberg limit tests

Tests to determine the liquid limit and the plastic limit shall be performed on representative cohesive soil samples collected from different strata. The Liquidity Index/Consistency Index shall be determined.

Grain size distribution tests

The specific gravity and the grain size distribution of representative soil samples collected from different strata shall be determined with standard sieves and a hydrometer.

Grain size distribution curves with USCS classification of representative samples shall be specified in the soil investigation report.

Unconfined compression tests

Unconfined compression tests shall be performed with a constant strain rate on representative undisturbed specimens with a diameter of 3.56 cm. Stress- strain diagrams of these shall be attached to the soil investigation report.

Consolidation tests

With a 1:1 load increment ratio and 24 hour duration for each increment, standard consolidation tests shall be performed on 2.54 cm thick, representative undisturbed specimens with a diameter of 5.08 cm.

Chemical analyses

The groundwater and the soil shall be analyzed and classified with regard to their aggressive action on concrete. The classification shall comply with

DIN 4030 or recognized standards.

The results and recommendations shall be part of the soil test report.

The chemical analyses shall determine the sulfate and chloride contents as a minimum as well as the pH value.

Electrical resistivity tests

Electrical resistivity tests shall be made for 4 samples.

6.5 Results of Geotechnical Investigations

The reports shall be complete and shall contain, but not be limited to, the information specified below.

Description of the scope of work carried out containing:

work program

methods and systems (equipment) used

works carried out (field investigations and laboratory tests)

Layout location plans of soil investigations, showing:

the area

the general layout plan

locations of boreholes, soundings, trial pits and plate tests (if any) carried out

Comprehensive map surrounds.

Logs, tables

The subsurface conditions, for example the sequence of the strata, the nature

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and properties of the individual strata as well as the groundwater conditions shall be determined and described in the borehole logs. The results of the laboratory tests and the diagrams of the test results shall be included in the report.

Borehole logs, trial pit logs and surroundings logs shall include:

actual ground level and reference to the local Datum description and limits of various soil layers

samples taken SPT results water levels

depth of borehole/pit/sounding

Soil profiles (cross-sections)

The results of the subsoil investigations shall (in addition to the borehole logs) also be shown in the form of cross-sectional drawings with a vertical scale of 1:100 showing, e.g.:

actual ground level and plant datum at the points of investigations results of boreholes including standard penetration test (SPT) graphs

trial pit profiles

CPT diagrams

proposed foundation levels

limit lines of soil layers (soil strata)

groundwater level legend (key).

Soil classification

The soils shall be classified according to British Standard BS 3882, USCS or to the German DIN 18196 standards.

Groundwater classification

After the chemical analysis, the groundwater shall be classified according to its aggressive action on concrete. The classification shall comply with

ASTM standards or equivalent codes.

Foundation Proposal

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Admissible bearing pressures of different types of foundations shall be advised. Type and engineering values of proposed pile foundations - if necessary - shall be given. Explanation of recommended soil improvement methods shall be made. Geotechnical restrictions of earth works (cut and fill, slopes, etc.) shall be advised.

Recommendations for foundations shall be derived from the in-situ investigations and from the laboratory tests.

6.6 Reporting's

Comprehensive investigation reports shall be produced for each site in two stages. Within six weeks of completion of the soil investigation field work, the Contractor shall submit the draft final report to the Employer's Representative for comments and approval. The draft report shall be complete and shall contain, but not be limited to, the information specified under item 4.5. A final revision shall be issued after incorporation of comments and requirements.

All report deliverables, documentation, maps and drawings shall be compatible with M/S Office 2003 suite and CAD systems. Data to be interchanged with topographic surveyor shall be in electronic format for further electronic processing.



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