Section 6. Employer's Requirements

6.1 Scope of Supply of Plant and Installation Services by the Contractor

General:

The works covered by the Bid/Tender is Design, Supply, Erection, Installation, Testing and commissioning including civil works of 2D **(10mX5m)** Bay Extension (33 kV side works, Grid substation) at Kulaura and other related works on Turnkey Basis under Power Distribution System Development Project, Sylhet Division, BPDB Sylhet.

The scope of Plant & Equipment and services include design, manufacture, quality assurance, erection, dismantling (where required), inspection & testing, packing for export, insurance & shipment to site, complete construction & installation, jointing, terminating, bonding, earthing, painting, transportation, setting to work, site testing & commissioning of all the equipment necessary for safe operation of the 2D **(10mX5m)** Bay Extension. Moreover, the existing equipment dismantled from the existing substation shall be handed over and deposited to Project Store, Sylhet without any damage as per direction of Project Director or Engineer of this project.

The detail requirements are listed in the technical specification and Guaranteed Technical particulars (GTP) in the tender document. The contractor shall remedy all defects during the defect liability period of the Plant & Equipment as per contract.

The contractor is responsible for ensuring that all and any items of work required for the safe efficient and satisfactory completion and functioning of the Plant & Equipment and services,

The conceptual layout, general arrangement and single line diagram for the proposed 2D **(10mX5m)** Bay Extension are attached in Annex-8 & 9. The arrangement is indicative and the detailed layout design will be prepared and submitted by the EPC Contractor for BPDB's approval. The station layout and equipment rating shall be based on the single line diagram. The Contractor shall work out an optimum layout based on the requirement and specific features of the manufacturer's product within the constraints of overall dimensions of the plot. The layout and equipment setup shall be optimized in such way as to keep free space, if any, for other purpose and future expansion.

The detailed design arrangement of the equipment shall be the responsibility of the Contractor subject to the approval of the Engineer. The Contractor shall submit all drawings, manuals, designs and calculations for review prior to commencing manufacturing and /or installation works.

Moreover, the contractor shall be responsible for Transportation of machineries/ equipment to Project Site including moving the equipments and materials from the designated store to the site shall be done by the contractor as per Consignee's advice and requirement and during the testing, commissioning, functional operation all the consumables goods or any equipment/machineries/materials are required to complete the Plant & Equipment and services shall be the responsibilities of the contractor and all the necessary arrangement for Power, Water, accommodations or any such facilities and tools-tackles and necessary instruments for erection, dismatling,installation, testing and commissioning of the Project Site will be supplied/ arranged by the Contractor within the quoted price. The contractor should handover all the removed materials/ goods at the place within Layout plan as instructed by the Consignee

Note: *Tenderers shall quote a Firm Turnkey Contract Price for the Plant & Equipment and services as described in Price Schedule and in Section 6,* ***7, 8 & 9*** *of this Tender document. If the Tenderer deemed necessary any additional Plant & Equipment and services out of the list of tender schedule for completion of the said Turnkey works and site requirement, contractor shall have to do the additional works. The costs of these additional works are deemed to be included within the quoted price. Tenderer are requested to visit the site to consider all requirements before the submission of the Tender.*

6.1.1 Design, Supply, Erection, Installation, Testing and Commissioning of 2D (10mx5m each) Bay Extension of 33kV Switchyard at Kulaura Grid Substation under S&D, Kulaura, BPDB, Moulavibazar.

(Not limited but at least the following works to be done by the turnkey contractor)

A. CIVIL & BUILDING WORKS:

Design, Manufacture, Supply, Installation/ Erection, Construction, Testing and commissioning and so on of the following works are the scope of works:

1) Earth filling, Land escaping, Leveling, Dressing of the proposed switchyard area. Employer will provide all lands only and contractor will fill it by sand (if necessary) upto ground level. Soil testing for soil resistivity and soil bearing capacity before designing, final leveling, consolidation, surfacing and compaction of related switchyard area with crushed rock (where required) to cater for the ultimate development of the substation.

2) Construction of cable trenches for control cable:
   (a) Within the switch yard area
   (b) Switch yard area to control room building

3) Construction of R.C.C foundations for, switch yard tower and all others equipment & Structure as required.
4) Supply of gravel and finishing the Switchyard surface by the gravel to the switchyard.
5) Design & Construction of 67.5 square meter horizontal extension on first floor of existing control room building as per price schedule for the substation control room, cable room, etc. including roof lime terracing, door, window, toilet etc. Electrification of the whole substation area is within the scope. In control room high quality tiles shall be installed in floor. For this new extension part, in the control room building having facilities of wash basin, bath shower

towel rod, soap case, auzo wash, glass rack, looking mirror, pan fitting with low-down, swan neck pillar cock, extra long bib cock, interior walls and floor finished by tiles, underground water reservoir tank and all allied civil works deemed necessary are included in the Bid complete in all respect. Overhead water tank on the top of the control room building & office building, underground water reservoir (tank), water lifting pump, suction pump and portable water supply system complete in all respect [Design shall be based on use of 20 persons per day for overhead water tank] Construction of septic tank, soak well, inspections pits, sewerage piping by PVC 6 inches dia. Pipe, toilet/ bathroom / lavatory located.

9) Soil testing for soil resistivity and soil bearing capacity before designing final leveling of Control room area.

11) Properly insulated False Ceiling of Control room, office, suitable for Air conditioning system.

12) Construction of drainage, sanitary system for whole sub-station area.

19) Supply and construction of Power cable trench and control cable rack inside the Ground floor of the substation building. Proper fire and water proof sealing of the cable entry (control & Power) at Control Room building, to prevent water entering from switch yard/outside to CR Building, preventing entry of rats and reptiles, fire proof etc.

20) Dismantling work as per Price Schedule, BOQ & field requirement.

21) Supply and installation of office room, Control room indoor illumination. Lighting levels within the building must be generally designed to meet the requirements of IEC Standards, and in particular, meet the following specific lighting levels:

- 400 lux between rows at switchgear front panels within the Control Building;
- 400 lux at the front of control panel within the Control Building;
- 160 lux to the rear of switchgear in the Control building
- 160 lux adjacent to the Battery Storage, Load Management Equipment, AC and DC panels

23) All civil works and necessary indoor & outdoor lighting [Energy efficient (LED) and automated] are required within the scope of the Tender. The substation control room building shall have the emergency automated dc lighting system in case of power failure.

NOTE: All doors & windows work to be finished by aluminum frame and high quality transparent 6 mm thick glasses. Both indoor & outdoor surface finishing works of walls, roof etc, to be synthetic high quality plastic paint and moisture proof snowcem respectively and treatment to be made by lime terracing for rain water leakage proof of the roof.

B. SUB-STATION / ELECTRICAL WORKS:

Design, Manufacture, Supply, Installation/ Erection, Construction, Testing and Commissioning etc. of the following works are the scope of works:

1) Supply and installation of **two nos. 33kV Line Feeders** comprising: 33kV VCB, CT, DS, LA, Control cable, Cable termination kit, PCM Panel, Supporting structures etc.

2) Supply and installation of 33kV Bus Potential Transformer of ratio $\frac{33kV}{\sqrt{3}}$ $\frac{110V}{\sqrt{3}}$

one set (three nos. in one set), to be installed on the switch yard gantry structure.

3) Supply and installation of Switch yard shielding materials.

4) Supply and installation of Switch yard grounding materials for extended sub-station area and equipment to be installed. Earth resistance of the substation shall be less than 0.5ohm.

5) Supply and installation of Switchyard outdoor illumination system for the extended area.

6) Supply and installation of 33KV Bus bar conductor (ACSR Martin)

7) Supply and installation of 33kV switchyard gantry structure two diameters (10M×5M) with bus bar, bus support insulator & hardware, jumper, shielding materials and grounding materials etc. as required complete in all respect.

8) Supply and installation/ connection of Control Cables.

9) 3 (Three) sets of As-built drawings together with operation and maintenance manual, **relevant IEC standards of the installed equipment shall be submitted for the Directorate of Design & Inspection -2, BPDB, Dhaka.** One electronic copy (soft copy in a CD) of all relevant As-built drawings together with operation and maintenance manual, **relevant IEC standards of the installed equipment shall be submitted for the Directorate of Design & Inspection -2, BPDB**

10) The Bidder must visit the site and assess the works before tender submission.

11) Supply and installation of switching boards to be installed at switchyard for functioning of lights etc.

12) Transportation of all equipment and materials, all installations, connections and testing, commissioning, inspection are within the scope of the Bid.

6.1.2 Bill of Quantities (BOQ)

1. All the items mentioned in the BOQ (as follows) shall be quoted in the respective format of the price schedule, otherwise bid will be rejected.

2. Schedule No: 3 & 5 is applicable for total price of all Substations (Not for individual substation).

5. Tenderer shall quote a Firm Turnkey Contract Price for the Supply and Related Services as described in Price Schedule according to Section 6, Section 7 & Section 8 of this Tender document. If the Tenderer deemed necessary any additional machineries/equipment/ materials / Supply and Related Services out of the list of tender Price Schedule for completion of the said Turnkey basis works(Supply and Related Services), contractor shall have to do the additional works (Supply and Related Services) without any additional cost. The costs of these additional works (Supply and Related Services) are deemed to be included within the quoted price.

6. **2D (5mX10m) Bay extension Bill of Quantity (BoQ) as follows:**

6.1.2.1 Bill of Quantities for Design, Supply, Erection, Installation, Testing and Commissioning of 2D Bay Extension (33 kV side works, Grid substation) under the S&D, Kulaura on Turnkey Basis under Power Distribution System Development Project, Sylhet Division.

Line Item No.	Description of Item	Quantity	
1	2	3	
1	Supply of 36 kV Vacuum, 1250A, 31.5 kA for 3 sec. outdoor circuit breaker along with accessories. (As per Scope of Works, Technical Specification & GTP).	Set	2
2	Supply of 33 kV, Single phase Lightning Arrester (ZnO-type) along with supporting structure and required accessories. (As per Scope of Works, Technical Specification & GTP).	Set (1 set = 3 nos.)	2
3	Supply of 33 kV Isolator 1250A, 31.5 kA for 3 sec. without earthing blade gang operated vertical mounted vertical break with supporting steel structure with necessary connectors and accessories. (As per Scope of Works, Technical Specification & GTP).	Set	2
4	Supply of 33 kV, Line Isolator 1250A, 31.5 kA for 3 sec. with earthing blade gang operated vertical break with supporting steel structure with necessary connectors and accessories. (As per Scope of Works, Technical Specification & GTP).	Set	2
5	Supply of 33 kV Single Phase Current Transformer ratio 400-800/5/5A class 5P20 for protection and 0.2 for measuring along with supporting steel structure and suitable be-metalic connectors and accessories as per field required. (As per Scope of Works, Technical Specification & GTP).	Set	1

6	Supply of 33 kV, Single Phase Potential Transformer ratio 33/√3/0.11/√3kV Class 0.2measuring & 3P for protection signaling instrument etc. along with supporting materials for installation on gantry structure with necessary connectors and other Accessories. (As per Scope of Works, Technical Specification & GTP).	Set (1 set = 3 nos.)	2
7	Supply of 33 kV, Bus section Isolator 1250A, 31.5 kA for 3 sec. gang operated horizontal structure for installation on gantry steel structure with necessary connectors and accessories as per field required. (As per Scope of Works, Technical Specification & GTP).		
8	Supply of 33kV off-load fused Isolator for bus PT with supporting steel structure and necessary connectors.	Set	1
9	Supply of 33 kV Bus bar Conductor ACSR Martin. (As per Scope of Works, Technical Specification & GTP).	Lot	1
10	Supply of 33 kV Disc Insulator set with necessary suitable front and back connecting clamps. (As per Scope of Works, Technical Specification & GTP).	Lot	1
11	Supply of Suitable Bus Bar Droppers, Conductors, connectors and outdoor marshaling kiosk, hardware clamps nuts bolts etc. suitable for connecting the individual items of S/S circuit equipment for complete substation. (As per Scope of Works, Technical Specification & GTP).	Lot	1
12	**Supply of Control cable of different sizes and LV PVC copper cable of different sizes as necessary and MCCB, connectors to connect different panels.** (As per Scope of Works, Technical Specification & GTP).	Lot	1
13	Supply of Shield wire overall diameter 9.525 mm standard steel. (As per Scope of Works, Technical Specification & GTP).	Lot	1
14	Supply of Terminal Tension clamp with fittings and PG Clamp set for fixing the shield wire with the gantry steel structure. (As per Scope of Works, Technical Specification & GTP).		
	Tension clamps with fitting	Lot	1
	PG Clamp		1
	Support clamp		1
15	Supply of 185 mm2 grounding copper conductor.	Lot	1
	Supply of Grounding rod (Earthing electrode) dia 16 mm each 4 Meter length. (As per Scope of Works, Technical Specification & GTP).		1
16	Supply of Suitable connector for connecting with individual items of substation equipment between sub-station equipment and earthing mesh. (As per Scope of Works, Technical Specification & GTP).	Lot	1
17	Supply of 33 kV Control Metering and Relay Panel for 33 kV Line Feeder with 3 O/C + 1 E/F Ins. + 3 Directional O/C + 1 Directional	Nos.	2

	E/F with Signaling & Control. (As per Scope of Works, Technical Specification & GTP).		
18	Supply of Sub-station galvanized steel structure materials 2D, 5m x 10m along with suitable beam at all 5m for supporting 33 kV Bus section Isolator and all other accessories as required. (As per Scope of Works, Technical Specification & GTP).	Lot	1
19	Supply of HP Sodium Lamp 250 Watts, 250 Volts single phase with shade & fittings and other related accessories.	Lot	1
20	Supply of 33kV, 1CX500mm^2 armor power cable (XLPE Copper Cable) including all termination kits & mid span kits and accessories for connecting between 33kV outdoor VCB and outgoing feeder. ((As per Scope of Works, Technical Specification & GTP)	km	0.5
21	**Civil Works:**		
	a) 67.5 mm^2 (13.5m X 5m) Horizontal Extension on First floor of existing control room building.	Lot	1
	c) Foundation of Equipment, Power & Control Cable Trench etc.		
22	Installation of complete Bay including erection, testing & commissioning.	Lot	1

6.2 Specification

Item No	Name of Item or Related Service	Technical Specification and Standards
1	2	3
	Plant & Equipment	**Bidder shall comply the Technical Specifications as per Section 7 & Guaranteed Technical Particular (GTP) as per Section-8, otherwise bid will be rejected.**
	Inspection and Tests	*As per Section 7 and Section 8*

6.3 Form of Completion Certificate

Contract No: Date:
To:

[Name of Contractor]

Pursuant to GCC Clause 39 (Completion of the Facilities) of the General Conditions of the Contract entered into between yourselves and the Employer dated *[insert date]*, for the supply and installation of plant and Services for *[name of contract],* we hereby notify you that the following part(s) of the Facilities was (were) complete on the date specified below, and that, in accordance with the terms of the Contract, the Employer hereby takes over the said part(s) of the Facilities, together with the responsibility for care and custody and the risk of loss thereof on the date mentioned below.

1. Description of the Facilities or part thereof: _____

2. Date of Completion: _____

However, you are required to complete the outstanding items listed in the attachment hereto as soon as practicable.

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defect Liability Period.

Very truly yours,

for and on behalf of the Employer

[***Signature***]

[***Title of the Project Manager***]

6.4 Form of Operational Acceptance Certificate

Contract No: Date:
To:

[Name of Contractor]

Pursuant to GCC Clause 40.3 (Operational Acceptance) of the General Conditions of the Contract entered into between yourselves and the Employer dated *[insert date]*, for the supply and installation of plant and Services for *[name of contract]*, we hereby notify you that the Functional Guarantees of the following part(s) of the Facilities were satisfactorily attained on the date specified below.

1. Description of the Facilities or part thereof: _____

2. Date of Operational Acceptance: _____

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defect Liability Period.

Very truly yours,

for and on behalf of the Employer

[***Signature***]

[***Title of the Project Manager***]

6.5 Form of Change Order Procedure and Forms

Contract No: Date:
To:

[Name of Contractor]

CONTENTS

1. General
2. Change Order Log
3. References for Changes

ANNEXES

Annex 1 Request for Change Proposal
Annex 2 Estimates for Change Proposal
Annex 3 Acceptance of Estimate
Annex 4 Change Proposal
Annex 5 Change Order
Annex 6 Pending Agreement Change Order
Annex 7 Applications for Change Proposal

Change Order Procedure

1. General

This section provides samples of procedures and forms for implementing changes in the Facilities during the performance of the Contract in accordance with GCC Clause 64 (Change in the Facilities) of the General Conditions.

2. Change Order Log

The Contractor shall keep an up-to-date Change Order Log to show the current status of Requests for Change and Changes authorized or pending, as Annex 8. Entries of the Changes in the Change Order Log shall be made to ensure that the log is up-to-date. The Contractor shall attach a copy of the current Change Order Log in the monthly progress report to be submitted to the Employer.

3. References for Changes

(1) Request for Change as referred to in GCC Clause64 shall be serially numbered CR-X-nnn.

(2) Estimate for Change Proposal as referred to in GCC Clause 64 shall be serially numbered CN-X-nnn.

(3) Acceptance of Estimate as referred to in GCC Clause 64 shall be serially numbered CA-X-nnn.

(4) Change Proposal as referred to in GCC Clause 64 shall be serially numbered CP-X-nnn.

(5) Change Order as referred to in GCC Clause 64 shall be serially numbered CO-X-nnn.

Note: (a) Requests for Change issued from the Employer's Home Office and the Site representatives of the Employer shall have the following respective references:

Home Office	CR-H-nnn
Site	CR-S-nnn

(b) The above number "nnn" is the same for Request for Change, Estimate for Change Proposal, Acceptance of Estimate, Change Proposal and Change Order.

Annex 1. Request for Change Proposal

(Employer's Letterhead)

To: Date:

Attention:

Contract Name:
Contract Number:

With reference to the captioned Contract, you are requested to prepare and submit a Change Proposal for the Change noted below in accordance with the following instructions within _____ days of the date of this letter _____.

1. Title of Change: _____

2. Change Request No. _____

3. Originator of Change: Employer: _____
   Contractor (by Application for Change Proposal No. _____[1]:

4. Brief Description of Change:
   _____

5. Facilities and/or Item No. of equipment related to the requested Change: _____

6. Reference drawings and/or technical documents for the request of Change:

   Drawing No./Document No. Description

7. Detailed conditions or special requirements on the requested Change:
   _____

8. General Terms and Conditions:

   (a) Please submit your estimate to us showing what effect the requested Change will have on the Contract Price.

   (b) Your estimate shall include your claim for the additional time, if any, for completion of the requested Change.

   (c) If you have any opinion negative to the adoption of the requested Change in connection with the conformability to the other provisions of the Contract or the safety of the Plant or Facilities, please inform us of your opinion in your proposal of revised provisions.

_____

(d) Any increase or decrease in the work of the Contractor relating to the services of its personnel shall be calculated.

(e) You shall not proceed with the execution of the work for the requested Change until we have accepted and confirmed the amount and nature in writing.

Signature:	*[insert signature of authorised representative of the Employer]*
Name:	*[insert full name of signatory with National ID Number]*
Title of the Signatory:	*[insert title of the Signatory]*
Name of the Employer:	*[insert name of the Employer]*

Annex 2. Estimate for Change Proposal

(Contractor's Letterhead)

To: Date:

Attention:

Contract Name:
Contract Number:

With reference to your Request for Change Proposal, we are pleased to notify you of the approximate cost of preparing the below-referenced Change Proposal in accordance with GCC Sub-Clause64.2.1 of the General Conditions. We acknowledge that your agreement to the cost of preparing the Change Proposal, in accordance with GCC Sub-Clause64.2.2, is required before estimating the cost for change work.

1. Title of Change: _____

2. Change Request No./Rev.: _____

3. Brief Description of Change: _____

4. Scheduled Impact of Change: _____

5. Cost for Preparation of Change Proposal: _____[2]

   (a) Engineering (Amount)

   (i) Engineer _____hrs x _____ rate/hr =
   (ii) Draftsperson _____hrs x _____ rate/hr =
   Sub-total _____hrs

   Total Engineering Cost

   (b) Other Cost

   Total Cost (a) + (b)

[2] Costs shall be in the currencies of the Contract.

Signature:	*[insert signature of authorised representative of the Employer]*
Name:	*[insert full name of signatory with National ID Number]*
Title of the Signatory:	*[insert title of the Signatory]*
Name of the Employer:	*[insert name of the Employer]*

Annex 3. Acceptance of Estimate

(Employer's Letterhead)

To: Date:

Attention:

Contract Name:
Contract Number:

We hereby accept your Estimate for Change Proposal and agree that you should proceed with the preparation of the Change Proposal.

1. Title of Change: _____
2. Change Request No./Rev.: _____
3. Estimate for Change Proposal No./Rev.: _____
4. Acceptance of Estimate No./Rev.: _____
5. Brief Description of Change: _____
6. Other Terms and Conditions: In the event that we decide not to order the Change accepted, you shall be entitled to compensation for the cost of preparation of Change Proposal described in your Estimate for Change Proposal mentioned in para. 3 above in accordance with GCC Clause64 of the General Conditions.

Signature:	*[insert signature of authorised representative of the Employer]*
Name:	*[insert full name of signatory with National ID Number]*
Title of the Signatory:	*[insert title of the Signatory]*
Name of the Employer:	*[insert name of the Employer]*

Annex 4. Change Proposal

(Contractor's Letterhead)

To: Date:

Attention:

Contract Name:
Contract Number:

In response to your Request for Change Proposal No. _____, we hereby submit our proposal as follows:

1. Title of Change: _____

2. Change Proposal No./Rev.: _____

3. Originator of Change: Employer: _____
   Contractor: _____

4. Brief Description of Change: _____

5. Reasons for Change: _____

6. Facilities and/or Item No. of Equipment related to the requested Change: _____

7. Reference drawings and/or technical documents for the requested Change:

   Drawing/Document No. Description

8. Estimate of increase/decrease to the Contract Price resulting from Change Proposal:[3]

(Amount)

   (a) Direct material

   (b) Major construction equipment

   (c) Direct field labor (Total _____hrs)

   (d) Subcontracts

   (e) Indirect material and labor

[3] Costs shall be in the currencies of the Contract.

(f) Site supervision

(g) Head office technical staff salaries

Process engineer	_____hrs @	_____ rate/hr
Project engineer	_____hrs @	_____ rate/hr
Equipment engineer	_____hrs @	_____ rate/hr
Procurement	_____hrs @	_____ rate/hr
Draftsperson	_____hrs @	_____ rate/hr
Total	_____hrs	

(h) Extraordinary costs (computer, travel, etc.)

(i) Fee for general administration, _____ % of Items

(j) Taxes and customs duties

Total lump sum cost of Change Proposal
(Sum of items (a) to (j))

Cost to prepare Estimate for Change Proposal
(Amount payable if Change is not accepted)

9. Additional time for Completion required due to Change Proposal

10. Effect on the Functional Guarantees

11. Effect on the other terms and conditions of the Contract

12. Validity of this Proposal: within *[Number]* days after receipt of this Proposal by the Employer

13. Other terms and conditions of this Change Proposal:

    (a) You are requested to notify us of your acceptance, comments or rejection of this detailed Change Proposal within _____ days from your receipt of this Proposal.

    (b) The amount of any increase and/or decrease shall be taken into account in the adjustment of the Contract Price.

    (c) Contractor's cost for preparation of this Change Proposal:[2]

[2] Specify where necessary.

Signature:	*[insert signature of authorised representative of the Contractor]*
Name:	*[insert full name of signatory with National ID Number]*
Title of the Signatory:	*[insert title of the Signatory]*
Name of the Contractor:	*[insert name of the Contractor]*

Annex 5. Change Order

(Employer's Letterhead)

To: Date:

Attention:

Contract Name:
Contract Number:

We approve the Change Order for the work specified in the Change Proposal (No. _____), and agree to adjust the Contract Price, Time for Completion and/or other conditions of the Contract in accordance with GCC Clause64 of the General Conditions.

1. Title of Change: _____

2. Change Request No./Rev.: _____

3. Change Order No./Rev.: _____

4. Originator of Change: Employer: _____
   Contractor: _____

5. Authorized Price:

   Ref. No.: _____ Date:
   _____
   Foreign currency portion _____ plus Local currency portion _____

6. Adjustment of Time for Completion

   None Increase _____ days Decrease _____ days

7. Other effects, if any

Authorized by: _____ Date:
(Employer)

Accepted by: _____ Date:
(Contractor)

Annex 6.Pending Agreement Change Order

(Employer's Letterhead)

To: Date:

Attention:

Contract Name:
Contract Number:

We instruct you to carry out the work in the Change Order detailed below in accordance with GCC Clause64 of the General Conditions.

1. Title of Change: _____

2. Employer's Request for Change Proposal No./Rev.: _____ dated: _____

3. Contractor's Change Proposal No./Rev.: _____ dated: _____

4. Brief Description of Change: _____

5. Facilities and/or Item No. of equipment related to the requested Change: _____

6. Reference Drawings and/or technical documents for the requested Change:

Drawing/Document No.	Description

7. Adjustment of Time for Completion:

8. Other change in the Contract terms:

9. Other terms and conditions:

Signature:	*[insert signature of authorised representative of the Employer]*
Name:	*[insert full name of signatory with National ID Number]*
Title of the Signatory:	*[insert title of the Signatory]*
Name of the Employer:	*[insert name of the Employer]*

Annex 7. Application for Change Proposal

(Contractor's Letterhead)

To: Date:

Attention:

Contract Name:
Contract Number:

We hereby propose that the below-mentioned work be treated as a Change in the Facilities.

1. Title of Change: _____
2. Application for Change Proposal No./Rev.: _____ dated: _____
3. Brief Description of Change: _____
4. Reasons for Change:
5. Order of Magnitude Estimation (in the currencies of the Contract):
6. Scheduled Impact of Change:
7. Effect on Functional Guarantees, if any:
8. Appendix:

Signature:	*[insert signature of authorised representative of the Contractor]*
Name:	*[insert full name of signatory with National ID Number]*
Title of the Signatory:	*[insert title of the Signatory]*
Name of the Contractor:	*[insert name of the Contractor]*

Signature Seal

6.6 Supplementary Information

[The Tenderer shell furnish additional description/information covering all activities, if any]

Section 7. Technical Specification

7.1 TECHNICAL SPECIFICATIONS FOR 33kV 2D Bay Extension EQUIPMENT

7.1.1 Scope

This clause describes the General Technical Requirements for the new 33 KV Circuit Breaker with PCM and general switchyard equipment, and shall be read in conjunction with the Project Requirements, Schedules and Drawings in the specification.

The Contractor shall demonstrate that the switchgear has been designed, built and installed in accordance with the relevant international standards and the specification as specified in the tender documents. It shall also operate and perform on a site in accordance with the requirements of the specification and in the environment defined herein.

The design shall be proven by the submission at the time of Tender of test certificates covering all specified tests deemed to be pertinent to the plant and to the conditions in which it will operate or, if such test certificates cannot be supplied or are deemed unacceptable by the Engineer, type tests which will be subject to the conditions of this Contract shall be carried out at no extra cost to the Employer.

The requirement for switchgear spares, tools and appliances, including test, maintenance and handling equipment shall be as stated in the tender document.

7.1.2 REFERENCES

7.1.2.1 British Standards

BS	159	Specifications for HV bus bars and bus bar connections
BS	1977	Specifications for high conductivity copper tubes for electrical purposes
BS	2898	Specifications for wrought aluminium for electrical purposes. Strip with drawn or rolled edges.
BS	3938	Specification for current transformers.
BS	5253	Specifications for AC disconnectors and earthing switches.
BS	6651	Lightning Protection
BS	7354	Code of practice for design of HV open terminal stations.

7.1.2.2 IEC Standards

1.	IEC 62271	HV Switchgear and Controlgear.
2.	IEC 60376	Specification and acceptance of new sulphur hexafluoride
3.	IEC 60480	Guide to checking of sulphur hexafluoride taken from electrical equipment.
4.	IEC 60060	High Voltage test techniques.
5.	IEC 60071	Insulation Co-ordination
6.	IEC 60099-5	Surge arresters Part 5: Selection and application reccommandation
7.	IEC 60129	AC disconnectors (isolators) and earthing switches
8.	IEC 61869-1&2	Current transformers.
9.	IEC 61869-1&3	Voltage transformers.

10.	IEC 60273	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.
11.	IEC 61850	Communication network and system in substation
12.	IEC 60529	Degrees of protection provided by Enclosure (IP code)
13.	IEC 60255	Electrical relays
14.	IEC 62271-1	High voltage switchgear and control gear: common specification
15.	IEC 62271-100	High voltage switchgear and control gear: Part 100: Alternating current circuit breakers
16.	IEC 62271-102	High voltage switchgear and control gear: Part 102: Alternating current disconnector and earthing switch

7.1.3 33 KV VACUUM CIRCUIT BREAKER

1.	Installation	:	Outdoor Sub-station.
2.	Type	:	Vacuum Circuit Breakers
3.	Number of Phase	:	3 (Three)
4.	Operation	:	Single Break in Service/ Pole
5.	Nominal Voltage	:	33 KV
6.	Maximum Operating Voltage	:	36 KV
7.	Frequency	:	50 Hz
8.	Rated Current for	:	1250A
9.	Symmetrical Breaking Capacity	:	1800 MVA
10.	Asymmetry	:	50%
11.	Short Time Current Duration	:	31.5 KA, 3 Sec.
12.	Making Current (Peak) KA	:	80KA
13.	Opening Time (Maximum)	:	0.05 Sec.
14.	Breaking Time	:	<3 Cycle
15.	Capacity of Vacuum Interrupter at rated short circuit current switching	:	≥50 nos. of operations
16.	Basic Insulation Level (1.2/50 Micro Second Wave)	:	170kVp
17.	Power Frequency Test Voltage (Dry)		70 KV at 50 Hz, 1 Min.
18.	Rated Operating Sequence	:	O - 0.3 Sec – CO – 3 min – CO
19.	Standard	:	Design, Manufacture, Testing, Installation and Performance shall be in accordance with the **latest edition of IEC-60056 & IEC-62271-100**
20.	FEATURES		
	- Circuit Breaker terminal connectors shall be suitable for ACSR Merlin, Gros Beak (636MCM). - Grading terminal connector. - All current carrying parts shall be made of copper including top & bottom pad/terminals. - Externally visible circuit breaker position indicator. - Electrically remote controlled operating mechanism. - Shall be capable of the interrupting duties produced by the switching of transformer magnetizing current and the switching of line charging current. Tests certificate demonstrating this ability of the circuit breakers shall be submitted with the offer.		

- Circuit Breaker closing mechanism shall be 230 volt AC motor wound spring-operated type such that the closing speed is independent of the operator. Spring charging motor shall be AC driven Universal motor. Rectifier in motor circuit is not acceptable.
- Shall have two tripping coils and one closing coil. Trip coil and close coil shall have freewheeling diode installed.
- Hand closing and tripping shall be done through manual levers.
- Trip free mechanism as specified in **IEC 60056-1** i.e. tripping is independent.
- Local "Close" and "Trip" controller.
- VCB should be re-strike free.
- VCB should be trip free.
- Operation Counter.
- Supporting Steel Structure.
- Bushing Insulator as Specified in latest version IEC-60137.
- Weather proof sheet steel control kiosk, with hinged door on three sides and necessary multi-core cable glands. Controls from this position will normally is used under maintenance and emergency conditions only. AC 230V lighting system inside the door of control kiosk shall be provided.
- ARC suppression type contacts.
- Manually operating devices for slow closing for inspection and maintenance. It shall not be possible to slow close a breaker when in normal services.
- Earthing pad with provision for earth leads.
- Standard sundries like anti-condensation heaters, MCBS wiring board etc.

Facilities to be incorporate for tripping and lockout of the breaker in the event Vacuum failure falling below stipulated value.

- Rating plate and diagram plate shall be made of stainless steel and have engraved letters filled with black enamel paint with clear visibility.
- Evidence of prototype tests together with test certificate from an internationally reputed/accredited institution covering the equipment shall be furnished with the offer. The test duty shall be as per the requirements of **IEC-60056.** Laminated control & protection drawing set shall be fitted/supplied inside the control box/kiosk.
- Motor-driven, spring charged
- Automatically charged after each closing operation
- O-C-O operation without recharging
- Mechanical / electrical interlocking, anti-pumping
- Provision for manual charging
- Manual closing and tripping arrangement
- Mechanical ON-OFF, operation counter and spring-charged indication
- All necessary positive interlocks installed, as per IEC guidelines.
- Marking and data to be shown on the Nameplate will be as per approval.

7.1.3.1 INFORMATION REQUIRED for Outdoor type VCB

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information/ Documents have to be submitted:-

a) The Bidder/ Manufacturer shall submit with the bid the testing procedure & list of testing/ measuring equipment, meters etc. along with valid Calibration Certificate(s) from competent authority used in manufacturer's laboratory for performing Routine Test as per IEC standard.
b) Construction, Installation, Operation & Maintenance Manual.

c) Outline, Dimensional, Cross-sectional & General arrangement drawings of offered type equipment with mounting structure arrangement.

Manufacturer's printed catalogue describing specification and technical data of the offered type equipment.

7.1.3.2 TEST CERTIFICATES:

The following test certificates along with test results for offered similar or higher Ampere rating **VCB** for same voltage class from any short-circuit testing liaison (STL) Member [*http://www.stl-liaison.org/web/03_Members.php*] Testing Organization or Laboratory as per relevant IEC standard. The type test report along with results shall include at least the following tests:

a) Lightning Impulse Voltage withstand tests
b) Power Frequency Withstand Tests
c) Temperature Rise tests.
d) Measurement of Resistance of the main circuit.
e) Short-time withstand current and peak withstand current tests.
f) Mechanical Endurance tests
g) Short Circuit performance tests.
h) Out of phase making & breaking tests
i) IP55 tests

7.1.3.3 Special TEST CERTIFICATES:

The following test certificates along with test results for offered similar or higher Ampere rating **VCB** for same voltage class from independent Testing Organization or Laboratory as per relevant IEC standard.

a) Dielectric tests
b) Short-circuit current making & breaking tests
c) Mechanical operation test at ambient temperature
d) Additional tests on auxiliary and control circuits
e) Tightness test
f) EMC test

7.1.3.4 TESTS AT MANUFACTURERS WORKS FOR OUTDOOR TYPE VCB

General

Functional electrical, material, mechanical and hydraulic tests shall be carried out at manufacturers' premises. The extent and method of recording the results shall be agreed by the Purchaser in ample time to enable the tests to be satisfactorily witnessed or to make any changes to the proposed program of tests.

MATERIAL TESTS

The supplier shall provide test pieces free of charge as required to enable the quality of the material to be determined at the supplier's expense. Purchaser may at its own discretion and by specific arrangement accept certified particulars of tests carried out in the absence of his authorized representative.

TYPE TEST
Type tests are required to prove the general design of the offered equipments/ materials. The Tenderer shall submit the type test reports of the offered equipments/ materials from as per relevant clause.

ROUTINE TESTS
All equipments/ materials shall be subjected to routine tests as per latest version of relevant IEC/ BS or equivalent international standards as mentioned in the contract at the manufacturers works and shall include, but not be limited to, an operational test.

7.1.4 33KV PCM PANEL

7.1.4.1 General

The panels shall be vermin and dust proof free standing type completely metal enclosed by sheet steel (minimum 1.62 mm thick) with necessary reinforcement color gray with appropriate spray painting. The approximate dimension of the PCM panel shall be 2100 mm (Height) x 900 mm (Width) x 700 mm (Depth) while viewed from the front side, suitable for opening at the back by hinged door with locking arrangement. The panels shall be neatly and completely wired before shipment.

The work relating to protection, control and panels for 33/11KV Sub-stations shall comprise of development of elementary diagram, design, manufacture, test and supply of pre-wired control panels to be installed in the sub-station control room. The protection, control and panels are to be pre-wired with relays and meters in position. The elementary primary diagram shall be produced giving a clear representation of each protection, control and metering function. The standard design, drawing, manufacturing, testing & performance shall be in accordance to the IEC-298 standards.

7.1.4.1 A 33 kV Protection, Control, Metering and Relay Panel For Power Transformer, each Panel comprising (Not Applicable):

1.	Indicating analogue Ampere meter flush mounting with dual scales options, 0-300/600A for connecting to current transformer ratio 300-600/5-5-5A for 5/6.67 MVA, 10/13.33MVA , 16/20 MVA Power Transformer.	3 (three) nos.
2.	Indicating analogue voltmeter with six position selector switch flush mounting with scales 0-40 KV for connection to potential transformer ratio (33/√3)/ (0.11/√3)/(0.11/√3) KV, (50 Hz).	1 (one) set
3.	a) Numerical Programmable Multifunctional type MFM Meter It shall be capable of measuring and displaying MW, MVAR, PF, V, I, f, ø etc. distinguishing import and export operation.	1 (one) no.
	b) 3 phase, 4 wire, 3 element solid state, indoor type, multi tariff programmable KWh meter of class of accuracy 0.2S with the features for measuring the parameters viz. phase voltages, phase currents, system frequency, per phase & total KW with demand, KVAR, Power factor etc.	1 (one) no.

4.	Numerical programmable type Three Phase combined IDMT Over Current relay and Earth fault protection relay of 5 Amps, 50 Hz, 110V dc, 3 second operating time ratings having 3 (Three) over current units and one earth fault with current setting range of the O/C & E/F relay shall be from **$0.1*I_n$ to $40*I_n$** (where I_n is relay nominal current) for both overcurrent and earth fault element. All O/C & E/F relays shall have both IDMT & DT (51) and Instantaneous (50) function along with IEC NI, VI, EI, LTI etc. curve setting capability with all other necessary protection & monitoring functions.The relays are housed in a horizontal, flush mounting draw-out case (tropicalized) with self-reset trip relay (relaying 02 nos. NO contacts as spares) (Not to be included in Differential Relay). The numerical programmable relay shall have IEC 61850 communication protocol suitable for SAS implementation. Necessary Binary I/O module along with the relay (alternately separate BCU will also be accepted) shall be provided for SAS/SCADA operation.	1 (one) set
5.	Numerical programmable type Differential relay with REF inbuilt feature for 33/11KV, 5/6.67 MVA, 10/13.33MVA , 16/20 MVA Power Transformer. The relay(s) are housed in a horizontal, flush mounting draw-out case (tropicalized) with hand-reset trip relay (having 02 nos. NO contacts as spares). Differential relay shall have user defined 3 nos. curves for differential and REF protection with second and fifth harmonic blocking features. The numerical programmable relay shall have IEC 61850 communication protocol suitable for SAS implementation	1 (one) set
6.	Separate Auxiliary Flag Relays for Device/Self Protection of Power Transformer to be provided. The following Auxiliary Flag Relays shall be available - **OTA, OTT, WTA, WTT, BA, BT, OLTC Surge, PRD for main tank & OLTC**, etc.	1 (one) set
7.	OLTC Tap position indicator & Lower/Raise push-button switchs with blinking feature along with AVR relay etc. AVR relay shall have IEC-61850 communication protocol for SAS. The panel shall be equipped with Oil & winding temperature indication meter, auto/manual selection switch for tap lower/rise operation and master/follower control function for facilitate parallel operation of transformers and appropriate data communication port have to be provided. Also it shall have local/remote selector switch, fan start & stop controlling push button/electrical switch with manual/auto operation mode selection. Indication LED for fan running (Red), fan stop (Green), OLTC in progress (Yellow) etc. shall be provided. Annunciation for OLTC out of step, OLTC faulty/motor tripped, OLTC max./min. position etc. along with othertransformer's self-protection alarm & trip signals shall be provided. Annunciator shall have 30 or more window for facilitate all the alarm & trip signals mentioned with buzzer/hooter and accept, reset & test push button/electrical switch.	1 (one) set
8.	All necessary switches (Local and remote selector switch, TNC switch, etc.), CT, PT test terminal blocks, signaling set lamps, master trip relay, trip circuit supervision relay for each trip circuit coil, PT supervision relay, auxiliary relay, MCB, fuse and provision for lighting etc. terminal blocks, mimic diagram with circuit breaker control indicating switches and isolating position indicating switches, indicating lamps shall be provided to indicate "Spring Charge"/ readiness for closing and healthy trip circuit indicating readiness for tripping. The mimic and positions of circuit breaker control cum position indicating switch and isolator position indicating switch arrangement in the panel. Mimic diagram shall contain LED based Semaphore Indicator for Isolator/Breaker/Earth switch position.The annunciator shall have 30 or more windows for facilitate transformer related all the alarm & trip signals and OLTC related alarm and indication signals and have built in buzzer and AC/DC fail relay.	1 (one) set
9.	70 W, 230 V AC, Single Phase heater with thermostat and a visible light indicator which indicate the "ON"- "OFF" position of the heater	1 (one) set
10.	Master Trip relays	2 (two) set

7.1.4.1 B 33 KV PROTECTION, CONTROL, METERING AND RELAY PANEL FOR LINE FEEDER (INCOMING /OUTGOING), each comprising:

1.	Indicating analogue Ampere meter flush mounting with dual scales option (0-400A/800A) for connecting to the current transformer ratio 400-800/5-5A for Line Fedder.	3 (three) nos.
2.	Indicating analogue voltmeter with six position selector switch flush mounting with scales 0-40 KV for connection to potential transformer ratio (33/√3)/ (0.11/√3)/(0.11/√3) KV, (50 Hz).	1 (one) set
3.	a) Numerical Programmable Multifunctional type MFM Meter It shall be capable of measuring and displaying MW, MVAR, PF, V, I, f, ø etc. distinguishing import and export operation.	1 (one) no.
	b) 3 phase, 4 wire, 3 element solid state, indoor type, multi tariff programmable KWh meter of class of accuracy 0.2s with the features for measuring the parameters viz. phase voltages, phase currents, system frequency, per phase & total KW with demand, KVAR, Power factor etc.	1 (one) no.
4.	Numerical programmable type Three Phase combined IDMT Over Current relay and Earth fault protection relay with directional feature of 5 Amps, 50 Hz, 110V dc, 3 second operating time ratings having 03 (Three) over current units and 01(one) earth fault with current setting of 50 to 200% and one earth fault unit with current setting range of the O/C & E/F relay shall be from **$0.1*I_n$ to $40*I_n$** (where I_n is relay nominal current) for both overcurrent and earth fault element. All O/C & E/F relays shall have both IDMT & DT (51) and Instantaneous (50) function along with IEC NI, VI, EI, LTI etc. curve setting capability with all other necessary protection & monitoring functions.The relays are housed in a horizontal, flush mounting draw-out case (tropicalized) with self-reset trip relay (relaying 02 nos. NO contacts as spares) (Not to be included in Differential Relay). The numerical programmable relay shall have IEC 61850 communication protocol suitable for SAS implementation. Necessary Binary I/O module along withthe relay (alternately separate BCU will also be accepted) shall be provided for SAS/SCADA operation.	1 (one) set
5.	All necessary switches (Local and remote selector switch, TNC switch, etc.), CT, PT test terminal blocks, signaling set lamps, master trip relay, trip circuit supervision relay for each trip coil, PT supervision relay, auxiliary relay, MCB, fuse and provision for lighting etc. terminal blocks, mimic diagram with circuit breaker control indicating switches and isolating position indicating switches, indicating lamps shall be provided to indicate "Spring Charge"/ readiness for closing and healthy trip circuit indicating readiness for tripping. The mimic and positions of circuit breaker control cum position indicating switch and isolator position indicating switch arrangement in the panel. Mimic diagram shall contain LED based Semaphore Indicator for Isolator/Breaker/Earth switch position. The Annunciator shall have 12 windows and have built in buzzer and AC/DC fail relay.	1 (one) set
6.	70 W, 230 V AC, Single Phase heater with thermostat and a visible light indicator which indicate the "ON"- "OFF" position of the heater	1 (one) set

7.1.4.1 C FOR 33 KV PANEL FEATURES:

Each PCM panel shall be equipped with the following:

a.) Instruments and Relays described elsewhere. All the relays shall be IEC 61850 protocol type for automation network of the 33/11kV Sub-station. In addition, numerical relay shall have sufficient contacts and shall be configured for SAS operation. Intermediate auxiliary relay with sufficient spare contacts shall be used for controlling CB or any other switching devices through numerical relay in case of SAS operation.
b.) Status indicating discrepancy, Control switches for 33 kV Circuit Breaker with safety arrangements.
c.) Illuminated Circuit Breaker and Isolator position indicators.
d.) Signaling relays (annunciator, compact type) to yield audiovisual signals on faults and have reset feature.
e.) The inside of the panel will have all auxiliary relays to sense the operation of gas relays, over temperature, over current, differential relay operation failure of auxiliary voltage (DC & AC) etc. and to transmit for tripping and fault signaling.
f.) All inside equipment described and required shall be neatly arranged inside the panel.
g.) Thermostat control heater with status indicating illumination lamp (LED) shall be provided.
h.) The terminal blocks for connecting the incoming multi-core cables shall be placed at the bottom part and necessary glands/ opening shall be provided for the entry of the outside cables.
i.) Sufficient-working spaces shall be provided inside the panel between instruments and wiring for easy approach.
j.) All AC, DC auxiliary power circuits and PT secondary circuits entering the control panel shall be provided with MCCB. Separate MCBs shall be provided for DC supply to Power, Control and Alarm & Indication circuits.
k.) Provision to hang danger/ caution board.
l.) The PCM panel shall be SCADA/SAS compatible and hence all intelligent devices, digital energy meters etc. shall comply IEC61850. All physical connections for control, measurement and status indication shall be made SAS ready.
m.) Sufficient spare terminals (at least 10%) in each terminal block.
n.) Stabilizing resistance and Metrocil of appropriate value by calculation for the for the high impedance REF scheme in the PCM panel.
o.) There must be two trip coils, both trip coils shall be energized by separate contacts of trip relay for protection tripping. However, for manual tripping, only one trip coil can be engaged only.
p.) All CT Terminal blocks shall have shorting, isolating and jacking (test barrel) facility while PT terminal blocks shall have isolating and jacking (test barrel) facility.

q.) Circuit Breaker control indicating switches and isolating position indicating lamps to indicate spring Charge/ Readiness for closing and healthy trip circuit indicating readiness for tripping.
r.) Signaling /indicating lamps shall be LED type only.
s.) Auxiliary relays, trip relays with spare contacts, fuses.
t.) All necessary switches etc. Local/remote switches shoild have atleast 4NO+4NC contact
u.) Provision for lighting etc.

v.) 70W, 230V AC, 1-phase heater with thermostat and control switch and a visible light indicator which indicate the "ON"- "OFF" position of the heater. Master trip auxiliary relay coil rating shall be 110Volt DC.

w.) Mimic diagram along with semaphore for CB, DS and ES. Mimic diagram shall contain LED based Semaphore Indicator instead of moving Semaphore indicator. The color and size of the mimic shall be as described below:

33 KV	GREEN	½" X 1/8"
11 KV	BLACK	½" X 1/8"

x.) Ferrule marking and color coding for all type of wiring shall be as follows:

1. **Ferrule marking:**
   - i. "A"- for differential protection circuit
   - ii. "C"- for O/C & E/F protection circuit
   - iii. "D"- for metering circuit
   - iv. "E"- for PT circuit
   - v. "L"- for Alarm & Indication circuit
   - vi. "S"- for fault recorder
2. **Color coding:**
   - i. "Black"- for phases of AC supply
   - ii. "White"- for neutral of AC supply
   - iii. "Grey"- for control circuit
   - iv. "Brown & Grey"- for (+) and (-) DC supply respectively
   - v. "Red, Yellow, Blue, Black"- for CT and PT circuit
   - vi. "Yellow with green strip"- for earthing

y.) Detailed schematic diagram of control circuit of PCM inside panel.

z.) Separate relay shall be used for over current, Earth fault protection and differential protection.

aa.) Annunciator shall have 12 nos. window for incoming and outgoing panel and 24 nos. windows for transformer panel with builtin buzzer.

bb.) Necessary communication cable and software shall be supplied.

cc) Inter tripping arrangement for 11 kV incomer (from 33 kV transformer feeder tripping) and for 33 kV transformer feeder (from directional tripping of 11 kV incomer or Stand by E/F tripping) shall be provided. All type of tripping shall be done through Master Trip relay.

dd) Supply RTCC Panel with AVR relay and tap changing control switch along with necessary indication system (Tap position, temperature etc.).

ee) Following LED Indicators including Lamp test facility shall be provided in the panel:

●	●	●	●	●	●	●	●
DC Available	DS close indication	DS open indication	**CB Close**	**Spring Charged**	**CB Open**	ES close indication	ES open indication

Besides the provisions of control, signal, protection and metering described, any other provisions to suit with the requirement of associated equipment of the concern feeder shall be provided. All meters and relays shall be flush mounting. There shall be panel-grounding terminal.

The bidder shall quote the particulars of various protective relays, meters, Auxiliary relays signaling relays, discrepancy control and position indicating switches etc. of the control panel, mentioning the names of the manufacturers.

7.1.4.1 D Alarms

The following alarm provision shall be made:

1. **33 KV TRANSFORMER FEEDER (30 or more window Annunciator): NOT APPLICABLE**

Main DC Fail	**AC Fail**	**Main Relay-1 Faulty**	**Main Relay-2 Faulty**	**TCS-1 Unhealthy**	**TCS-2 Unhealthy**
PT Failure	**OTI High Alarm**	**OTI High Trip**	**WTI High Alarm**	**WTI High Trip**	**PRD Trip**
MT Buchholtz Alarm	**MT Buchholtz Trip**	**OLTC Surge Trip**	**O/C Trip**	**E/F Trip**	**87T Trip**
87N/64 Trip	**11 kV Inter trip**	**Main tank oil level high/low**	**Lockout operated pare**	**Spare Trip relay-2 operated**	**OLTC out of step**
OLTC faulty/motor tripped	**OLTC in max. position**	**OLTC in min. position**	**Spare**	**Spare**	**Spare**

2. **33 kV Incoming/Outgoing Feeder (12 window Annunciator)**

Main DC Fail	**AC Fail**	**Main Relay Faulty**	**PT Failure**
TCS-1 Unhealthy	**TCS-2 Unhealthy**	**O/C Trip**	**E/F Trip**
67 Trip	**67N Trip**	**Trip relay operated**	**Spare**

7.1.1 E TESTS

Complete tests shall be made at the manufacturer's factory in accordance with the latest relevant IEC 62271-200:2003 standards. Among others, at least the following test shall be included:

a) Wiring Check
b) Functional check
c) Di-electric Test
d) Verification of protection

Test plugs shall be supplied. Test results of instruments and relays are to be provided along with the bid.

7.1.4.1 F Construction Details

Each panel shall be fabricated from steel sheet (minimum 1.62 mm thick) with necessary steel member reinforcement to make the structure self supporting. All joints are to be welded and ground to be made smooth.

Mounting brackets required shall be arranged inside the panel for mounting and fixing auxiliary devices and terminal blocks.

Instruments meters control switches and protective relays shall be mounted on the front panel only. Panel output mounting studs and support brackets shall be accurately located.

Finished panel surface shall be free of waves and other imperfections exterior panel surfaces shall be send blasted, ground smooth, filled, panel and finished with gray enamel. Interior surface shall be sand blasted, primed and finished with glass white enamel.

The panel shall be designed to have bottom closed and with an adequate number of 50 mm knock outs provided to facilitate entry of control wires and cables. The back end closure of the panel shall be equipped with hinged formed door. The door shall be rigid and shall be equipped with three point latches.

The supplier shall furnish internal panel wiring and circuit protection. The supplier shall provide one 70W, 240, AC strip heater in the panel. The heater shall have a separate switch. Engraved name plate shall be provided at the top of the front enclosure.

7.1.4.1 **G PANEL WIRING**

The supplier shall provide internal wiring and connections, in accordance with the requirements of the following paragraph.

All wiring used within the panel shall conform to the requirements of these specifications and shall be installed and tested at the factory. All wiring shall be neatly and carefully installed in wring gutters of raceway wiring raceway shall be plastic wiring duct with covers. Instrument wiring on the panel shall be numbered sequentially from the sources to the panel instrument and the number of the source equipment shall be used as a prefix for the individual wire numbers, wiring shall be terminated at terminal blocks plainly lettered or marked in accordance with the manufacturer's connection diagrams.

Sufficient clearance shall be provided for all the leads. All the leads for external circuit wiring shall be connected to grounded terminal blocks located for convenient connection of external circuits.

Splices will not be permitted in panel wiring.

All the terminal block connections shall be made with ring type lugs. Pre-insulated ring type terminals with crimp guide or per-insulated slotted spring spade terminals shall be provided on devices equipped with individual fitted covers.

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

The size of the wiring used in the panel shall be conform to the following requirements:

a.) Ampere meter and current transformer circuit: 6 Sq.mm (RYB color code shall be used)
b.) All other wiring: 2.5 Sq.mm.

Closing circuit of the PCM panel shall have Interlocking mechanism with DS/ES switch. DC/AC supply of the 33 kV breaker panel shall be supervised through corresponding PCM panel. Single

point grounding of the neutral of CT/PT circuits shall be ensured. It is always recommended that the neutral of CT/PT is grounded at the CT/PT junction box end. Ferrule marking and color coding shall be as per clause **"7.1.4.1 C 33 kV PCM Panel Features"**

7.1.4.1 **H POWER SUPPLY DISCONNECT**

Each panel mounted devices requiring AC or DC supply, shall have disconnecting devices from the power supply in the tripped or open condition.

The MCCB's used in DC control circuit shall have a rating of 6 A and 250 V. The tumbler switch in the heater shall have the same rating.

Each S/S will be equipped generally with the following :

3 (Three) phase MCCB for incoming from Auxiliary transformers	- 1 (one) no.
MCCB for incoming DC for battery	- 1 (one) no.
MCCB for AC outgoing	- 10 (ten) nos.
MCCB for DC outgoing	- 10 (ten) nos.

The fuses shall be modular type with Bakelite frame and reinforced retaining clips.

7.1.4.1 I INDICATING LIGHTS

Indicating lights of LED type shall be have transparent glass lenses and appropriately sized resister. CB spring charged indication- Blue, Panel DC available indication- White, CB close indication- Red, CB open indication- Green, DS close indication- Red, DS open indication Green, ES close indication- Red"ES open indication- Green. It is recommended to install the CB, DS & ES Open/close indicating LED lamps/semaphore in the mimic bus.

7.1.4.1 J TERMINAL BLOCKS

Terminal blocks shall provided with white marking strips, circuit designation by the supplier shall be inscribed on the marking strip with black print, terminals in a quantity of not less than 25 percent of the interconnected terminals in excess shall be provided on each terminal block for circuit modifications and for termination of all conductors in multi-conductor cable.

All CT Terminal blocks shall have shorting, isolating and jacking (test barrel) facility while PT terminal blocks shall have isolating and jacking (test barrel) facility.

CT, PT, Control, Alarm etc. wiring shall be separately grouped or segregated.

All physical connections for control, measurement and status indication shall be made SAS ready hence Terminal Blocks shall be kept reserved if necessary.

Terminal block shall be grouped in each panel for easy accessibility unrestricted by interference from structural members and instruments. Sufficient spaces shall be provided on each side of each terminal block to allow an orderly arrangement of all the lead to be terminated on the block.

7.1.4.1 K INSTRUMENTS AND DEVICES

Indicating instruments shall be semi flush panel type with 1% percent accuracy class except for energy meters which shall be of 0.2. They shall be approximately 100 mm square with black 240 degree scales on a white back ground.

All AC instruments shall be designed for operation on 5A current transformers secondary and 110V (50 Hz) potential transformer secondary.

7.1.4.1 L TRIP RELAYS

Following shall be the main features of a high speed tripping relays:

All tripping relays shall be of the heavy duty type suitable for panel mounting and shall have operating coils which are rated sufficiently to operate in conjunction with series flag relays. If necessary, normally closed contacts in series with the relay operating coil, shall be delayed for a period which will allow series flag relays to operate satisfactorily. All other tripping contacts should be instantaneous i.e. no intentional time delay. The operating time shall not exceed 10 milliseconds at rated voltage. The operating range of the relay shall be from 70% to 120% of rated voltage. Electrical reset facilities shall be available for operation, from remote and supervisory controls. High speed tripping relays shall prevent closing of the associated circuit breakers until reset. Wherever the tripping relay contacts need to break the d.c. current, sufficiently rated magnetic blow out contacts or such approved means shall be used.

Trip Relay shall be of following types:

a. Self-reset type for O/C, E/F protection
b. Hand & Electrical reset type for Differential, REF and Transformer Self-protection
c. Operating Coil Voltage: 110 V DC (No series resistor allowed)
d. Shall have in built freewheeling diode.

7.1.4.1 M SUPERVISION RELAYS

7.1.4.1 M.1 **Trip Circuit and Protection Supply Supervision**

The trip circuit supervision function shall be a seperate relay and independent of control and protection unit provided in the switchgear. Trip circuit supervision relays shall be provided to monitor each of the trip circuits of all 33kV circuit breakers and each relay shall have sufficient contacts for visual/audible alarm and indication purposes. The trip circuit supervision scheme shall provide continuous supervision of the trip circuits of the circuit breaker in either the open or closed position and independent of local or remote selection at the local operating position. Relay elements shall be delayed on drop-off to prevent false alarms during faults on dc wiring on adjacent circuits, or due to operation of a trip relay contact. Series resistances shall be provided in trip supervision circuits to prevent mal tripping a circuit breaker if a relay element is short circuited. Relay alarm elements shall be equipped with hand resetting flag indicators.

Trip circuit supervision relay (TCSR) shall supervise not only the trip coil but also the whole trip circuit during both breaker open and close position (pre-close & post-close). Both trip circuits shall be supervised by separate TCS relay. TCS function of main relay shall be avoided for supervision.

7.1.4.1 M.2 D.C. Supply Supervision

Supervision relays are required for each protection supply, Main protection, Back-up and Trip Relay Reset. Similarly for each trip circuit supply and for each alarm/ indications supply. These supervision relays are to be independent of alarms from the trip circuit supervision scheme so that the operator can clearly differentiate via the available alarms between loss of supply due to a blown fuse / tripped MCB and failure of a trip circuits supervision /faulty supervision wiring.

DC supply supervision shall be performed by the built in AC/DC fail relay of the Annunciator. Hence, the Annunciator shall be powered by dual source (with internal/external AC/DC changeover switch).

7.1.4.1 M.2 PT Supply Supervision

Each PT supply secondary circuit shall be supervised by individual PT supply supervision relay with at least 1NO+1NC. The relay shall detect failure of PT supply and will provide alarm to the respective annunciator for selected PT supply to the panel.

7.1.4.1 N SPECIFICATION OF 110V, 3 x 5(6) A, 3-PHASE, 4-WIRE, 3-ELEMENT, INDOOR TYPE MULTI-TARIFF PROGRAMMABLE METER WITH ASSOCIATED INSTRUMENT TRANSFORMERS ENCLOSED IN METERING PANEL.

7.1.4.1.N. A GENERAL

The meters are required for the purpose of energy metering of medium/high/extra-high voltage consumer metering at 132 kV or 33 kV or 11kV level. KWh is the unit for the purpose.

System voltage	Nominal service voltage 110V (PT Secondary), 3 phase 4wire, solidly grounded neutral at source, maximum system voltage 120V line to line.
System frequency	50 Hz

7.1.4.1.N. B SPECIFICATION OF 110V 3 x 5(6)A, 3-PHASE, 4-WIRE 3-ELEMENT, INDOOR TYPE MULTI TARIFF PROGRAMMABLE DIGITAL ENERGY METER

The consumer meters are required for the purpose of energy metering of low voltage consumer who purchases power at 11 kV/33 kV line through PT & CT. kWh is the unit for revenue purpose.

System voltage	:	Nominal service voltage 110V, 3 phase 4 wire, solidly grounded neutral at source, maximum system voltage 120V line to line.
System frequency	:	50 Hz
Standard	:	The Energy Meter should be designed, manufactured and tested in accordance with IEC 62052-11, 62053-22 and 62053-23 or ANSI C 12.16, 12.10 (latest publication) or specified in this specification
Installation	:	Indoor Type
Type	:	Solid state.
Application	:	Registration of KWh (Peak & off-peak), Total KVarh(Q1+Q4), KW on 3- phase, 4-wire supply for balanced & unbalanced load (unidirectional). Peak 17.00-23.00. hrs and off peak 23.00-17.00 hrs (programmable) Bangladesh standard time. The software for Time of Use (TOU) shall be so developed to accommodate future tariff and can be customized, if the purchaser changes the tariff. The software

shall be compatible with Windows operating system.

Connection : 3-phase 4-wire, solidly grounded neutral.

Nos. of element : 3 (Three)

Rated current : Basic current 5 amps and maximum current ≥6 amps.

Multiplication factor : The following shall be inscribe on the mater. Dial reading X CT ratio X PT ratio = Actual reading in KWh.

Register : Solid state LCD display type register. The display shall be programmable, automatic and include:

- Meter ID
- Time & date
- Cumulative KWh (Peak & off-peak)
- Cumulative Total KVarh (Q1+Q4)
- Maximum demand (KW) with time & date
- Cumulative Maximum demand (kW) for billing month.

Maximum demand (MD) in kW shall be registered using the technique of cumulating on integration period controlled by built-in process and the MD shall be continuously recorded and the highest shall be indicated. The highest MD shall be added to the cumulative store, which shall be automatically initiated after an interval of one month / one billing period by means of built-in timing device.

- Integration period: 30 (thirty) minutes.
- Number of MD reset (Automatic& manually).
- Average PF for billing period.

Instantaneous:

- Phase voltage with indication
- Phase amps with direction.
- Power factor (average).
- Demand (KW)
- Voltage phase angel (each phase) or P.F. Angle(each phase)
- Current phase angle(each phase)
- Tampering indication in the register.

Memory storage : The meter shall have sufficient capacity (minimum 400 KB) to store the following readings and data in non-volatile memory even in case of power failure.

- Equipment identification codes, security codes and access codes.
- Number of power interruption with date & time (minimum 100 events).
- Latest power failure time & date
- Date & time of meter tempering. (Voltage & Current missing, demand reset , time change).
- Event logs
- Current & Previous registered in month KWh (Peak & off-peak), Total KVarh (Q1+Q4)
- Current & Previous month registered with maximum KW demand since last MD reset with time and date of its occurrence.

The meter must have sufficient capacity to store data at 30 (thirty) minutes interval for at least 180 (one hundred eighty) days.

- Load Profile data [kWh, KVarh (Q1+Q4)

- Phase voltage or Vh
- Phase amps or Ah

Accuracy class : Accuracy class is 0.2s (point two s) for active energy (KWh) & 0.5s for reactive energy (Kvarh)

Number of digit Minimum 5 (Five) integer with 3 (three) decimal (Total 8 digit).

Type of Display Solid-state LCD display.

Time switch : The time switch shall be built-in type and shall be designed to perform a present cycle of operation. Time switch shall reset MDI at the end of every month (billing period) automatically. In the event of failure of power supply and battery, at the same time set memory shall not be lost i.e. the set program shall be recorded in non-volatile memory. The maximum error shall be kept within ± 1 (one) second per day. Time error adjustment facility shall be provided.

Battery reserve : Each time switch must be provided with lithium battery which allow the switch to function for a period of not less than 10 (ten) years. The guaranteed life of the battery should not be less than 10 (ten) years and shall have provision for easy replacement. The shelf life of the battery should be minimum 15(fifteen) years or more.

Construction : The meter shall be completely self-contain round socket or enclosure type. The meter cover shall be made of polycarbonate/acrylic /phenolic /resin and socket cover shall be made of metal polycarbonate/ acrylic /phenolic /resin. The meter cover and socket /enclosure shall be provided with security sealing provisions to prevent unauthorized access to the internal meter works and socket /enclosure sealing shall be designed to accommodate both padlock and wire type seal.

IEC meters shall be minimum IP51. The ANSI Standard meter shall be effectively sealed to prevent entrance of rain and dust into its internal parts. The meter shall pass Rain test described in underwriter's laboratory standard UL-50 (USA) for type 3 enclosures. A general purpose finish of class 1 as specified in section 7 of ANSI C12.10 shall be provided for the meter and it shall meet the requirement of weather simulation test (Sec. 7.2.1 of ANSI C12.10) and salt spray test (ASTM B117). It shall be designed to operate continuously for the normal life of the meter in unsheltered outdoor tropical location exposed to the elements without corrosion or other damage to parts to adversely affect meter accuracy or reliability.

Enclosure for IEC Standard Meter

The meter shall be surface mounted in PCM panel with necessary wiring. The enclosure box should be made either of high quality flame retardant ABS Resin of minimum 3 mm thickness or of galvanized sheet steel of minimum 1.22 mm (18 SWG) thickness or of auto extinguishable, shockproof and UV resistant, hot molded glass reinforced polyester of minimum 3 mm thickness. The box shall have hinged front door with one toughened glass window or transparent UV resistant Polly carbonate to enable easy reading of meter. The metering box shall be weather proof, dust proof, rodent and inspect proof in accordance with enclosure classification IP54. Service cable entry and exit will be sides of the box and 40 (forty)

mm diameter hole with black PVC conic cable gland shall be provided for side entry & exit for this purpose. All material parts shall have anti-corrosive protection.

All materials shall be designed, manufactured and tested as per IEC or equivalent International standards except as mentioned. The front door shall be removable and provision must be made for sealing in the closed position.

Socket	:	Meter sockets shall be suitable for installation of offered type meter. Meter sockets shall be 3-phase, 4-wire wye, 600 volt class, made from 16 gauge sheet metal. Meter sockets shall be similar except as described below. Meter sockets shall approximately 14″ (35.6 cm) H×9″(22.9cm) W×4″ (10.2 cm) D and rectangular in shape. Sockets shall be the same size as 1-phase sockets and terminal blocks shall be interchangeable. Sockets shall be ring less type, sealing latch to be stainless steel and have adequate means for socket grounding. Meter socket shall have a 2″(5 cm) Diameter top opening complete with a 1- ¼″ (3.2 cm) hub. Meter socket shall have 4 knockouts with a range up to 2″(5 cm) Diameter, one on the back, one in the bottom and one in each side. Meter socket shall comply with ANSI C 12.6, 12.10 The Socket shall have written permanently (not in paper printed) "connection diagram" distinctly marked in addition to all standard data.
Terminal	:	Socket connected type/ Non-symmetrical, bottom entry, front connection, and connection type with extended terminal cover: Minimum 10 Terminals to accommodate up to 06 sq. mm size of cable. The terminal cover for the offered energy meter shall be extended type, and which can be sealed independently. There shall be free space between bottom of the terminal and the bottom of the terminal cover.
Connection	:	3-phase, 4-wire solidly grounded neutral.
Service life of meter	:	Shall be minimum 15 (fifteen) years.
Visual indication of operation	:	Pulse indicator on the front of meter as per meter constant.
Special condition	:	a) The factory calibration conforms to relevant IEC or equivalent international standard. LCD display shall be shown consecutively and continuously one after another. The display shall be automated i.e. no external means shall be required to see the display. Each display shall last for at least 5 (five) sec. b) Meter Electronic Circuit biasing voltage shall have to be ensured from each phase to phase and each phase to neutral and

minimum basing voltage 40V.

Meter Sealing	:	The Energy meter body will be hermetically sealed or ultrasonically welded to avoid unauthorized opening of meter cover.
Communication port	:	The meter must be provided with a suitable communication port to allow down loading of desired information stored in the meter to a PC via hand held data logger as per IEC 1107 or equivalent standard.
Remote Communication	:	The meter shall be equipped with external GSM-GPRS Modem, which will be able to interface with RS232, RS485 for data communication with the central server from meters, having all accessories like power supply adapter, necessary connecting cables, antenna with minimum 2.5 meter extension cable, connectors, enclosure box with fixing materials etc. The modem shall be compatible with existing AMR system of BPDB.

7.1.4.1.N.C TAMPER AND FRAUD PROTECTION FEATURE:

The meter shall have the following features to prevent/detect tamper and fraud:

- **Phase Sequence Reversal:** The meter should work accurately irrespective of phase sequence of supply.
- **Missing Potentials:** The meter shall be capable of detection occurrence of missing potential of one phase or two phase(s), which can happen due to intentional/accidental disconnection of potential link(s).
- **Terminal cover** must have micro-switch provision to monitor unauthorized opening. Opening of terminal cover shall trigger an event to be recorded in the event log memory.
- **Software Access:** Software access for configuration and setting of the meters.

7.1.4.1.N.D TECHNICAL FEATURE

- The body cover and socket / enclosure shall be provided security sealing provisions to prevent unauthorized access to the internal meter works.
- The meter shall be provided with connection diagram.
- The data access should be protected by minimum 3(three) steps software password in meter.
- The meter shall have provision of phase to phase and each phase to neutral biasing.
- The meter shall have minimum biasing voltage of 40V.
- The meter and socket/enclosure shall have provision of earthing.
- Meter must operate and accurately register demand and energy when service voltage is applied across any two of the three input terminals or when service voltage is applied from any input terminal to neutral. Meter will continue to operate even the neutral is missing.
- The meter and socket/ enclosure must be the same country of origin other wise the bid will be rejected.
- The registration of KWh (Peak & off-peak) on 3-phase, 4-wire supply for balanced & unbalanced load will be unidirectional. i.e. if one, two or three phase supply is/are reversed, it will take the absolute (kWh-del) + absolute (kWh-rev) and will add them together as total 3-phase KWh.
- The meter shall be equipped with remote GSM & PSTN communication option.
- It has to be ensured that the meter complies IEC61850 for SAS operation. If required, internal/external module as protocol converter can be used for the compatibility with IEC61850

- The meter shall have permanently print nameplate distinctly marked with the following in addition to all standard data:
    1. The word "BPDB" and insignia of BPDB.
    2. Voltage and current rating.
    3. Frequency.
    4. Number of element, number of wire and multiplication factor.
    5. Accuracy class.
    6. Year of manufacture.
    7. Serial number.
    8. Name of manufacturer.
    9. Meter constant.

7.1.4.1. N. E Display of measured values/ Meter Display

- The Sequence of LCD display should be user programmable.
- The contrast setting of LCD display should be visible in different lighting environment and distinctly visible in broad daylight.
- The meter should be of displaying time and date, the direction of energy i.e. as import/export or +/-, active tariff and internal fault indicators.
- There should be up to three groups of display to priorities the display. Each showing a programmable function group.

7.1.4.1.N. F Meter Parameterisation Software

- The parameterisation software must run on Windows operating environment.
- The software must be protected by software keys to control duplication and installation.
- The software should have a customizable printing feature by task list.
- The meter must be able to display or record meter ID, Program, Programmer ID, C. T. ratio, V. T. ratio, Total (KWh, KVarh, KVAh, KW, KVar, KVA, P.F); per phase (voltage, current, KW, KVar, KVA, P.F, phase voltage angle, phase current angel); Load profile having minimum 8(eight) Channels data stored in different interval for 90 days.
- Tamper feature: The meter must have Errors & Warnings codes, History log and Event log(minimum 400events) to record date & time of all power outages, demand resets, time change.
- In addition, each software key must bear a unique user ID and that is not transferable to another PC that has different user ID.
- The Meter should be able to display the phasor diagram.
- The software for Time of Use (TOU) shall be compatible to accommodate future tariff and can be customized, if the purchaser changes the tariff .The software shall be compatible with Windows operating system.
- The Meter must be provided with meter passwords to secure communication between meter software and meter having minimum 3(three) access levels.
- The AMR Software have to be compatible with BPDB's existing AMR System. The Tenderer have to develop the total AMR System with exiting and supplied AMR Solution. In this case the tenderer have to provide their meter protocols so that all exiting meters and supplied meters data will be downloaded and managed in a single AMR System.

7.1.4.1.N. G EXTERNAL MODEM WITH ACCESSORIES

GSM/GPRS modem with RS-232/RS-485 ports, meter interfaced power supply, connection cables, antenna with minimum 2.5 meters cable, mounting facilities, enclosure (if necessary). The modems will be capable of GSM and GPRS connectivity simultaneously. For GSm configuration the AT command will be available and for GPRS communication the APN, reset time, username, password, port number, etc. are configurable. The modem will have the following specification.

Interruption (< 1 ms), RS-232 (at least 1), GPRS class 10, operating band 900/1800, auto reset capability (with phone call, SMS). The modem will be robust, durable and compatible with the employers existing service condition.

7.1.4.1.N. H Manufacturer

All the energy meter shall be supplied from any of the following Country: -

a) European Country.
b) North American Country.
c) Japan
d) Australia

The tenderer should submit authentic document with the tender against the country and location of the offered Electric Energy Meter Manufacturing plant which will be verified during tender evaluation.

Note: Related software & accessories if required for Energymeters is within the scope of supply.

7.1.4.1.O PROTECTIVE RELAYS

All Protective relays shall be numerical programmable type and shall comply relevant IEC or equivalent international standard. Contract arrangement of the relays should conform to the requirements of the diagram. All the relays shall be IEC 61850 protocol type for automation network of the 33/11kV Sub-station.

All the protective relays shall be supplied from any of following manufacturers:

ABB (Switzerland/Finland/Sweden)/
Siemens (Germany/ Switzerland)/
Alstom (France/UK)/
Schneider (france/UK)/
NR, China/
SEL, USA.

Note: Related software & accessories if required for Relays is within the scope of supply.

7.1.4.1.P. AUXILIARY RELAY

Auxiliary relays with sufficient contact shall be used for transformer self-protection (OTA, OTT, WTA, WTT, BA, BT, OLTC Surge, PRD for main tank. etc.). Apart from these relays, each 33 kV PCM Cubicle shall be provided with 1 (one) set separate Auxiliary and signaling relay and wiring with fuses. This relay shall be used for control & monitoring of CB, DS and ES through numerical relay/BCU in case of SAS operation.

7.1.4.1.**Q. ANNUNCIATOR**

Each PCM panel shall be equipped with 1 (one) set Annunciator with sufficient windows (LED type with blinking facility) to display the alarms as per requirement. Annunciator shall have built in buzzer and AC/DC fail relay and shall be powered by dual source (with internal/external AC/DC changeover switch). Buttons for Accept, Mute, Test, Reset etc. shall be provided in the Annunciator.

7.1.4.1.**R. INDICATING AMMETERS**

Each 33 KV PCM Cubicle will be provided with 3 Ammeters (1 for each phase), analogue type.

7.1.4.1.**S. INDICATING VOLTMETERS**

1 (one) voltmeter with a multi-selector switch (phase to phase, phase to neutral, off) shall be installed on 33 KV transformer panel.

7.1.4.1.**T. MIMIC BUS**

LED based Semaphore Indicator showing the position (open/close) of Circuit Breaker, Isolator and Earth Switch shall be inserted within the mimic bus.

Mimic bus material shall be brass, bronze or copper with enamel finished or anodized aluminum or plastic. The mimic bus and included symbols shall be shaped, colored and located as international standard. Light indicator showing position (opening/closing) of circuit breaker shall be installed.

The mimic bus shall be attached to the panel by mechanical devices, not with adhesive. Attachment shall be closely spaced to hold all parts of the mimic bus firmly to the panel face.

Mimic bus shall be provided with the following dimensions and color code:

Voltage	Bus Color	Thick	Dimension (mm)
33 KV	Green	3	12

Note : One set of relay testing plug shall be supplied with protection, metering and control panel which will be included in the quoted price. Each cubicle shall be complete according to the specification, features and bill of materials but not limited to these items; the cubicles should be complete in all respects, to make it operational. 33kV bus name (1,2,3,4.....) shall be indicated with visible permanent sticker in the 33kV mimic bus

7.1.4.1. U AVR Relay

Remote Tap Changer Cubicle (RTCC) Panel shall be equipped with AVR relay for automatic OLTC operation. It shall have provisions of auto/manual tap lower/rise operation and master/follower control function to facilitate parallel operation of transformers and appropriate data communication port have to be provided. AVR relay shall have IEC 61850-communication protocol for SAS.

7.1.4.1.U INFORMATION REQUIRED

The Tenderer/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information/Documents has to be submitted along with the tender:-

(a) Manufacturer's drawing showing Outline dimension & General arrangement drawings of offered type equipment.
(b) Manufacturer's Printed Catalogue describing specification and technical data of the offered type equipment.
(c) The Tenderer/Manufacturer shall submit with the bid the testing procedure & list of testing/measuring equipment, meters etc. used for Factory test witness.
(d) Construction, Installation, Operation & Maintenance Manual.
(e) Manufacturer's valid ISO Certificate.

7.1.4.1. V TESTS AT MANUFACTURERS WORKS FOR PCM PANEL

General

Functional electrical, material, mechanical and hydraulic tests shall be carried out at manufacturers' premises. The extent and method of recording the results shall be agreed by the Purchaser in ample time to enable the tests to be satisfactorily witnessed or to make any changes to the proposed program of tests.

MATERIAL TESTS

The supplier shall provide test pieces free of charge as required to enable the quality of the material to be determined at the supplier's expense. Purchaser may at its own discretion and by specific arrangement accept certified particulars of tests carried out in the absence of his authorized representative.

TYPE TEST

Type tests are required to prove the general design of the offered equipments/ materials. The Tenderer shall submit the type test reports of the offered equipments/ materials from as per relevant clause.

ROUTINE TESTS

All equipments/ materials shall be subjected to routine tests as per latest version of relevant IEC/ BS or equivalent international standards as mentioned in the contract at the manufacturers works and shall include, but not be limited to, an operational test.

7.1.5 TECHNICAL SPECIFICATION OF 33KV ISOLATOR WITH EARTH BLADE

7.1.5.1 General Specification:

1.	Installation	Outdoor Sub-station
2.	Type	Air
3.	Construction	Open
4.	Operation	Gang
5.	Operating Mechanism	Manual
6.	Mounting Position	Vertical on Supporting Structure
7.	Number of Pole	3 (Three)
8.	Frequency	50 Hz
9.	System Nominal Voltage	33 kV
10.	System Maximum Voltage	36 kV
11.	Basic Insulation Level	170 kV
12.	Rated Normal Current	1250 A
13.	Rated Short Time Withstand Current	31.5 KA (3 Sec.)
14.	Rated Power frequency withstand voltage (kVrms), 1 min	70 kV
15.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC standards.

A. Features

1) The isolators shall be single break Pattern [Vertical break or Horizontal break (centre break)] off-load type with manual operating mechanism for the earth blade. There shall be interlocking arrangement with the breaker to ensure that the Isolator can only be operated with breaker in "OFF" position. Necessary controls, accessories and auxiliary operating mechanism for manual operation shall be provided in water proof outdoor boxes.

2) The earthing device shall be gang operated & integral with the switch. The unit shall be complete with channel type mounting base, insulators, and phases coupling tube for gang operation and adjustable operating rod with insulating link and intermediate guide for operating rod.

3) Auxiliary switch operated by the phase coupling tube shall be provided to control circuits for operating devices like indicators/alarms & interlocking with 10% spare contacts.

4) Terminal connectors shall be suitable for ACSR Dog/Merlin/ Gross Beak/ HAWK conductor as required.

5) Earthing steel pads shall be provided with provision of earth leads.

6) Cable glands for multi-core control/ power cables as required.

7) There shall be provisions for pad locking in "ON" & "OFF" position.

8) Provision of key interlocking.

9) Mechanical interlocking between earthing device & the switch shall be provided.

10) All accessories, nuts, bolts etc. required for mounting the isolator on structure as required.

11) All ferrous parts shall be hot dip galvanized after completion of machining. Galvanizing shall be in accordance with BS-729 and ASTM A90.

12) All control devices shall be suitable for operation from 110 Volts DC available in the control room.

13) Operating mechanism shall be fully tropicalized and housed in waterproof housing.

14) Complete supporting steel structure.

15) Isolator and earthing devices shall be accordance with IEC-129. They shall be complete with supporting steelwork and installed to permit maintenance of any section of the sub-station plat when the remainder is alive and shall be so located that the minimum safety clearances are always maintained.

16) The air gap between terminals of the same pole with the isolator open shall be of a length to withstand a minimum impulse voltage wave of 115 percent of the specified impulse insulation rating to earth.

17) Isolating switches shall be designed for live operation and isolators shall be hands operated. Where used for feeders they shall be capable of switching transformer magnetizing currents main contacts shall be of the high-pressure line type and acing contacts.

18) All feeder isolators shall be fitted with approved three phase link earthing devices, mechanically, coupled or interlocked with the main isolator so that the earthing device and main isolator can not be closed at the same time.

19) Isolator operating mechanism shall be of robust construction, carefully fitted to ensure free action and shall be un-effected by the climatic conditions at site. Mechanism 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. The mechanism shall be housed in weatherproof enclosure complete with auxiliary switches, terminal blocks and cable gland plates. All steel and malleable iron parts including the support steelwork shall be galvanized as per BS-729 and ASTM A90.

B. Blades:

All metal parts shall be of non rusting and non corroding material. All current carrying parts shall be made from high conductivity electrolytic copper. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities if provided on current carrying parts, shall be made of copper alloy. The bolts or pins used in current carrying parts shall be made of non corroding material. All ferrous castings except current carrying parts shall be made of malleable cast iron or cast steel. No grey iron shall be used in the manufacture of any part of the isolator. The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces, where this is impracticable adequate corona shield shall be provided. Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by short circuit forces, gravity, wind pressure, vibrations, shocks, or accidental touching of the connecting rods of the operating mechanism. The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals i.e. after every 1000 operations or after 5 years whichever is earlier.

C. Base:

Each isolator shall be provided with a complete galvanized steel base provided with holes and designed for mounting on a supporting structure.

D. Supporting Structure

All isolators and earthing switches shall be rigidly mounted in an upright position on their own supporting structures. Details of the supporting structures shall be furnished by the successful tenderer. The isolators should have requisite fixing details ready for mounting them on switch structures.

E. Test Certificates:

The following test certificate along with test results for offered type Isolator confirming to the tender document shall be submitted with the offer from internationally reputed Independent testing laboratory or reputed & renowned testing laboratory as per relevant IEC Standard, otherwise the bid will be rejected.

a) Short time & peak withstand current.
b) Resistance measurement of the main circuit.
c) Temperature rise.
d) Lightning Impulse Voltage withstand.
e) Dielectric test
f) Operating and mechanical endurance test
g) Verification of the protection
h) Operation at the temperature limits

F. Information Required

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

a) Manufacturer's Printed Catalogue describing specification and technical data for crucial components of all type of **33 kV Isolators**.
b) Outline and General Arrangement drawings.
c) The Bidder/ Manufacturer shall submit the list of available testing/ measuring equipment, meters, etc., along with valid Calibration Certificate(s) from competent authority used in manufacturer's laboratory for performing Routine Test as per IEC standard.

7.1.6 TECHNICAL SPECIFICATION OF 33KV ISOLATOR WITHOUT EARTH BLADE

7.1.6.1 General Specification:

1.	Installation	Outdoor Sub-station
2.	Type	Air
3.	Construction	Open
4.	Operation	Gang
5.	Operating Mechanism	Manual
6.	Mounting Position	Vertical on Supporting Structure
7.	Number of Pole	3 (Three)
8.	Frequency	50 Hz
9.	System Nominal Voltage	33 kV
10.	System Maximum Voltage	36 kV
11.	Basic Insulation Level	170 kV
12.	Rated Normal Current	1250 A
13.	Rated Short Time Withstand Current	31.5 KA (3 Sec.)
14.	Rated Power frequency withstand voltage (kVrms), 1 min	70 kV
15.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC standards.

A. Features

1) The isolators shall be single break Pattern [Vertical break or Horizontal break (centre break)] off-load type with manual operating mechanism for the earth blade. There shall be interlocking arrangement with the breaker to ensure that the Isolator can only be operated with breaker in "OFF" position. Necessary controls, accessories and auxiliary operating mechanism for manual operation shall be provided in water proof outdoor boxes.

2) The earthing device shall be gang operated & integral with the switch. The unit shall be complete with channel type mounting base, insulators, and phases coupling tube for gang operation and adjustable operating rod with insulating link and intermediate guide for operating rod.

3) Auxiliary switch operated by the phase coupling tube shall be provided to control circuits for operating devices like indicators/alarms & interlocking with 10% spare contacts.

4) Terminal connectors shall be suitable for ACSR Dog/Merlin/ Gross Beak/ HAWK conductor as required.

5) Earthing steel pads shall be provided with provision of earth leads.

6) Cable glands for multi-core control/ power cables as required.

7) There shall be provisions for pad locking in "ON" & "OFF" position.

8) Provision of key interlocking.

9) Mechanical interlocking between earthing device & the switch shall be provided.
10) All accessories, nuts, bolts etc. required for mounting the isolator on structure as required.

11) All ferrous parts shall be hot dip galvanized after completion of machining. Galvanizing shall be in accordance with BS-729 and ASTM A90.

12) All control devices shall be suitable for operation from 110 Volts DC available in the control room.

13) Operating mechanism shall be fully tropicalized and housed in waterproof housing.

14) Complete supporting steel structure.

15) Isolator and earthing devices shall be accordance with IEC-129. They shall be complete with supporting steelwork and installed to permit maintenance of any section of the sub-station plat when the remainder is alive and shall be so located that the minimum safety clearances are always maintained.

16) The air gap between terminals of the same pole with the isolator open shall be of a length to withstand a minimum impulse voltage wave of 115 percent of the specified impulse insulation rating to earth.

17) Isolating switches shall be designed for live operation and isolators shall be hands operated. Where used for feeders they shall be capable of switching transformer magnetizing currents main contacts shall be of the high-pressure line type and acing contacts.

18) All feeder isolators shall be fitted with approved three phase link earthing devices, mechanically, coupled or interlocked with the main isolator so that the earthing device and main isolator can not be closed at the same time.

19) Isolator operating mechanism shall be of robust construction, carefully fitted to ensure free action and shall be un-effected by the climatic conditions at site. Mechanism 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. The mechanism shall be housed in weatherproof enclosure complete with auxiliary switches, terminal blocks and cable gland plates. All steel and malleable iron parts including the support steelwork shall be galvanized as per BS-729 and ASTM A90.

B. Blades:

All metal parts shall be of non rusting and non corroding material. All current carrying parts shall be made from high conductivity electrolytic copper. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities if provided on current carrying parts, shall be made of copper alloy. The bolts or pins used in current carrying parts shall be made of non corroding material. All ferrous castings except current carrying parts shall be made of malleable cast iron or cast steel. No grey iron shall be used in the manufacture of any part of the isolator. The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces, where this is impracticable adequate corona shield shall be provided. Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by short circuit forces, gravity, wind pressure, vibrations, shocks, or accidental touching of the connecting rods of the operating mechanism. The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals i.e. after every 1000 operations or after 5 years whichever is earlier.

C. Base:

Each isolator shall be provided with a complete galvanized steel base provided with holes and designed for mounting on a supporting structure.

D. Supporting Structure

All isolators and earthing switches shall be rigidly mounted in an upright position on their own supporting structures. Details of the supporting structures shall be furnished by the successful tenderer. The isolators should have requisite fixing details ready for mounting them on switch structures.

E. Test Certificates:

The following test certificate along with test results for offered type Isolator confirming to the tender document shall be submitted with the offer from internationally reputed Independent testing laboratory or reputed & renowned testing laboratory as per relevant IEC Standard, otherwise the bid will be rejected.

a) Short time & peak withstand current.
b) Resistance measurement of the main circuit.
c) Temperature rise.
d) Lightning Impulse Voltage withstand.
e) Dielectric test
f) Operating and mechanical endurance test
g) Verification of the protection
h) Operation at the temperature limits

F. Information Required

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

a) Manufacturer's Printed Catalogue describing specification and technical data for crucial components of all type of **33 kV Isolators.**
b) Outline and General Arrangement drawings.
c) The Bidder/ Manufacturer shall submit the list of available testing/ measuring equipment, meters, etc., along with valid Calibration Certificate(s) from competent authority used in manufacturer's laboratory for performing Routine Test as per IEC standard.

7.1.7 TECHNICAL SPECIFICATION OF 33 KV OFF-LOAD FUSED ISOLATOR FOR BUS PT.

A. General :

1.	Installation	Outdoor
2.	Type	Air
3.	Construction	Open
4.	Operation	Gang
5.	Purpose	Bus PT
6.	Operating Mechanism	Manual
7.	Base Mounting Position	Vertical
8.	Number of Pole	3 (Three)
9.	Frequency	50Hz
10.	System Nominal Voltage	33 kV
11.	System Maximum Voltage	36 kV
12.	Continuous Current	400 A
13.	Fuse Rating	5A
14.	Fuse Type	HRC Cartridge
15.	Rated Short Time Withstand Current	31.5KA 3 Sec.
16.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC standards.
17.	Features - Single Break Pattern [Vertical break). - Channel type mounting base, insulator & phase coupling tube for gang operation and adjustable operating rod with insulating link and intermediate guide for operating rod. - Terminal connectors shall be suitable for ACSR Merlin/ Grosbeak/ HAWK conductor as required. - Glands for multi-core control cables. - Provision for pad locking in "ON" & "OFF" position. - Galvanized Nuts, bolts & all accessories shall be required for mounting the isolator on structure. - All ferrous parts shall be hot dipped galvanized after completion of machining. Galvanizing shall be in accordance with BS-729 and ASTM A90. - 2 sets of spare fuse links (6 Nos.) shall be supplied with each set of isolator. - All steel supporting structures for mounting on the structures. - For enclosed fuses a positive mechanical indication shall be provided to indicate a blown fuse. - The design shall provide reasonable protection against accidental earthing by animals	

	or birds. - All the movable current carrying contacts shall be silver plated. - Arcing horn if the unit is combined. - Disconnecting blade has continuous current rating as specified. - Isolating devices shall be accordance with IEC-129. They shall be complete with supporting steel work and installed to maintenance of any section of the sub-station plant when the remainder is alive and shall be so located that the minimum safety clearances are always maintained. - The air gap between terminals of the same pole with the isolator open shall be of a length to withstand a minimum impulse voltage wave of 115 percent of the specified impulse insulation rating to earth. - Isolating switches shall be designed for live operation and isolators shall be hands operated. Where used for feeders they shall be capable of switching transformer-magnetizing currents. Main contacts shall be of the high-pressure line type and arcing contacts, if provided, shall be to the Engineer's approval. - Service conditions require that isolating switches shall remain alive and in continuous service for periods of up to 2 years in the climatic conditions specified without operation or maintenance. These contacts shall carry their rated load and short circuit currents without over heating or welding and at the end of the two years period the maximum torque required at the operating handle to open 3-phase isolator shall not exceed 350 NM. - All feeder isolators shall be fitted with approved three phase link earthing devices, mechanically, coupled or interlocked with the main isolator so that the earthing device and main isolator con not be closed at the same time. - Isolator operating mechanism shall be of robust construction, carefully fitted to ensure free action and shall be un-effected by the climatic conditions at site. Mechanism 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. The mechanism shall be housed in weatherproof enclosure complete with auxiliary switches, terminal blocks and cable gland plates. All steel and malleable iron parts including the support steelwork shall be galvanized as per BS-729 and ASTM A90. - At least two pairs of auxiliary contacts for each isolator shall be provided.

7.1.8 TECHNICAL SPECIFICATION OF 33 KV OFF-LOAD ISOLATOR WITHOUT EARTH BLADE FOR BUS SECTION.

7.1.8.1 General

1.	Installation	Outdoor
2.	Type	Air
3.	Construction	Open
4.	Operation	Gang
5.	Operating Mechanism	Manual
6.	Mounting Position	Vertical for Bus Isolator & Horizontal for Bus Coupler on supporting structure
7.	Number of Pole	3 (Three)
8.	Frequency	50 Hz
9.	System Nominal Voltage	33 kV
10.	System Maximum Voltage	36 kV
11.	Basic Insulation Level	170 kV
12.	Rated continuous Current	1250 A
13.	Rated Short Time Withstand Current	31.5 kA (3 Sec.)
14.	Rated power frequency withstand voltage, kV (rms) 1 minute	70KV
15.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC standards.

A. Features

1) The isolators shall be single break Pattern [Vertical break or Horizontal break (centre break)] off-load type with manual operating mechanism for the earth blade. There shall be interlocking arrangement with the breaker to ensure that the Isolator can only be operated with breaker in "OFF" position. Necessary controls, accessories and auxiliary operating mechanism for manual operation shall be provided in water proof outdoor boxes.

2) The earthing device shall be gang operated & integral with the switch. The unit shall be complete with channel type mounting base, insulators, and phases coupling tube for gang operation and adjustable operating rod with insulating link and intermediate guide for operating rod.

3) Auxiliary switch operated by the phase coupling tube shall be provided to control circuits for operating devices like indicators/alarms & interlocking with 10% spare contacts.

4) Terminal connectors shall be suitable for ACSR Dog/Merlin/ Gross Beak/ HAWK conductor as required.

5) Earthing steel pads shall be provided with provision of earth leads.

6) Cable glands for multi-core control/ power cables as required.

7) There shall be provisions for pad locking in "ON" & "OFF" position.

8) Provision of key interlocking.

9) Mechanical interlocking between earthing device & the switch shall be provided.

10) All accessories, nuts, bolts etc. required for mounting the isolator on structure as required.

11) All ferrous parts shall be hot dip galvanized after completion of machining. Galvanizing shall be in accordance with BS-729 and ASTM A90.

12) All control devices shall be suitable for operation from 110 Volts DC available in the control room.

13) Operating mechanism shall be fully tropicalized and housed in waterproof housing.

14) Complete supporting steel structure.

15) Isolator and earthing devices shall be accordance with IEC-129. They shall be complete with supporting steelwork and installed to permit maintenance of any section of the sub-station plat when the remainder is alive and shall be so located that the minimum safety clearances are always maintained.

16) The air gap between terminals of the same pole with the isolator open shall be of a length to withstand a minimum impulse voltage wave of 115 percent of the specified impulse insulation rating to earth.

17) Isolating switches shall be designed for live operation and isolators shall be hands operated. Where used for feeders they shall be capable of switching transformer magnetizing currents main contacts shall be of the high-pressure line type and acing contacts.

18) All feeder isolators shall be fitted with approved three phase link earthing devices, mechanically, coupled or interlocked with the main isolator so that the earthing device and main isolator can not be closed at the same time.

19) Isolator operating mechanism shall be of robust construction, carefully fitted to ensure free action and shall be un-effected by the climatic conditions at site. Mechanism 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. The mechanism shall be housed in weatherproof enclosure complete with auxiliary switches, terminal blocks and cable gland plates. All steel and malleable iron parts including the support steelwork shall be galvanized as per BS-729 and ASTM A90.

B. Blades:

All metal parts shall be of non rusting and non corroding material. All current carrying parts shall be made from high conductivity electrolytic copper. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities if provided on current carrying parts, shall be made of copper alloy. The bolts or pins used in current carrying parts shall be made of non corroding material. All ferrous castings except current carrying parts shall be made of malleable cast iron or cast steel. No grey iron shall be used in the manufacture of any part of the isolator. The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces, where this is impracticable adequate corona shield shall be provided. Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by short circuit forces, gravity, wind pressure, vibrations, shocks, or accidental touching of the connecting rods of the operating mechanism. The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals i.e. after every 1000 operations or after 5 years whichever is earlier.

C. Base:

Each isolator shall be provided with a complete galvanized steel base provided with holes and designed for mounting on a supporting structure.

D. Supporting Structure

All isolators and earthing switches shall be rigidly mounted in an upright position on their own supporting structures. Details of the supporting structures shall be furnished by the successful tenderer. The isolators should have requisite fixing details ready for mounting them on switch structures.

E. Test Certificates:

The following test certificate along with test results for offered type Isolator confirming to the tender document shall be submitted with the offer from internationally reputed Independent testing laboratory or reputed & renowned testing laboratory as per relevant IEC Standard, otherwise the bid will be rejected.

i) Short time & peak withstand current.
j) Resistance measurement of the main circuit.

k) Temperature rise.
l) Lightning Impulse Voltage withstand.
m) Dielectric test
n) Operating and mechanical endurance test
o) verification of the protection
p) Operation at the temperature limits

F. Information Required

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

a) Manufacturer's Printed Catalogue describing specification and technical data for crucial components of all type of **33 kV Isolators**.
b) Outline and General Arrangement drawings.
c) The Bidder/ Manufacturer shall submit the list of available testing/ measuring equipment, meters, etc., along with valid Calibration Certificate(s) from competent authority used in manufacturer's laboratory for performing Routine Test as per IEC standard.

7.1.9 33KV CURRENT TRANSFORMER

A. GENERAL TECHNICAL PARTICULARS:

1.	Application	Metering and Protection
2.	Installation	Outdoor.
3.	Construction	Sealed Tank
4.	Insulation	Oil
5.	Number of Phase	Single
6.	Rated Frequency	50 Hz
7.	Mounting	On Supporting Structure
8.	System Primary Rated Voltage	33 kV Phase to Phase
9.	Maximum System Voltage	36kV Phase to Phase
10.	System Earthing	Effectively earthed
11.	Basic Insulation Level (1.2/50 μ sec.)	170 kV
12.	Power Frequency Withstand Voltage (1 min. 50 Hz).	70 kV
13.	33 kV Line Feeder Ratio:	400-800/5-5A
	Transformer Feeder Ratio: **(Not Applicable)**	300-600/5-5-5A
14.	Primary	Single Winding
15.	Secondary	Double Winding
16.	Accuracy Class	0.2S for Measurement, 5P20 for Protection.
17.	Burden	30VA

18.	Short Time Current Rating	31.5 kA for 3 Sec.
19.	Extended Current Rating	120% of Rated Current
20.	Over Current Rating	< 10 A
21.	Creepage Distance	25 mm/ KV (minimum)
22.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC 61869-1 & IEC 61869-2 standards.

B. FEATURES & ACCESSORIES:

a) Current transformer shall have porcelain outdoor type bushing.
b) Terminal connectors provided, shall be suitable for ACSR Merlin/ Grosbeak/ Hawk conductor as
required.
c) The equipment must be tropicalized and suitable for the outdoor location.
d) Galvanized nuts, bolts and all accessories required for mounting on structure.
e) All ferrous parts shall be hot-dip galvanized after completion of machining. Galvanizing shall be
in accordance with BS-729.
f) Each terminal shall have cadmium-plated nuts and bolts.
g) Sealing/locking arrangement for the secondary terminal box shall be provided.
h) Diagram plate and rating nameplate shall be provided. Rating plate and diagram plate shall be made of stainless steel and have engraved letters filled with blank enamel paint mentioning manufacturer's name, client name, year of manufacturing, contract no & model no, rating, etc.
i) Supporting clamps, all accessories shall be provided with the CT's for installation on supporting gantry structure for line feeders CT's.

C. INFORMATION REQUIRED

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

a) Manufacturer's Printed Catalogue describing specification and technical data for crucial components of **33KV Current Transformer**.
b) Outline and General Arrangement drawings.
c) The Bidder/ Manufacturer shall submit the list of available testing/ measuring equipment, meters, etc., along with valid Calibration Certificate(s) from competent authority used in manufacturer's laboratory for performing Routine Test as per IEC standard.

7.1. 10 TECHNICAL SPECIFICATION OF SINGLE PHASE 33KV POTENTIAL TRANSFORMER

A GENERAL TECHNICAL PARTICULARS:

1.	Application	Metering and Protection
2.	Installation	Outdoor
3.	Insulation	Oil
4.	Type	Voltage Induction
5.	Construction	Oil Tank
6.	Number of Phase	Singe Phase (1Set=3Nos)
7.	Frequency	50 Hz
8.	Mounting Mounted	Supporting on Gantry Structure Mounted
9.	System Primary Rated Voltage	33 kV (Phase to Phase)
10.	System Primary Maximum Voltage	36 kV (Phase to Phase)
11.	System Earthlings	Effectively earthed
12.	Basic Insulation (Impulse withstand Voltage)	170 kV
13.	Power Frequency Withstand Voltage	70 kV
14.	The neutral end of primary winding, for direct connection to ground	Insulated to withstand the 10 kV low frequency test.
15.	Type of Secondary Winding	Double Winding
16.	Transformation Ratio	$(33/\sqrt{3})/ (0.11/\sqrt{3})/ (0.11/\sqrt{3})$ kV
17.	Creepage Distance	25 mm/ kV (minimum)
18.	Rated Secondary Burden	30 VA
19.	Voltage limit factor	1.2 continuous
20.	Class of Accuracy	0.2 for metering and 3P for protection.
21.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC IEC 61869-1 & IEC 61869-3.

B FEATURES & ACCESSORIES:

a) Potential transformer shall have porcelain outdoor type bushing.

b) Terminal connectors provided, shall be suitable for ACSR Merlin/ Grosbeak/ Hawk conductor as required.

c) The equipment must be tropicalized and suitable for the outdoor location.

d) Galvanized nuts, bolts and all accessories required for mounting on structure shall be provided.

e) All ferrous parts shall be hot dip galvanized after completion of machining, galvanizing shall be in accordance whether BS-729.

f) Each terminal shall have cadmium-plated nuts and bolts.

g) Each Voltage transformer is to be protected by high voltage fuse of the high rupturing capacity cartridge type. All fuses are to be clearly identified and easily accessible.

h) Diagram plate and rating nameplate shall be provided. Rating plate and diagram plate shall be made of stainless steel and have engraved letters filled with blank enamel paint mentioning manufacturer's name, client name, year of manufacturing, contract no & model no, rating, etc.

i) Sealing/locking arrangement for the secondary terminal box shall be provided.

C INFORMATION REQUIRED

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

a) Manufacturer's Printed Catalogue describing specification and technical data for crucial components of **33KV Potential Transformer**.
b) Outline and General Arrangement drawings.
c) The Bidder/ Manufacturer shall submit the list of available testing/ measuring equipment, meters, etc., along with valid Calibration Certificate(s) from competent authority used in manufacturer's laboratory for performing Routine Test as per IEC standard.

7.1.11 33 KV SINGLE PHASE LIGHTNING ARRESTER

1.A SCOPE

This specification covers the general requirements of the design, manufacture, testing and inspection requirement of 33kV Outdoor Type Single Phase, Metal Oxide (ZnO), Gapless Lightning Arrester and accessories as specified.

1.B GENERAL :

Lightning arresters shall protect substation and pole-mounted equipment from voltage impulses or surges resulting from lightning strokes, system faults, circuit switching, load rejection or other events. The arresters shall limit such over-voltages to voltage levels below equipment BIL ratings. The country of origin and place of manufacturer shall be same.

1.C STANDARDS

Performance, Design & Testing of Outdoor Type Single Phase Metal Oxide (ZnO) Gapless Lightning Arrester shall conform to the latest edition of the IEC-60099-4 or equivalent international Standards unless otherwise specified herein.

1.D SERVICE CONDITIONS

a.	Altitude	:	1000 meters above the sea level
b.	Maximum ambient temperature	:	48° C
c.	Minimum ambient temperature	:	3°C
d.	Relative Humidity	:	50-100%
e.	Average annual rainfall	:	3454 mm
f.	No. of annual rainy days	:	80-120 days
g.	Isokeraunic level	:	80-120 days/year
h.	Pollution of ambient air	:	dust, salt, chemicals

1.E SYSTEM PARTICULARS

SL. NO.	SYSTEM CHARACTERISTICS	VOLTAGE LEVEL
1.	Nominal System Voltage, KV (Voltage Class)	33
3.	Maximum System Voltage, KV	36
4.	System Frequency, Hz	50
5.	Type of System Grounding	Solidly earthed system
6.	Rated Fault Level (3-Phase Symmetrical), kA 1 sec.	31.5
7.	Lightning Impulse Withstand Level(LIWL), kV	170

1.F TECHNICAL REQUIREMENTS

Lightning arrester shall have the following characteristics:

1	Application	Distribution Transformer/ Overhead Line/ Power Cable Line/ Power Transformer of heavy duty class.
2	Type of Arrester	Station Class, Metal Oxide (ZnO), Gapless
3	Construction	Single Unit, gapless hermetically sealed in with non-linear characteristics with high energy capacity, all enclosed in housing.
4	Installation	Outdoor
5	Mounting	Gantry mounted
6	Rated Arrester Voltage (rms, Ur)	36kV
7	Continuous Operating Voltage (COV, Uc)	22- 27.5 kV
8	Number of Phase	1
9	Nominal Discharge Current (kAp) of 8/20 micro second wave	10 kA
10.1	Type of Lightning Arrester housing	Porcelain
10.2	Power Frequency withstands voltage of Lightning Arrester Housing, Dry & Wet.	≥ 70 kV (Dry & wet)
10.3	Impulse Withstand Voltage of Lightning Arrester Housing.	≥170 kV (peak)
11	Lightning Impulse Residual Voltage (8/20 micro-second wave)	80 or better
12	Steep Current Impulse Residual Voltage at 10kA for 1 micro-second front time.	85 or better
13	High Current Impulse Withstand Value (4/10 micro-second)	100 or better
14	Minimum Energy Discharge capability (kJ/kVr) at rated voltage.	5
15	Line Discharge Class	3
16	Creepage distance (minimum)	31 mm/ kV
17	Partial Discharge (pico-coulomb) when energized at 1.05 times its continuous operating voltage.	Not exceeding 10 pC

1.G BASIC FEATURES

1.G.1 CONSTRUCTION:

Lightning arresters shall be gapless type described briefly as follows:

a. Gap less Arresters shall have elements of zinc oxide to perform both the surge discharge and power frequency reseal functions. ZnO arrester shall have excellent thermal stability for high energy surges, external pollution & temporary over voltage. Zinc oxide elements block RMS value should be minimum 3kV.

1.G.2 INSULATORS

The housing insulator of Lightning Arrester shall be wet process porcelain. The insulator sheds shall be designed to minimize the trapping of contamination and shall have a high Creepage distance (minimum 31mm/kV) and a high dielectric strength, as specified in article 1.6 above. Also, the minimum aerial distance between contact terminal to ground shall be 25 inch (635mm) for 33kV.

1.G.3 CONNECTORS

The Line lead and earthing terminal with clamps shall be provided, suitable to accommodate AAC/ ACSR/ Copper Conductor of diameter from 10.0mm to 15 mm. - The necessary connecting wire (5meter for each LA) for the connection of each Lightening arrester to surge counter shall also be included in the scope of supply.

1.G.4 NAMEPLATE

Information required for identification must be embossed on a stainless steel nameplate firmly fixed to the arrester and shall include:

a. Arrester classification
b. Manufacturers identification or symbol
c. Arrester model and identification number
d. Arrester voltage rating
e. Year of manufacture
f. Contract Number.

1.G.5 SURGE COUNTER

Tenderer shall supply surge counter/Monitor for each phase of the surge arrester. It shall be integrated into the arrester ground connection and counts the surge arrester responses that have occurred. Surge counter with leakage current meter shall also offer monitoring of arrester leakage current. The surge counter shall be analog or digital type. Surge arrester shall have suitable earth terminal to connect surge counter with insulated cable. Surge counter shall be of at least 4 digit.

1.G.6 MOUNTING

For pole mounted Mounting steel bracket and fixing bolts, nut, washer, Standard clam etc. shall be provided with the arrester for steel cross-arm. The mounting steel bracket & necessary fittings shall be hot dip galvanized as per BS-729.

For structure mounted surge arrester, arrester shall be supplied with insulating base.

1.G.7 FINISH

All exposed steel or iron parts of the arrester except threaded parts smaller than 3 inch in diameter, shall be hot-dip galvanized in accordance with ASTM A153.

1.H TESTS:

1.H.1 TYPE TEST CERTIFICATES:

Tenderer's shall include in their offer the following type tests report as prescribed in IEC60099-4 for offered type Lightning Arrester of same voltage class:

i. Insulation withstand test on the arrester housing.
ii. Residual voltage test.
    a. Step current impulse residual voltage test.
    b. Lightning impulse residual voltage test.
    c. Switching impulse residual voltage test.
iii. Long duration current impulse withstand test.
iv. Operation duty test.
    a. High-current impulse operating duty test.
    b. Switching surge operating duty test.
v. Short-circuit test.
vi. Internal partial discharge test.
vii. Bending moment test.
viii. Environmental test.
ix. Seal leak rate test.
x. Radio interference voltage (RIV) test.

1.H.2 ROUTINE TEST:

Manufacturer shall have all routine test facilities for arrester at their own manufacturing premises. The following routine tests shall be carried out on all the arresters as per IEC 60099-4 and the test reports shall be made available for the observation at the time of inspection.

i. Residual voltage test.
ii. Internal partial discharge test.
iii. Reference voltage test.
iv. Leak test.

1.H.3 SPECIAL TEST:

Following special tests shall be performed during Pre-Shipment Inspection & Post-Landing Inspection (if necessary).

a. Insulation resistance test :
   Insulation test result shall be more than 1GΩ.
b. Seal Test:
   The randomly selected samples as specified shall be sunk in the 1 (one) meter deep water tank for minimum 4 (four) hours. After removing samples from the water tank, the insulation resistance test shall have to perform again. The insulation resistance test result shall not vary more than 10% before and after seal test. After completing this test the MCOV shall be applied on Arrester at least five times. In each time the result shall be satisfactory as per specification.

1.I DOCUMENTATION:

The following documents must be submitted along with the tender, without which the tender shall be considered as non-responsive.

1.I.1 Filled up Guaranteed Technical Particular (GTP) of the offered equipments.

1.I.2 Manufacturer's Production capacity as mentioned in Tender Data Sheet (TDS) of tender document.

1.I.3 Outline drawings and internal construction of offered equipment (including surge counter) considering the conceptual arrangement and nomenclature of a 33kV Lightning Arrester.

1.I.3.a At least 02(two) nos. of Manufacturer's Supply Experience for similar type Lightning Arrester of same voltage class within the last 5 (Five) years; years counting backward from the date of publication of Invitation for Tender (IFT) in the newspaper. The Supply Experience covering at least 25% of the Tendered quantity in a single Contract will be considered only.

Manufacturer's supply experience (supported by copy of Contract Agreement and Certificate from purchaser) shall be furnished in the following format:

Sl. No.	Name, Address, Phone No. E-mail & Fax No. of the Purchaser	Contract No. & Date	Contract Value	Description of material with Quantity	Date of completion of supply
1.					
2.					

1.I.3.b At least 02 (Two) nos. of Manufacturer's Satisfactory Performance Certificates (supported by the supply record) from Electricity Utility as End User depicting that similar type Lightning Arrester of same voltage class has been supplied within last 05 (five) years; years counting backward from the date of publication of IFT in the newspaper and has been in satisfactorily service for at least 01 (one) year. The Satisfactory Performance Certificate(s) shall be in End User's official pad in English and shall contain End User's full mailing address, e-mail address, website address, fax/telephone number for the convenience of authentication.

1.I.3.c The following provision will be applicable for purchasing less or equal to 5000 (five thousand) nos. of Lightning Arrester from new local manufacturers:

i. At least 02(two) nos. of Manufacturer's Supply Experience for similar type Lightning Arrester of same voltage class within the last5 (Five) years; years counting backward from the date of publication of Invitation for Tender (IFT) in the newspaper. The Supply Experience covering at least 5% of the Tendered quantity in a single Contract will be considered only.

Manufacturer's supply experience (supported by copy of Contract Agreement/ Work Order /Certificate from purchaser) shall be furnished in the following format:

Sl. No.	Name, Address, Phone No. E-mail & Fax No. of the Purchaser	Contract No. & Date	Contract Value	Description of material with Quantity	Date of completion of supply
1.					
2.					

ii. At least 02 (Two) nos. of Manufacturer's Satisfactory Performance Certificates (supported by the supply record) from public/private organization as End User depicting that similar type Lightning Arrester of same voltage class has been supplied within last 05 (five) years; years counting backward from the date of publication of IFT in the newspaper and has been in satisfactorily service for at least 01 (one) year. The Satisfactory Performance Certificate(s) shall be in End User's official pad and shall contain End User's full mailing address, e-mail address, website address, fax/telephone number for the convenience of authentication.

iii. The New Manufacturer shall submit the following document with the Tender document:
   a) Location of the Factory & layout plan.
   b) List of Capital Machineries (Related to manufacturer of the Tendered goods).
   c) Factory Project Profile
   d) Production Line description.
   e) List of Key Personnel (with Bio-data).
   f) Source of raw materials.
   g) Sample of offered item.
   h) Testing facilities & calibration certificates of testing equipments.

iv. New Local Manufacturer's factory/manufacturing plant shall be visited & inspected by the Tender Evaluation Committee (TEC) and/or TEC nominated members, to assess the New Manufacturer's production capability and will submit a report regarding Technical and Financial aspect in comparison to the information and document furnished by Tenderer. If the assessment report is not satisfactory, the related tender proposal of the tenderer will be considered as Non-Responsive.

All costs regarding visiting & inspection shall be borne by the New Manufacturer.

Factory shall be inspected by Tender Evaluation Committee (TEC) and/or TEC nominated members as per following guide lines:

1. Location of the Factory & layout plan.
2. List of Capital Machineries (Related to manufacturer of the Tendered goods)
3. Factory Project Profile
4. Production Capacity (Yearly)
5. Production Line description.
6. List of Key Personnel (with Bio-data)
7. Testing Facilities as per IEC60099-4 or latest revision there on.
8. Source of raw materials.
9. Provide sample of the Tendered product manufactured in the Factory for testing during factory Inspection.
10. Testing of offered type Lightning Arrester and ZnO shall be witnessed at manufacturer's testing laboratory.

All other clauses of the specification and Guaranteed Technical Particulars (GTP) except Supply record & Performance Certificate (Clause no. 1.9.4.a&1.9.4.b) shall be applicable for tender Submission and Evaluation.

1.I.4 Type test report as per clause no. 1.8.1 for offered type Lightning Arrester of same voltage class as per IEC 60099-4. All Type Test shall be done from any of the following independent testing laboratories:

I. CESI, Italy
II. ESEF ASEFA, France
III. JSTC Japan
IV. KEMA, The Netherlands
V. PEHLA, Germany
VI. TUV Rheinland, Germany
VII. SATS, Norway
VIII. STLNA, USA
IX. VEIKI, Hungary
X. ZKU, Czech Republic
XI. UL, USA

1.J Packing:

The complete Machines are to be export-packed and properly protected for shipment, rough transportation and storage. Specific care shall be taken for protection in store and reference is made to the climatic condition prevailing in Bangladesh. The packing used for equipment shall be 100% waterproof.

The supplier shall be responsible for damages due to inadequate packing. A packing list showing the contents of each packing shall be enclosed in a waterproof envelope secured to the outside of the packing case. A copy of the packing list shall also be enclosed inside the package.

All packages imported are liable to be opened for Customs examination and packing shall therefore be designed to facilitate opening and re-packing thereafter.

A red band (20 cm. wide) shall be painted all around each package. Each package shall have the following information printed on it in bold letters:

- Name of supplier.
- Port of Loading.
- Port of destination.
- Name of Consignee.
- Contract Number.
- Brief description of Stores.
- Number of Packages.
- Gross and net weight.
- Measurements.

In addition, each package shall be clearly marked or stencilled in red on two sides, the shipping mark, "Name of Utility, Bangladesh" inscribed within a triangle mark as shown below:
The Shipping Mark

UTILITY'S LOGO
BANGLADESH

On the other two sides arrow marking with the wording "THIS SIDE UP" and "FRAGILE" shall be clearly marked or stencilled to indicate the face of the package to be kept upward.

FRAGILE

THIS SIDE UP

1.K PRE-SHIPMENT INSPECTION

The Purchaser shall appoint a team consisting Engineers and they shall be entitled at all reasonable time during manufacture and/or pre-shipment to inspect and witness the Quality Assurance Test (QAT) of the offered item to confirm quality of the equipments to the specification at the manufacturers' premises. Manufacturer shall have all routine test facilities at their own manufacturing premises.

The contractor shall, after consulting the Purchaser, give the Purchaser reasonable notice in writing of the date and place at which any material or equipment will be ready for testing as provided in the contract and if the Purchaser does not attend at the place so named on date, which the supplier has stated in his notice, the Supplier may proceed with the tests, which shall be deemed to have been made in the Purchaser's presence, and shall forthwith forward to the Purchaser duly certified copies of Test Readings.

Inspection Team will witness the following test on random sampling basis (sample selected by the Inspection Team) during factory test in manufacturer's factory premises.

In case of purchasing more than 30,000 (Thirty Thousands) arresters, the Manufacturer shall have to perform tests described in section 1.8.2 on 15 nos.randomly selected samples. In case of purchasing less than 30,000 (Thirty Thousands) arresters, the Manufacturer shall have to perform tests described in section 1.8.2 and 1.8.3 on 10 nos. randomly selected samples.

The tests, as agreed upon by the Purchaser and the Supplier, shall be carried out as per relevant IEC/BS Standard or equivalent.

As and when the Purchaser is satisfied that any materials/equipment shall have passed the relevant tests, the Purchaser shall notify the Contractor in writing to the effect.

Should any inspected/tested goods fail to conform to the specification, the Purchaser shall have the right to reject any of the items or complete batch if necessary. In that case the Supplier shall have to replace the goods without any financial involvement to the Purchaser.

Nothing in this clause shall in any way release the Supplier from any warranty or other obligations under the contract.

1.L POST-LANDING INSPECTION AND TESTING

The inspection team constituted by BPDB shall perform post-landing inspection in presence of supplier's representative after the delivery of the item at the designated store of BPDB.

The supplier shall arrange the program of such inspection. Any defect or damage have been found at post-landing inspection, the defective or damaged item to be repaired/ replaced by the supplier at his own cost.

The purchaser's right to inspect, test (where necessary) and reject the items after delivery at the designated store of BPDB shall in no way be limited or waived by reason of the goods having previously been inspected, tested and passed by the purchaser prior to the good's delivery.

The PLI Committee in its report shall mention the quantity of goods. The post landing inspection of goods shall generally cover the following, but not limited to:

(i) Visual inspection of goods;
(ii) Conformance with approved drawings with respect to dimensions and type.
(iii) If necessary the inspection team may select randomly 5 to 10 nos. of Arresters from each lot and carryout the test(s) in following manner:
    a. Routine test which will confirm clause no 1.8.2 (Tests which are available in Bangladesh)
    b. Special test in accordance with clause no 1.8.3.
    c. The selected samples will be sent to BUET/RUET/CUET/KUET to carryout the above tests. All costs of testing of samples including carrying, loading, un-loading etc. will be borne by the supplier.

If the tests of lightning arrester(s) are not satisfactory then the inspection team will randomly select double of the earlier sample size and carryout the test as per above from the same laboratory. If the test of any one of the sample fails, the batch under this inspection will be rejected and the delivered quantity will be taken back from the store by the supplier at his cost.

7.1.12.1 Earthing Screen

Earthed screens shall be provided to protect the equipment from direct lightning strikes. The screens shall be of aluminium clad steel wires of not less than 50 sq.mm. total section, and connected to provide low impedance paths to earth.

The layout of the earth wires shall be such that equipment to be protected generally lies within areas bounded by two or more conductors, in which case the protected angle shall not exceed 45 degree centigrade. Where equipment is protected by a single earth wire, the protective angle shall not exceed 35 degree centigrade to the vertical.

The earth screens shall be suitable for extension to protect the substation equipment to be installed in future stages of development.

Connections shall be made of copper strip of 30mm x 5mm cross section between the overhead earthed screen wire and the main substation earthing system at each support unless the galvanized steel support structure has sufficient area and current carrying capacity.

Earth wires shall be held in clamps with free pin type joints between clamps and supports.

Connections shall be provided for the terminations of the earth wires of the overhead lines, including bimetal connectors where necessary.

The design of all structures shall generally comply with the specification and in addition is to ensure that in the event of breakage of one earth wire, the Factor of Safety is not less than 1.5.

7.1.12.2 GROUNDING MATERIAL

The grounding wire shall be 125mm^2 stranded copper conductor. All nuts & bolts shall be cadmium plated. The washers shall be sine plated.
All clamps contort shall be of 25mmx 4mm copper.
All clamps connectors shall be of quality manufacturer such as Burnaby or equal.
Connector to equipment shall be by bare copper cable/flexible copper braid as required.
The grounding copper electrode shall be 16 mm Dia. And each 4 meter length.

7.1. 13 TECHNICAL SPECIFICATIONS 33kV DISC INSULATOR WITH FITTINGS

7.1. 13 .1 STANDARDS:

These 33 kV Disc Insulator with Fittings specified in this Section shallconform to the latest edition of the following standards for operation in overhead lines in air under local ambient conditions. Design, Manufacture, Testing and Performance shall be in accordance with latest revisions of BS, IEC standards as listed below or other equivalent internationally acceptable Standards:

IEC-120	:	Ball & Socket Coupling.
IEC-305	:	Characteristics of String Insulator Unit.
IEC-383	:	Insulator Tests.

IEC-437	:	Radio Interference Tests.
IEC-506	:	Switching Impulse Tests.
IEC-575	:	Thermal Mechanical Performance Tests.
BS-137	:	Method of test & requirements.
BS-916	:	Bolts, Screws & Nuts.

7.1.13.2 SPECIFICATIONS:

A. Specification of Disc Insulator:

These 33 kV Disc Insulators shall be designed as per above standards for operation in overhead lines in air under local ambient conditions.

1.	Installation	Overhead line for suspension or termination.
2.	Nominal System Voltage, kV	33 (line to line).
3.	Type of System	Three phase, 50 Hz, Three Wire, Effectively earthed.
4.	Highest System Voltage, kV	36 (three phase).
5.	Atmospheric Condition	Moderately polluted.
6.	Altitude, meter	0-300 above sea level.
7.	Maximum Ambient Temperature, °C	45.
8.	Insulator Material	The Insulator shall be made of good commercial grade wet process porcelain. The porcelain shall be sound, thoroughly vitrified and free from defects and blemishes that might adversely affect the life of the Insulator. The exposed parts of the porcelain shall be smoothly glazed and shall be brown in color unless otherwise specified.
9.	Type of Insulator	Ball & Socket type Disc, security clip made of Stainless Steel or Phosphor Bronze.
10.	Markings	Each Insulator shall be marked with the name of Trade Mark of the manufacturer, the type of Insulator and the year of manufacture. These markings shall be legible and indelible.
11.	Maximum Nominal Diameter of Insulator, mm	255
12.	Nominal Spacing, mm	146
13.	Minimum Nominal Creepage Distance, mm	292
14.	Coupling Size, mm	16
15.	**WITHSTAND VOLTAGE, MINIMUM**	
15.1	Power Frequency, dry	70
15.2	(one minute), kV	40
15.3	Power Frequency, wet (one minute), kV	170
	Impulse 1.2x50 micro-sec wave, kV	
16.	**FLASHOVER VOLTAGE, MINIMUM**	
16.1		78
16.2	Power Frequency, dry, kV	45

16.3	Power Frequency, wet, kV	180
16.4	50% Impulse 1.2x50 micro-sec wave, positive, kV	185
	50% Impulse 1.2x50 micro-sec wave, negative, kV	
17.	**POWER FREQUENCY PUNCTURE VOLTAGE MINIMUM, kV**	110
18.	**RADIO-INFLUENCE VOLTAGE DATA MINIMUM:**	
18.1	Power Frequency Test Voltage, RMS to Ground, kV	10
18.2	Maximum RIV at 1000 KC Micro-volt	50
19.	**MECHANICAL FAILING LOAD MINIMUM, kN**	70

B. Specification of 33 kV Strain Insulator String Set:

33 KV Strain Insulator String Set consisting of the following component parts for each set. Design, Manufacture, Testing and Performance shall be in accordance with latest revisions of BS-3288 or other equivalent internationally acceptable Standards.

1.	Anchor Shackle	Made of forged steel galvanized complete with cotter bolt and Pin, UTS-6800 Kg, Galvanization as per BS-729 OR ASTM A-153 part 1 or ASTM A-153.
2.	Ball Eye	Oval eye type, made of forged steel galvanized, UTS-6800 Kg, Galvanization as per BS- 729 part 1 or ASTM A-153.
3.	Socket Eye	Made of malleable iron galvanized complete with cotter bolt and Pin, UTS-6800 Kg, Galvanization as per BS- 729 part 1 or ASTM A-153.
4.	Strain Clamp	Bolted type, Made of malleable iron galvanized or Alluminium Alloy, suitable for accommodating ACSR GROSBEAK of overall diameter 25.15 mm, complete with bolts, nuts, washers, Alluminium Alloy liner etc., UTS-6800 Kg, Galvanization as per BS- 729 part 1 or ASTM A-153 in case of malleable iron or other ferrous metal.
5.	Disc Insulator	3 (Three) Nos. are required for each set.

7.1.14 H-TYPE CONNECTORS

7.1.14.1 STANDARDS:

The H-Type Connectors as specified in this Section shallconform to the latest edition of the following standards for operation in overhead lines in air under local ambient conditions. Design, Manufacture, Testing and Performance of the H-Type Connector shall be in accordance with the BS-3288 Part-1 &BS-4579 Part 3 or equivalent International standards.

7.1.14.2 SPECIFICATIONS:

The H-Type Connectors will be used for connecting the ACSR Conductors to ACSR Conductors, AAC Conductors to AAC Conductors and Copper Conductors to AAC conductors. These should be Uni-metal or Bi-metal type according to the contractions and applications of such connectors.

These should be made from high conductivity Aluminium and pre-filled with oxide inhabiting compound. The design of the compression type connectors should be such that galvanic corrosion is minimised. Conductor rough & tooling shall be clearly joined on the connectors.

The connector must have at least the same conductance as the conductor for which it is intended to be used and shall carry the full continuous current rating of the conductor size they are designed for.

The original quality of contacts shall be maintained through out the service life of the connectors. Glow discharge and radio interference must be reduced to a minimum level.All compression type connectors shall be suitable for installation, using either manual or hydraulic compression tools.

The size of the connectors for different Conductors is as follows:

	Grove A		**Grove B**		
	Max (mm^2)	Min (mm^2)	Max (mm^2)	Min (mm^2)	Length in mm
ACSR GROSBEAK/ACSR GROSBEAK	400	350	400	350	150.00
ACSR MERLIN/ACSR MERLIN	185	150	185	150	112.00
ACSR DOG/ ACSR DOG	120	95	120	95	63.00
AAC WASP/ AAC WASP	120	95	120	95	63.00
AAC ANT/ AAC ANT	70	50	70	50	47.00
AAC WASP / Service Bail	120	95	35	16	63.00
AAC ANT /Service Bail	70	50	35	16	47.00

INFORMATION REQUIRED:

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

a) Manufacturer's Printed Catalogue describing specification and technical data for offered Accessories.
b) Dimensional drawing of offered Accessories.
c) Detail description of testing facilities at manufacturer's plant

7.1.15 SHIELD WIRES:

1.	Installation	Sub-station
2.	Type	Stranded
3.	Material	High Strength Steel
4.	Nominal Size	9.525 mm
5.	Number of Strand	7 (Seven)
6.	Diameter of Each Strand	3.05 mm
7.	Overall Diameter	9.525 mm

8.	Weight per KM Length	407 Kg
9.	Rated Ultimate Tensile Strength	4,900 Kg/mm^2
10.	Class of Zinc Coating	Class-A
11.	Galvanization	As per BS-729 OR ASTM A-153
12.	Grade of Steel	60,000 Kg
14.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC standards.

A. FEATURES

- Wires shall be shipped on standard non-returnable wooden reels Gross weight shall not exceed 800 Kg per reel. The minimum length of wire per reel shall be 1500 M.
- Each reel shall have the following information stenciled on side size and kind of conductor, length of conductor, gross and net weight. No joints of any kind shall be made in the finished wire entering into the construction of strand.
- The diameter of each zinc coated wire forming the strand shall not differ from the diameter specified by more than plus or minus 0.01 mm.
- The strand shall have a left hand lay with a uniform pitch of not more than 16 times the normal dia. of the strand.

B. PACKING AND SHIPPING

Grounding wire reels shall be constructed sufficiently strong to withstand usual requirement shipping, transporting and field erection.

C. HARDWARE FOR SHIELD WIRE

i) Angular 90^0 bolted type T-connector of malleable iron galvanized steel or aluminum alloy suitable for 9.525 mm dia, 7/3.05 mm stranded high strength galvanized steel wire run to 9.525 diameter, 7/3.05 mm stranded high strength galvanized steel wire tap.

ii) Angular 45^0 bolted type clamp made of aluminum alloy suitable for 9.525 mm diameter, 7/3.05 mm stranded high strength galvanized steel wire run to 9.525 mm diameter 7/3.05 mm stranded galvanized steel wire tap.

iii) Shield wire clamp set suitable for 9.525 mm diameter 7/3.05mm stranded high strength galvanized steel wire, comprising of the followings :
   a) Bolted wire strain clamp made of malleable iron galvanized steel or aluminum alloy complete with nuts bolts washers etc. anchor shackle made of forged steel galvanized complete with cotter bolt and pins.
   b) Double eye rectangular made of forget galvanized.
   c) Wire clip made of malleable iron galvanized or aluminum alloy.

7.1.16 PG CLAMP

7.1.16.1 STANDARDS:

The PG Clamps as specified in this Section shallconform to the latest edition of the following standards for operation in overhead lines in air under local ambient conditions. Design, Manufacture, Testing and Performance of the PG Clamp shall be in accordance with the BS-3288 Part-1 &BS-4579 Part 3 or equivalent International standards.

7.1.16.2 SPECIFICATIONS:

The PG Clamps will be used for connecting the ACSR Conductors to ACSR Conductors and AAC Conductors to AAC Conductors. Parallel Groove Clamp, a non tension bolted type connector, shall be made of Aluminium Alloy, massively designed body. The bolts are made of Galvanised Steel. For the insulated conductors, 0.80 mm thick PVC insulation cover is to be provided with full length clamp.

The clamps must have at least the same conductance as the conductor for which it is intended to be used and shall carry the full continuous current rating of the conductor size they are designed for.

The original quality of contacts shall be maintained through out the service life of the clamps. Glow discharge and radio interference must be reduced to a minimum level.

The size of the connectors for different Clamps is as follows:

Inf

o r m	Conductor Size (sq. mm)	Conductor Diameter (mm)	**Dimension**		No. of Bolt
			L (mm)	W (mm)	
ACSR GROSBEAK, either side	370	25.15	125	50	3
ACSR MERLIN, either side	170	17.35	110	45	3
ACSR DOG, either side	100	14.15	95	30	2
ACSR RABBIT, either side	50	10.05	80	22	2
AAC WASP, either side	100	13.17	95	30	2

i red

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

a) Manufacturer's Printed Catalogue describing specification and technical data for offered Accessories.
b) Dimensional drawing of offered Accessories.
c) Detail description of testing facilities at manufacturer's plant.

7.1.17 SUB-STATION STEEL STRUCTURE

GENERAL

The structural steel shall conform to the latest provision of ASTM A36/BS-4360 and all the parts shall be hot dip galvanized as per BS-729 after fabrication.

SCOPE

The work covered by these specifications shall include design, fabrication, marking, painting, galvanizing,

supply of all materials, suitable for the location, sea worthy packing, transportation to S/S site, storage on the site, site visit needed to complete the sub-station structures, miscellaneous steel members, nuts, bolts, plates etc. according to specifications and drawings prepared by the bidder and approved by the Purchaser.

DESIGN DATA

Structure shall be designed on the basis of the following:

i) Buses, structures, conductors and shield wires shall be designed to withstand the force of a true wind velocity of 160 KM per hour (120 kg/m^2 on round surface, 200 KG/m^2 on flat surface). The over load capacity factor shall be 2.

ii) All connections between steel members shall be bolted, minor welds will be allowed for fabrication purposes before galvanization, but no welding will be permitted in the main legs of members of terminal structure. The diagonals and struts shall be bolted directly to the structure legs and to each other. Gasket plats shall not be used unless absolutely necessary.

Members shall be design to avoid depressions that can trap water, such depressions if unavoidable, shall have drain holes, and connections shall be designed so that all bolts can be tightened in the field using a flat erection wrench. The ends of connected members, shall, where necessary, be clipped or cut to allow free movement of the wrench.

The quantity of bolts, nuts and locking devices furnished shall include the number of each size required for erection plus an additional 5% of that number to cover loss and damages.

The bus supports shall be designed to withstand a momentary short circuit current equal to the momentary short circuit rating of the associated breakers.

All shield wires for the sub-station shall be 9.525 mm dia 7 strands with high strength steel galvanized wire.

The contractor must supply complete detailed drawings, bill of materials, composition of materials etc. all connectors, clamps, fittings, hardware, etc. with their range of adjustment. Detailed catalogues, printed literatures etc. showing all significant characteristics for all those things for which the contractor intends to offer must be supplied with the offer. Particular items proposed to be supplied, must be arrow marked in the catalogue.

Material

All materials used for the sub-station structures and buses shall be new and undamaged and shall conform to the requirements given below certified test reports for all steel materials shall be submitted to the Engineer before such materials shall be fabricated. The latest revisions to the specified American Society for Testing Materials (ASTM) and General Specifications ruling.

i) **STEEL STRUCTURE MEMBER**

The main steel structure shall be designed for the loading specified and separate additional structures as necessary shall be provided for overhead line terminations, disconnect switches, bus supports, potential devices lightning Arresters and other equipment.

The structures steel shall conform to the latest revision of ASTM for "Steel Bridge and Buildings" or equivalent and all parts shall be hot dip galvanized after packing for fabrication.

All structures shall be shipped completely unassembled unless other-wise specified. All S/S parts shall be plainly marked as aid in assembly and the marking shall agree with the identification on the erection drawings.

The structures shall be completed with all bolts, nuts and locking devices which are required for erection of the structures and for installation of equipment.

ii) **CONNECTION FASTENERS**

All connections shall be made with hot dip galvanized, sodium carbon, heat treated, regular square head, bolts to meet Feb Spec FF-B-575. Type-1, Grade-5 or of equivalent standard with hot dip galvanized, heavy semi finished hexagonal nuts. Each fastener shall gave a locking devices by screw and bolt, length of which shall provide 3mm (minimum) to 12.5 mm (maximum) projection beyond nut when connection is tightened. Standard ASTM-A 394 or equivalent.

iii) WELDING ELECTRODE

Where welding is permitted in Fabrication it shall be done in accordance with ASTM specification A233 using F-70 series low hydrogen electrode as recommended by American Welding Society (AWS) or equivalent for various grades of steel.

iv) **GALVANIZED COATING**

All angles, channels, plates and other shaped or members required for these structures shall be galvanized in accordance with ASTM specification A123 or equivalent. Galvanizing is to be applied on after fabrication is competed as per BS-729 (1971) Galvanization shall be done when fabrication is complete.

FABRICATION

The Purchaser/ Engineer shall be notified when fabrication of the materials is to begging so that Owner/ Engineer may, if desires, provide shop inspection.

Each steel component shall be completely fabricated and then galvanized in the shop. All workmanship and finishing shall be first class and equal to the best practices in modern steel fabricating shops. All angles and members shall be fabricated in accordance with the standard, specifications and details given in the edition of the "Steel Construction Hand-Book" issued by the American Institute of Steel Construction or its equivalent. Structural item as delivered to the job site shall have all members straight, free from warp, bends or local deformations, accurate, sot that when the structure is assembled, proper fit will be provided. All reaming of holes shall be done at the factory before galvanizing. Punching, drilling or reaming of holes after galvanizing will not be permitted. Holes, 18mm in diameter shall be provided in the steel for ground connection on each leg of each structure. Legs or members shall be drilled with 18 holes at 1.5m intervals, in all of members where ground conductors are to be installed for grounding of shield wires or equipment. These holes shall be made before galvanizing. Holes shall be drilled and attachment devices shall be furnished on the terminal structures for all overhead circuit conductors and shield wires.

The bolt holes shall not exceed the diameter of the bolt by more than 1.5mm. Leg angles and other members shall be lap spliced and the back of the inside angle shall be round to clear the fillet of the outside angles.

i) **WELDING**

All welding done in the shop on steel members shall be by the shield metal are processes using joints

details performed in accordance with the American Welding Society (AWS) code or equivalent. All welding procedures and operators shall be qualified by an independent testing laboratory in accordance with AWS standard qualification procedures. Accurate records of operator and procedure qualifications shall be maintained by the contractor and shall be available to the owner or Engineer. All welds shall be continues and shall develop full strength of the least strength component unless otherwise shown on the drawings.

Components shall be thoroughly cleaned before welding and shall be accurately fitted and rightly secured in position during welding and weld surface shall be smooth and uniform and shall be thoroughly cleaned of all slag flux before galvanizing.

ii) **MAKING**

Each separate structure member shall be plainly stamped with a number. All like parts shall have the same number. The marking shall be stamped into the metal with figures at least 15mm high. Impression shall be made before galvanizing and have sufficient depth so that hey are plainly visible after galvanizing. The mark shall be placed as nearly as possible in the same relative position on each pieces so as to be seen plainly after assembly of the structure.

The mark numbers shall be composed of letters and numbers that will designate the S/S and type of structure. These markings shall the same as shown on the fabrication and erection drawings.

iii) **GALVANZING**

All steel components of the structures shall be galvanized using the hot dip process. Fabrications shall be completed before galvanizing. All pieces to be galvanized shall be thoroughly cleaned to remove paint, grease, rust, scales or other materials that could interfere with the bonding of zinc with the steel. Galvanization shall be as per BS-729.

The contractor shall perform all works in accordance with the rules and requirements as specified under ASTM specifications A123, A153 and BS-729.

After galvanizing, steel members may be straightened, if necessary by being re-rolled or pressed only. No punching welding or any other work which may damage the protective cover shall be allowed after galvanizing, except the lapping of nuts. All holes shall be free from pelter after galvanizing.

iv) **DRAWINGS**

The contractor shall furnish to the employer/ engineer complete fabrication and erection drawings along with the strength calculations on buses and loading on each structure foundation of each type of S/S structure for approval before fabrication. Drawings shall show outline, dimensions, drilling and details of fabrications.

STRUCTURE

All structures shall be designed, fabricated, galvanized etc. as specified and as described below :

i) **TERMINAL STRUCTURES**

The "Terminal Structure" is identified as the structure on which the 11 KV services cable/overhead conductor are terminated. When designed to accept the cable termination, this shall be complete with all plates, bases and other fittings required for mounting the cable and box for 11 KV XLPE single core cable of appropriate size 2x1Cx300 Sq.mm cable per phase) with mounting switches etc.

For overload conductors and shield wires, the maximum tension per conductor shall be 450 Kg.

ii) **BUS SUPPORT STRUCTURES**

The bus support structures shall be pedestal type, steel columns used to support the strain ACSR S/S buses. These structures shall be designed to withstand the forces outlined herein without damage off deformation. All plates and bus support insulators shall be furnished.

STRUCTURE FOUNDATION

The contractors shall furnish the detail design for foundations of all steel structures considering soil pressure of <4880 Kg/m^2. A copy of calculations and design criteria for foundation along with complete bill of materials of sand, cement, reinforcing bar and concrete aggregate etc. shall be furnished after singing of the contract and at the time of drawing approval.

PACKING

i) Steel members shall be shipped unassembled only members with the same mark shall be bundled together.
ii) All packages shall be securely tied with heavy gauge annealed galvanized steel bands to withstand transportation handling.
iii) Parts shall be handled and loaded, without damaging the materials or galvanized coatings.
iv) The contractor shall replace, free charge all materials which has been damaged due to inadequate of faulty packing.

H. TAGGING

i) For erection purpose, each package or bundle shall be tagged to identify the number of pieces.
ii) For shipping purpose separate tagging shall be used for each package and bundle showing the name and number of the contract, gross weight, port of dispatch and the destination in Bangladesh.

7.1.18 BUS-BAR CONDUCTOR AND JUMPERS

1.	Installation	Sub-station, Outdoor.
2.	Type	Aluminum Conductor Steel Reinforced (ACSR)
3.	Code Name	MARTIN ACSR for Bus-Bar Gross Beak ACSR for Jumpers
4.	Conductor Size	1351.5 MCM for MARTIN ACSR 636 MCM for Gross Beak (ACSR)
5.	Standard	Performance, design & testing shall be in accordance to the latest editions of ASTM B-232.
6.	Shipment	On standard non-returnable wooden reels Gross weight shall not exceed 2000 Kg per reel.
7.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC standards.

A. FEATURES

- Shall be of continuous length between supports.
- Conductors to be used for bus bars shall be stressed not more than 33% of their breaking strength.
- Overhead conductors carried by the S/S structures shall be erected with such a tension that when the conductors are subject to a transverse wind pressure of 640 Pascal's on the whole projected area, the factor of safety is not less than 2 (Two).
- When dissimilar metals are in contact, approved means shall be provided to prevent elector-chemical action and corrosion.

ELECTRICAL HARDWARE FOR 33KV SWITCHYARD

- All connectors shall be compression type and made of Aluminum alloy suitable for the conductor.
- Load support clamps shall be complete with bolts, nuts, lock washers etc. complete and of the appropriate size.
- Clamps and fittings made of steel or malleable iron shall be galvanized as per BS-729.
- Joints and connections shall be such as to permit easy dismantling. All necessary terminals and connections (bi-metallic) shall be provided for connection to the equipment. Suspension and tension conductor clamps shall be as light as possible and shall be of approved type.
- Tension conductor clamps shall be not permit slipping of or damage to or failure of the complete conductor or any part, thereof at a load less than 70% of the breaking load of the conductor.
- Catalogue with making on the catalogues of the hardware proposed shall be submitted with the offer.

7.1.20 SUB-STATION EARTHING

A. SCOPE

These Clauses describe the General Requirements for the Earthing and Lightning Protection and shall be read in conjunction with the Project Requirements and Schedules.

B. REFERENCES

American Standard

ANSI/IEEE std 80 : IEEE Guide for Safety in AC Substation Grounding
ANSI/IEEE std 81 : IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potential of a Grounding System.
DIN VDE 0141 : Earthing Systems for Power Installations with Rated Voltages above 1 KV.

British Standards

BS 1432 : Specification for copper for electrical purposes; high conductivity copper rectangular conductors withdrawn or rolled edges.
BS 1433 : Specification for copper for electrical purposes; Rod and bars.
BS 2871 : Specification for copper and copper alloys. Tubes.

BS 2874 : Specification for copper and copper alloy rods and sections (other than forging stock).
BS 4360 : Specification for weldable structural steel.
BS 6360 : Specification for conductors in insulated cables and cords.
BS 6651 : Protection of Structures against Lightning.
BS 6746 : Specification for PVC insulation and sheath of electric cables.
BS 7430 : Code of Practice for Earthing.

International Standards

ISO 427 : Wrought copper-tin alloys - chemical composition and forms of wrought productions.
ISO 428 :Wrought copper-aluminum alloys - chemical composition and forms of wrought productions.
ISO 11 87 :Special wrought copper alloys - chemical composition and forms of wrought products.
ISO 1137 :Wrought coppers having minimum copper contents of 99.85% - chemical composition and forms of wrought products.

C. GENERAL

An earthing System generally in accordance with the requirements of IEEE 80 and BS 7430 shall be designed under this contract. Installation and supply of all materials and equipment also included. The earthing system shall also be including earth electrodes and connections to all electrical equipment and metallic structures on the site. The earth electrodes shall limit the potential rise under fault conditions and buried conductors shall be provided to limit potential differences on the site and adjacent to the site to ensure safety to people and animals. Protection of all electrical equipment against lightning shall also be provided.

D. EXTENT OF WORK

The work under the clause **"SUB-STATION EARTHING"** comprises the site testing, design, supply and installation including excavation, back filling and temporary reinforcement of earthing system and connections to electrical apparatus at the substation. Also included the lightning protection scheme and the provision of portable earthing devices.

The contractor shall be required to undertake all necessary earth resistively tests at the sub-station sites and from the tests result to undertake the design of the earthing system. The design as well as providing safe passage to earth for the stated earth fault currents, shall also include calculation of step, touch and mesh potentials, which shall be within the allowable limits of the standards quoted in the specification.
The design calculations of step, touch and mesh potentials accompanied by full installation drawings and material requirement schedules, shall be submitted to and receive the approval of the Engineer before materials procurement or installation commences.

E. SOIL SURVEY

The preliminary tender design shall be based on a value of 100 ohm-m soil resistivity.

Not later than one month after the site has been handed over for access, the Contractor shall carry out an earth resistivity survey of the sites and report in writing to the Engineer in accordance with the approved program. The report shall detail the methods and instruments used and the results of the surveys. Based on the results the Contractor shall include in the report his proposal for the resistiveties to be used in the design of the earthing system.

The surveys shall show the variation of resistivity across the site and with the depth below the site. The Contractor shall consider if there is a need to model the resistivity in two layers and if there is any advantage in the use of deep rod electrodes.

The surveys shall also determine the depth and nature of any underlying rock, which may limit the depth for driving earth rods or if boring will be necessary for installing earth rods.

The weather conditions prior to and at the time of the surveys shall be recorded in the report and an assessment made of the seasonal variations in resistivity based on meteorological data for the area. The program for the project should, as far as possible, time the resistivity surveys to take place during a dry season.

The report should also state if there are any indications that the ground is corrosive to bare copper.

The report shall be approved by the Engineer before proceeding with the design of the earthing

F. FAULT CURRENT AND DURATION

Each site shall be provided with an earth grid of buried conductors designed for an earth fault current of **31.5 KA** for three second. The preliminary earthing, design shall be such that the ground potential rise shall not exceed 2 kV.

G. EARTH ELECTRODE SYSTEM DESIGN

i) Design Calculations

The design of the earth electrode systems shall be based on the approved earth resistivity data and the system fault currents and their duration.

The design calculations in detail shall be submitted for approval of the Engineer and shall be based on the methods given in the standards listed. The calculations shall include the following parameters:-

(a) earth resistance of the whole system and of its components.
(b) earth potential rise
(c) step, touch and mesh potentials inside and outside the perimeter fence
(d) requirements for a high resistance surface layer
(e) conductor ratings

Earthing points shall be provided such that the combined resistance of the earth grid and all other earthing points does not exceed 0.5 ohm during the dry season.

The earth potential rises shall not exceed the CHIT limits appropriate to the classification of the system unless special precautions are taken to cater for transferred potentials.

Step, touch and mesh potentials shall be within the permitted limits calculated in accordance with the standards given in IEEE 80 for the proposed surface layer.

ii) Earth Electrode

The earth electrode shall comprise a system of bare copper conductors forming a mesh buried near the surface of the ground and supplemented, if required, by one or more of the following electrodes:-

(a) a system of interconnected rods driven into the ground.
(b) a mesh system of bare conductors buried in the ground.
(c) structural metal work in direct contact with the ground.

(d) reinforcing steel in buried concrete.
(e) a system of bare conductors buried near the surface of the ground outside the perimeter fence.

iii) Mesh System

The mesh system shall be designed with above to limit touch, step and mesh potentials taking into account the combined length of the mesh conductors, other buried conductors and rods but excluding any buried conductors outside the perimeter fence. Due regard shall be given to non-linear distribution of the fault current giving rise to the highest potentials at mesh corners.

The rating of the mesh conductors shall be compatible with the fault currents after allowing for parallel paths of hard drawn high conductivity copper strip with a minimum conductor size of 200 mm^2.

The conductor shall be installed in trenches excavated by the contractor at a minimum depth of 1000 mm. The system will be installed after all foundations have been laid and the site filled to 100 mm below finished level. When the earthing grid has been laid and back filled, bricks will be laid up to finished site level. Where the excavated material is rocky or may be difficult to consolidate, the back filling shall be carried out using other material to the approval of the Engineer. The cost of such material shall be deemed to be included in the Contract.

iv) Interconnected Rods

If the design calculations show that a mesh alone is unable to limit the required values, then the mesh shall be supplemented by the use of interconnected copper earthing rods driven into the ground or installed in bored holes.

Rods shall be installed inside the perimeter fence to enclose the maximum possible area compatible with the earthing of any metallic fence. (The spacing between rods shall not be less than their length, unless rating considerations determine otherwise). The copper rod electrodes of 15mm diameter shall be interconnected in groups of four to eight rods by insulated copper conductors and non-ferrous clamps to form a ring. Each group shall be connected to the mesh by duplicate insulated copper conductor via disconnecting test links.

Individual rods may be connected directly to the mesh, provided the rod can be disconnected for testing.

Rods installed in bored holes may be used to reach lower resistivity ground strata at depths beyond the reach of driven rods or where rock is encountered and it is not possible to drive rods. After installing the rod the bored hole shall be back-filled with a low resistivity liquid mixture, which shall not shrink after pouring, to ensure good contact between the rod and the ground for the life of the installation.

The resistance and rating of individual rods and the combined resistance of the groups of rods in the proposed design shall be calculated and the rating of the interconnecting conductors shall not be less than that of the group of rods with a minimum conductor size of 200 mm^2.

The calculation of potentials in the design of the complete installation shall be made without the group of rods with the lowest estimated resistance to simulate the condition with the group disconnected for testing.

v) Other Conductors

As an alternative to rods to supplement a mesh, additional bare copper conductors with a cross-section area of not less than 150mm^2 may be used. They shall be buried in the ground within the perimeter fence to enclose the maximum possible area compatible with the earthing of any metallic fence. Such conductors may be laid below the mesh, below foundations or in areas where there is no plant. It shall be shown by calculation that the step potentials are low in such areas.

The conductor shall be in a ring, or a part of a ring, with at least two widely separated connections to the mesh or other parts of the earthing system.

vi) Reinforcing Steel

The reinforcing steel in the foundations of buildings containing the primary electrical equipment may be used as auxiliary electrodes, subject to the approval of the Engineer. The contractor shall show in the design calculations that the fault currents and d/c stray currents will not damage the structure.

Steel reinforcing mesh in the floors of the building may also be used for the control of step and touch potentials within the building subject to approval of the Engineer.

vii) Conductors Outside Perimeter Fence

If the design calculations show that the step and touch potentials outside the perimeter fence or wall exceed the limits, than additional bare conductors shall be buried in the ground outside the fence in the form of rings encircling the whole site.

The distance of the conductors from the fence and the depth shall be determined in the design to ensure that step and touch potentials are within the limits.

The minimum conductor size shall be 75mm^2 copper and shall be connected to the fence or the mesh with 75mm^2 conductors at each corner of the site and at intervals of not more than 100m. These conductors shall not be included in the calculations called for above.

POWER TRANSFORMER NEUTRAL GROUNDING (Not Applicable)

Neutral of POWER TRANSFORMER seperately Grounded by 03(Three) Nos. of Electrode (round Bar) of 16 mm Dia with 04(Four) Meter Length Each and Length of the electrode will be decided as per Design calculation. From Transformer Neutral to Electrode Connection 300 sq-mm Copper Conductor will be used.

MATERIALS AND INSTALLATION

Description	Size
Mesh Conductor Cross Section Area	200 sq-mm(Min)
Dia & Length of Each electrode/Rod	16 mm & 04(Four) Meter
Total Length of the electrode & Mesh Conductor	as per Design calculation
Conductor for Neutral of Power Transformer	2x150 sq-mm(Min)

The size/type of earthing Riser/Connectors for different equipment shall be as follows:

1	Neutral of the Power Transformer 33/11kV	-not less than 2x150 mm^2 copper conductor with adequate insulation
2	Body of the Power Transformer, 33/11kV	- bare copper bar of not less than 120mm^2 for each power transformer 2 nos.

3	Neutral of the station transformer, 33/0.4 KV	- not less than 150 mm^2 copper conductor with adequate insulation
4	Body of the station transformer, 33/0.4 KV	- not less than 120 mm^2 Cu wire
5	33 KV PT LV Neutral	- 16 mm^2 Cu. Wire.
6	11 KV PT LV Neutral	- 16 mm^2 Cu wire
7	Steel mounting structure at the switchyard	- 120 mm^2 Cu wire for each steel mounting structure 2 nos.
8	Body of the indoor 33 KV switchgear Panel	- not less than 3x120 mm^2 Cu wire
9	Body of the indoor 11 KV switchyard Panel	- not less than 120 mm^2 Cu wire at minimum 2 points
10	Body of the Indoor control relay panel - 33/11 KV A.C. distribution panel. DC distribution panel, battery charger and other miscellaneous indoor equipment.	- 120 mm^2 Cu wire
11	33 KV Lightning Arrestor Outdoor	- not less than 120 mm^2 Cu wire at minimum 2 points

The earthing leads with appropriate thimble shall be connected to the welded flat bar earth electrode, by bolts & nuts.

The other ends of the earthing leads shall be connected to the equipment/chassis at appropriate terminals by using thimbles/connectors etc and nuts & bolts.
Appropriate earthing devices and arrangement shall be provided for all 33KV and 11KV switching panels having provision for operation from the front.

H. DESIGN OF EARTH SYSTEM

i) Earth System

An earth system shall comprise the following components:-

(a) the conductors between the earth electrode system and the main earth bar
(b) the main earth bar
(c) the conductors between the main earth bar and the metallic frames, enclosures or supports of electrical equipment
(d) the conductors between structural metalwork and non-electrical equipment and the main earth bar

The rating of earth system conductors connected between an item of electrical plant and the earth electrode system shall be sufficient to withstand the fault currents and duration, after allowing for the parallel paths through the earth system conductors, with any one conductor disconnected.

The design comprising all the above mentioned items shall be submitted to the Engineer for approval within four months of the award of contract.

ii) Connection of the System Neutrals and Earth

The system neutral points within a substation shall be arranged in two groups with a conductor from earthing point.

The copper earth electrodes of a neutral earthing point shall be arranged in two groups with a conductor from each group to a test link and there shall be duplicate bare copper conductors of cross

sectional area not less than 150 mm^2 from each test link to the earth grid. The duplicate connection may be in the form of a ring.

Neutral earthing connections between the substation system (transformer) neutral and the test links shall be of bare copper tape, secured and supported on stand-off insulators so that there is no contact between copper tape and transformer tank.

Neutral earthing conductors shall normally be buried directly in the ground but where necessary, they may be cleared to walls, fixed to cable racks or laid in the cable trenches.

iii) Main Earth Bar

The main coppper earth bar shall be in the form of a ring or rings of bare conductors surrounding, or within an area in which items to be earthed are located. Where two or more rings are installed, they shall be interconnected by at least two conductors which shall be widely separated.

The main earth bar, or parts thereof, may also form part of the earth electrode system, providing this is bare conductor.

Each main earth bar shall be connected by at least two widely separated conductors to the earth electrode system.

The minimum conductor size for the main earth and interconnections between earth bars and the earth electrode system shall not be less than 200 mm^2.

iv) Electrical Equipment Tank and Structure Connections to Earth

Connections between: (a) all HV electrical equipment and (b) LV electrical equipment comprising substantial multi-cubicle switchboards and the main earth bar shall be duplicated. The bare copper conductor size shall have a minimum cross section area of 150 mm^2.

All substation equipment, including disconnectors, earth switched, main transformer tanks, current and voltage transformer tanks, switchboards, electrical supporting steelwork and gantries etc. shall all be connected with the earth grid.

Surge Arresters installed for the protection of transformers and reactors shall be connected by low reactance paths both to the transformer tanks and to the earth grid.

Capacitor voltage transformers used in connection with line traps shall be connected by direct low reactance paths to a single earth rod for each Arrester, in addition to the earth grid.

An earth mat shall be installed at all operating positions for outdoor HV equipment manual operating mechanism boxes and local electrical control cubicles to ensure the safety of the operator. The mat shall be directly bonded to the cubicle and the conductors forming the mat and the bonding connection shall have a minimum copper cross-section area of 75 mm^2.

Galvanized structures comprising bolted lattice components shall not be used as the sole earth connection path to post and strain insulators or to overhead line earth conductors.

Buildings containing electrical equipment shall be provided, at each level, with a ring of earthing conductors which shall have duplicate connections to the earth grid outside the building. The frames

of all switchgear, control and relay panels and other electrical equipment and exposed structural metal work shall be connected by branches to a ring. The ring and branch conductors shall be of the same material as the earth grid. Strip run within buildings, inside cable trenches or above ground level on apparatus shall be neatly supported on non-ferrous clamps.

Fixed earthing connectors for use with portable earthing devices below shall be provided on each bus bar and on both sides of high voltage equipment is by tubular bus bars.

Rigid loops in the copper earthing strip branch bond between the equipment and the earthing grid shall be provided adjacent to each item of high voltage equipment for use with the portable earthing devices. The rigid loops shall be marked green.

Connections between other LV electrical equipment and the earth bar need not be duplicated. The single conductor shall be rated to withstand the fault rating of the equipment.

v) Connections to Non-Electrical Structural Metalwork and Equipment

All metal work within the project area which does not form part of the electrical equipment shall be bonded to the main earth bar except where otherwise specified. The bonding conductor size shall be not less than 150 mm^2.

Individual components of metallic structures of plant shall be bonded to adjacent components to form an electrically continuous metallic path to the bonding conductor.

Small electrically isolated metallic components mounted on non-conducting building fabric need not be bonded to the main earth bar.

I. MATERIALS AND INSTALLATION

i) Conductors

Conductors shall be of high conductivity copper in the form of circular conductors stranded to IEC 228(BS 6360) or solid rods or bars to BS 1433.

Conductor sheaths shall be of PVC to meet the requirements of BS 6746 Grade TM1 or IEC 502 Grade ST1 with a minimum thickness of 1.5mm.

Buried conductors which are not part of the earth electrode system shall be PVC sheathed circular stranded cable.

Bare strip conductors only shall be used for earth electrodes or voltage control meshes.

Conductors buried in the ground shall normally be laid at a depth of 800 mm in an excavated trench. The back fill in the vicinity of the conductor shall be free of stones and the whole back fill shall be well consolidated. Conductors not forming part of a voltage control mesh shall be laid at the depth required by the approved design and in the case of a PVC sheathed conductor, at the same depth as any auxiliary power or control cables following the same route.

All conductors not buried in the ground shall be straightened immediately prior to installation and supported clear of the adjacent surface.

ii) Earth Rods

Earth rods shall be driven to a depth below the ground water table level, to be determined by the Contractor during soil investigation and survey of site.

The earth rods shall be of hard-drawn high conductivity copper with a diameter of not less than 15mm with hardened steel driving caps and tips. The rods should be as long as possible but couplings may be used to obtain the overall depth of driving required by the design.

The rods shall be installed by driving into the ground with a power hammer of suitable design to ensure the minimum of distortion to the rod. Where it is not possible to drive rods to the full depth required due to the presence of a strata of rock, then holes shall be drilled or blasted in the rock. The holes shall be filled with betonies or other approved material prior to inserting the rod.

If difficult driving conditions arising from hard or rocky ground are encountered or are anticipated or there is a need for deep rods, then high tensile steel rods shall be used. High tensile steel rods shall have a molecularly bounded high conductivity copper coating with a minimum radial thickness of not less than 0.25 mm. The overall diameter shall be not less than 12 mm. Rolled external screw threads shall be used on the rod for coupling and after rolling the thickness of the copper coating on the threaded portion shall be not less than 0.05 mm.

Rods, driving caps and tips shall about at couplings to ensure that the couplings and screw threads are not subject to driving forces. All screw threads shall be fully shrouded at the couplings. Alternatively, conical couplings may be used to the approval of the Engineer.

High conductivity copper for earth rods shall have a minimum copper content (including silver) of 99.90% to ISO 1337, Cu-ETP or Cu-FRHS (BS 2894 Grade C 101 or C102) for copper earth rods and to ISO 1337 Grade Cu-ETP (BS 28734 Grade C 101) for the molecular bonded copper coating of steel rods.

The steel for copper-clad steel rods shall be low carbon steel with a tensile strength of not less than 570 N/mm^2 to ISO 630, Grade Fe 430A (BS 4360 Grade 43A) or better.

Couplings for copper rods shall be of 5% phosphor bronze (copper-tin-phosphorous) to ISO 427, CU Sn_4 (BS 2874, Grade PB 102M) and for copper bonded steel rods of 3% silicon or 7% aluminum bronze to BS 2874, Grade CS 101 and BS 2871, Grade CA 102.

iii) Fittings

Clips supporting strip conductors not buried in the ground shall be of the direct contact type and clips for circular conductors shall be of the cable saddle type. The clips shall support the conductors clear of the structure.

Conductors shall be connected to earth rods by a bolted clamp to facilitate removal of the conductor for testing rod.

Disconnecting links shall comprise a high conductivity copper link supported on two insulators mounted on a galvanized steel base for bolting to the supporting structure. The two conductors shall be in direct contact with the link and shall not be disturbed by the removal of the link. Links for mounting at ground level shall be mounted on bolts embedded in a concrete base.

Disconnecting links mounted at ground level and the connections at the earth rods shall be enclosed in concrete inspection pits, with concrete lids, installed flush with the ground level.

All conductor fittings shall be manufactured from high strength copper alloys with phosphor bronze nuts, bolts, washers and screws. Binary brass copper alloys will not be acceptable. All fittings shall be designed for the specific application and shall not be permanently deformed when correctly installed.

Sheathed conductor support fittings may be of silicon aluminum, glass-filed nylon or other tough non-hygroscopic material for indoor installations.

Fittings not in direct contact with bare or sheathed conductors may be of hot-dip galvanized steel. Bi-metallic connectors shall be sued between conductors of dissimilar materials and insulating material shall be interposed between metallic fittings and structures of dissimilar materials to prevent corrosion.

iv) Joints

Permanent joints shall be made by exothermic welding (Cad Welding) below ground, or crimping for above ground connections.

Detachable joints shall be bolted and stranded conductors at bolted joints shall be terminated in exothermic welded lugs or a crimped cable socket. The diameter of any holes drilled in strip conductors shall not greater than half the width of the strip.

Connections to electrical equipment shall be detachable and made at the earthing studs or bolts provided on the equipment by the manufacturer. When an earthing point is not provided, the point and method of connection shall be agreed with the Engineer.

Connections to metallic structures for earthing conductors and bonding conductors between electrically separate parts of a structure shall be either by direct exothermic welding or by bolting using a stud welded to the structure. Drilling of a structural member for a directly bolted connection shall only be carried out to the approval of the Engineer.

Bolted joints in metallic structures, including pipe work and which do not provide direct metallic contact, shall either be bridged by a bonding conductor or both sides of the joint shall be separately bonded to earth, unless the joint is intended to be and insulated joint for cathodic protection or other purposes.

When the reinforcing in concrete is used as a part of the earthing system, the fittings used to provide a connection point at the surface of the concrete shall be exothermically welded to a reinforcing bar. This fitting shall be provided with a bolted connection for an earthing conductor. The main bars in the reinforcing shall be welded together at intervals to ensure electrical continuity throughout the reinforcing.

No connections shall be made to reinforcing bars and other steelwork which do not form part of the earthing system and are completely encased in concrete.

J. EARTHING OF FENCES

i) Method

Metallic fences shall be separately earthed unless they come within 1.8m of any equipment of structure above the surface of the ground and which is connected to the main earthing system. If the separation of 1.8m cannot be obtained, the fence shall be bonded to the main earthing system.

ii) Separately Earthed Fences

The earthing of a fence shall be provided by connecting certain metallic fence posts to an earth rod by a copper conductor. The earth rod shall be driven adjacent to the posts inside the fence line to a depth of not less than 3.0m. where no metallic posts are provided, the earth rods shall be connected directly to the metal wires, mesh or other components of the fence.

If, owing to the nature of the ground, it is not possible to drive earth rods, then fence posts shall be connected to the center point of a 20m length of bare copper conductor buried in the ground at a depth of 500mm, running closely parallel to the inside of the fence.

The earth rods or bare conductor electrodes shall be installed at each corner post, below the outer phase conductors of overhead line connections passing over the fence, at each gate and at intervals of not more than 100m.

iii) Bonded Fences

Fences which need to be bonded to the main earthing system of the installation shall be connected by copper conductors to the nearest accessible point on the main earthing system at each point where the fence comes within 1.8 m of any electrical equipment. Bonds shall also be made to each corner post, below the outer phase conductors of overhead line connections passing over the fence at each gate and at intervals of not more than 100m.

iv) Bonding of Fence components

Fences made up bolted steel or other metallic component do not require bonding between components. Where such fences have non-metallic component, bonds shall be installed to maintain continuity between metallic components. Reinforced concrete components shall be treated as being non-metallic.

Longitudinal wires for supporting other fence component or for anti-climbing guards and the wires of chain link, shall be directly bonded to each electrode or to each bond to the main earthing system.

Metallic component on masonry, brick, concrete or similar boundary wall shall be treated in the same manner as metallic fences.
Wire fence component coated for anticorrosion protection shall be earthed inn accordance with this clause.

v) Gates

The fixed metallic components on both sides of the gate shall be directly bonded together by a copper conductor installed under the surface of the access way. Flexible conductors shall be installed to bond the moving parts of the gates to the metallic fixed parts. An earth rod or a bond to the main earthing system shall be installed at each gate.

iv) Potential Control Outside Fences

Where the approved design calculations show that the touch or step potentials outside the fence or boundary wall would otherwise be excessive, bare copper conductors shall be buried in the ground outside the fence or boundary wall at such depths and spacing as are shown in the approved design calculations to give acceptable touch and step potentials. The conductors shall form complete rings surrounding the installation and each ring shall be bonded to the adjacent ring and to the fence at each corner, below the outer phase conductors of overhead line connections passing over the fence at each gate and at intervals of not more than 100 m. In this case separate earth electrodes are not required for the fences.

If the boundary fence or wall is substantially non-metallic, the rings of conductors shall be bonded to the main earth system at each corner of the site and at intervals of not more than 100m. Any metallic components on such boundary fences or walls shall be bonded to the earthing system in accordance with this Specification.

If the boundary fence is metallic and is not within 1.8 m of any part of the main earthing system or equipment bonded thereto, the fence and outer conductor rings shall but be connected to the main earthing system unless the approved design calculations show otherwise.

Any meshes formed by bonding the outer conductors to he main earthing system shall be sub-divided by additional conductors, if required, to give acceptable touch, step and mesh potentials.

vii) Conductors

All conductors used for earthing and bonding the fences and components and for outer rings shall have a cross-sectional area of not less than 70 mm^2.

vii) Portable earthing devices

Portable earthing devices for use with outdoor 33KV apparatus in substations shall be supplied in the numbers stated in Schedule of Technical Requirements and shall comprise:

(a) Copper alloy earth end clamp for connection to the rigid loops in equipment earth bonding connections.
(b) Aluminum ally line and bus bar end clamp to suit the type supplied under the Contract.
(c) Flexible stranded aluminum alloy conductor with clear protective PVC sheath, size suitable for the specified fault level and duration.
(d) Telescopic operating pole of glass fibre or similar material, of sufficient length to reach the height of connections to high voltage equipment from ground, but retractable into a carrying length not exceeding 2.5m, and complete with non-slip hand grips.

K. SUB-STATION EARTHING AND EARTHING ERECTION

General earthing of all equipment shall be in accordance with the IEC recommendation No. 80 :1976-Guide for safety in alternating current sub-station Grounding, the British standard code of practice CP-1013: 1965 or other approved standard.

i) Earthing System

Each site shall be provided with an earth grid of buried copper strip conductors designed for an earth fault current of 31.5 KA for 3 seconds for all S/S. For the purpose of preliminary design it shall be assumed that the distribution of the fault current will be such that the ground potential rise of each site will not exceed 2 KV.

The preliminary design shall be based on clay silt having an assumed resistively of 100 ohm meters. Step and touch voltages both inside and outside the station shall not exceed 50 V.

The design of earth grid over the area occupied by switchgear and associated apparatus shall be based on a maximum grid spacing of 5m x 5m. Conductors shall be buried at 800mm depth.

Earthing points will be provided so that the combined resistance of the earth grid and earthing points shall be less than 0.5 ohm under dry climatic conditions.

The operating mechanisms of isolators, earth switches and circuit breaker kiosks not integral with the circuit breaker shall be connected to the earth system by a branch entirely separate from that employed to earth their bases. The branch is to be installed such that the connection would pass beneath where and operator would stand, so as to minimize step potential.

Fences shall be earthed independently of the sub-station grid.

Connections to plant and equipment shall be made using the earthing terminals specified in the contract where a strip has to be drilled to fit an earth terminals the diameter of the hole shall not be greater than ½ the width of the strip.

Joints in earthing strip shall employ chemical welding or high compression joints or clamps.

ii) Earthing Electrode

Each Earhting point shall consist of a group of copper rods drawn into undisturbed soil to a minimum depth of 4m. Each copper electrode shall be complete with approved non ferrous clamps for the connection of earthing conductors and with a hardened steel tip and cap for driving by means of a power hammer. The number of electrodes per group shall be not less than four and not more than eight, 16mm diameter rods and each copper electrode rod shall be 4 meter length and the number of rod groups per sub-station have been declared in the price schedule.

The electrodes of an earthing point will be arranged in two sub-groups with a conductor from each sub-group to the test link of the earth grid.

In addition to the above a single electrode is to be driven as close as possible and connected to the following :

i) Three phase set of surge diverts.
ii) Three phase set of voltage transformers.
iii) Three phase set of power transformers.
iv) The fence where an overhead line crosses at gates and at fence corners. The distance between electrodes is not to exceed 50 m.

Separate Earthing Electrode with special earth pit shall be provided for the following two items:
(i) Power Transformer neutral earthing
(ii) Lightning Arrester earthing

It has to be ensured that the earthing resistance of these separate earth electrode satisfies the basic requirement of earthing resistance.

iii) Insulated Earthing Conductors

Conductors for interconnection between the electrodes in any group and between groups and the connections between the link chambers and sub-station earthing main grid shall have twin conductors with a combined rating of 31.5 KA for three seconds for all S/S. The neutral points of the 11KV system shall be connected to the link chamber with twin conductors as above.

Earthing conductors shall be of annealed high conductivity copper and shall be stranded in accordance with IEC-228 table VII class-2. They shall be protected with an extruded PVC sheath of 100 volts grade.

iv) Sub-station Earthing Screen

Approved earth screens shall be provided to protect the equipment from direct lightning strikes. The screens shall be of the steel corned aluminum wires of not less than 35 Sq.mm total cross section and connected to provide low impedance paths to earth.

The layout of the earth wires shall be such that generally equipment to be protected lie within areas bounded by lines drawn from the earth wire at 35 degree to the vertical in a plane perpendicular to the axes of the earth wire. The earth screen shall be suitable for extension to protect the sub-station equipment to be installed in suitable stages of development.

Connections shall be made of copper strip of 150 Sq.mm cross section between each support for the overhead earthed screen wire and the main sub-station earthing system. Earth wires shall be held in clamps with free pin type joints between clamps and supports connections shall be provided for the terminations of the earth wires of the overhead lines including bimetal connectors where necessary.

The necessary stays, fittings, anchors, flying stays and additional masts shall ensure clearance of not less than 4600 mm over roadways for circuit breaker or transformer removal. The design of all structures shall ensure that in the event of breakage of either one earth wire or one stay wire the factor or safety is not less than 1.5.

L. REQUIREMENT EARTHING

i) 11 kV Switchgear (Not Applicable)

All metal parts including any relay 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 to the bar shall be sufficient to carry the rated short time withstand current of the switchgear for three seconds.

The frame of the draw-out circuit breakers shall be connected to the earth bar through a substantial plug type contact.

ii) Low Voltage Switchboards

Earth metal of switchboards fuse and distribution boards and distribution boards shall be bonded together and earthed to the main sub-station earthing system. Earthing connections shall be carried out in bare copper strip having a 3 second rating not less than 31.5 KA for all S/S

iii) Control Panels

Each control panel shall be provided with a copper earth bar of not less than 80 Sq.mm cross-section and arranged so that the bars of adjacent panels can be joined together to from a common bus.

The common earthing bus bar of control and relay panels shall be connected to the main station earthing systems via a copper earthing connection of not less than 80 Sq.mm.

7.1.21 TECHNICAL ORIENTATION AND QUALITY TEST WITNESS:

A. FACRORY INSPECTION AND TEST WITNESS:

Witnessing of the manufacturing process and tests of the equipment at manufacturer's premises including transfer of technical know-how shall be required/held as detailed elsewhere in Particular Conditions of Contract (GCC 32.1) of tender document and other than this the following will be as follows:

The BPDB's inspection team proposed by the purchaser or consignee (if consignee is Project Director) and approved by the competent authority shall have the right to inspect, examine and test the workmanship and performance of the goods/materials to confirm the conformity to the specification at all reasonable time before and during manufacture at the manufacturer's premises.

The manufacturer will allow inspection team to inspect the manufacturing process and quality control and progress of the work at any time need by BPDB's inspection team. This team will witness the Factory/Technical orientation & Quality test at the manufacturer's plant. The Manufacturer shall have facilities to carry out all tests at its premises and shall provide free of charge such assistance, labor, materials, electricity, fuel, stores, apparatus and instruments as may be requisite and as may be reasonably demanded to carry out such test efficiently.

The inspection team maximum 2 (two) times may inspect (if required) the goods during the manufacturing process or after manufacture of Goods as required and shall also request to supplier for the purchase/ import/ shipping documents of major/key materials of Goods and shall check in accordance with Guaranteed Technical Particulars (GTP) and guarantees of the contract. All expenses for such tests shall be borne by the supplier.

BPDB's Inspection Team will witness the routine test at the manufacturer's premises. Tests shall be performed in accordance with the relevant IEC/BS/ANSI/ASTM/BDS standards or any other standard mentioned in the contract document which shall be complied with the Guaranteed Technical Particulars (GTP) of the Contract. All expenses for such tests shall be borne by the Contractor.

At the time of Factory Test witness BPDB's Inspection Team will check the calibration seal/certificate of the testing/measuring equipment, meters etc. issued by the competent authority. The contractor shall ensure that the Manufacturer shall complete the calibration of the testing/ measuring equipment, meters etc. before the inspection of BPDB's team.

The Supplier shall, after consulting the consignee, give notice to the consignee in writing of the date and the place where the material or equipment will be ready for testing at least 15 days before schedule of inspection. The consignee shall give the supplier timely notice in writing of his intention to attend the test. As and when the consignee is satisfied that any materials/equipment shall have passed the tests referred to in this clause, consignee shall notify the contractor in writing to that effect.

Should any inspected/ tested goods fail to conform to the specification, the consignee shall have the right to reject any of the items or complete batch if necessary. In that case Supplier has to replace the equipment and to make good of them and the supplier shall conduct similar pre-delivery Inspection and factory tests without any financial involvement to the consignee. In case any of the Equipment/goods found not conforming to the specification at the time of post landing Inspection, the supplier will in no way be relieved from the responsibility of replacing them on making them good at their own cost, despite the Equipment

were found good at the time of Factory Acceptance Test in respect of quality and quantity. Nothing in this clause shall in any way release the supplier from any warranty or other obligations under the contract.

If the offered goods are manufactured within the purchaser's country then the manufacturer/supplier shall have the testing facilities at manufacturer's/supplier's premises in accordance with the relevant IEC/BS/ANSI/ASTM/BDS Standards. The inspector(s) shall sent the sample material (selected by the BPDB's Inspection Team consisting of at least three engineers in each consignment) to CERS, BPDB/BUET/CUET/KUET/RUET/DUET to carry out any test(s) pending due to lack of testing facilities or any reason at the manufacturer's/supplier's premises. All cost of testing including carrying, loading, un-loading etc. will be borne by the supplier and shall be deemed to be included in the offered price. If the sample(s) fails to confirm the specification, the full consignment will be rejected.

No goods shall be packed, prepared for shipment/delivery unless it has been approved and written instructions have been received from the consignee.

On successful completion of Pre-shipment inspection/quality test witness, delivery of goods will be made to the designated stores under contractor's/supplier's responsibility until Post-Landing Inspection is successfully completed without any obligation on part of BPDB. Quality and quantity of the delivered goods will be determined at the time of post-landing inspection at the designated stores in presence of the authorized representative of the contractor/supplier. After approval of the satisfactory Post-Landing Inspection, R&I Report will be issued following the contractual obligations.

B. RANDOM SAMPLE TEST DURING FACTORY INSPECTION AND WITNESS: Required

During Pre-delivery Inspection & Factory Test Witnessing of the goods to be supplied under the Contract, the Inspection Team will witness the routine tests at the manufacturer's premises. The Inspection Team will select goods on random sampling basis. The Tests shall be performed in accordance with the relevant IEC/BS/ANSI/ASTM/BDS standards or any other standard mentioned in the contract document which shall be complied with the Guaranteed Technical Particulars (GTP) of the Contract. All expenses for such tests shall be borne by the Contractor.

C. ACCEPTANCE REPORT OF GOODS FOR DELIVERY:

If the test results of the tested sample(s) during factory test witness by the BPDB's inspection team fail to confirm the specification and the Guaranteed Technical Particulars (GTP), the full consignment will be rejected. A formal delivery order will be issued after satisfactory pre-delivery inspection & test report by BPDB's inspection team.

D. POST-DELIVERY INSPECTION & TESTING:
Post Landing Inspection shall be done after arrival of the goods at **Final destination**

The Supplier shall inform (within 5 (five) working days) the purchaser or consignee (if consignee is Project Director) immediately after arrival of the goods at the designated store of BPDB (as per delivery schedule). An Inspection team of BPDB (may be the previously or newly formed team) shall start to perform the post-landing inspection not beyond 10 (ten) working days in presence of supplier's representative after getting information from supplier about the delivery of goods at designated store. The Supplier shall arrange post-landing inspection as per program in consultation with the consignee. If any defect or damage has been found at post-landing inspection, the defective or damaged materials/ goods shall be replaced by the supplier at his own cost within the stipulated time.

The purchaser's or consignee's (if consignee is Project Director) right to inspect, test (where necessary) and reject the goods after delivery at the designated stores of BPDB shall in no way be limited or waived by reason of the goods having previously been inspected, tested and passed by the purchaser prior to the goods' delivery.

The Inspection team will check the physical conditions and quantity of the goods delivered. The inspection team will select the sample of good(s) on random sampling basis and sent the selected sample goods to CERS, BPDB or BUET/ CUET/ KUET /RUET (as selected by the inspection team) to carry-out the test(s) as per contract to confirm the conformity to the approved Technical Specifications, Guaranteed Technical Particulars (GTP), drawings and relevant standards. If the tested sample(s) fail to confirm the specifications in tests, the full consignment will be rejected. All cost of testing of Materials/ Goods including carrying, loading, un-loading etc. will be borne by the supplier.

7.2 TECHNICAL SPECIFICATION OF POWER CABLES, CONDUCTOR AND CONTROL CABLES

7.2.1 TECHNICAL SPECIFICATIONS/REQUIREMENTS OF 33 KV, 1CX500 SQ.MM XLPE CU CABLE WITH TERMINATION KIT

The manufacturing process shall be designed to eliminate irregularities like protrusions, voids and contamination etc. to ensure the long-term reliability of the 33kV XLPE Cu cable. The 33kV XLPE Cu cable covered in this specification shall be manufactured by Triple extrusion and Gas curing process ensuring circularity and concentricity of the extruded layers around the conductor and all three layers (conductor screen, XLPE insulation and insulation screen) shall be extruded in simultaneous triple extrusion process. The details of manufacturing process and curing to be adopted shall be mentioned clearly in the offer.

Raw materials used to manufacture the cable shall be of highest quality and it should meet material standards mentioned in IEC 60 502-2. The materials shall be clean and packed in moisture and dust proof packing. Material received by manufacturer should be checked/ tested to ensure that it meets material specification.

Loading of the extruder in the manufacturing plant shall be performed entirely closed and dust proof environment. Contamination shall be avoided by the use of a fully enclosed material handling system. The use of special means like pressurized air etc. for transport of granules, as far as practicable, shall be avoided.

The cross linking, curing and cooling may be carried out in one operation and shall be a gas curing process under high pressure to eliminate the formation of voids in the insulation and contaminants in the dielectric. Process conditions such as curing and cooling temperatures, production speed etc. shall be closely monitored during manufacture to ensure a good degree of cross-linking through the whole insulation.

The cable will be laid in underground in an area with highly moist soil so metal sheath of either lead or aluminium shall be employed to act as moisture barrier layer.

Cable Construction

The 33kV XLPE Cable shall have stranded compacted round copper conductor, taped with semi conducting tapes, conductor screening with extruded semi conducting thermosetting compound, with completely gas cured XLPE insulation, adequate insulation screening consisting of extruded semi conducting thermosetting compound layer, taped with semi conducting water swellable tape, extruded/welded corrugated Aluminium sheathed and overall extruded termite repellent black PE sheathed with outer conducting layer.

Conductor

The conductor shall be stranded compacted round copper conductor complying the requirement of flexibility Class-2 of IEC 60 228. The wires shall be made of high conductivity copper and shall be stranded mid compacted. The copper used for the conductor shall be of highest purity. The nominal area of conductor shall be 500 sq. mm.

The minimum number of wires in conductor shall be 61 and the maximum DC resistance of conductor shall be 0.0366 Ω/KM at 20°C.

Conductor Screen

The conductor screen shall consist of an extruded layer of thermosetting semi conducting compound and shall be continuous and cover the whole surface of the conductor. The screen shall be firmly bonded to XLPE insulation. The minimum thickness of conductor screen shall be 0.8 mm. (approx.)

A non-hygroscopic semi conducting tape may be applied over the conductor surface under extruded layer. The outer surface of the conductor screen shall be circular and free from irregularities.

Insulation

The insulation shall be cross-linked polyethylene (XLPE). The insulation material shall comply with the requirement as per IEC 60 502-2. The insulation shall be applied by extrusion and vulcanisation to form a compact homogenous body free from micro voids and contaminants. The nominal thickness of insulation shall be 8.0 mm.

Insulation Screen

The insulation screen shall consist of an extruded layer of thermosetting semi conducting compound and shall be continuous and cover the whole surface area of insulation. It shall be firmly bonded to the insulation.

The minimum thickness of insulation screen shall be 0.5 mm.

Metallic Screen
The metallic Screen shall consist of a concentric layer of copper wires or a combination of copper wires and helically applied coppertape(s) as per IEC Standard.
The metallic Screen shall be so designed to carry the specified earth fault current of 40KA for 1 second.

Separation Sheath
The Separation Sheath should covering the whole surface area of the metallic screen as per IEC Standard.

Armour
The armour shall be Aluminium Alloy round wires or Corrugated Aluminum sheath as per IEC Standard.

Outer sheath
The outer sheath shall consist of an extruded layer of black medium density polyethylene. The outer sheath shall be of sufficient hardness to discourage termite attacks. The properties of outer sheath material shall be as per IEC 60 840. The nominal thickness of outer sheath shall be 2.6 mm.

Marking on Outer Sheath
The following particulars shall be either marked on Cable outer sheath or printed over a tape at suitable regular intervals.

a) Manufacturer's name and/or trade name.
b) Voltage grade viz. 33 kV or 11 kV.
c) Cable size (no. of core x conductor cross section).
d) Year of manufacture.
e) Purchaser's name i.e. BPDB.

The spacing between one set of marking and lie beginning of the next on the legend shall not exceed 300 mm. In case of printed over a tape, the same shall be provided inside the cable.

Straight-through joint box for 33KV XLPE, 1-Core, 500 mm² Copper cable

Item No.	Description of Items	Particulars
I	Application	For 33KV, 1-core, XLPE 500 mm² Copper Conductors
Ii	Installation	For underground horizontal mounting
Iii	System	33KV, effectively earthed system
Iv	Cable conductor	500 mm² 1-core, Copper Conductors
V	Construction	The joint shall be proof against ingress of moisture and water

Vi	Kit content	- Compression ferrules - Valid filling tape - Heat shrinkable stress control tubing - Truck resistant sealant tape - Heat shrinkable high voltage insulating tape - Heat shrinkable black/red dual wall - Estomeric tube - Roll spring - Heat shrinkable outer jacket tube - Cable preparation kit - Solderless earth connection kit - Misc. other material - Installation instructions

Indoor Termination Kits for 33KV, XLPE, 1-Core, 500 mm² Copper cable

I	Application	For 33KV, 1-core, XLPE 500 mm² Copper Conductors
Ii	Installation	For Indoor switchgear terminations
Iii	System	33KV, effectively earthed system
Iv	Cable conductor	500 mm² 1-core, Copper Conductors
V	Kit content	- Heat shrinkable high voltage insulating and non-tracking tubing - Heat shrinkable stress control tubing - Stress relieving mastic strip - Truck resistant sealant tape - Cable preparation kit - Solderless earth connection kit - Compression lugs for 500 mm² Copper Conductors - Installation instructions

Outdoor Termination Kits for 33KV, XLPE, 1-Core, 500 mm² Copper cable

I	Application	For 33KV, 1-core, XLPE 500 mm² Copper Conductors
ii	Installation	For outdoor installation on poles/structures
iii	System	33KV, effectively earthed system
iv	Cable conductor	500 mm² 1-core Copper Conductors
v	Kit content	- Heat shrinkable high voltage insulating and non-tracking tubing - Heat shrinkable stress control tubing - Stress relieving mastic strip - Truck resistant sealant tape - Heat shrinkable truck resistant rain skirt

		- Support insulator - Cable preparation kit - Solderless earth connection kit - Compression lugs for 500 mm^2 Copper Conductors - Support insulators Tee Brackets - Installation instructions

7.2.2 Tests for All 33kV XLPE Power Cables .

All type, routine and acceptance (special) tests shall be carried out as per IEC 60 502-2. The manufacturer of cable must have at least ISO 9001 certified quality Assurance system in their manufacturing system.

Routine Tests

The following routine tests shall be carried out on each manufactured length

a) Partial discharge test
b) Voltage test
c) DC voltage test on outer sheath
d) Conductor resistance test

Special (Acceptance) Tests

The following tests shall be made on samples which, for the tests in items (b) and (g), may be on complete drum length of cable taken to represent batches

a) Conductor examination
b) Measurement of electrical resistance of conductor
c) Measurement of thickness of insulation and non-metallic sheath
d) Measurement of thickness of metallic sheath
e) Measurement of overall cable diameter
f) Voltage test for 4 hours
g) Hot set test for XLPE insulation
h) Measurement of capacitance

Frequency of Tests

The above special (acceptance) tests shall be made on one length from each manufacturing series of the same type size of cable, but shall be limited to not more than 10% of the number of lengths in any contract, rounded to upper unity.

Type Tests

The following tests shall be included in the type tests (Electrical) Tests.

a) Bending test followed by Partial discharge test
b) Tan δ measurement
c) Heating cycle test followed by partial discharge measurement
d) Impulse withstand test followed by a power frequency voltage test

e) Voltage test for 4 hours

Test on cable components

a) Check for cable construction
b) Resistivity of semi conducting layers
c) Test for determining the mechanical properties of insulation before and after ageing
d) Test for determining the mechanical properties of non-metallic sheath before and after ageing.
e) Ageing tests on pieces of complete cable to check compatibility of materials
f) Pressure test at high temperature on sheath
g) Hot set test on XLPE insulation
h) Carbon black content of PE sheath
i) Shrinkage test on XLPE insulation.

7.2.3 Technical Orientation and Quality Test Witness of XLPE Power cable:

The Purchaser shall have the right to inspect/test the goods/materials to confirm their conformity to the specification. The purchaser shall be entitled at all reasonable time during manufacture to inspect, examine and test of goods/materials at the manufacturers' premises, workmanship and performance.

At least the following test along with routine test shall be carried out as per latest version of IEC Standard or equivalent IEEE standard or BS standard unless otherwise mentioned at the manufacturer premises or other places where the test facilities are available:-

1. MeasurementofElectricalResistanceofconducts.
2. Highn voltagetest
3. Partialdischargetest
4. Capacitancetest
5. Voltagetestoncableserving
6. Measurement of dimension of insulation and conductor

The Supplier shall, after consulting the purchaser, give the Purchaser reasonable notice in writing of the date on and the place at which any material or equipment will be ready for testing as provided in the contract and unless the purchaser shall attend at the place so named on date, which the supplier has stated in his notice, the supplier may proceed with the tests, which shall be deemed to have been made in the purchaser's presence, and shall forth with forward to the purchaser duly certified copies of test readings.

When the purchaser intends to attend the test he shall promptly inform the supplier accordingly in writing, so that he can take action. The purchaser shall give the supplier timely notice in writing of his intention to attend the test. The contractor shall submit the factory test report to the engineer for check and verification at least 15 days prior to inspection.

Where the supplier provides for tests on the premises of the supplier or of any manufacturer of the supplier, except where otherwise specified, shall provide free of charge such assistance, labor, materials, electricity, fuel, stores, apparatus and instruments as may be requisite and as may be reasonably demanded to carry out such test efficiently.

These test shall be performed as per relevant IEC Standard or equivalent IEEE standard or BS standard only routine tests as agreed upon, will be performed.
As and when the purchaser is satisfied that any materials/equipment shall have passes the tests referred to in this clause, purchaser shall notify the contractor in writing to that effect. Should any inspected/tested goods fail to conform to the specification, the Purchaser shall have the right to reject any of the item or complete batch if necessary. In that case Supplier have to replace the Equipment and to make good of them without any financial involvement to the Purchaser. In case any of the Equipment found not conforming with the specification at the time of post landing Inspection, the supplier will in no way be relieved from the responsibility of replacing them on making them good at their own cost, despite the Equipment were found good at the time of Factory Acceptance Test. Nothing in this clause shall in any way release the supplier from any warranty or other obligations under the contract.

7.2.4 Technical Specifications/Requirements Of 0.4 kV, 1x185 mm2 PVC Copper Cable

7.2.4.1 GENERAL SPECIFICATIONS :

These single core cables shall be designed as per above standards and suitable for operation at a maximum voltage of 1000V line to line and suitable for use underground buried in earth or in ducts and above ground in air or in buildings under local ambient conditions.

The maximum acceptable length of cable on a drum shall be 500M and shall be supplied on standard non-returnable treated wooden drum, each drum having stenciled on each side: drum number, code name of conductor, drum wound length together with gross and net weight, the manufacturer name, the purchaser's name and contract number with date. The cover of the drum should be of same treated wood.
Cable construction shall be as per BS 6004:1994 or equivalent to any internationally acceptable standard. Conductors shall be circular plain annealed copper in accordance with IEC 60228. Thickness of insulation shall be in accordance with IEC 502-1. The over sheath shall be an external layer of black PVC.

A means of identifying the cable size and BPDB ownership shall be inscribed throughout the length of the Cable in a single line on the PVC Insulation. The letters shall be upright block characters embossed on the surface; they are being not more than 300 mm between each group. The manufacturer's name with year of manufacture and Progressive Meter Marking shall be provided throughout the length of the cable.

Drum wound length of each drum may vary up to ± 5% of the total drum length as tolerance. However, the sum of total drum length shall be as per ordered quantity. Only one short length of conductor on a drum is considered for acceptance, if necessary. For the other

requirements, the given data shall be considered as minimum and maximum where necessary. No negative tolerances for the diameter and thickness are acceptable.

Description	Unit	Requirements
Cable Size	mm^2	1CX185
Material		PVC Insulated plain annealed copper.
Numbers & Diameter of wires	No/mm	18/To be mention
Maximum resistance at 30 °C	Ω/KM	0.124
Nominal thickness of insulation	Mm	1.80
Nominal thickness of sheath	Mm	1.80
Co lour of sheath		Black
Approximate outer diameter	Mm	21.9
Approximate weight	Kg/KM	1640
Continuous permissible service voltage	V	600/1000
Current rating at 30 °C ambient temperature U/G	Amps	350
Current rating at 35 °C ambient in air	Amps	405

7.2.20FEATURES AND ACCESSORIES:

- Conductors shall be delivered on standard non-returnable strong wooden drum. The central hole of the drum shall be reinforced to fit on axle size 95 mm diameter. The interior of the conductor drum shall be lined with bituminous paper to prevent the conductor from being in contact with timber or Aluminium water proof paper and felt lining shall overlap at seams by at least 20 mm and the seams shall be sealed.
- Drum shall be adequately protected by securely fastening substantial wooden battens around the periphery. These battens shall be secured by means of hoop metal bindings. Conductor drum shall be treated in an approved manner to resist termite and fungus attacks and shall be suitable for outside storage for a minimum period of 3 years in an equatorial climate without undue deterioration.
- The PVC covering shall be complete with PVC/A for Insulation and PVC-ST2 for Sheath as per requirement of IEC60502-1.
- There shall be only one length of conductor on a drum.
- Treated wooden drum standard: AWPA C_1 – 82, C_2 –83, C_{16} –82, P_5 –83.

7.2.21INFORMATION REQUIRED:

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

a) Manufacturer's Printed Catalogue describing specification and technical data for offered cable.
b) Cross-sectional drawings of offered cable.
c) Detail description of testing facilities (Routine & Type Test) at manufacturer's plant.

7.2.5 SPECIFICATION FOR COPPER CONTROL CABLE

7.2.5.1 STANDARDS:

The cable as specified in this Section shall be conforming to the latest edition of the following standards for operation under local ambient conditions. Design, Manufacture, Testing and Performance of the cable shall be in accordance with the IEC 502-1, BS 6004:1994 or equivalent International standards.

7.2.5.2 Specifications:

These cables shall be designed as per above standards and suitable for operation at a maximum voltage of 1000V line to line and suitable for use underground buried in earth or in ducts and above ground in air or in buildings under local ambient conditions.
The maximum acceptable length of cable on a drum shall be 1000M and shall be supplied on standard non-returnable treated wooden drum, each drum having stencilled on each side, drum number, code name of conductor, drum wound length together with gross and net weight, the manufacturer name, the purchaser's name and contract number with date. The cover of the drum should be of same treated wood.
Cable construction shall be as per BS 6004:1994 or equivalent to any internationally acceptable standard. Thickness of PVC insulation shall be in accordance with IEC 502-1. The over sheath shall be an external layer of black PVC.

A mean of identifying the cable size and BPDB ownership shall be inscribed throughout the length of the Cable in a single line on the PVC Insulation. The letters shall be upright block characters embossed on the surface; they are being not more than 300 mm between each group. The manufacturer's name shall be provided throughout the length of the cable with year of manufacture.

Drum wound length of each drum may vary up to ± 5% of the total drum length as tolerance. However, the sum of total drum length shall be as per ordered quantity. Only one short length of conductor on a drum is considered for acceptance, if necessary. For the other requirements, the given data shall be considered as minimum and maximum where necessary. No negative tolerances for the diameter and thickness are acceptable.

Description	Unit	Requirements					
Cable Size	mm^2	4CX2.5 mm^2	4CX4m m^2	4CX6m m^2	8CX2.5 mm^2	16CX2.5 mm^2	24CX2.5 mm^2
Material		plain annealed copper	plain annealed copper	plain annealed copper	plain annealed copper	plain annealed copper	plain annealed copper
Numbers & Diameter of wires	No/mm	7/0.67	7/0.85	7/1.04	7/0.67	7/0.67	7/0.67
Diameter of Steel wires/ Strips	mm	1.4	4×0.8	4×0.8	4x0.8	4x0.8	4x0.8
Thickness of Steel Tape	mm	-	0.25	0.25	0.25	0.25	0.25
Maximum resistance at 30 °C	Ω/KM	7.28	3.20	3.20	7.69	7.69	7.69
Nominal thickness of PVC insulation	mm	0.8 (min.)	1.0 (min.)	1.0 (min.)	0.8 (min.)	0.8 (min.)	0.8 (min.)
Nominal thickness of PVC sheath	mm	1.8 (min.)	1.8 (min.)	1.8 (min.)	1.8 (min.)	1.8 (min.)	1.8 (min.)
Colour of sheath		Black	Black	Black	Black	Black	Black
Approximate outer diameter	mm	17	20	21	20	25	28
Approximate weight	Kg/KM	670	810	920	1040	1630	1730
Continuous permissible service voltage	V	600/1000	600/1000	600/1000	600/1000	600/1000	600/1000

7.2.5.3 FEATURES AND ACCESSORIES:

- Cables shall be delivered on standard non-returnable strong wooden drum. The central hole of the drum shall be reinforced to fit on axle size 95 mm diameters. The interior of the conductor drum shall be lined with bituminous paper to prevent the conductor from being in contact with timber or Aluminum water proof paper and felt lining shall overlap at seams by at least 20 mm and the seams shall be sealed.
- Drum shall be adequately protected by securely fastening substantial wooden battens around the periphery. These battens shall be secured by means of hoop metal bindings. Conductor drum shall be treated in an approved manner to

resist termite and fungus attacks and shall be suitable for outside storage for a minimum period of 3 years in an equatorial climate without undue deterioration.

- There shall be only one length of cable on a drum.
- Treated wooden drum standard: AWPA C_1 – 82, C_2 –83, C_{16} –82, P_5 –83.

7.2.5.4INFORMATION REQUIRED:

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

a) Manufacturer's Printed Catalogue describing specification and technical data for offered cable.
b) Cross-sectional drawings of offered cable.
c) Detail description of testing facilities (Routine & Type Test) at manufacturer's plant.
d) Manufacturer's valid ISO 9001 Certificate.

7.2.6 Technical Specifications/Requirements Of All Control Cable XLPE Insulated Armoured Copper Cable

7.2.6.1 STANDARDS:

The cable as specified in this Section shall be conforming to the latest edition of the following standards for operation under local ambient conditions. Design, Manufacture, Testing and Performance of the cable shall be in accordance with the IEC 502-1, IEC 60228, BS 6004:1994 or equivalent International standards.

7.2.6.2 Specifications:

These All Control cables shall be designed as per above standards and suitable for operation at a maximum voltage of 1000V line to line and suitable for use underground buried in earth or in ducts and above ground in air or in buildings under local ambient conditions.

The acceptable length of cable on a drum shall be 1000M and shall be supplied on standard non-returnable treated wooden drum, each drum having stenciled on each side : drum number, code name of conductor, drum wound length together with gross and net weight, the manufacturer name, the purchaser's name and contract number with date. The cover of the drum should be of same treated wood.

Cable construction shall be as per BS 6004:1994 or equivalent to any internationally acceptable standard. Conductors shall be circular plain annealed copper in accordance with IEC 60228. The armoured shall be round Aluminium Wire.Thickness of insulation shall be in accordance with IEC 502-1. The over sheath shall be an external layer of black PVC.

A means of identifying the cable size and BPDB ownership shall be inscribed throughout the length of the Cable in a single line on the PVC Insulation. The letters shall be upright block characters embossed on the surface; they are being not more than 300 mm between each group. The manufacturer's name with year of manufacture and Progressive Meter Marking shall be provided throughout the length of the cable.

The insulation shall be cross-linked polyethylene (XLPE). The insulation material shall comply with the requirements as per IEC-60502-2. The insulation shall be applied by extrusion and vulcanization to form a compact homogeneous body free from micro voids and contaminates.

7.2.6.3 FEATURES AND ACCESSORIES:

- Conductors shall be delivered on standard non-returnable strong wooden drum. The central hole of the drum shall be reinforced to fit on axle size 95 mm diameter. The interior of the conductor drum shall be lined with bituminous paper to prevent the conductor from being in contact with timber or Aluminium water proof paper and felt lining shall overlap at seams by at least 20 mm and the seams shall be sealed.
- Drum shall be adequately protected by securely fastening substantial wooden battens around the periphery. These battens shall be secured by means of hoop metal bindings. Conductor drum shall be treated in an approved manner to resist termite and fungus attacks and shall be suitable for outside storage for a minimum period of 3 years in an equatorial climate with out undue deterioration.
- The PVC covering shall be complete with PVC/A for Insulation and PVC-ST2 for Sheath as per requirement of IEC60502-1.
- There shall be only one length of conductor on a drum.
- Treated wooden drum standard: AWPA C_1 – 82, C_2 –83, C_{16} –82, P_5 –83.

7.2.6.4 INFORMATION REQUIRED:

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

a) Manufacturer's Printed Catalogue describing specification and technical data for offered cable.

b) Cross-sectional drawings of offered cable.

c) Detail description of testing facilities (Routine & Type Test) at manufacturer's plant.

d) Manufacturer's valid ISO 9001 Certificate.

7.2.6.5 Type Test

Type Test Reports for XLPE Insulated and PVC sheathed Copper cable (4CX4mm^2) from an independent testing Laboratory/ Institute as per relevant Standards (unless otherwise specified).

7.2.6.6 Marking on Outer Sheath

The following particulars shall be either marked on Cable outer sheath or printed over a tape at suitable regular intervals.

f) Manufacturer's name and/or trade name.

g) Cable size (no. of core x conductor cross section).

h) Year of manufacture.

i) Purchaser's name i.e. BPDB.

j) Meter Marking (PVC cable should carry a meter mark)

The spacing between one set of marking and lie beginning of the next on the legend shall not exceed 300 mm.In case of printed over a tape, the same shall be provided inside the cable.

Note: No negative tolerances for the diameter and thickness are acceptable

4CX2.5mm² XLPE Insulated Armoured Copper Cable

Description	Unit	Requirements
Cable Size	mm²	**4CX2.5mm²**
Material		XLPE Insulated and PVC sheathed Armoured Copper Cable
Numbers & Diameter of wires	No/mm	7/0.67
Maximum resistance at 20 °C	Ω/KM	3.20
Nominal thickness of insulation	mm	0.80
Nominal thickness of sheath	mm	1.8
Co lour of sheath		Black
Approximate outer diameter	mm	18
Approximate weight	Kg/KM	670
Continuous permissible service voltage	V	600/1000
Current rating at 30 °C ambient temperature U/G	Amps	34
Current rating at 35 °C ambient in air	Amps	31

4CX4mm² XLPE Insulated Armoured Copper Cable

Description	Unit	Requirements
Cable Size	mm²	**4CX4mm²**
Material		XLPE Insulated and PVC sheathed Armoured Copper Cable
Numbers & Diameter of wires	No/mm	7/0.85
Maximum resistance at 20 °C	Ω/KM	4.61
Nominal thickness of insulation	mm	0.70
Nominal thickness of sheath	mm	1.8
Co lour of sheath		Black
Approximate outer diameter	mm	18.4
Approximate weight	Kg/KM	720
Continuous permissible service voltage	V	600/1000
Current rating at 30 °C ambient temperature U/G	Amps	34
Current rating at 35 °C ambient in air	Amps	31

4CX6mm² XLPE Insulated Armoured Copper Cable

Description	Unit	Requirements
Cable Size	mm²	**4CX6mm²**
Material		XLPE Insulated and PVC sheathed Armoured Copper Cable
Numbers & Diameter of wires	No/mm	7/1.04
Maximum resistance at 20 °C	Ω/KM	3.08
Nominal thickness of insulation	mm	0.70
Nominal thickness of sheath	mm	1.8
Co lour of sheath		Black
Approximate outer diameter	mm	19.80
Approximate weight	Kg/KM	860
Continuous permissible service voltage	V	600/1000
Current rating at 30 °C ambient temperature U/G	Amps	64
Current rating at 35 °C ambient in air	Amps	56

8CX2.5mm² XLPE Insulated Armoured Copper Cable

Description	Unit	Requirements
Cable Size	mm²	**8CX2.5mm²**
Material		XLPE Insulated and PVC sheathed Armoured Copper Cable
Numbers & Diameter of wires	No/mm	7/0.67
Maximum resistance at 20 °C	Ω/KM	7.69
Nominal thickness of insulation	mm	0.70
Nominal thickness of sheath	mm	1.8
Co lour of sheath		Black
Approximate outer diameter	mm	20
Approximate weight	Kg/KM	1040
Continuous permissible service voltage	V	600/1000
Current rating at 30 °C ambient temperature U/G	Amps	64
Current rating at 35 °C ambient in air	Amps	56

16CX2.5mm² XLPE Insulated Armoured Copper Cable

Description	Unit	Requirements
Cable Size	mm²	**16CX2.5mm²**
Material		XLPE Insulated and PVC sheathed Armoured Copper Cable
Numbers & Diameter of wires	No/mm	7/0.67
Maximum resistance at 20 °C	Ω/KM	7.41
Nominal thickness of insulation	mm	0.70
Nominal thickness of sheath	mm	1.8
Co lour of sheath		Black
Approximate outer diameter	mm	25.00
Approximate weight	Kg/KM	1260
Continuous permissible service voltage	V	600/1000
Current rating at 30 °C ambient temperature U/G	Amps	15
Current rating at 35 °C ambient in air	Amps	12

24CX2.5mm² XLPE Insulated Armoured Copper Cable

Description	Unit	Requirements
Cable Size	mm²	**16CX2.5mm²**
Material		XLPE Insulated and PVC sheathed Armoured Copper Cable
Numbers & Diameter of wires	No/mm	7/0.67
Maximum resistance at 20 °C	Ω/KM	7.69
Nominal thickness of insulation	mm	0.70
Nominal thickness of sheath	mm	1.8
Co lour of sheath		Black
Approximate outer diameter	mm	28.00
Approximate weight	Kg/KM	1730
Continuous permissible service voltage	V	600/1000
Current rating at 30 °C ambient temperature U/G	Amps	15
Current rating at 35 °C ambient in air	Amps	12

7.3 CIVIL AND ARCHITECTURE GENERAL PROVISION FOR AIS SUB-STATION

7.3.1 References

7.3.1.1 General

The design and construction shall conform to the latest edition of the relevant codes and standards. Any proposed substitution for the listed standards by an equivalent standard will be subject to approval by the Engineer. Relevant standards include.

7.3.1.2 Design and Construction Standards

BDS 612	Portland Cement
BS EN 124	Gully and Manhole tops for vehicular and pedestrian areas
BS 812	Testing Aggregates
BDS 243 : 1963	Coarse and Fine aggregates from natural sources for Concrete; ASTM C33, Concrete Aggregates; ASTM C330, Lightweight Aggregates for Structural Concrete; ASTM C637.
BS 1377	Methods of test for soil for civil Engineering purposes
BS 1722:Part10	Anti-intruder fences
BS 1881	Testing concrete
BS 2853	Design and testing of overhead runway beams
BS 3148	Methods of test for water for making concrete
BS 3921	Clay bricks
BDS 580	Steel bars and wires for the reinforcement of concrete
BS 5262	External renderings
BS 5395	Stairs, ladders and walkways
BS 5572	Sanitary pipe works
BS 5628	Code of practice for use of masonry
BS 5930	Code of practice for site investigations
BS 6031	Code of practice for earth works
BS 6367	Code of practice for drainage of roofs and paved areas
BNBC 2006	Code of practice for dead and imposed loads
BNBC 2006	Code of practice for wind loads
BS 6465	Sanitary installations
BS 6651	Code of practice for protection of structures against lightning
BS 6700	Design, installation, testing and maintenance of services supplying water for domestic use.
BNBC 2006	Code of practice for foundations
BS 8005	Sewerage
BS 8100	Lattice towers and masts
BS 8102	Code practice of protection of structures against water the ground structural use of concrete.
BS 8110	Structural use of concrete
BS 820	Lightning of buildings

BS 8215	Code practice for design and installation of damp-proof courses in masonry
BS 8290	Suspended ceilings
Bs 8301	Code of practice for Building drainage

7.3.1.3 STANDARDS AND CODES OF PRACTICE

The engineering & execution of all Civil, Structural & Architectural works shall be principally based on Contract Document and Bangladesh National Building Code (BNBC), otherwise the latest edition or revision of the applicable portion of the following Codes and Specifications. In case any particular aspect of works is not covered by this Standard, other standard specifications may be specified by the Engineer, shall be followed by the code those are mentioned below as per chronological priority.

1) Contract Document
2) Bangladesh National Building Code (BNBC)
3) Rules & Regulations of local authorities.
4) American Codes and standards (ASTM, ACI & AASHTO).
5) The Bureau of British Standard Codes.
6) Indian Standard Codes (IS Code).
7) Chinese Codes.
6) Environmental protection agency.
7) Local Statutory regulations.

Basic design conditions shall be as follows:-
a. Seismic Zone Coefficient: Seismic Zone-2, Zone coefficient, Z=0.15 (as per BNBC, 2006).
b. Design Storm: Based on frequency-intensity Duration curves prepared for Sylhet Zone.
c. Basic Wind Speed : 260 km/h
d. Design load for road : H-20-S16-44 (AASHTO)
e. Standards and codes of practice : BNBC, ASTM, ACI and inter-national codes of practice and other Standards to be approved by the Engineer.

7.3.2 Design

Both Architectural and Structural Design shall be submitted by the contractor to the employer for approval.

7.3.2.1 Architectural and structural Requirements of Buildings

The details Architectural, Structural & other related drawing and design with Green Building concept shall be submitted by the contractor to employer for approval.

1. **Structure** : Modern Architectural designed R.C.C or Steel Framed Structure featured by
   Green Building Technology.
2. **Partition Wall** :

   For all Exterior wall thickness should be 10 (ten) inches and to be used 1st class brick. For all Interior wall thickness should be 5 (five) inches except the Fire wall using for Indoor X-formers & Battery Room at control floor and to be used 1st class brick.

3. **Covered Area**: Minimum required area in Building are included with service areas & Other
   Specific Functions - Control Room, Battery room, Cable Trench, Store, Office Rooms, walkway, open Space & stair case etc.

4. **Foundation for AIS Sub-station** :

   For horizontal extension of Control Building :

   Construction of 67.5 sq. mm. horizontal extension on first floor of existing control room building
   Plinth Level at +3ft above from Ground Level
   Ground Floor clear height will be as per existing Control room
   1st Floor clear height will be as per existing Control room.

5. **Floor/Roof Finish** :

   To be used 24 inch x 24 inch size European standard Mirror Polished Homogeneous tiles for Control Room Floor, Office Floor/ Dormitory Floor approved by the engineer. To be used Standard quality Non-skid Homogenous CC Finished for Roof Top Floor, Cable Room Floor & X-Former Floor approved by the engineer.

6. **Toilet/ Sanitary**:
   - To be Constructed 100 users septic tank at control building with indoor transformer and 50 users septic tank at control building with outdoor transformer, inspection pit, sewerage line, apron, drain etc.
   - Floor and full height wall of the Toilet should be furnished by European Standard Tiles with decorative boarder. Floor tiles should be non-slippery.
   - To be used European Standard Commode, Basin and others Sanitary Fittings & Fixtures (such as Pillar Cock, Bib Cock, Push

Shower etc.) should be European Standard as well as approved sample and design.

- To be provided water supply system with Deep Tube well & over head water tank.

7. **Electrical Fittings & Fixture** :
   - Concealed Electrical wiring by Eastern/BRB/Paradise Fire Resistant Cable
   - European Made MK type Gang switch, socket MCB etc
   - Provision for Internet facility system, Dish Antenna line, Telephone & Intercom wiring, Dedicated High Voltage Electrical line.
   - Sufficient Earthling facilities.
   - To be used LED Light
   - To be provided sufficient Air Conditioner
   - To be provided sufficient Ceiling Fan

8. **Interior Wall Finishing** : Smooth Finished & soft colored Plastic paint should be used over the Plastering work of interior wall and ceiling.

9. **Exterior Wall:** Smooth Finished & Architectural approved colored weather coat should be used over the Plastering work of Exterior wall. Some where should be used Ceramic Facing brick / Rustic Tiles

10. **Window** : Window Should be made Standard Quality 1.2mm thickness of Thai Aluminum frame/plate and minimum 5mm thickness glass using U.S (AAMA) Standard.

11. **Door** : Door Frame and Shutter should be made by solid wood such as Burma Teak, Teak Chambal, Chapalish etc. & Fire Protected Door should be used for Fire Exit access at building which shall be approved by the owner's engineer.

12. **Stair Railing** : Should be used approved designed SS Railing in the Stair case.

13. **Sign, Signal & Annotation :**• Integrated Design of Different kind of Indicators like- Acrylic Sign Board, LED Sign Board, Neon Sign Board, Reception Sign Board, Safety Sign, PVC Letters, Glow Sign Board, Customized Display Boards, Overhead

Signage, Metal Nameplates, Commercial Sign Boards, Outdoor Signs, Electronic Sign Boards etc. should be provided in the design & construction.

- Digital LED Signboard with the features of- **Excellent visibility (even in daylight); Good quality at reasonable price and light weight; Simple installation, Safe to touch and clean; Changing color for attracting attention; Extremely low power consumption.**
- Should be provided the **Accessories like Adaptor and chains etc.**

14. **Drainage:** Each control building shall be provided with a septic tank designed for 100 users at control building with indoor transformer , 50 users at control building with outdoor transformer and a soak well of open brick construction 10 m deep by 2.2 m diameter filled with broken bricks.

15. **Approval & Test of the BPDB. authorized : Over all Approval should be taken from concern office Materials & Item (if required) should be tested from any Institutions of Bangladesh furnished by the Contractor.**

The columns of the ground story shall be external above roof level to permit starter bars to be left in place for a future story. The floor shall be a RCC slab designed for 5.5 KN/m^2 for control room floor and live load for all other floor shall be taken as per BNBC-2006.

The main entrance to all buildings shall be shaded, either by a projection of the roof over the entrance verandah or by a separate roof at a lower level. This area of roof shall also be lime terraced and drained by rainwater pipes.

The head of each down pipe shall be fitted with an enlarged hopper and purpose made cast iron grill set into recess in the roof projection.

Window openings shall be fitted with protruding concrete sunshades above and at the sides of the openings.

All external walls shall be 250 mm first class brick work also provide 237.5mm x 68.75mm x 12.5mm (9.5"x2.75"x0.5") or any other standard sizes of Mirpur ceramics facing bricks or similar approved, or rendered Rustic Tiles as required by the architectural plan. The internal walls shall be generally of 125 mm thick first class brick work. Internal walls shall all be

rendered and receive one sealer coat plus two finishing coats of Plastic emulsion paint. All brickwork shall be tied into the RCC frame by galvanized ties.

Externally, rendered walls shall receive primer plus two finishing coats of PEP acrylic external quality paint or similar approved.

The height of control rooms shall be provided about 1 (One) meter clearance over the top of the cabinets to the underside of the false ceiling. In the switch gear rooms, about 1 meter clearance shall be provided over the switch gear to the underside roof slab but the Contractor shall provide a greater clearance if it is required to remove equipment. The clearance may be reduced below down stand beams provided no equipment is required to be removed from the top of the switch gear. All rooms in any building shall be one height.

Control buildings housing switch gear and control equipment shall include a cable basement to facilitates connection to the equipment. Basements shall be constructed so as to protect the building sub structure from water in accordance with BS 8102.

Provision for Fire fitting & fixture for Installation of fire equipment, fire detection, fire protection etc. Control room building should have the standard sized fire exit/scape with facilities and the fire scape should be designed according to floor area accommodation.

7.3.2.2 Ground conditions, Foundations and Site Investigation

(a) Fill Sites
On fill sites where the depth of fill exceeds 3 meters the contract assumes piled foundations shall be installed below buildings. If placed foundations are found to be unnecessary in the final site investigation report, a reduction in contract value shall be agreed on the basis of schedule rates.

Piles shall be concrete (cast in situ or pre-cast) complying with BS 8004. Where timber piles are used, adequate strip footings shall be provided to support the building after the timber piles have deteriorated by which time settlement will be complete.

On every fill site the Contractor shall prove that his switchyard foundation will not suffer settlement greater than 20 mm by constructing a foundation and load testing this to twice the design bearing pressure for a minimum of 20 days.

Outdoor equipment shall be provided with spread footings. The Contractor will be provided by the Employer with a survey of soil levels prior to filling. The Contractor shall impose the site layout on the survey to check for uneven depth of fill below any foundation and where uneven depth of fill exists his foundation proposals shall restrict final differential settlement to a 1 in 400 slopes.

If a fill site has not been exposed to one wet season before foundation work starts, the Contractor shall flood the site to a depth of 50 mm for 10 days (Not required on hydraulic fill site). This requirement is because silt sands will generally compact to a denser condition on first time flooding.

On all fill sites the Contractor shall pipe rainwater from pipes down to paddy level and shall prevent water pond in open foundations and backfill all foundations as soon as possible.

The Contractor shall monitor settlement of the fill (by placing concrete posts 50x50x750 mm deep on a 10 meter grid and taking readings) at 30 day intervals from the time he is given access to each fill site.

When a fill site is handed over to the Contractor, The Contractor shall become responsible for maintaining the entirely of the fill in good condition, including all batter slopes.

(b) Unfilled Sites

Original delta levels are generally 4 meters below road level. Therefore most sites are historically fill sites but fill settlement can sensibly be considered complete, where fill is over 3 years old.

(c) Site Investigation

The Contractor may appoint a sub contractor to carry out the site investigations but all work and all lab work shall be witnessed by one of his own staff who shall countersign all recorded data.
The site investigations and analysis of the data in a final report giving full details of foundation proposals shall be completed at each site by the programmed date.
Boreholes shall be taken on a 25 meter grid with at least three additional boreholes beside each building. Additional boreholes may also be required where uneven fill depth is encountered. The boreholes shall be located to an accuracy of ±0.5 m and shall be located to site layout.

Boreholes shall be a minimum of 20 meters depth or twice building footing width, whichever is greater or as per site condition & decision of the employer. All boreholes shall be back filled with compacted sand.

In each bore hole the following tests shall be carried out :

Standard penetration tests at 1.5 meter intervals.

Undisturbed samples shall be taken at around 1.5 meters depth and 3 meters depth and tested by unconfined compression tests.

One dimensional consolidation tests shall be carried out on undisturbed samples taken at 1,5,3 and 4.5 meters depth. The samples shall be saturated and the range of applied pressure shall fully reflected the in situ conditions. Graphs showing void ratio (e) and applied pressure shall be submitted along with the coefficient of compressibility for the range of loading anticipated. Mv shall be in m^2/MN and shall be recorded at each stress increment. The coefficient of consolidation, cv, shall be given in $m^2/year$.

Particle size analysis shall be carried out for each stratum and specified gravity, moisture content, liquid limit and plastic limit determined.

Ground water level shall be determined by dipping the boreholes. Where collapse of the boreholes occurs, casing shall be used and left in until the water level remains constant for two days.

In cohesive soils a vane test to BS 1377 : part 9 shall be carried out at three different depths. The Contractor shall check the aggressively of soil and ground water at each site to concrete and take all measures necessary to ensure the long term durability of concrete. Along with Project Office, Office of the Director, Directorate of Design & Inspection-III, BPDB shall supervise all civil related works performed by the Contractor through design drawing review, recommendation for approval, site visits (wherever necessary) for quality check and will ensure smooth civil works advancement in the Facility.

(d) Site Investigation Report/o//

The report shall be submitted by the key date at each site given in the program. The Contractor shall submit 2 copies of the report to the Engineer. The report shall propose full details of foundations and loading thereon and shall provide estimates of likely settlements and differential settlements. The report shall be the work of the Contractor's own foundation Engineers.

If the Contractor uses a local site investigation contractor, he shall appoint one of his own staff to oversee the entire operation and each piece of data shall be countersigned by this person.

The Contractor shall supply, install and test at least one of the types of Pile in accordance with the approved design and the drawing showing the Piling arrangement. Each Pile shall be suite existing the sub-strata at the site.

(e) Foundations

The minimum depth of all foundations shall be 1.5 m from Existing Ground Level.

All formations shall be hand rammed or mechanically compacted before placing 70 mm minimum thickness of Class B concrete blinding, within 24 hours of bottoming excavation, which blinding shall project 300 mm minimum distance beyond all footings. Each footing shall be inspected by the Engineer. Where soil condition is poor (on fill sites or already filled sites) or where the Contractor leaves foundations exposed and soil conditions deteriorate, one of the following measures shall be carried out as agreed with the engineer.

(i) Blinding depth and projection shall be increased

(ii) Soft soil shall be removed and replaced with compacted viti sand with the top 200 mm consisting of Viti sand and brick chips.

The cost of this work shall be borne by the Contractor.

Between column footings all walls, including all internal wall shall be provided with a reinforced concrete strip footing of minimum dimension 800 mm wide by 250 mm deep placed at the same level as column footings and linked structurally to the footings. In addition column footings shall be tied at foundation level and also floor level by beams to every adjacent column in both orthogonal directions. These beams shall be designed to resist 1 in 200 differential settlement without distress and shall be capable of resisting the earthquake load of Sylhet region as per BNBC 2006

The deepest parts of any foundations shall be completed first. All foundations shall be completed and back filled, including all cable tunnel and cable trench work inside buildings, before walls are raised above floor levels. All other foundations shall be back filled within 7 days of completing concerning.

All exposed concrete and outer surfaces of cable trenches and cable tunnels shall receive two coats of bitumastic paint before back filling to reduce ingress of water. The Concrete surface shall be ground smooth and all air holes etc. filled (rubbed down with a cement slurry) before painting.
The Contractor shall monitor settlement of all foundations each month and report this settlement to the Engineer until settlement has reduced to less than 1.5 mm in 3 months.

The tops of all foundations shall terminate 1000mm above site average finished surface level. All exposed edges shall have 20 mm x 20 mm chamfers.

Excavation shall only be carried out when the ground water table at least 1000mm below foundation level. The excavation shall be kept dry during the construction period by providing sumps and pumps as required. During the rain season, shelters shall be erected over all open excavations.

Any over excavation shall be filled with Class B concrete.

All back fill shall be completed to 95% maximum dry density as defined by BS 1377 test method. 2.5 Kg rammer.

Before starting foundation work the Contractor shall clear all sites of trees, tree roots shrubs, debris, surplus soil, and any buildings.

Foundations shall be designed to resist uplift, assuming the water table is at ground level and the weight of soil resting on a foundation is that included within a 15^0 frustum.

On fill sites where the depth of fill exceeds 3 meters, the Contractor shall provide piled foundations in accordance with BS 8004 for control buildings. If timber piles are used, adequate strip footings shall be provided to support the structure after the timber pile has deteriorated, by which time the fill will be fully consolidated. One working pile chosen by the Engineer shall be load tested at each site to 150% of design load in accordance with BS 8004.

7.3.2.3 Drainage

The entire surface within boundary walls shall be of uniform sloping site, sloping at q in 150 minimum slopes to open channels around the entire perimeter. These channels shall be designed for a rainfall intensity of 60 mm per hour. Outside the boundary wall the contractor shall be responsible for drainage up to 20 meters from the wall and will at some sites need to construct outlets with suitable erosion protection down to paddy level.

The concrete wall of cable trenches shall project at least 70 mm above brick paving level to prevent run off entering the cable trench. The floors of all cable trenches /tunnels shall be sloped to soak ways.

The cable trenches shall be free from surface water drainage. If the cutoff area exceeds 30 m^2 it shall be drained by a 200 mm minimum diameter concrete pipe to the boundary drain. The Contractor's drainage design shall avoid all pond water to avoid forming a mosquito breeding ground .

All drainage pipe work within buildings shall be ductile iron, generally of 100 mm diameter. Floor drains shall be placed in each battery room and toilet.

External Pipe work shall be 150 mm minimum diameter concrete pipes at a minimum depth of invert of 700 mm. Where pipes, including existing pipes along with site, are less than 400 mm above adjacent foundations they shall be surrounded in concrete. Where required, drainage pipes shall be kept below cables, allowing 1.1 m cover to top of pipes.

Manholes shall be of brick construction with 600mm x 600mm clear openings and air tight ductile iron covers to BS EN 124. Manholes shall be located at each change of direction. Minimum fall on all pipelines shall be 1 in 80. Manhole shall not be located in roads.

The Contractor shall be responsible for all negotiations with local authority WASA where a connection to a public sewer is proposed. Where high water levels in public sewers may cause effluent to back up into a site, non return valves shall be fitted. The Contractor shall provide all protection required to existing sewers and shall deepen foundations, including boundary wall foundations, where required all foundations are below adjacent sewers. The Contractor shall draw longitudinal sections of all pipelines.
Each control building shall be provided with a septic tank designed for 50 users and a soak away of open brick construction 10 m deep by 2.2 m diameter filled with broken bricks. The septic tank shall be located at least 15 meters from buildings. Other buildings shall have septic tanks designed for the required number of users. All foul drains shall vented by a vent pipi to above roof level. The inner surface OD all manholes and septic tanks shall be painted with 2 coats of bitumastic paint to protect it against sulphate attack. The septic tank shall have access holes directly over the inlet pipes and outlet pipes. Where public sewers exist alongside a site, the Contractor shall connect directly to the foul sewer, provided effluent from the sewer is treated.

The Contractor shall construct the drainage first to ensure that at no stage is rainwater ponded on any part of the site. All rainwater shall be able to run off the site or shall be immediately pumped off site by the Contractor. The Contractor shall complete all necessary drains before casting any roof and large concrete area which will create large run off. The condensate drains for the air conditioning shall also be connected to the drainage. Two vents of minimum height 2.2 m shall be provided on each septic tank.

If a town's water supply is unreliable, the roof rain water shall be collected in an underground tank of standard Employer's design. Scope of this work shall be agreed at Bid stage.

7.3.3 Earth Work

7.3.3.1 Scope

This clause covers the performance of all works in connection with the required excavation for the various type of foundations and equipment, as shown in the drawing, or any other excavation and banking that may be necessary during the progress of works including the removal, use or disposal of all excavated materials.

7.3.3.2 Clearing

(1) Clearing shall mean include the remove of trees and shrubs, stumps and other objectionable matters from the area necessary for the works. The contractor shall cut and remove them from the project area or turn them as approved by the Engineer.

(2) By no means shall the contractor fell any trees outside the premise of the construction site without permission of the parties concerned even if such trees cause obstacle against smooth execution of the work. Therefore, any such trees shall be felled upon negotiation with and permission of the possessor.

7.3.3.3 Excavation

(1) Excavation under this section shall consist of the removal, hauling, dumping and satisfactory disposal of all materials from required excavations.

(2) The excavated slope surface shall be protected against any erosion due to heavy rains during construction period. Should any damage be caused on any face of slope, the contractor shall immediately repair any such damage at his expense.

(3) Excavation shall be carried out by adopting a suitable excavation for the ground so as not to loosen the ground outside the excavation. If necessary, temporary sheeting shall be constructed.

(4) During excavation, work shall be performed carefully so as not to cause any damage to adjacent structures and buried structures.

(5) If the excavated material is to be temporarily stockpiled, designated spaces shall be kept from the shoulder of the road while considering the earth pressure at the excavated surface and the working space. Temporary sheeting or other such structures, if necessary, shall be constructed so that the stockpile can be protected from damage or being washed away.

(6) Excavation of road, if any, shall be done in such a manner as not to hamper vehicular traffic. If excavation is to be performed in the vicinity of residences, appropriate care shall be taken so as not to hinder the passage of residents.
Spoils, materials and equipment shall be carefully handled.

(7) After completion of excavation, excavated widths and bottoms shall be subject to inspection by the engineer.

(8) Blasting shall not be employed during excavation.

(9) Any and all excess excavation for the convenience of the contractor or over-excavation performed by the contractor for any purpose or reason, except may be ordered in writing by the engineer, and whether or not due to the fault of the contractor, shall be at the expense of the contractor. All such excess excavation and other excavation shall be filed at the expense by the contractor with materials approved by the engineer.

(10) The contractor shall be entitled to request the engineer in writing to change the excavation line as required according to the soil conditions of the foundation following the progress of excavation. In such a case, upon excavation up to the laid excavation line, the contractor shall prepare the detailed design drawing of the said foundation and submit it to the engineer for his approval.

(11) All objectionable materials such as, oil, mud, rock fragments, loose rock, chips, mortar, organic matters and stagnant water, shall be removed from the surface of the foundation.

7.3.3.4 Sheeting

(1) Sheeting shall be of the type that is suitable to the condition of foundation and Ground water and shall have a safe structure.

(2) If sheet piles on retaining piles are to be driven at the piling location in the vicinity of buried structures, where they shall be investigated and confirmed by manual trench excavation etc. prior to piling in order to protect these structures from being damaged when piles are to be pulled out, carefulness shall be taken into account to cause no damage to the buried structures.

7.3.3.5 Banking

Foundation of banking shall be treated as follows:

(1) Any material having a harmful effect on banking shall be removed.
(a) Where inflow of ground water is expected, it shall be treated so as not to cause inundation.
(b) In case of sloped ground with unfavorable conditions, such as unsuitable soil, poor drainage, etc, a method, such as excavating the ground into steps in advance in order to increase its stability, shall be planned and reported to the Engineer.

(2) Unless otherwise specified, settlement allowance shall be 3 per cent of the height of the banking and the surface shall be graded evenly within =5 cm.

(3) Materials for banking shall not include any harmful materials, such as fertile soil or pieces so wood.

(4) Materials for banking shall not be of an extremely swelling nature.

(5) Impermeable clay shall not be used for back-filling of a structure which is susceptible to earth pressure.

(6) Banking shall be formed by spreading soil of less than 50 cm in thickness and by sufficiently compacting each layer.

(7) The type of compactor shall be one that is suitable or banding materials.

(8) Materials for banking shall be so treated as to have optimum water content in percent of dry weight.

(9) Rocks shall be spread out evenly so as not to form any void space.

(10) Temporary facilities shall not be buried in banking. If it becomes inevitable to do so, it shall be reported to the engineer and shall be approved by the engineer, upon which appropriate measures shall be taken to prevent any unfavorable effect on the banking.

(11) As a standard, extent of satisfactory compaction shall be as follows :

K75 =1.5 Kg./cm3 or more

Where : K 75 is a coefficient of bearing capacity determined by the plate load test.

When required by the engineer, the contractor shall perform in-sity tests and penetration test to confirm the extent of compaction and the result shall be submitted to the engineer.

(12) Any banking work on rainy day shall be carried to upon approval of the Engineer.

7.3.3.6 Back-Filling

(1) Back filling shall be executed as construction proceeds along with the removal of shoring and other materials at the back filling site.

When sheeting is to be left and buried in order to prevent shear failure of soil or due to some other inevitable reasons, it shall be done so according to the direction of the engineer.

(2) Except those which are specified in the specifications or the drawings, all the materials for back filling shall be in accordance with the clauses of "Banking" 2.5 of these specifications.

(3) If the inflow of water exists at the site of back filling it shall be appropriately treated.

(4) In back filling, the layer of spreading shall be around 50cm or less per lift, and it shall be graded as horizontally as possible, and shall be sufficiently compacted by hydraulic filling or by use of an appropriate compactor such as a rammer.

(5) Extent of compaction shall be such that it will prevent future settlement and such that the designated bearing capacity can be obtained. If necessary, the extent of compaction shall be measured by a cone penetrometer etc. and the record shall be submitted to the engineer.

(6) If there is any surface or buried structure owned by the public or the third party at the site of back filling, care shall be taken so as to cause no harmful effect to them, and the execution of the work shall be carried out following direction by the engineer and in the presence of relevant administrators.

(7) For back filling adjacent to a structure, compaction and back filling shall be carried out in such a manner that will prevent damage to the structure.

No stones or the like shall be used for back filling.

7.3.3.7 Disposal of Excavated Materials

(1) Spoils produced by excavation shall be piled, graded, sloped or disposed of at the locations specified by the Board or Engineer and it shall be subject to inspection by the engineer.

Spoil, whose disposal areas are not specified by the engineer, shall be disposed of by the contractor at his responsibility.

(2) In transporting the spoils, care shall be taken so as to neither hamper traffic nor cause trouble to the third party by scattering the spoil over the road.

7.3.3.8 Gravel Layer

(1) Gravel and rubble produced locally shall be used. Gravel layer shall, in principle, be laid in a single layer with no large gaps, stand on end and interstices shall be filled with granular gravel.

(2) The compaction shall be executed by a compaction machine (rammers, etc.)

(3) Gravel layer shall be well compacted together with covering gravel and shall be graded and finished to the designated level.

7.3.4 Piling

7.3.4.1 Pile Driving

(1) Piles shall be driven by a pile driver, suitable for the type and size of the piles, geological conditions and construction environment, and in such a manner as to cause no public nuisance, such as noise, to the third party.

(2) The method for construction joint of piles shall be submitted in writing to the engineer and shall be subject for approval by the engineer.

(3) Records shall be kept during the poling operation and these shall be submitted to the engineer.

(4) Piles shall be driven vertically and at the exact locations indicated in the drawings, and pile driving shall be continuous without interruption to avoid deviation of pile head.

(5) Caps and other suitable materials shall be used as a cushion to protect the head of piles.

(6) Toward the end of driving the amount of penetration shall be measured for each pole as directed by the engineer.

(7) Should it be difficult to drive any pile up to the specified depth, the contractor shall carry out such pilling work in accordance with the instructions of the engineer.

(8) Method and equipment of pile driving to be employed for construction works shall be subject to approval of the engineer prior to execution.

(9) When driving a group of piles, driving shall begin from the center and gradually moved outward.

(10) When eccentric error exceeds the allowable values shown in the table below or when a pile is damaged or creaked during piling operation, it shall be reported to the engineer, and the pile shall be replaced or an additional pile shall be driven.

Type of Foundation	Allowance	Remarks
All foundations	10 cm or less	

(11) Upon completion of piling, any void portions inside piles shall be filled back with soil obtained from at site excavation.

7.3.4.2 Field Joining of Piles

(1) Field joining of piles shall be carried out by arc welding.

(2) Welders shall have not less than 6 months continuous experience in welding of pile, and shall be qualified by JIS Z-3801, "Standard Qualification Procedures for welding Technique", or equivalent BDS.

(3) Are welding rods shall be standard items specified in IETC (International Electro technical Commission) or equivqlent "Covered Electrodes for Mild Steel", or equivalent. Welding rods shall be completely dry prior to use.

(4) The welding surface of parent metal shall be carefully cleaned of slag, moisture, dust, rust, oil, paint or other foreign matter.

(5) The root face of steel pipe pile shall be 2mm,

(6) Welding shall be performed carefully by selecting welding current and welding speed which ensure complete penetration of welding rood to avoid cracks in any portion of the weld.

(7) Welding shall not be performed when the parent metal is wet from rainfall or when strong winds are blowing. However, when the portion to be welded in suitable protected, welding may be performed upon approval of the engineer.

(8) If harmful defects or cracks have been found in the weld, the deposited metal shall be carefully chipped off and the affected part shall be re-welded and then inspected by the engineer.

7.3.4.3 Treatment of Pile head

(1) The head of the piles shall be cut to the designated level and shall be embedded into the footing.

(2) The steel pipe piles shall be anchored into the footing by a method specified otherwise.

7.3.4.4 Transportation and Handling

Care shall be taken in transportation ad handling of pole so as to prevent damage to them.

If the pile is damaged or deformed to the extent that it is impractical for the intended use, the contractor shall repair it prior to driving, and it shall be inspected and approved by the engineer.

7.3.5 Reinforced Concrete Work

7.3.5.1 General

(1) This clause covers the performance of all reinforced of all reinforced concrete work for permanent structures in accordance with the drawings and these specifications.

(2) The contractor shall furnish all materials and equipment for the performance of concrete work.

(3) Reinforced concrete work and plain concrete work shall comply with ACI (American Concrete Institute), BNBC (Bangladesh National Building Code) or equivalent standard.

(4) Covering

(a) The covering shall be at least one diameter of the reinforcement.

(b) In general, the covering shall be at least those shown in Table-1.

Table-1 : Minimum Covering (mm)

Conditions	Slabs	Beams	Columns
When not directly exposed to rain or wind	20	40	40
Large and important structure, or when exposed to Rain or wind	25	40	65
When effective coating is not applied on the portion Which may be subjected to injurious chemical reaction			
Due to smoke, acid, oil, salts, etc.	37.5	50	75

(c) In case of footings and important members of a structure it is recommended that the covering be at least 7.5 cm when concrete is placed directly facing the ground, and at least 5 cm for bars with diameter of more than 16cm and 4 cm for bars with the diameter of less than 16 mm when the concrete is buried and directly facing the ground or when it is subjected to severe weather conditions. However, the covering at the bottom side of slabs may be at least 2.5cm even if the portion of it is subjected to extreme weather condition.

(d) The covering in structures which are required to be especially fire-proof shall be determined based on the temperature of the fire, duration, characteristics of aggregate to be used, etc.

7.3.5.2 Quality of Concrete

(1) General

Concrete shall have the uniform quality with the required strength, durability, water tightness etc.

(2) Strength

(a) The strength of concrete shall generally be based on 28 days compressive strength.

(b) Compression tests for concrete shall be performed in accordance with ACI, BNBC or equivalent standard.

7.3.5.3 Materials

Materials used for the construction of buildings shall conform to standard specifications listed in this part of the Code. Any deviation from the type design or architectural detail from those specified in these standards may be accepted by the Building Official as long as the materials standards specified therein are conformed with.

7.3.5.3.1 Cement

Cement for shall be Ordinary Portland Cement complies with the standards listed as follows: BDS 232: 1974, Portland Cement (Ordinary and Rapid Hardening) or ASTM C150, Portland Cement; ASTM C91, Masonry Cement; ASTM C595, Blended Hydraulic Cements.

Cement for other than masonry shall conform to the following standards: BDS 232, Portland Cement (Ordinary and Rapid Hardening); BDS 612, Sulphate Resisting Portland Cement-Type A; ASTM C150, Portland Cement; ASTM C 595, Blended Hydraulic Cements; and to other such cements listed in ACI 318.

7.3.5.3.2 Water

(1) Water shall be free from injurious amounts of oils, acids, salts, organic materials or other materials that may be deterious to concrete.

(2) Sea water shall not be used in mixing concrete for reinforced concrete.

7.3.5.3.3 Fine Aggregate

(1) General

Fine aggregate shall be clean, strong, hard, durable, suitably graded and free from injurious amounts of dust, mud, organic impurities, salts etc.

Beach sand shall not used for concrete.

(2) Grading

Fine aggregate shall consist of large and small particles suitably mixed, and its grading shall, as a standard, be within the range shown in table 2.

Table-2 : Standard Grading of Fine Aggregate

Nominal Size of Sieve (mm)	Weight percentage of those passing a sieve	Nominal size of sieve (mm)	Weight percentage of those passion a sieve

10	100	0.6	25 – 65
5	90 – 100	0.3	10 – 35
2.5	80 – 100	0.15	2 – 10
1.2	50 – 90		

Sieve analysis shall be in accordance with JIS A 1102, or equivalent BD standard.

7.3.5.4 Coarse Aggregate

(1) General

Coarse aggregate shall clear, strong, hard, durable, suitably graded and free from injurious amount of flakes, elongated pieces, organic impurities, salts etc.

(2) Grading

Coarse aggregate shall consist of large and small particles suitably mixed, and its grading shall be within the range shown in Table 3 as a standard.

Sieve analysis shall be performed in accordance with JIS A 1102, or equivalent BD standard.

Table-3 : Standard Grading of Coarse Aggregate

SS (mm)	Weight percentage of those passing a sieve

SA (mm)		50	40	30	25	20	15	10	5	2.5
			95			40		10	0	
	40	100								
			100			65		30	5	
					95		30		0	0
	25			100						
					100		70		10	5

SS : Nominal Size of Sieve
SA : Size of Aggregate

7.3.5.5 Reinforcement

Reinforcement in masonry shall conform to the standards listed as follows: ASTM A82, Cold Drawn Steel Wire for Concrete Reinforcement; ASTM A615M, Deformed and Plain Billet Steel Bars; ASTM A616M, Rail-Steel Deformed and Plain Bars; ASTM A617M, Axle-Steel Deformed and Plain Bars; ASTM A706M, Low-Alloy Steel Deformed Bars; ASTM A767M, Zinc-Coated (Galvanized) Steel Bars; and ASTM A775M, Epoxy - Coated Reinforcing Steel Bars.

7.3.5.6 Crushed Stones

Crushed Stone to be used as coarse aggregate shall conform to the following standards: BDS 243 : 1963, Coarse and Fine Aggregates from Natural Sources for Concrete; ASTM C33, Concrete Aggregates; ASTM C330, Lightweight Aggregates for Structural Concrete; ASTM C637, Aggregates for Radiation-Shielding Concrete; ASTM C332 , Lightweight Aggregate for Insulating Concrete; IS: 9142 Artificial Lightweight Aggregates for Concrete Masonry Units.

7.3.5.7 Admixture

Admixtures to be used in concrete shall be subject to prior approval by the Building Official and shall comply with Sec. 2.4.5.1 through 2.4.5.5.

- **Chloride** : Calcium chloride or admixtures containing chloride from admixture ingredients shall not be used in prestressed concrete, concrete containing embedded aluminum in concrete cast against permanent galvanized metal forms, or in concrete exposed to severe or very severe sulphate-containing solutions (see Sec 5.5.2.1 of Part 6).
- **Standards** : Air-entraining admixtures shall conform to ASTM C260. Water-reducing admixtures, retarding admixtures, accelerating admixtures, water-reducing and retarding admixtures, and water-reducing and accelerating admixtures shall conform to ASTM C494, Chemical Admixtures for Concrete, or ASTM C1017, Chemical Admixtures for Use in Producing Flowing Concrete.
- **Pozzolanas** : Fly ash (Pulverized Fuel Ash) or other pozzolans used as admixtures shall conform to ASTM C618.
- **Blast Furnace Slag** : Ground granulated blast-furnace slag used as an admixture shall conform to ASTM C989.
- **Pigment for Coloured Concrete** : Pigment for integrally coloured concrete shall conform to ASTM C979.

7.3.6 Storage of Materials

7.3.6.1 Storage of Cement

(1) Cement shall be stored separately for each type in either silos or damp-proof warehouses.

(2) Silos to store cement shall be built or equipped with suitable means so that cement will not be retained at the bottom without being conveyed out.

In case of sacked cement, it shall be stacked on the floor rising at least 30 cm from the surface or the ground, and shall be stored in such a manner as to facilitate conveyance and inspection. Height of each stack shall be at most 13 sacks.

(3) Any portion of Cement which has hardened during its storage shall not be used at all. Cement stored for long period shall be tested for its quality prior to its use.

(4) Cement with excessively high temperature shall be used only after lowering the temperature.

7.3.6.2 Storage of Aggregate

(1) Fine aggregate, coarse aggregate and other aggregate of different type and grading shall be separately stored between each.

(2) When receiving, storing and handling aggregate, facilities shall be well maintained, and handling shall be carefully performed so that no segregation of large particles from small ones may occur, no foreign materials may become mixed, or in case of coarse aggregate, no particles may be crushed.

(3) Storage facility of aggregate shall be equipped with a suitable drainage system, and shall have a suitable capacity so that the aggregate with uniform surface water may be used and the aggregate received may be used after being tested.

(4) In hot weather, aggregate shall be stored in a place with a facility to avoid direct exposure to the sun etc. so that extreme drying or temperature rise in the aggregate does not occur.

7.3.6.3 Storage of Reinforcement

Reinforcement shall not be directly placed on the ground, and it shall be stored in a warehouse or a place with suitable cover.

7.3.6.4 Storage of Admixture

(1) Admixture shall be stored so as to be free from dusts and other impurities. Admixture in power form shall be stored in such a manner that absorption of water and hardening are prevented, and admixture in liquid form shall be stored in such a manner that segregation and change in quality are prevented.

(2) Admixture materials shall be carefully handled so as not to be scattered.

(3) Admixture material shall be stored in silos or warehouses which are desirably damp-proof and shall be used in the same order as they are received.

(4) Admixture stored for a long period of found to have changed shall be tested prior to its use. Should it be found in the test that the admixture does not possess the required characteristics, its use shall not be allowed.

7.3.7 Testing of Materials

(1) The all materials (cement, water, fine aggregate, coarse aggregate, reinforcement, admixture, etc.) to be used shall be approved by the engineer after the contractor submits the results of tests.

(2) The testing method shall comply with the various codes of ASTM, ACI, BNBC or equivalent standard.

7.3.8 Mix Proportions

7.3.8.1 General

(1) Mix proportion for concrete shall be determined in such a manner that the unit quantity of water is minimized while the required strength, durability, water tightness and the workability suitable for the work are secured.

(2) Mix proportion for concrete and results of test mixing shall be determined so as to provide the required strength, workability, uniformity and durability. The scheme of mix proportion shall be submitted to the engineer for approval, The attached form of submission shall be used. The design strengths of the concrete shall be the classes indicated below.

4 Fc	=	210 kg/cm2	For Architecture and Switchyard
4 Fc	=	180 kg/cm2	For Transmission
4 Fc	=	120 kg/ cm2	For leveling Concrete

Where 4 Fc means concrete compressive strength at the age of 28 days.

Basic design date for mixing are indicated in the table herein.

Table - 4 : Basic Mix Data

Class	Design strength 4Fc (kg/cm²)	Maximum size of aggregate(mm)	Slump (cm)	Air entertainment (%)	
E	210	25	10 - 15	4 1	Architecture Switchyard
B	180	40	10 - 15	4 1	Transmission
C	120	40	10 - 15	4 1	Leveling Concrete

Note :

1. Specific gravity in design
   Cement - 3.15, Fine Aggregate - 2.62, COARSE Aggregate and Crushed Stones - 2.62

2. Relationship between C/W (Cement water ratio) and maximum compressive strength at 28 days.
   ø 28 = 210 + 215 C/W

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					Quantity (per mixed 1 m³) (kg/m³)				
Maximum size or aggregate (mm)	Slum	Air entrain-ment (%)	Maximum water/ cement W/c (%)	Sand percen-tage S/a (%)	Water W	Cement C	Fi	Coarse aggregate	Admixtures
								mm-mm	mm-mm

7.3.9 Batching and Mixing

7.3.9.1 Batching

(1) General

Each material to be used in concrete is obtained.

(2) Batching Equipment

(a) Batching method and batching equipment for each material shall be subject to the approval of the engineer in advance.

(b) Batching equipment for each material shall be inspected and adjusted, if necessary, prior to the commencement of the construction work and periodically during the construction.

(3) Batching of materials

(a) Batching shall be made in accordance with the job mix. Test for surface water of the aggregate shall be in accordance with ASTM or equivalent or as directed by the engineer. Test for the quantity of the effective absorption of water, in case of dried effective absorption of water, shall be as directed by the engineer.

(b) Volume of one batch shall be determined as directed by the engineer.

(c) Each material shall be batched by weight for each batch except the water and the solution of admixture, which may be measured by volume.

(d) Error in the measurement in each batch shall be at most the values given in Table 5.

Table-5 : Allowable Error in Measurements

Type of Materials	Permissible Error (%)
Water	1
Cement &Admixture Material	2
Aggregate	3
Solution of Admixture Agent	3

7.3.9.2 Mixing

All concrete shall be mixed thoroughly until there is a uniform distribution of materials and shall be discharged completely before the mixer is recharged.

Ready mixed concrete shall be mixed and delivered in accordance with the requirements of "Specification for Ready Mixed Concrete" (ASTM C94) or "Specification for Concrete Made by Volumetric Batching and Continuous Mixing" (ASTM C685).

Job mixed concrete shall be mixed in accordance with the following:

a) Mixing shall be done in a batch mixer of approved type.

b) Mixer shall be rotated at a speed recommended by the manufacturer.
c) Mixing shall be continued for at least 90 seconds after all materials are in the drum, unless a shorter time is shown to be satisfactory by the mixing uniformity tests of "Specification for Ready Mixed Concrete" (ASTM C94).
d) Materials handling, batching, and mixing shall conform to the applicable provisions of "Specification for Ready Mixed Concrete" (ASTM C94).
e) A detailed record shall be kept to identify:
   i) number of batches produced;
   ii) proportions of materials used;
   iii) approximate location of final deposit in structure;
   iv) time and date of mixing and placing.

(1) General

Materials for concrete shall be thoroughly mixed until the mixed concrete becomes uniform in quality.

(2) Mixers

(a) Mixers shall be either tilting batch mixers or forced batch mixers.

(b) Any concrete mixers to be used under this project shall be subject to approval of the engineer.

(c) Mixers shall be such that they will not cause any separation of materials at the time of discharging.

(3) Mixing

(a) When charging a mixer, all the materials shall be charged uniformly and simultaneously in principle.

(b) Mixing time shall, in principle, be determined based on tests. As a standard, it shall be at least 1 minute and 30 seconds for tilting type misers and 1 minute for forced mixers.

(c) Mixing shall not be continued for more than three times the specified mixing time.

(d) Materials for new batch shall not be charged into the mixer until all the concrete in the mixer is discharged.

(e) Mixers shall be thoroughly cleaned before and after their use.

(f) Concrete left as mixed and commenced setting shall not be used after re-tempering.

7.3.10 Conveying and Placing

(1) Prior to the commencement of the construction work, a plan of conveying and placing shall be made and this shall be subject to the approval of the engineer.

(2) Concrete shall be conveyed by methods which will minimize separation and loss of materials, shall be placed immediately and then shall be thoroughly compacted. Even when it is impossible to place the concrete immediately due to some special reasons, the time between mixing and the completion of placing shall not exceed 45 minutes.

During the waiting period, the concrete shall be protected against direct exposure to the sun, wind and rain, and the concrete left for a relatively long time shall be re-mixed without adding my water. No portion of concrete which has started to harden shall be used.

(3) When extreme separation is observed in concrete during its delivery or placement, it shall be made uniform in quality by re-mixing.

7.3.10.1 Conveying

(1) Conveying

Equipment to be used in conveying concrete shall be those which can easily deposit. Should the delivery distance be long, they shall be equipped with such facility as an agitator.

(2) Buckets

Structure of buckets shall be such that they will not cause any separation of materials when charging or discharging concrete and that the concrete can be easily and swiftly deposited from them.

(3) Belt Conveyors

Should belt conveyors be used, they shall be suitably located so that they will be suitably located so that they will not impair the quality of the concrete and the end of the line shall be provided with baffle plates and an elephant trunk so that the separation of materials can be prevented.

(4) Buggies and Trolleys

Should buggies or trolleys be used, a level runway or path shall be constructed so that separation of materials will not occur in conveying concrete.

(5) Chutes

(a) Should any chute be used, it shall be a drop chute in principle. The drop chute shall be connected to an elephant trunk so that the separation of materials is minimized.

(b) Open chutes may be used, only when approved by the Engineer. Each open chute shall be inclined at uniform angle all along its length, and the slope shall be such that it will not cause any separation of materials of the concrete to be placed. The distance between the bottom end of the chute and the surface on which concrete is to be deposited shall be at most 1.5m. the discharging end shall be equipped with a suitable elephant trunk.

7.3.10.2 Placing

(1) Preparation

(a) Prior to the placement, the arrangement of reinforcement, forms etc. shall be approved by the engineer.

(b) Prior to the commencement of the placement, it shall be certified that conveying equipment and placing equipment are in conformance to the plan of placing specified in Clause-____

(c) Prior to the placement, conveying equipment, placing equipment and the inside of forms shall be thoroughly cleaned to prevent foreign materials from being mixed into the concrete. Portions expected to face concrete and to absorb water shall be moistened in advance.

(d) Water in pits and sumps shall be removed prior to the placement of the concrete. Suitable protective measures shall be taken so that water running into these pits and sumps will not wash the concrete just placed.

(2) Placing

(a) Concrete shall be placed in accordance with the plan of placing specified in Clause-____should it be inevitable to change the placing method, it shall be so done as directed by the Engineer.

(b) When concerning is done in hot weather, special attention shall be given to the materials, placement, curing etc.

(c) Portions such as the ground and foundations which may absorb the water in concrete shall be thoroughly wetted prior to the placement of concrete.

(d) Temperature in concrete at the time of placing shall be at most 35° C.

(e) Conveying equipment for concrete shall be such that they will protect concrete from being dried or heated.

(f) Concrete shall be protected as soon as the placement is completed or interrupted. Special care shall be exercised to keep the surface of the concrete moist.

(g) During the concerning operation, attention shall be paid not to disturb the arrangement of the reinforcement.

(h) Concrete shall be embedded into concrete with abundant mortar. Should any notable separation of materials be observed during concerning, the concrete shall be remised to obtain the uniform quality and necessary measures to prevent separation shall be taken before the placing operation is resumed.

(i) Concrete for one section shall be placed continuously until it is completed.

(j) Concrete shall, in principle, be placed in such a manner that the surface of the placed concrete will be horizontal within the section. One lift in placement shall be at most 40 cm, in principle.

(k) Should concrete be placed in layers, each succeeding layer shall be placed while the one below it is still plastic. Should it become necessary to place concrete on top of a layer which has started setting, it shall be done in accordance with Clause 4.10.

(l) When height of the form work is great, it shall be provided with openings for concrete placing, or the placement shall be done using from chutes in order to prevent the concrete from being segregated or from adhering to the reinforcement or to the forms above the layer to be placed.

(m) The height of the end of buckets and hoppers shall be at most 1.5 m above the level of placement.

(n) Should there by any water coming out and accumulated during the placement, the concrete shall not be placed further until the water is removed by a suitable means.

(o) When concerning high structures such as walls and columns continuously, the consistency of the concrete and the rate of lifting shall be controlled in such a manner that separation of materials during the placement and the compaction is minimized.

7.3.11 Compaction

(1) In principle, internal vibrators shall be used to compact the concrete. When it is difficult to use internal vibrators in the case of thin walls, form vibration shall be used.

(2) Vibrators to be used shall be subject to the approval of the engineer.

(3) Concrete shall be thoroughly compacted immediately after placement and shall be thoroughly worked around the reinforcement and into the corners of the form. Where conditions take compaction difficult, batches of mortar containing the same proportions

of cement, sand and water as used in the concrete shall first be deposited to certify the compaction.

(4) When compaction is achieved by vibrators, it shall be inserted into the layer below the one just placed by about 10cm. The vibrators shall be pulled out very slowly so that no hole will form in the concrete.

(5) When concerning is to be compacted by internal vibrators, the spacing and the time of their application shall be as directed by the engineer.

7.3.12 Additional Placing

Should additional placing be made on top of a layer which has already started to harden, it shall be thoroughly and carefully worked on as directed by the engineer so that the top and the lower layer becomes monolithic.

(1) Wet Curing.

(a) Concrete, after being placed, shall be sufficiently cured without being subjected to injurious effects caused by low temperature, drying, sudden change in temperature, etc.

The contractor shall report the said method to the engineer and obtain his approval.

(b) Concrete shall be protected from vibrations, impacts and loads while it is hardening.

(2) Wet Curing

(a) Concrete being placed and compacted shall be protected from the sun, wind, showers etc.

(b) Any exposed surface of concrete which has hardened to a degree that works can be done without impairing it shall be either covered with wet mats, canvas, sand etc. or directly watered, and shall be kept moistened continually for at least 5 days after the placement in case ordinary Portland cement is used.

(c) When sheathing boards are expected to become dry, they shall be watered.

7.3.13 Joints

(1) General

(a) Location and structure of joints as shown and specified in the drawings shall be observed.

(b) Should any joint not specified in the design be made, its location, direction and method of construction shall be determined in the plan of construction so that it will not impair the strength and the appearance of the structure, and this shall be subject to the approval of the engineer.

(2) Construction Joints

(a) Construction joints shall be located where the shear acting there is as small as possible, and with their face in perpendicular, in principle, to the direction of compression in the member.

(b) Should it be unavoidable to make a construction joint at a location where large shear is action, it shall be reinforced by forming tenors or grooves, or embedding suitable steel.

(3) Construction of Horizontal Construction Joints

(a) Sided of the surface of a horizontal construction joint intersecting the forms shall be kept as horizontal and straight as possible.

(b) When new concrete is placed, the surface of the old concrete shall be removed of all laitance, interior concrete, loosened aggregate, etc. and shall be thoroughly wetted.

(c) Prior to the placement of new concrete, the forms shall be tightened, and either cement paste or mortar with the same mix proportions as in concrete shall be applied on the surface of the old concrete.

The concrete shall then be placed immediately and shall be compacted so that is will be in tight contact with the old concrete.

(4) Construction method for Vertical Construction Joints

(a) When a vertical construction joint is to be made, the forms at the joint shall be rigidly supported, and the concrete in the vicinity of the point shall be thoroughly compacted by vibrators.

(b) Fresh concrete shall be placed after the surface of the aged concrete at the joint is removed of the surface film or is roughened and thoroughly wetted, followed by the application of cement paste or mortar, or after the surface is treated as directed by the engineer.

(c) Fresh concrete shall be thoroughly compacted at the time of placement so that the fresh and the aged concrete is in tight contact with each other. It is recommended that the new concrete be compacted again after a suitable delay by applying vibration.

7.3.14 Reinforcement Works

7.3.14.1 Processing of Reinforcement

(1) Reinforcement shall be processed to the shape and the dimension as shown in the drawings by a method which will not impair the quality of the material.

(2) Reinforcement shall be processed in ordinary temperature. When it is unavoidable to heat for processing, the whole process shall be subject to the approval of the engineer.

7.3.14.2 Fabrication of Reinforcement

(1) Prior to fabrication, reinforcement shall be thoroughly cleaned and free from loose rust and any other material which may impair the bond between the reinforcement and the concrete.

(2) Reinforcement shall be placed to the designated position, and shall firmly be fabricated so that it will not be dislocated ruining the placement of concrete. Erection bars, if required, shall be used for this purpose.

Important crossings of reinforcement shall be fastened by either annealed wire of at least 0.9mm in diameter.

(3) Clearance between reinforcement and sheathing board shall be maintained correctly by use of spacers.

(4) Reinforcement shall be always inspected by the engineer after the completion of fabrication.

7.3.14.3 Joints of Reinforcement

(1) Lap joints of reinforcement shall be made by lapping the required lengths and fastening them together at several points with annealed wire of at least 0.9mm in diameter.

(2) Reinforcement projecting form the structure and exposed for future jointing shall be protected from damage, corrosion, etc.

7.3.15 Forms and Timbering

Forms and timbering shall be so designed and constructed as to have the required strength and rigidity, to secure correct position, shape and dimension of the structure and to secure the satisfactory quality in concrete.

7.3.15.1 Materials

Materials to be used for the form and the timbering shall be selected based on the strength, rigidity, durability workability, effect on the concrete to be placed.

7.3.15.2 Design of Forms

(1) Forms shall be those which can easily be fabricated and stripped; joints of sheathing boards and panels shall be forced in parallel with or perpendicular to the axis of the member so that it will have a structure which is tight against mortar.

(2) The structure of form shall be such that the corners of concrete can be moulded even when it is not particularly specified.

(3) Temporary openings, if necessary, shall be made at suitable locations to facilitate cleaning and inspection of the forms and the placing of concrete.

7.3.15.3 Design of Timbering

(1) Suitable types of timbering shall be selected and the load carried by them shall be correctly transferred to the foundation by appropriate means.

(2) As for the timbering for important structures, design drawings shall be prepared by they shall be subject to the approval of the engineer.

7.3.15.4 Construction of Forms

Stripping agents shall be applied on the inside of the sheathing board.

7.3.15.5 Construction of Timbering

(1) Timbering shall be constructed so as to have sufficient strength and stability.

(2) An amount of the settlement of the form words due to the weight of the placed concrete shall be estimated and a chamber shall be introduced, if necessary, in the shoring.

7.3.15.6 Inspection of Forms and Timbering

(1) Forms and timbering shall be inspected by the Engineer prior to the placement of contents.
(2) Condition of forms and timbering shall be inspected during the placement of concrete.

7.3.5.7 Removal of Forms and Timbering

(1) Forms and timbering shall not be removed until the concrete reaches a strength required to carry the concrete weight and the load applied during the construction work.

(2) Time and sequence of the removal of the removal of the forms and timbering shall be subject to the approval of the engineer.

7.3.15.8 Loading on a Structure Immediately After Removal of Forms and Timbering

Loading on a structure immediately after the removal of the forms and timbering shall be subject to the approval of the engineer.

7.3.16 Finishing

7.3.16.1 General

When the uniform appearance should be obtained on the exposed surface, special attention shall be given to place the concrete for the predetermined section continuously without changing the materials, proportions and the method of the placement.

7.3.16.2 Surface Not Facing Sheeting Boards

(1) Surface of the concrete compacted and approximately leveled to the required level and shape shall not be finished until the water coming out ceases or is removed.

(2) Cracks formed after finishing but before hardening shall be removed by tamping or re-finishing.

7.3.6.3 Surface Facing Sheathing Boards

(1) Concrete which will be exposed shall be placed and compacted in such a manner that the surface solely composed of mortar will be secured.

(2) Projections and lines formed on the surface of concrete shall be removed to ensure surface flatness. Honeycombs and chipped places shall be removed and the surface and the surface shall be moistened and patched with appropriately proportioned concrete or mortar to be finished flat.

(3) Cracks formed after the removal of the forms due temperature stress, drying shrinkage, etc. shall be repaired as directed by the Engineer.

7.3.17 Quality Control and Inspection

7.3.17.1 General

Materials of concrete, reinforcement, equipment's and workmanship shall be controlled produce reinforced concrete of the required quality economically.

7.3.17.2 Tests of Concrete

(1) During construction, the following tests shall be carried out as directed by the Engineer.
(2) Air test
(3) Compression test of concrete.
(4) Others

7.3.17.3 Inspection of Forms and Timbering

(1) Forms and timbering shall be inspected by the Engineer Prior to the placement of contents.
(2) Condition of forms and timbering shall be inspected during the placement of concrete.

7.3.17.5 Removal of Forms Timbering

(1) Forms and timbering shall not be removed until the concrete reaches a strength required to carry the concrete weight and the load applied during the construction work.
(2) Time and sequence of the removal of the forms and timbering shall be subject to the approval of the Engineer.

7.3.17.5 Loading on All Structure Immediately after Removal of Forms and Timbering

Loading on a structure immediately after the removal of the forms and timbering shall be subject to the approval of the Engineer.

7.3.18 Finishing

7.3.18.1 General

When the uniform appearance should be obtained on the exposed surface, special attention shall be govern to place the concrete for the predetermined section continuously without changing the materials, proportions and method of the placement.

7.3.18.2 Surface Not Facing Sheathing Boards

(1) Surface of the concrete completed and approximately leveled to the required level and shaper shall not be finished until the water coming out ceases or is removed.

(2) In order to determine the suitability of the curing method and the time to remove the forms, and in order to certify the safety for early loading, strength tests shall be preformed on specimens cured under the conditions as similar as possible to those of the concrete at the site.

Should the result of the test indicate that the obtained strength of the specimen is much smaller than that of the specimens cured under the control condition, the method of curing at the site shall be changed as directed by the Engineer.

(3) For Compression test of concrete, six (6) test specimens shall be required for each concrete. Three (3) specimens shall be tested for seven (7) or fourteen (14) days strength, the remained three(3) specimens shall be tested for twenty- eight (28) days strength.

The expense for the above tests shall be included is the unit prices.

(4) Should it become necessary after the completion of the work, non- destructive test of concrete or tests on concrete specimens cut from the structure shall be carried out.

7.3.18.3 Test of Reinforcement Bars

In the case where there is no test certificate of reinforcement bars (mill sheet) or incase the Engineer deems necessary, the contractor shall carry out the characteristics test of reinforcement bars and obtain an approval of the Engineer.

7.3.18.4 Test Method

Test method shall conform the those specified in ASTM, ACI, BNBC or equivalent, unless directed otherwise by the Engineer.

7.3.18.5 Report

The result of the tests shall be reported to the Engineer without delay.

7.3.18.6 Control of Concrete by Compressive Strength

(1) Control of concrete by compressive strength shall generally be based on 28 days compressive strength. Specimens, in this case, shall be taken in such a manner that they will represent the concrete of the structure.

(2) Test results of compressive strength to be used for the control of concrete shall generally be obtained by averaging the compressive strength specimens taken from the same batch.

(3) Should the quality of concrete be controlled by the test results, it shall be use the control test.

7.3.18.7 Inspection of Quality of Concrete

(1) The contractor shall submit to the Engineer the results of Inspection of Quality of concrete obtained according to the quality control test in the preceding Paragraph 8.16.6 and obtain and approval of the Engineer.

(2) Should it be found in the inspection that the quality of the concrete is not suitable, remedial measures such as modifying the mix proportions, performance tests of equipment's and facilities, improvement of the working method, etc. shall be taken. The concrete placed in the structure shall be checked if it can perform the designated function and the suitable measures, should it become necessary as directed by the Engineer.

7.3.19 Inspection of Structures

Structures shall be inspected after their completion as directed by the engineer.

- **Brick Masonry Work**

Prior to commencing the brick masonry work, the surface of brick shall thoroughly be cleaned and sufficiently moistened in order to ensure smooth adherence of mortar to the brick surface.

7.3.20 Road Work

The Construction work of roads shall be carried out in accordance with the Drawing.

However, demolition and restoration of the public roads (including private roads) shall be carried out according to the specifications designated the official in charge of road management not with standing the provisions described in the specifications and the Drawing.

7.3.20.1 Road Work Inside The Premises

(1) Sub -grade

a) Any excavation and banking work required for sub-grade construction shall be carried out in accordance with the respective provisions in General Provision SECTION-2 : EARTH WORKS.

b) The material required for banking and displacement shall be so placed that the finished thickness of one layer after compaction will become 20 cm or less.

c) The sub-grade surface shall be finished by proof- rolling in order to obtain the contact pressure sufficient to permit smooth traffic of vehicles of 8 tons or over should any defects be detected as a result of proof-rooling, such detective sub-grade surface shall be finished again to the satisfaction of the Engineer.

d) The finished sub-grade surface shall be within + 5 cm of the design elevation.

(2) Sub base Course

(a) The materials to be used for sub base course shall be in accordance with the specification described in the Drawing. The Contractor shall submit a report concerning the quality of materials and the methods of sampling to the Engineer for approval.

(b) The finished surface of sub base course shall be within -10 mm and + 5mm of the design elevation.

(3) Surface Course (Asphalt pavement)

(a) Prior to commencing pavement, the sides of concrete side walk, manhole, etc. shall be cleaned, and molten asphalt, etc. shall be coated over the sides.

(b) The surface to be seal-coated and prime- coated shall be finished into even level, and after perfecting removing any bloc, dust and other foreign matters, such surface shall be cured and dried.

(c) The mixtures shall be spread uniformly, rolled and finished into the specified thickness. Then, the finished surface shall be measured in parallel to the center line of the load by using a 3 m straight line ruler. In this case, the depth of any concise sections shall not exceed 5 mm.

(d) The Contractor shall submit a report on the materials to be used for pavement of surface course and method therefore to the Engineer to the Engineer for approval.

(4) Inspection

The Contractor shall receive inspection of the Engineer during the course and after completion of sub base course and surface course works.

7.3.20.2 Public Road (Including Private Road)

(1) Demolition of Pavement

Demolition of Pavement for public roads including private roads shall be carried out so carefully as not to cause any hazardous effect upon the surrounding portions of cement, concrete or pavement.

(2) Road Keeping and Restoration

(a) The road keeping shall be of a construction applicable to the prevailing site conditions and so provided as not to cause any danger or trouble against traffic.

(b) The contractor shall submit the drawings for road keeping to the Engineer for approval.

(c) The Contractor shall constantly patrol any spots of road keeping and exert his utmost efforts perform maintenance and repair of such roads in order to eliminate any trouble against smooth traffic.

(d) The Contractor shall carry out maintenance and repair of any pertinent roads so carefully as not to cause any trouble against smooth traffic until the said roads have been restored and taken over to the official in charge of road management.

7.3.21 Drainage Work

(a) The drainage work shall be as described in the Drawing and carried out in accordance with General Provision SECTION-2 : EARTH WORK AND SECTION-3 : REINFORCED CONCRETE WORK.

(b) The water – plumbing facility for drainage shall be of such a construction as not to cause any trouble against the surrounding area and structure. The contractor shall submit the design and execution schedule for the water plumbing work to the Engineer for approval.

7.3.22 Painting Work

7.3.22.1 General

This clause covers all painting applied to surface of plaster wood, and metal indicated in the Drawing. No painting shall be applied to surfaces of stainless steel copper, bronze, brass or any/all steel in contact with concrete. Painting work shall be performed by skilled workmen. Selection of color shall be as determined by the Engineer, unless otherwise specified.

7.3.23 Materials and Painting Coat

7.3.23.1 Materials

Materials to be used in this clause shall be as follows and shall conform PAINTS AND VARNISHES

- **Water Based Paints**

  Water based paints shall conform to the following standards:

BDS 500:1965	Specification for Distemper Dry (under revision);
BDS 1097:1984	Specification for Plastic Emulsion Paint. Part I for Interior Use; Part 2 for Exterior Use;
IS 5410-1969	Specification for Cement Paint, Colour as Required;
IS 428-1969	Specification for Distemper, Oil Emulsion, Colour as Required

- **Ready Mixed Paint and Enamels**

  Ready mixed paints and enamels shall conform to the following standards:

BDS 13:1960	Specification for Ready Mixed Paints, Varnish, Lacquers and Related Products (under revision);
BDS 14:1960	Specification for Black Bituminous Paint, Brushing for General Purposes (under revision);
BDS 397:1964	Specification for Ready Mixed Paint, Brushing, Red Oxide Zinc Chrome, Priming (under revision);
BDS 398:1964	Specification for Ready Mixed Paint, Spraying, Red Oxide Zinc Chrome, Priming (under revision);
BDS 399:1964	Specification for Aluminum Paint, Spraying for General Purposes, in Dual Container (under revision);

BDS 400:1964	Specification for Aluminium Paint, Brushing, for General Purposes in Dual Container (under revision);
BDS 401:1964	Specification for Varnish, Finishing, Exterior, Type-I, (Synthetic) (Tentative) (under revision);
BDS 402:1989	Specification for Ready Mixed Paint, Brushing, Finishing, Semigloss, for General Purposes (First Revision);
BDS 499:1965	Specification for Ready Mixed Paints, Brushing, for Road Marking (white, yellow and black) (under revision);
BDS 616:1966	Specification for Enamel, Brushing, Exterior (i) Undercoating, (ii) Finishing, Colour as Required (under revision);
BDS 617:1966	Specification for Enamel, Brushing, Interior (i) Undercoating, (ii) Finishing, Colour as Required (under revision);
BDS 926:1980	Specification for Ready Mixed Paint, Brushing, Petrol Resisting, Air Drying, for Exterior Painting of Containers, Colour as Required;
BDS 927:1980	Specification for Ready Mixed Paint, Brushing, Petrol Resisting, Air Drying, for Interior Painting of Tanks and Containers, Red Oxide (colour unspecified);
BDS 928:1980	Specification for Ready Mixed Paint, Brushing, Acid Resisting, for Protection Against Acid Fumes, Colour as Required;
BDS 973:1981	Specification for Specification and Methods of Test for Linseed Stand Oil for Paints and Varnishes;
BDS 974:1981	Specification and Methods of Test for Raw Tung Oils for Paints and Varnishes;
BDS 1005:1981	Specification for Ready Mixed Paint, Brushing, Finishing, Stoving, Enamel, Colour as Required;
BDS 1141:1986	Specification for Ready Mixed Aluminium Priming Paints for Woodwork;
BDS 1151:1986	Specification for Pavement Marking Paints;

7.2.24 **Thinners and Solvents**

These shall conform to the following standards:

IS 324-1959	Specification for Ordinary Denatured Spirit (revised);
IS 533-1973	Specification for Gum Spirit of Turpentine (Oil of Turpentine) (First Revision);
IS 82-1973	Methods of Sampling and Test for Thinners and Solvents for Paints (First Revision).

- **Varnishes and Lacquers**

These materials shall conform to the following standards:

BDS 401:1964	Specification for Varnish, Finishing, Exterior, Type-I, (synthetic) (under revision);
BDS 1064:1983	Specification for Varnish, Staving;
BDS 1065:1983	Specification for Varnish, Acid Resisting;
BDS 1066:1983	Specification for Varnish, Finishing, Interior;

IS 197-1969	Methods of sampling and Test for Varnishes and Lacquers (First Revision);
IS 340-1978	Specification for Varnish, Mixing (First Revision);
IS 346-1952	Specification for Varnish, Spirit, Clear, Hard;
IS 347-1975	Specification for Varnish, Shellac for general purposes (First Revision);
IS 348-1968	Specification for French Polish (First Revision);

7.3.23.2 Painting Coat

Number of coats shall be as indicated in the table below.

Number of coats Material to be painted		Primary	Secondary	Finishing
Steel	Outdoor	2	2	1
	Indoor	2	1	1
Wood	Outdoor	1	2	1
	Indoor	1	1	
Concrete Plaster and board	Outdoor	1	2	1
	Indoor	1	1	1
Acid – proof	Indoor	1	3	1
Galvanized steel	Outdoor	2	1	1
	Indoor	1	1	
Touch –up of galvanized steel		1	1	1

7.3.23.3 Workmanship

(1) Smooth Finished & soft colored Plastic paint should be used over the Plastering work of interior wall and ceiling.

(2) Smooth Finished & Architectural approved colored weather coat should be used over the Plastering work of Exterior wall. Somewhere should be used Ceramic Facing brick (Strip)/ Rustic Tiles as per direction/decision of Architecture or approved 3D view.

(3) Painting shall be applied by spraying, brushing or rolling.

(4) Surfaces to be painted shall be smooth, dry and free from dirt, loose mill scale, rust, grease, or other deleterious material

(5) The contractor shall submit the samples and catalogue of paint of the Engineer for approval.

7.3.23.4 Protection
Drop clothes shall be furnished and place to fully protect all parts or work during execution of the contract. The Contractor shall be held responsible for paint droppings on cement floor and base.

Paint droppings shall be entirely removed, and damaged surfaces shall be repaired in a manner satisfactory to the Engineer.

No work shall be accepted which shows laps. Stains, flat or glossy spots or imperfections in surface over which paint or other finish is applied.

All rubbish, waste, or surplus materials shall be removed from time to time, and all woodwork, hardware, floors or other adjacent work shall be cleaned.

All glass throughout the building shall have all paint or varnish sports and brush marks removed, and upon completion of the painting work, all glass that is scratched or damaged by the painter's work, shall be replaced at the contractor's responsibility.

Hardware and other unpainted metal surfaces shall be cleaned.

CONTROL BUILDING

7.3.24 Temporary Work, Earth Work and Piling Work
7.3.24.1 General

The work of the above items shall be specified in clauses "TEMPORARY WORK", "EARTH WORK" and "PILING WORK" in Section 1 "GENERAL PROVISIONS", unless otherwise specified.

7.3.24.2 Materials of Pile
The pile is to be used for Control Building shall be R.C.C Pile.

7.3.25 Concrete Work

7.3.25.1 General

Concrete work shall be as specified in Clause "CONCRETE WORK" in SECTION 1 "GENERAL PROVISIONS", unless otherwise specified.

7.3.25.2 Classification of Materials to Be Used for Buildings

7.3.25.2.1 Concrete

The classification to be used for structural concrete shall be 4 Fc= 210 kg/cm2 concrete. (class E 210-10-25)
The classification to be used for leveling concrete shall be 4 Fc = 120 kg/ cm2 concrete. (class C 120-10-40)
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7.3.25.2.2 Reinforcing Bar

Reinforcement and welding of reinforcement to be placed in concrete shall conform to the requirements of this section.

a) Deformed Reinforcement : Deformed reinforcing bars shall conform to the following standards; BDS 1313, Steel Bars and Wires for Reinforcement of Concrete; BDS 580, Rolled Deformed Steel Bars (intermediate grade) for Concrete Reinforcement; Reinforcement conforming to the ASTM, Standards: A615M, Deformed and Plain Billet-Steel Bars; A616M, Rail-Steel Deformed and Plain Bars; A617M, Axle-Steel Deformed and Plain Bars; A706M, Low-Alloy Steel Deformed Bars; A767M, Zinc Coated (Galvanized) Steel Bars; and A775M, Epoxy-Coated Reinforcing Steel.

b) Deformed reinforcing bars with a specified yield strength (f_y) exceeding 410 MPa may be used, provided f_y shall be the stress corresponding to a strain of 0.35 per cent and the bars otherwise conform to ASTM standards noted above. Fabricated deformed steel bar mats conforming to ASTM A184M and deformed steel wire complying with ASTM A496 may be used. Deformed wire for concrete reinforcement shall not be smaller than size D4 (Nominal diameter : 5.72 mm), and for wire with a specified yield strength f_y, exceeding 410 MPa f_y shall be the stress corresponding to a strain of 0.35 per cent.

Welded deformed steel wire fabric conforming to ASTM A497 may be used; for a wire with a specified yield strength (f_y) exceeding 410 MPa, f_y shall be the stress corresponding to a strain of 0.35 per cent. Welded intersections shall not be spaced farther apart than 400 mm in direction of calculated stress, except for wire fabric used as stirrups.

7.3.25.2.3 Form

7.3.25.2.3.1 Form Oil

Form oil shall be light colored paraffin oil or other acceptable non-staining material. Form in contact with concrete shall be given a uniform light spray coating of the specified form oil coating in accordance with the manufacturer's recommendations. Form coating shall be applied to the forms before they are set.

7.3.25.2.3.2 Form Ties

Form ties shall have sufficient strength, stiffness and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders. The type of form ties used shall be submitted to the Engineer for approval.

7.3.26 Steel Reinforcement

7.3.26.1 Lapped Splices in Reinforcement

Splices at points of great stress shall be avoided wherever possible, and care shall be exercised to avoid concentration of splices at one place.

a) Length of Lap

The lengths of laps in lapped splices shall be in accordance with the Drawings and indicated below.

40 d without hook
35 d with hook

The length of lap in a lapped splice of reinforcing bars of different diameters shall be based on the nominal diameter of smaller bar.

7.3.26.2 Anchorage of Reinforcement

The length of anchorage of reinforcement shall be determined in accordance with the type of reinforcing bar, the grade of concrete and type of stress acting on the reinforcement, and shall be as indicated in the table below, unless otherwise indicated.

Length of Anchorage of Reinforcement

Re-Bar	Strength of Concrete Ordinary Concrete		Length of Anchorage Lower Bar Beam	Floor, Roof
SD30	210kg/mc2	35 d or 25 d with hook	25 d or 15 d with hook	10 d and 15 cm or more

Note : "d" denotes nominal diameter of reinforcing bar.

7.3.26.3 Dowels

Dowels shall be installed at right angles to construction joints. Dowels shall be accurately aligned parallel to the finished surface and shall be rigidly held in place and supported during placing of the concrete.

7.3.26.4 Concrete Protection for Reinforcement

The thickness of concrete cover for reinforcement shall be determined to provide necessary fire resistance, durability and bearing strength of the member. Minimum concrete cover shall be provided in accordance with the table below.

Table : Minimum Thickness of Concrete Cover for Reinforcement

Item	Structure Element		Covering Thickness (cm)	
	Floor, Wall	Covered finish	2	
		Uncovered	3	
		Interior finish	3	
Part not		Uncovered	3	
Contacting Column, Beam wall Ground		Exterior, covered finish	3	
		Uncovered	4	
	Bearing wall		4	

Table : Minimum Thickness of Concrete Cover for Reinforcement (Cont'd)

Item	Structure Element		Covering Thickness (cm)	
		Wall, Column, beam, floor	4	
Part contacting ground		Foundation, retaining wall	6	

7.2.26.5 Concrete Test

The test of concrete shall be executed as follows :

a) The concrete tests, necessary to maintain the quality control of concrete, shall be executed and their test results shall be submitted to the Engineer.

b) For concrete compressive tests, six (6) test specimens shall be required for each concrete placement.

c) Three (3) specimens shall be tested for seven (7) or fourteen (14) days strength, the remained three(3) specimens shall be test tested for twenty-eight (28) days strength.

d) The test of concrete shall be executed once for each 150m 3 or less of concrete to be poured on the same day.

The expense for the above tests shall be included in the unit prices.

7.3.26.6 Tolerances for Concrete Construction

Concrete structure shall be constructed to the line shown in the drawings.

Any structure which does not conform to such lines within the tolerances listed below shall be repaired, removed and made a new by the contractor.

Tolerances limits of concrete structure shall, as a standard, be in accordance with the table below.

Tolerance Limited

Type	Item		Tolerances against base line (mm)
Column, wall	A. Form	Architecturally formed	3
		Others	5
	B, Concrete surface		7
Beam, slab	A. Form		1
	B. Deflection		3
	C. Concrete surface		7
	A. Column line		3

7.3.26.7 Steel Thrown Finish

After the placing of concrete has been completed, steel trowel finish shall be applied to interior concrete floors, such as bed of vinyl asbestos tile and exposed steel trowel finish floor as indicated in the drawings.

The finished floor surfaces shall be true plane surfaces with no deviation in excess of 3.0mm when tested with a 300mm.
Surfaces shall be pitched to drains where indicated in the drawings.

Instead of hand finishing, the contractors may use an approved power finishing machine provided that the finished surfaces are free of machine marks or ridges.

7.3.26.8 Concrete Surfaces to Be Exposed

Form surfaces that will be in contact shall be of material that is non-reactive with concrete and that will produce concrete surfaces equivalent in smoothness and appearance to that produced by new plywood panels.
Smaller size panels shall be used only where required by openings or joint details, with each area less than 120 cm wide formed with a single panel accurately cut to the required dimensions.

Cut surfaces shall be smooth and treated with form coating. Panel joints that will be in contact with concrete shall be smooth and free of offset.

Form materials with defects that will impair the texture and appearance of finish surfaces shall not be used.

Column forms shall be made with a minimum number of joints.

7.3.27 Masonry Work

7.3.27.1 Concrete Block Masonry

7.3.27.1.1 General

This clause covers walls, partitions and lintels constructed with pre-cast concrete hollow blocks reinforced with steel bars.

7.3.27.1. Materials

1) Cements and aggregate

Cement and aggregates to be used in the concrete hollow block shall be as specified in the clause "REINFORCED CONCRETE WORK". Coarse aggregate for blocks shall not be larger than one-fifth (1/5) of the narrowest with of hollow block section.

2) Cement mortar and concrete

Reinforcing bars shall be as specified in the clause " REINFORCED CONCRETE WORK"

3) Cement mortar and concrete

Standard mix proportion shall be as follows, unless otherwise shown:

	Work	Mix proportion (by volume) Cement : (slaked lime) : sand
	For masonry Joint	1 : 3
Cement mortar	For Tamping	1 : 3
	For painted joint	1 : 3
Concrete	For Tamping	1 : (2.5) : 3.5

7.3.27.1.3 Working Drawings

Working drawings of the block laying plan including reinforcing for arrangements and the places of anchor bolts shall be submitted to the engineer for approval.

7.3.27.1.4 Application Method

1) Reinforcing Bars

Unless otherwise specified, reinforcing bars shall be of D10, and shall be placed at three (3) block intervals horizontally and two (2) block intervals vertically.

Intersection of the bars shall be securely tied with wire. The extra reinforcing bars to be used for the perimeters of the opening shall be of D 13.

2) Laying

The concrete surface to receive blocks shall be cleaned and thoroughly wetted prior to laying the masonry units. All masonry units shall be clean and free from surface dust before laying, and shall be laid by suing cement mortar.

Fractional parts of units will not be permitted where whole units can be used. Joints shall be 10mm thick, and as uniform as possible.

All exposed joints shall be raked 10mm deep and tooled firmly so as to produce a smooth, tight surface. All cell where reinforcing bars are inserted and blocks are jointed shall be compactly filled with specified mortar (tamping mortar).

Laying of blocks shall not exceed 1.2 meters per day in height.

Pipes and conduits to be inserted in the concrete hollow block walls shall be embedded in such a manner as not to cause any damage to the block. The contractor shall coordinate placing of all items embedded in masonry, and shall be responsible for any changes in positions.

7.3.28 Lintel

Lintels for opening shall be of reinforced concrete and extended to a length of at least 20mm into the adjoining walls.

All cells of the blocks directly below the extended lintels shall be filled with mortar.

7.3.29 Bond Beam

When the height of concrete block wall exceeds 30 times the wall thickness, reinforced pre-cast or pour in place concrete bond beam shall be provided at each 30 times exceeding the wall thickness.

7.3.30 Precast Concrete Block

7.3.30.1 General

Materials, such as cement, aggregate, reinforcing bars, etc. shall be as specified in the Clause "REINFORCED CONCRETE WORK"

Maximum size of coarse aggregate shall be less than 5mm. Specific gravity of coarse aggregate shall be 2.7 or more, unless otherwise specified.

Mix proportion of cement, sand : coarse aggregate shall be 1:2:4, respectively.

7.3.30.2 Light weight Concrete Block for Roofing

Specific gravity of coarse aggregate for lightweight concrete shall be 1.7.- 1.9.

7.3.31 Water Proofing Work

7.3.31.1 General

This clause covers all waterproofing, built up roofing and mortar waterproof.

7.3.31.1.1 Built Up Roofing

7.3.31.1.2 Materials

(1) Asphalt Primer

Asphalt primer shall be applied by spraying or brushing. The quality of material shall be in accordance with the table below:

Drying Time	Not less than 8 hours
Remainder after drying	Not less than 35%
Specific Gravity	Less than 1.0

Test method for the above shall comply with JIS K 5400 or equivalent BDS

(3) Asphalt Compound

The quality of materials shall conform to ASTM, and shall in accordance with the table below.

	Asphalt Compound
Penetration (25 °C, 100 gr, 5 sec.)	20 – 30 (2.0 ~ 3.0 mm)
Softening Point °C	Not less than 90 °C
Carbon disulfide	Not less than 97%
Matte ability (25 °C)	Not less than 2.5mm
Volume of Evaporation	Less than 0.5%
Penetration after evaporation	Not less that 70%

Flashing Point (open cup method)	Not less than 230 °C
Specific Gravity	1.01 - 1.04

(3) Asphalt Roofing

Asphalt roofing shall comply with JIS A 6006 (Asphalt Roofing Felts), or equivalent BDS and shall be 45kg. – item (21.0m x 1.0 m per roll)

The Contractor shall submit sample of asphalt roofing to the engineering for approval.

(i) Specific roofing shall, in principle, consist of copper mesh (#38) or glass-fiber (#23) coated with asphalt, and the weight of standard item shall be 55kg.

(ii) Perforated Roofing
Quality of material shall comply with JIS A 6006 or equivalent BDS
The Contractor shall submit the sample to the engineer for approval.

7.2.31.1.3 Grades of Water Proofing

Working Process	Class – A	Class - B
1	Asphalt Primer (0.31/m²)	Asphalt Primer (0.31/ m²)
2	Perforated roofing within layer of sand	Asphalt (0.1 kg/ m²)
3	Asphalt (1.2 kg/ m²)	Asphalt Roofing
4	Special roofing	Asphalt (1.0 kg/ m²)
5	Asphalt (1.0 kg/ m²)	Special roofing
6	Special roofing	Asphalt (1.0 kg/ m²)
7	Asphalt (1.0 kg/ m²)	Asphalt roofing
8	Asphalt roofing	
9	Asphalt (2.0 kg/ m²)	

Class – A shall be applied for the roof.
Class – B shall be applied for the lavatory.

Inclination of the base concrete shall be, in principle, more than 1/100.

7.2.31.1.4 Application Method

Asphalt primer shall be evenly sprayed over the base concrete or roof insulation board. Asphalt compound shall then be vinyl poured and spread over the asphalt primer. Compound heated to a temperature exceeding 230°C shall not be used.

In the case of class – A, perforated roofing shall be laid between asphalt primer and asphalt compound.

Asphalt felt, roofing and special roofing shall be flatly laid over each respective asphalt compound. The sides and ends of these sheets shall be provided with an overlap of at least 9 centimeters. The joints shall be completely water tight and not be concentrated.

Care shall be exercised for the roofing works surrounding anchor bolts, parapets and roof drains to prevent any leakage.

7.2.32 Mortar Waterproofing

The waterproofing agent shall be used for mortar waterproofing of roof and balcony.

Cement and sand to be used for waterproofing mortar shall be as specified in the clause "PLASTER WORK"

The catalogue and mix proportion shall be submitted to the Engineer for approval.

The application method of mortar shall be as specified in the clause "PLASTER WORK"

7.2.32.1 Caulking
7.2.32.2 General

The Contractor shall furnish all materials, labor and equipment necessary to complete the work as specified or as directed by the engineer.

The contractor shall submit the catalogues and work procedures to the engineer for approval.

7.2.32.3 Material

(1) Oil caulking compound shall conform to JIS A 5751 (Oil Based Caulking compounds Buildings) or equivalent.

(2) Thiokol caulking shall conform to JIS A 5754 (Polysulfide Sealing compound for Buildings) or equivalent.

(4) Thiokol caulking shall be used as joint for all surroundings of exterior doors, windows and concrete panels.

7.2.32.4 Workmanship

All joint surfaces to be filled shall be sound, clean and dry. All concrete surfaces shall be fully cured before application of caulking.

Joint surfaces to be filled shall be primed with the manufacturer's recommended primer, compatible with the Thiokol base sealing compound and appropriate for the surfaces to be sealed.

Mixing and application of filling compound shall be in accordance with the manufacturer's recommendations, and shall be submitted to the engineer for approval.

All filler work shall be done by skilled workmen.

7.2.33 Control Joint for Roof

Control joint shall be provided between mortar finish and light weight concrete block and at about 4.0mm of intervals in light weight concrete block area of roof.

Control joint shall consists of elastight and asphalt mortar.

7.2.34 Tile Work

7.2.34.1 General

This clause covers all works required for mosaic tile, ceramic tile and others applied on floors and wall.

Working drawings shall be submitted to the engineer for approval.

Prior to starting work, the contractor shall submit samples of tile to the Engineer for approvals.

7.2.34.2 Materials

7.2.34.2.1 Floor Finish

- To be used 600mmx600mm (24 inch x 24inch) size European standard Mirror Polished Homogeneous tiles for 1st to 6th Floor.
- For Ground/Underground Floor finish to be used as per Transformer based design such as use dry gravels for bottom of the Transformer and Rustic Tiles for walk way or common space.

Materials to be used in the works shall be high quality, high grade and good appearance.

7.2.34.2.2 Ceramic Tile for Interior Wall Finish (GWI) for Bath room's wall

Special color and size of European standard Ceramic Tile with decorative Boarder shall be used in Bath rooms & other necessary interior walls.
Materials to be used in the work shall be high quality, high grade and good appearance.

7.2.34.2.3 Ceramic Tile for Exterior Wall Finish

Ceramic tile for exterior wall finish shall be of 60mm x 227mm, colored, glazed and manufactured by qualified manufacturer as approved by the engineer. (if required)

The color of tile shall be designated by the engineer.

7.2.34.2.4 Setting Materials

(1) Cement, sand to be used for mortar bed shall be as specified in the clause "REINFORCED CONCRETE WORK"

(2) Bedding mortar shall be mixed with one part Portland Cement and three parts sand.

7.2.34.3 Setting

(1) Mosaic Tile

The mortar setting bed shall be floated to a uniform plumb and level surface to bring the finish surface to the required plane.

Thickness of mortar shall be about 10 millimeters.

Mosaic sheets shall be placed in positions on the pure coat and freshly combed into the mortar setting bed with trowel. Sheets shall be tamped firmly into place and made true and even with the finished surface line or plane.

Expansion joints or control joints at 6 meters on center shall continue through the mortar bed and mosaic tile and shall be kept free from mortar and grout. Those shall be filled with an approved caulking compound and shall be as close as possible to the color of the grout mortar. All joints, after removal of the paper, shall be grouted leaving then completely and uniformly filled. At no time shall sand or any abrasive be used that will damage the natural sheen of the mosaic tile. All excess grout and glue shall be removed from the face of the tile leaving the finished surface clean.

(2) Ceramic Tile

Laying of ceramic tile shall comply with the specifications for "Mosaic Tile" for floors, tile lay out work shall begin from the center lines of areas to eliminate use of half tiles.

For walls, tile layout work shall begin from the top of the wall and proceed downward.

Tile shall be soaked in clean water for at least one hour prior to setting and applied to setting beds within five minutes after soaking.

(3) Protection

The contractor shall provide and install barriers or other forms of protection and covering to prevent damages.

(4) Cleaning

Tiles shall be thoroughly cleaned after grouting and painting has sufficiently set. A;; traces of cement or foreign matter shall be removed from tiles. Exposed hardware and plumbing trim shall be covered with baseline during tile setting. Base line shall be removed and metal shall be cleaned and polished.

7.2.34.4 Gun Sprayed Tile

Gun sprayed tile shall be applied on the surface of concrete as indicated in the drawings.

Gun sprayed tile shall conform to JIS A 6910 - C or equivalent.

Sealer shall be applied on the concrete surface so as to prevent moisture from main material and to increase adhesion of main material.

Main material shall consist of white Portland Cement, dolomite plaster and coloring agent. The color shall be designated by the Engineer.

7.2.35 Metal Works

7.2.35.1 General

This clause covers all metal works for flooring, siding, walling, flushing, railings, roofing, raiser, plumbing, and other pertinent fixtures. The contractor shall submit fabrication and installation drawings to the engineer for approval.

7.2.35.2 Handrails

7.2.35.2.1 Steel Railings

For Stair case railing to be used Stainless Steel Pipe, Square Box & other decorative post as per drawing to the engineer for approval.
Steel railings, including pipe inserts to be embedded in concrete shall conform to JIS G 3452 and shall be galvanized, unless otherwise specified.

Square pipe shall be of the size indicated in the Drawings.

Galvanizing coat damaged by bolting, welding and other field works shall be repaired and painted with two coats of silver zinc paint.

7.2.35.2.2 Fabrication

Mitered and welded joints shall be made by fitting post to top rail and intermediate rail to post mitering comers, groove welding joints, and grinding smooth.
Railings may be bent at comers instead of jointed, provided that the bends are made in suitable jigs and that the pipe is not crushed or damage.
Edge of the railings shall be covered with steel plates.

7.2.35.2.3 Installation

Rails shall be installed by means of steel sleeve inserts which shall be seat and anchored in the concrete.

Ports shall be inserted into the galvanized steel sleeves embedded in concrete or shall be welded to the stringer, beam or toe plate made level, perpendicular and aligned.

The space between pipe posts and pips sleeve inserts except those marked " Removable handrail" as indicated in the drawings shall be filled solid with molten lead or shall be welded.

7.2.35.3 Steel Ladders

Materials to be used for steel ladders shall conform to JIS G 3101 – SS 41 or equivalent.

Steel ladders shall be fabricated of l- 65 x 6 steel angle stringers and 19mm diameter steel bar rungs. Rungs shall be spaced 350mm apart and shall be inserted into the stringers and welded thereto.

The ladders, including welded on bracket, shall be pointed.

7.2.35.4 Corner Guards

Comer guards for jamps, where directed by the engineer and sills of opening and edges of concrete column and wall shall be of steel angles or steel plates, conforming to JIS G 3101-SS 41 or equivalent, anchored into concrete with welded steel straps or end weld stud anchors.

7.2.35.5 Stair Safety Nosing for Concrete Stair

Stair safety nosing shall be of extruded bronze or stainless steel with cross hatched nosing.

Safety nosing shall be provided with integrally cast or bent anchors for embedding into concrete.

7.2.35.6 Divider Strips

Divider strips shall be half hard brass and shall be placed between different types of floorings as indicated. Divider strips shall be secured to floors by strip anchors or by flat head countersunk brass screws set in lead plugs.

7.2.35.7 Roof Drain

Roof drains shall be of cast iron baked with refined tar and shall conform to JIS A 5511, or equivalent, The size shall be in accordance with the drawings.

7.2.35.8 Corner Bead

Corner bead shall be half hard brass, and shall be placed at edges of columns and wall where mortar or plaster is applied.

7.2.35.9 Blind Box

Blind boxes shall be provided above all windows faced to outdoor, excepting for lavatory, storage, janitorial, kitchen and rooms which located on the first floor.

They shall be constructed of 1.6mm thick steel plate conforming to JIS G 3131, JIS G 3141 or equivalent and shall be painted.

Hanger bracket for installation of the blind box shall be galvanized 6mm thickness flat bar conforming to JIS G 3101 SS 41 and shall be installed at spacing of 90cm diameter expansion blots.

Connection between blind box and hanger bracket shall be 6mm diameter bolts and nuts.

7.2.35.10 Doorsill

Prior to commencement of floor finish work, doorsill shall be provided in place between different types of flooring, unless otherwise indicated, and shall be stainless steel conforming to JIS G 4305 - SUS 304 or equivalent.

7.2.35.11 Flashing Plate

Flashing Plates shall be of 2.3mm galvanized steel plate conforming to JIS G 3131, G 2341 or equivalent.

Flashing plates shall be provided at wall and roof opening for piping and at surrounding areas of windows, louvers rolling doors and doors facing outdoors.

7.2.35.1 2 Embedded Plate, Hook and Sleeve

The contractor shall provide plates, hooks and sleeves to be embedded in concrete as required.

Embedded plates, hooks and sleeves shall have sufficient thickness, diameter and anchorage in order to fix equipment, piping and other necessary items. Painting shall be applied on the plates and hooks after fixing the equipment and piping.

The materials to be used for plates, hooks and sleeves shall conform to JIS G 3101 SS 41 or equivalent.

7.2.35.13 Joiner

Joiners shall be provided at surrounding space of suspended ceilings and shall be of aluminum conforming to JIS H 4000 or equivalent.

Small screws shall be of stainless steel or of high strength aluminum alloy.

7.2.35.14 Down Spout

Downspouts to be used for drains shall be steel pipe conforming to JIS G 3442 or equivalent.

Metal bracket shall be of 50mm x 4.5mm steel plate conforming to JIS G 3101 SS 41 or equivalent and galvanized.

Downspouts shall be fixed with metal brackets at maximum of 2.0m per space.

7.2.36 Plaster Work

7.2.36.1 General

7.2.36.1.1 Treatment of Bed

(1) Concrete surfaces which are too smooth to receive plastering shall be roughened before hand with chisels.

(2) Where wall and floors of concrete, concrete block, etc. are distorted or uneven, the bed shall be repaired with mortar.

7.2.36.1.2 Cleaning and Wetting of Bed

The bed, scratch coat, and treated surface of bed shall be cleaned and suitably wetted before application of the following coat.

Portions of the base or coated surface which are not bonded shall be immediately repaired.

7.2.36.1.3 Curing

In order to prevent soiling and premature drying of plastered surface, window and door work shall be completed prior to commencement of the plaster work sheet coverings provided and sprinkling of water performed.

In order to prevent the soiling of neighboring members and other finished surface, suitable protection shall be provided using paper, boarding, tarpauling sheet or other suitable means.

7.2.37 Mortar Plastering

7.2.37.1 Materials

(1) Cement shall conform to JIS R 5210 ordinary Portland Cement or locally produced equivalent.

(2) Sand shall be of good quality free of salts, mud, trash and /or organic matters. The gradation shall be in accordance with the table below.

Table Gradation of Sand

Gradation (by weight)	Type of Mortar Plastering
Passing 5mm sieve.....100%	First coat ad second coat
Passing 0.15mm sieve .....not more than 10%	
Passing 2.5mm sieve.....100%	Finish coat
Passing 0.15mm sieve.....not more than 10%	

Water shall be clean and free of sales, iron, sulfur and/ or organic matter, as specified in he clause " CONCRETE WORK".

7.2.37.2 Mixing

The mix proportions of mortar shall be of standard type in accordance with the table below.

Table Mix Proportion (by Volume)

Base	Portion to be Plastered	First Coat	Second Coat	Finish Coat	
		C : S	C : S	C : S	Slaked Lime
	Floor			1 : 2	
	Interior Wall	1 : 2	1 : 3	1 : 3 : 0.3	
Concrete	Ceiling	1 : 2		1 : 3 : 0.3	
Concrete Block	Exterior Wall and others	1 : 2	1 : 3	1 : 3	
Wire lath	Interior Wall	1 : 3	1 : 3	1 : 3 : 0.3	
Metal Lath	Ceiling	1 : 2	1 : 3	1 : 3 : 0.3	
	Exterior wall and others	1 : 3	1 : 3	1 : 3	

In the above table, abbreviated C and S mean cement and sand, respectively.

7.2.37.3 Plastering Thickness

The thickness of application shall be in accordance with the standards indicated in the table below.

Table Plastering Thickness

		Plastering Thickness (mm)				
Bed	Portion to be plastered	First coat	Dubbing Coat	Second Coat	Finish Coat	Total
	Floor	-	-	-	30	30
Concrete	Interior wall	6	5	6	3	20
Concrete Block	Exterior wall	6	7	6	6	25
	Ceiling, others	4.5	-	4.5	3	12
	Interior wall	7.5	-	7.5	3	18
Wire Lath	Exterior wall	6	-	7.5	3	18
Metal Lath	Ceiling, waves	4.5	-	4.5	3	12

7.2.37.5 Application Method

(1) First Coat and Dubbing Out

Mortar shall be trawled on adequately to leave on conspicuous hollow. The surface of the first coat shall be roughened with tools such as metal combs.

The first coat shall be left standing for not less then 10 days allowing cracks to be fully developed before applying the next coat.

Dubbing out for concrete and concrete block shall be performed by roughening with tools such as metal combs and shall be left standing for not less then 5 days.

(2) Second Coat

For the second coat, a ruler shall be provided at external corners, internal corners and edges applied on order to attain an even finish.

(3) Finish Coat

The finish coat shall be applied in a manner so as to be blemish free by watching the degree of drying of the brown coat and by paying special attention to the surface, angles and edges.

The finish shall be either steel toweled, wood troweled or brushed as directed by the engineer.

For the exterior wall, the mortar shall first be troweled on with a wood travel, then furnished with a steel trowel and finally brushed avoiding use of water as much as possible.

(4) Floor Mortaring

In the case of concrete which is several days old, concrete paste shall be buttered on in adequate quantity and spread out with brooms and the like after which application of mortar shall be started.

Application of mortar shall be performed using stiff mortar containing a minimum of water and the mortar shall be tamped to bring moisture to the surface. The mortar shall be screened while paying attention to the grade upon and then shall be troweled smooth.

The crack control joint should be provided at intervals of approximately 3.0m. The joints shall be tooled.

(5) Base for Tile Fixing

In the case of using adhesives of wall tile or mosaic tile, mortar application shall be to the second coat.

7.2.38 Plastering

7.2.38.1 Materials

Plaster shall comply with JIS A6904 (Gypsum Plaster) or equivalent. Cement which is more than six (6) months aged shall not be used.

7.2.38.2 Mix Proportion

7.2.38.3

The mix proportions shall be as follows :

		Plaster				Applied Thickness	
Bed	Layer	For Finish	For Bed	Sand	White Fiber (g)/25kg	Ceiling	Wall
Concrete and concrete block	2nd coat	-	1	2.0	250	6.0	7.5
	Finish coat	1	-	-	-	1.5	1.5

7.2.38.3 Application Method

The surface to receive gypsum plastering shall be leveled with a coat of cement mortar of which the mix proportion of cement and sand is 1:2 prior to the application of plaster and the leveled surface shall be scratched to insure satisfactory adhesion of the plaster.

Before applying plaster, the receiving surface shall be pre pared by removing all foreign substances and shall be dampened.

7.2.39 Doors, Windows and Louvers

7.2.39.1 Wooden Doors and Frames

7.2.39.1.1 General

This clause covers wooden doors and wooden frames, including finish hardware, such as butts, hinges, locks, knobs, stops, strikes, holders, door chains and closures.

7.2.39.1.2 Materials

All doors shall be flush type, of sizes as shown in the drawings. Materials shall be, in principle, locally principle, locally produced. Standard flush doors be double paneled door of 6mm thick plywood and shall have stiffening ribs spaced at intervals of 15cm. Plywood shall be bended to the frames with a suitable adhesives which shall conform JIS K 6801 and 6803 or equivalent.

Waterproofed plywood shall be used for wooden doors for the lavatory.

The waterproofed plywood shall be of 6mm thickness five (5) play and the weight shall be 4.79 kg/m^2.

The each layer shall be completely pressed and adhered by using phonetic resin adhesives and the plywood shall be passed a boiling test and a dry and wet repeating test.

All wooden doors and frames shall be painted as specified in clause "PAINTING" unless otherwise specified.

7.2.39.1.3 Shop Drawings

The contractor shall submit stop drawings of fabricated items to the engineer for approval. The shop drawings shall clearly show the details of fabrication, installation, sizes, operation, methods of anchoring and any other pertinent details required for the installation thereof.

7.2.39.1.4 Wooden Door Frames

All frames shall be accurately set, plumb, level and shall be securely nailed to the wooden blocks embedded in the concrete or mortar.
Door Frame and Shutter should be made by solid wood such as Burma Teak as per direction/decision of the employer

7.2.39.1.5 Installation

Each door shall be accurately cut, trimmed and fitted to its frame and hardware with allowance for paint finish and possible swelling or shrinkage.
The clearance at the top shall not exceed 6mm.

7.2.39.1.6 Hardware for Wooden Doors

Hardware for wooden doors shall in principle be stainless steel conforming to The applicable standards are listed below :

BDS 113:1986	Specification for Latches and Locks for Doors in Buildings;
IS 204-78	Specification for Tower Bolts; Part I Ferrous Metals (Fourth Revision); Part II Nonferrous metals (Fourth Revision);
IS 205-1978	Specification for Nonferrous Metal Butt Hinges (Third Revision);
IS 206-1981	Specification for Tee and Strap Hinges (Third Revision);

IS 208-1979	Specification for Door Handles (Third Revision);
IS 281-1973	Specification for Mild Steel Sliding Door Bolts for Use with Padlock (Second Revision);
IS 362-1982	Specification for Parliament Hinges (Fourth Revision);
IS 363-1976	Specification for Hasps and Staples (Third Revision);
IS 364-1970	Specification for Fanlight Catch (Second Revision);
IS 452-1973	Specification for Door Springs, Rat-tail Type (Second Revision);
IS 453-1973	Specification for Double Acting Spring Hinges (Second Revision);
IS 729-1979	Specification for Drawer Locks, Cupboard Locks and Box Locks (Third Revision);
IS 1019-1974	Specification for Rim Latches (Second Revision);
IS 1341-1981	Specification for Steel Butt Hinges (Fourth Revision);
IS 1823-1980	Specification for Floor Door Stoppers (Third Revision);
IS 1837-1966	Specification for Fanlight Pivots (First Revision);
IS 2209-1976	Specification for Mortice Locks (vertical type) (Third Revision);
IS 2681-1979	Specification for Nonferrous Metal Sliding Door Bolts for Use with Padlocks (Second Revision);
IS 3564-1975	Specification for Door Closers (hydraulically regulated) (Second Revision);
IS 3818-1971	Specification for Continuous (piano) Hinges (First Revision);
IS 3828-1966	Specification for Ventilator Chains;
IS 3843-1966	Specification for Steel Backflap Hinges;
IS 3847-1966	Specification for Mortice Night Latches;
IS 4621-1975	Specification for Indicating Bolts for use in Public Baths and Lavatories (First Revision);
IS 4948-1974	Specification for Welded Steel Wire Fabric for General Use (First Revision);
IS 4992-1975	Specification for Door Handles for Mortice Locks (vertical type) (First Revision);
IS 5187-1972	Specification for Flush Bolts (First Revision);
IS 5899-1970	Specification for Bathroom Latches;
IS 5930-1970	Specification for Mortice Latch (vertical type);
IS 6315-1971	Specification for Floor Springs (hydraulically regulated) for Heavy Doors;
IS 6318-1971	Specification for Plastic Window Stays and Fasteners;
IS 6343-1982	Specification for Door Closers (pneumatically regulated) for Light Doors Weighing up to 40 kg (First Revision);
IS 6602-1972	Specification for Ventilator Poles;
IS 6607-1972	Specification for Rebated Mortice Locks (vertical type);
IS 7196-1974	Specification for Hold Fast;
IS 7197-1974	Specification for Double Action Floor Springs (without oil check) for Heavy Doors;
IS 7534-1974	Specification for Mild Steel Locking Bolts with Holes for Padlocks;
IS 7540-1974	Specification for Mortice Dead Locks;

IS 8756-1978	Specification for Ball Catches for use in Wooden Almirah;
IS 8760-1978	Specification for Mortice Sliding Door Locks, with Lever Mechanism;
IS 9106-1979	Specification for Rising Butt Hinges;
IS 9131-1979	Specification for Rim Locks;
IS 9460-1980	Specification Flush Drop Handle for Drawer;
IS 9899-1981	Specification for Hat, Coat and Wardrobe Hooks;
IS 10019-1981	Specification for Steel Window Stays and Fasteners;
IS 10090-1982	Specification for Numericals;
IS 10342-1982	Specification for Curtain Rail System

or equivalent.

7.2.40 Steel Fittings

7.2.40.1 General

This clause covers steel fittings, including finish hardware, such as butts, hinges, locks, knobs, stops, strikes, holders, door chains and closures.

7.2.40.2 Materials

Steel sheet shall conform to JIS G 3131, G 3141 or equivalent.

The thickness of steel plates shall be as designated below, unless otherwise specified.

Door Frame		1.6 mm
	Architrave	1.2 mm
	Threshold	2.3 mm
Door Leaf	Frame and flush plate	1.6 mm
	Stiffener and anchor plate	2.3 mm

Machine screws and rivets shall conform to JIS B 1101-1106, JIS B 1201-1205 and JIS B 1131-1133 or equivalent.

7.2.40.3 Steel Doors

Steel doors shall be single or double hollow core, single or double swig type or sliding type and with dimension and location as indicated in the drawings. All doors shall be complete with door frames, hard wares and any / all necessary accessories.

Shop fabricated frames without threshold shall be provided with temporary spreads at bottom to preserve proper shape during transportation and erection.

All metal surfaces shall be thoroughly cleaned and given two costs or rust inhibitive paint after being zinc plated in shop.

Field paint for finish shall be provided as specified in the clause " PAINTING"

7.2.40.4 Steel Louver

Steel louvers shall be of 45° slits and 100mm thick louvers and frame assembly.

The sizes shall be indicated in the drawings.

7.2.40.5 Shop Drawings

The Contractor shall submit shop drawings of fabricated items to the engineer for approval. The shop drawings shall clearly show the details of fabrication, installations, dimensions, sizes, operation, methods of anchoring and any other pertinent details required for satisfactory installation.

7.2.40.6 Installation

All frames shall be erected plumb, square and true to line and level, with secure fattening to structures and anchors.

Doorframes shall be installed by authorized representatives of the manufacturer, but before all plastering works are completed.

7.2.41 Aluminum Fitting

7.2.41.1 General

This clause covers all types of aluminum door, window, casements, and swing, sliding, pivoted, projected, fired and combination doors and windows, including operation hardware.

7.2.41.2 Materials

Extruded aluminum shape and sheet shall conform to JIS H 4100 and H 4000 respectively or equivalent.
Reinforcing strips, reinforcing struts anchors, etc. shall be of zinc plated steel plate conform G 310-SS41.

Small screws shall be of stainless steel conforming to JIS G 5121 SUS 304or of high strength aluminum alloy conforming to JIS H 4040 or equivalent.

7.2.41.3 Shop Drawings

The Contractor shall submit shop drawings of fabricated items to the engineer for approval.

The shop drawings shall clearly show the details of fabrication, installation, dimensions, sizes, operation, methods of anchoring and any other pertinent details required for satisfactory installation.

7.2.41.4 Installation

All aluminum 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 surface in contact or other masonry materials shall be provided one heavy brush coat of bituminous paint. Upon completion of the work the contractor shall remove and clean all surplus materials from these areas.

7.2.42 Glass And Glazing

7.2.42.1 General

The contractor shall furnish and install all glass required in doors and windows in accordance with the drawings and any direction of the engineer.
The applicable standards for glass and glazing are listed below :

ASTM C1036-90	Specification for Flat Glass;
ASTM C1044-90	Specification of Heat-Treated Flast Glass Kind HS, Kind FT Coated and Uncoated Glass;
ANSI Z 97.1	Safety Performance Specifications and Methods of Tests for Transport Safety Glazing Materials Used in Building;
CPSC 16 CFR	Safety Standard for Architectural Glazing Materials.

7.2.42.2 Materials

(1) Ordinary sheet glass shall conform to JIS R 3201 (Sheet Glass) or equivalent.

(2) Polished plate glass shall conform to JIS R 3202 (Polished plate Glass) or equivalent.

(3) Figured glass shall conform to JIS R 3203 (Figured Glass) or equivalent.

(4) Wired glass shall meet conform to JIS R 3204 (Wired Glass) or equivalent.

(5) Laminated glass shall conform to JIS R 3205 (Laminated Glass) or equivalent.

(6) Tempered glass shall conform to JIS R 3026 (Tempered Glass) or equivalent.

(7) Multiple glass shall conform to JIS R 3209 (Multiple Glass) or equivalent.

(8) Putty shall conform to JIS A 5752 (Putty for Metal Sash Glazing) and JIS A 5753 (Putty for wooden Fittings).

Putty for steel fittings, the quality shall be class 1, for aluminum fittings, class 2 as specified in JIS A 5752.

(9) The thickness of sheet glass and polished plate glass shall be 3.0mm for figured glass 4.0mm and for wired glass 6.8mm unless otherwise specified in the drawings.

7.2.42.3 Workmanship

No glazing work shall be carried out during rain or when the frames or glass is wet.

Frames shall be thoroughly cleaned before application of glazing compound.

All glass in windows and doors, except wooden doors, shall be set in full beds of glazing compound and pressed to a firm and even bearing without springing or forcing. Glass in windows shall be held firmly in place with snap type glazing beads and in doors with glazing channels or beads. Upon completion of construction work, all dirt, stains and mis-applied glazing compound shall be removed, and all glass shall be thoroughly cleaned on both faces.

7.2.43 Painting Work

7.2.43.1 General

Painting work shall be specified in clause "PAINTING WORK" in SECTION 1 "GENERAL PROVISIONS", unless otherwise specified.

7.2.44 Interior Finish Work

7.2.44.1 General

This clause covers the performance of all works in connection with the following.

1) Vinyl asbestos tile
2) Acid proof vinyl tile
3) Vinyl base
4) Asbestos cement board
5) Acoustic board
6) Suspended ceiling
7) Ceiling Access
8) Insulation
9) Nameplate for rooms
10) Accordion partition
11) Toilet Partition

Prior to starting work, samples of interior finish materials and shop drawings shall be submitted to the engineer for approval.

Types and sizes of nails, screws, bolts and quality of adhesives for fixing of interior finish shall correspond and match to characteristics of the interior finish materials and shall be submitted to the engineer for approval.

7.2.44.2 Fixing

Fixing shall not commence until after drying and cleaning of the base.

Fixing method of specified materials shall be in accordance with the manufacturer's specification and shall be submitted to the engineer for approval.

In performing fixing, adequate precautions shall be provided to avoid off set, gap and/or unevenness.

Suitable protection measures shall be provided on the interior finish until all finishing works are completed.

7.2.44.3 Vinyl Asbestos Tile for Floor Finish

Sizes of vinyl asbestos tile shall be 300mm x 300mm x 3mm thick conforming to JIS A 5705 or equivalent.

- The tiles shall be resistant to alkali, grease or oils.

- The vinyl tiles shall be bonded with asphalt adhesives.

7.2.44.4 Acid-Proof Vinyl Tile

The tiles shall be of acid proof type vinyl tile. The shape and dimensions shall be the same as those of vinyl asbestos tile.

7.2.44.5 Vinyl Base

Vinyl base shall conform to the manufacturer's recommendation of vinyl asbestos tile for flooring unless otherwise indicated, the height of the base shall be 100mm.

7.2.44.6 Asbestos Cement Board

Materials shall conform to " Flexible Board" in JIS A 5403 (Asbestos Cement Sheets) or equivalent.

When necessary, chamfering shall be carried out so as to facilitate the making of joints and prevent their irregularity.

Hardware fixings shall be countersunk screws of stainless steel.

7.2.44.7 Acoustic Board for Ceiling

(1) The material shall be of incombustible rock wool and perforated . The thickness of board shall be 12mm.

Acoustic boards shall be fixed on the base board with suitable adhesives or nails so as to facilitate the making of joints and prevent their irregularity.

(2) Base Board for Ceiling

Base Board shall be plaster boards conforming to JIS A 6901 (Gypsum Board) Grade 2 or equivalent.

The thickness of board shall be 9mm.

7.2.44.8 Suspended Ceiling

The Contractor shall provide a light weight suspension system.

The system shall have the means to properly support the entire ceiling when it is in place.

7.2.44.8.1 Main Runner

Main runners for all suspension system, unless otherwise specified, shall be of cold rolled zinc bonded light channel steel (-38mm x 15mm x 1.6mm) conforming to JIS G 3350.

The channel runner shall be installed 90cm on centers and suspended by steel bars of 6mm dia. Hangers with level adjustable nuts at 90cm intervals.

The grid shall be leveled to within 1/500.

7.2.44.8.2 Cross Furring

Cross furring for ceiling shall be of cold rolled zinc bonded steel (M-23-mm x23mm).

The M-furring shall be installed 30cm on centers and at right angles to the main runner by wire clips. All M-furring shall be straight in alignment and hold so as to enable level placement of plaster board on the suspension system.

7.2.44.8.3 Workmanship

The installation and workmanship shall be in strict accordance with the manufacturer's specifications and shall be made by skilled workmen.

7.2.44.8.4 Insulation

The contractor shall provide insulation boards under the roof slab.

The insulation boards shall be of 25mm thickness cemented excelsior boards conforming to JIS A 5404 or equivalent.

The insulation boards shall be fixed to forms of slab concrete by using nail.

7.2.44.9 Ceiling Access

Ceiling accesses shall be located at suitable places for maintenance of the lighting system and air conditioning ducts and shall be the size of 600m x 600mm.

The materials of the frame for reinforcement of access board shall be made of the same materials as the ceiling, shall be of aluminum conforming to JIS G 4100.

7.2.44.10 Nameplate for Rooms

Name plates shall be provided on all doors of rooms facing outdoors, corridors and other rooms.

The size, materials and name on the plates shall be designated by the engineer.

7.2.44.11 Accordion Partition

Accordion partition shall be provided as indicated in the drawings.

Accordion partition shall be of vinyl chloride leather, runner, hinge plate (JIS G 3141 Spec. 1.2mm galvanized), wire rods (JIS G 3505 or equivalent) hanger rail (JIS H 4100-6063, T5 or equivalent) frames, (HIS H 4100-6063, T5 or equivalent) magnet, cushion rubbers and frame holder weight of partition $1m^2$ shall be 7 Kg or less.

Panel shall be of plastic laminated board or steel and paper honeycomb.

Doors shall be of the same materials as panels and door frames shall be of Aluminum Alloy Extruded shapes.

7.2.44.12 Toilet Partitions

In Case of common toilet:

Melamine coated plywood toilet partitions shall be furnished and installed at the locations indicated in the drawings and as described herein.

Toilet partitions shall supported by stainless standing supporters anchored into the floor and y head connection (galvanized square tubing).

Partitions shall be flush type, consisting of two sheets of waterproof plywood. The plywood shall be coated with melamine. All partitions and screen shall be erected plumb, level and in perfect alignment, with hardware fully equipped for proper operation.

7.2.45 Sodding And Planting

7.2.45.1 Sodding

7.2.45.1.1 General

The Contractor shall furnish all work including labor equipment, materials, construction, etc., in connection with sodding work.

7.2.45.1.2 Top Soil with Fertilizer

Stones, leaves, pieces of wood and all foreign matter shall be cleared away before placement of the top soil.

Top soil shall be approved by the engineer. The soil shall be hauled and placed when it is sufficiently dry for spreading.

Manure fertilizer shall be well rotted, unleashed, and free from sawdust, shaving, refuse and / or harmful chemicals.

All manure delivered shall be free from any degree of fly manifestation. All manure fertilizer shall be spread and mixed with the top soil within 48 hours after arrival on the site. Fly breeding prevention shall be by the use of insecticides and / or larvaecides as approved by the engineer.

Areas to be sodded shall be prepared by placing top soil in the areas to the required thickness.

The central part of such areas shall be made higher in comparison to the surroundings to ensure proper drained.

7.2.45.1.3 Sod Planting

Sod planting shall be carried out where indicated in the drawings. Sod shall be planted in firm contact with the bed, and planting work shall be carried out by skilled workmen.

Density of sod planting shall be 70% or more of the area. After fixing the sheets of turf, sandy soil shall be spread at the rate of 0.01-0.02m3 per square meter by using a sieve.

7.2.45.1.4 Leveling of Ground

Before planting the sod, the contractor shall remove all foreign matter, such as weeds, stones and pieces of wood and level the ground. The cost of the leveling of the ground shall be included in the price of the grass planting.

7.2.45.1.5 Watering

Watering equipment of the type which prevents damage to finished surfaces shall be used.

Should the sod become dry, it shall be watered so as to wet the transplanted sod through to t he bottom and through to at least 5cm of the sod bed as well.

Additional watering shall be made as directed by the engineer.

7.2.45.1.6 Protection

Protection of seeded beds against traffic, human or otherwise, shall be provided by erecting barricades immediately after work is completed and by placing warring signs, markers etc. as directed by the engineer.

7.2.45.1.7 Maintenance

Sodden areas shall be maintained (watering, cutting, etc.) by the contractor until taking over.

7.2.45.1.8 Clean Up

After the turning operation has been completed, the surface shall be cleared of all tones larger than 2cm in diameter and of all roots, brush, trash or other matter that may interfere with maintenance operations.

Any paved area over which hauling operation is conducted shall be kept clean and any top soil or other materials which may lie upon the paved surface shall be promptly removed.

7.2.45.2 Planting

7.2.45.2.1 General

The Contractor shall furnish all work including labor, equipment, materials, construction etc. in connection with planting work.

The Contractor shall submit colored pictures of all varieties of trees and flowers to be planted to the engineer for approval.

7.2.45.2.2 Planting Concept

The number of plantings and species of trees and shrubbery shall be as follows.

Trees	:	25 trees
Shuddery	:	38m^2

Notes : Tree.....around 4.0m
Shrubbery.....less than 1.0m

Trees shall be planted so as to provide suitable shade.

The contractor shall survey the soil condition of the site for planting of the trees and shrubbery stated above and shall then carry in soil suitable for the said plants.

7.2.45.2.3 Workmanship

Before plants are carried to the site, the contractor shall prune one-fifth of the trees leaf areas but shall retain the natural form. Spray shall not cause wilting of the leaves. Planting details are shown in the next sheets.

Ground Line to be the
Same as at the nursery Drawings Surveyor's Flagging Tape (white)

Fixing wire

Spread 120° Apart

50 x 100 x 900 Stake

Construct Earth Saucer with
100mm high

Backfill with Fertilizer

SHRUB PLANTING DETAILS

7.2.46 Plumbing Equipment Work

7.2.46.1 General

This clause covers the performance of all water supply, sewage and sanitary equipment works to be executed according to the drawings and these specifications.

(1) Water Supply Equipment
(2) Sewage and Air Vent Equipment
(3) Sanitary Equipment
(4) Clarification Tank Equipment

The contractor shall submit shop drawings of the fabricated items to the engineer for approval. The shop drawings shall clearly show the details of fabrication, installations, dimensions, sizes, operation, methods of anchoring and any other pertinent details required for satisfactory installation and the contractor shall submit the result of tests at designated date specified here-in-after.

The contractor shall provide the spare parts for three years normal operation, unless otherwise specified.

7.2.46.2 Equipment and Material

The equipment, materials and accessories as specified herein shall be furnished together with spare parts for three (3) years normal operation except as indicated otherwise.

7.2.46.2.1 Drinking Water Tank

(1) Type of Drinking Water Tank

Drinking water tanks shall be of earthquake proof construction and consist of a sandwich construction panel with facing materials comprising fiberglass reinforced polyester (F.R.P.) mad from unsaturated polyester resin and glass fiber of which the core shall be formed plastic.

(2) Materials

The unsaturated polyester resin to be used for the facing material shall be waterproof and weather proof and harmless to human health.

The fiberglass shall be made from non alkali fiberglass as stipulated in JIS R 346~3417.

The foamed plastic materials to be used form the core shall be rigid and closed cell.

Any fillers and coloring agents shall be harmless to human health.

(3) Accessories

The drinking water tank shall be provided with the following accessories.

(a)	Water inlet pipe connections (F.R.P.)	1 set
(b)	Water outlet pile connections (F.R.P)	1 set
(c)	Drainage pipe connections (F.R.P)	1 set
(d)	Connections for overflow hole and overflow With insecticide nets (The insecticide nets shall be made of plastic and the connections shall be made of F.R.P)	1 set
(e)	Air passage and air vent with insecticide nets (The insecticide nets shall be make of plastic and the passage ad vent shall be made of F.R.P)	1 set

(f) Locking type manhole (Plastic Diameter : more than 500mm) 1 set

(g) Reinforcing materials, support metals and stands for elevated water tank. 1 set
(Rolled steel having properties in accordance with JIS G3101 and with dimensions and shapes in accordance with JIS G3192)

(h) Steel ladder 1 set

(i) Electrode mount

(j) Breakwater cover 1 set

(4) Shapes, Dimensions and Performance

The shapes and dimensions of the elevated water thank shall be in accordance with the manufacturer's specifications, and the performance shall be as specified in " List of Equipment" in the Design Drawing.

7.2.46.2.3 Pressure Pump Unit

(1) Type

Pressure pump unit shall be factory built and factory tested product.

The unit is consist of two pumps, small pressure tank, control panel, necessary pipes, cable and pressure gauge these components are arranged on the common steel frame.

(2) System Operations

(a) In initial operation, one pump starts by push button provided on control panel and starts to supply water in the pressure tank. The pump stops when the pressure rise of the pressure tank.

(b) When by consumed water in the pressure tank the pressure in the pressure tank fall the other pump starts to run and supply water to pressure tank.

(c) All the signal of pumps START-STOP are controlled by a pressure switch provided on pressure tank.

(d) Specifications

Quantity	1 set
Discharge bore	40 mm
Tank Capacity	30 liters
Pump Quantity	2 set/ unit

Type	End section centrifugal motor closed coupled type
	End section centrifugal motor closed coupled type
Pump Speed	3,000rpm.
Materials Casing	Cast Iron
Shaft	Stainless Steel
Impeller	Bronze
Motor Type	Drip-proof, squirrel cage raptor
Voltage	400V
Frequency	50Hz.
Insulation Class	E

(4) Accessories

Check Valve JIS 10kg/cm2 50-2 pieces

Gate Valve JS 10kg /cm2 50 – 4 pieces

7.2.46.2.4 Water Supply Pump

(1) Type

Water supply pump shall be submergible pump, using of submerged motor and multistage centrifugal pump.

(2) Specifications

Liquid	Fresh water or equivalent
Temperature	0-40 °C
Impeller	Multi stage centrifugal
Shaft Seal	Oil Seal
Bearing	Sleeve bearing
Cashing	Cast Iron.
Impeller	Bronze
Shaft	Stainless Steel
Flange Standard	10kg/ cm2 thin type
Motor	Submerged canned type
Motor Insulation Class	E

(3) Accessories

10 meters water proof cable

7.2.46.2.5 Sterilizing Equipment

(1) Type

The sterilizing equipment shall be chlorine sterilizing type, including of sterilizing chemical tank chemical feed pump, flow sensor, necessary pipes and cables.

(2) Operation

The equipment shall be designed to inject the chemical in proportion to the flow rate of drinking water, using a diaphragm pump.

(3) Specification

(a) Sterilizing Chemical Tank

Material	:	Polyethylene
Volume	:	50 liter

(b) Chemical Feed Pump

Type Discharge variable diaphragm type

Output	:	0.025KW
Phase	:	1ø
Frequency	:	50 Hz
Voltage	:	AC 220V

(c) Flow Sensor

Flow sensor shall distribute electric pulse in proportion to the flow rate.

(4) Accessories

(a) Chemical feed pipe; high pressure blade hose 6mmø ; 3 m length
(b) Chemical suction pipe; vinyl pipe 5 mmø ;1 m length
(c) Pump base ; 1 set (including anchor bolts)
(d) Injection valve ; made of PVC ; 1 set
(e) Cable ; CVV 2 mm2 - 2C ; 3 m
(d) Sterilizing Chemical ; 1 set

7.2.46.2.6 Water Filter

(1) Type

Up-light casing, cartridge filtering element type

(2) Materials and Specification

Casing –stainless steel
Normal use maximum pressure – stainless steel
Filtering element – exchangeable plastic cartridge (reusable by water washing type)

(3) Accessories

Spare filtering element	-	1 set
Drain Cock	-	1 set
Air Cock	-	1 set
Hole- in-anchor	-	1 set

7.2.46.2.7 Sanitary Equipment and Accessories

7.2.46.2.7.1 General

(1) All sanitary wares shall be of European standard high quality or equivalent to JIS A 5207.

(2) All fittings for sanitary wares shall be in accordance with European standard high quality JIS A 5514 or equivalent

(3) All accessories and visible sanitary wares such as faucets, flush valves and flushing pipes shall be nickel chromium plated.

7.2.46.2.7.2 Water Closet (Western/European Style)

- All Sanitary Fittings & Fixtures should be European Made as well as approved sample and design.

7.2.46.2.7.5 Wash Basing (For Lavatory)

(1) Wash Basin

V.C., 6.5 & wall hanging type

(2) Accessories

(a) Pillar cock (13mm)
(b) Angle type stop cock (13mm)
(c) Washer basin trap
(d) Back hanger
(e) Liquid soap holder (Vertical type 350 cc)

7.2.46.2.7.5 Wash Basin (For Battery Room)

(1) Wash Basin

V.C., 9.5 &

(2) Accessories

(a) Pillar cock (13mm)
(b) Eye bath
(Vertical flexible type, 13mm)
(c) Angle type stop cock (13mm)
with water supply pipe
(d) Wash basing trap
(e) Back hanger
(f) Liquid soap holder (push button type, 360cc)

7.2.46.2.7.6 Service Sink

(1) V.C. with Back

(2) Accessories

(a) Sink faucet (20mm with feed seat) :
(b) Trap (S type) :
(c) Trap connection fixtures :
(d) Chain and stopper :
(e) Back hanger :
(f) Rim cover :

7.2.46.2.7.7 Mirror

The mirror shall be frame-less and moisture proof, and the glass for mirror shall be 5mm thick and 360x455 mm in size, and in accordance with JISD 3202 (Float, Polished Plate Glass) or equivalent BDS standard.

7.2.46.2.7.5 Water Cock and Similar Items

The main structures constituting the septic tank shall be made of FRP (fiberglass reinforced plastic) having appropriate shape, dimensions and capacity. The structures shall have sufficient strength against soil pressure, water pressure, load etc. and shall be of a construction permitting easy inspection and cleaning. The functional requirements shall be as follows.

(1) Treatment Capacity

(a) Accommodation treatment for : 5 persons
(b) Estimated daily average volume of waste : 1 m 3 / day
(c) BOD concentration in discharge water : 90 ppm.

(2) Tank Equipment

The septic tank shall consists of blower unit, pre treatment tank and main tank and the equipment required for the tank shall be of the following specifications.

Blower Motor : 0.04 m3 / min, 0.2 KW, three Phase, 415V, 50 Hz x 1 set

Accessories : Distribution board and cable, air piping and required pertinent.

(3) Accessories

Sterilization Chemical : 1 set

Sanitary appliances shall conform to the following standards:

BDS 1162: 1987	Specification for Ceramic Wash Basins and Pedestals;
BDS 1163 : 1987	Specification for Vitreous Sanitary Appliances, Part-1, General Requirements; Part-2, Specific Requirements for Water Closets; Part-3, Specification Requirements for Urinal (Bowl type); Part-4, Specific Requirements for Foot Rest; Part-5, Specific Requirements for Integrated Squatting Pans.
ASHRA E90A-80	Energy Conservation in New Building Design;
ASHRA E 90B-75	Energy Conservation in New Building Design;
AWWA C700-77	Cold Water Meter Displacement Type;
AWWA C701-78	Cold Water Meter Turbine Type Class-I;
AWWA C702-78	Cold Water Meter Turbine Type Class-II;
AWWA C702-78	Cold Water Meter Compound Type,
BS 1125: 1987	Specification for WC Flushing Cisterns (Including Dual Flash Cisterns and Flush Pipes);
BS 1244	Metal Sink for Domestic Purposes;
BS 1254:1981	Specification for C Seats (Plastics);
BS 1329:1974	Specification for Metal Hand Rinse Basins;
BS 1876: 1992 (1977)	Specification for Automatic Flushing Cistern for Urinals

TREATMENT PROCESS
OF
SEPTIC TANK

7.2.46.2.8 Piping Materials and Pipe Fittings

7.2.46.2.8.1 Pipe

(1) Water Supply Pipes

The water supply pipe shall be the steel pipe lined with rigid PVC in accordance with JWWA-K66.

(2) Drainage and Air Vent Pipes

The drainage and air vent pipes shall be the galvanized steel pipe in accordance with JIS G 3442, tar-epoxy coating steel pipe in accordance with JIS G3443 and HASS-210, and / or the centrifugal reinforced concrete pipe as specified in JIS A 5303.

7.2.46.2.8.2 Pipe Joint

(1) Water Supply Pipe Joints
The water supply pipe joints shall comprise screwed type and flange type. Screwed type pipe joints shall be malleable cast iron pipe joints coated with plastic in `accordance with JIS B2301. The flange type pipe joints shall be mad by welding the flange to the end surface of the steel made joints as stipulated in JIS B 2211 or JIS B2212, and further by lining the internal surface with rigid PVC of the same specification as that used for lining for lining of the steel pipe.

(2) Drainage and Air Vent Pipe Joints

The drainage and air vent pipe joints shall be malleable cast iron pipe joint in accordance with JIS B2301, screwed type drainage pipe joint in accordance with JIS B23.3 and rigid PVC pipe joint accordance with JIS K6739.

7.2.46.2.8.3 Gate Valves

The gate valve shall be the 10 kg. Cm2 bronze screwed or flanged type gate valve as stipulated in JIS B2023, and B2044.

7.2.46.2.8.4 Check Valves

The check valve shall be the 10 kg /cm2 bronze screwed or flanged swing check valve as stipulated.

7.2.46.2.8.5 Flexible Joints

The flexible joint shall be of a bellows type and shall have sufficient flexibility and resistance against pressure. The bellows and protective steel band shall be make of cold rolled stainless steel plate / sheet (SUS – 304) as stipulated in JIS G4305.
The length of one flexible section shall be 400mm.

7.2.46.2.8.6 Strainers

The strainer shall be of a Y type. The case the nominal diameter is 50mmm or less, the strainer shall be of a screwed type made of bronze, but in case the diameter is 65mm or over, the strainer shall be of a flanged type made of cast iron.

The clean out plug shall be make of brass, and the strainer element shall be made of stainless steel, one spare strainer element shall be furnished.

7.2.46.2.8.7 Drainage Pipe Fitting

(1) General

(a) The water sealing depth of trap shall be 50mm or more, and the effective area of the drainage hole for strainer shall not be less than the sectional area of the drainage pipe.

b) The nickel chromium plated section of the drainage pipe fittings shall be equivalent to or higher than Class 1 or Grade 2 in JIS H 8617 (Electroplated coating of Nickel and Chromium).

(2) Floor Drain Trap

The floor drain trap shall be made of cast iron and the strainer shall be nickel chromium plated brass. The floor drain trap for asphalt waterproofed floor shall be of a waterproofing type, but that for other floors shall be of an ordinary type.

(3) Floor Clean out

The floor clean out shall be of a screwed type made of brass having a nickel chromium plating finish. The floor clean out for asphalt waterproofed floor shall be of a waterproofing type, but that for other types of floors shall be of an ordinary type.

(4) Under floor Clean out
The under floor clean out shall be of a screwed type made of brass.

(5) Drainage Pipe Fittings
The drainage pipe fittings shall be make of brass having a nickel chromium plating finish and the chain and stopper shall be made of stainless steel.

7.2.46.2.8.8 Pipe Washers

The pipe washer shall be made of nickel chromium coated brass or stainless steel.

7.2.46.2.8.9 Pipe Sleeves

The pipe sleeve shall be made of steel pipe or steel plate with a thickness of 0.4mm or over (0.7mm or over in case the nominal diameter exceeds 200mm). However, the non-water proofed floor pope sleeve to be used indoors shall be made of laminated cardboard.

7.2.46.2.8.10 Pipe Support Fittings

(a) The pipe support fittings shall resistant to contraction and expansion, rolling etc. of pipe and be of a construction having sufficient bearing strength against load of pipe when liquid is contained inside. The materials to be used shall be in accordance with JIS G 3101 (Roll Steel for General Structure).

All steel fittings shall be finished by galvanizing.

(b) The inserts shall have sufficient strength for supporting the pipe and shall have a construction having suitable for connecting hangers etc. All inserts shall be made of cast iron, press formed malleable cast iron or steel plate.

7.2.46.2.8.11 Cementing /Bonding Materials

(1) Thread Sealing Materials

(a) The threat sealing tapes shall be in accordance with JIS K6885 (unsintered polytetrafluoroethylene tapes for thread sealing (raw tapes) , and shall neither be hazardous to human health nor cause adverse effects upon drinking water.

b) The paste sealing agent shall not be affected by the liquid in pipe and shall consist of contents applicable to the purpose of use. In case the agent is used for sealing of piping for drinking water, it shall not be hazardous to health nor cause any adverse effect upon drinking water.

(2) Packing(s)
The packing shall be in accordance with JIS K6353 (Rubber Goods for Water Works Service) JIS R3453 (Compressed Asbestos Sheets) etc. and have sufficient durability applicable to the respective quality of water, water pressure, temperature etc.

(3) Caulking Lead

The caulking lead shall, in principle be the 5th Class of those stipulated in JIS H2110 (Pig Lead).

(4) Caulking Hemp

The caulking hemp shall in principle be the jute of #130 single thread which, tied in a bundle has a diameter or about 25mm.

7.2.46.2.8.12 Basin and Basin Cover

(1) General

(a) The materials for iron castings shall be equivalent to of higher than Grade 3 as stipulated in JIS G5501 (Gray Iron Castings)

b) The iron castings shall be baked with refined tars in accordance with JIS K 2473 (Processed Tars) to which more than 2% of linseed oil or drying oil is mixed, or shall be cold painted with refined bituminous materials to which synthetic resin finishes added.

(2) Invert Basin

(a) The invert basing shall be of a concrete construction and all visible portions shall be finished by mortar, the basin shall be furnished with a cover and an invert applicable to the piper diameter shall be provided on the bottom of the basin.

(b) The cover shall be make of cast iron with chain, and shall be of an door proof type able to withstand the weight of 2,500kg.

(3) Drainage Basin

(a) The drainage basin shall be a concrete construction and all visible portions shall be finished by mortar coating. Moreover, the basin shall be furnished with a cover.

(b) The cover shall be made of cast iron with chain and shall be of an door proof type able to withstand the weight of 2,500kg.

7.2.46.3 Execution

7.2.46.3.1 Foundation Works

(1) The foundation shall be of reinforced concrete construction able to withstand the weight of equipment and external forces and having sufficient bearing surface for installation of equipment. The foundation shall be built on the floor or ground having sufficient bearing capacity.

(2) Cement to be used shall be the ordinary Portland cement in accordance with JIS R5210 (Portland Cement).

(3) Regarding the sizes of aggregate, the size of gravel shall be 25mm or less that of crushed stone shall be 20mm or less and that of sand shall be 2.5mm or less.

7.2.46.3.2 Erection Works

7.2.46.3.2.1 Drinking Water Tank

(1) The drinking water tank shall be firmly fixed with anchor bolts shaving sufficient strength so that the tank will not slide laterally nor move in any way due to horizontal seismic force.

(2) The drinking water tank shall be installed on a horizontal plane on the foundation having a steel made base and the foundation shall have an even bearing surface against the load. The tank and the steel base shall be fixed firmly with anchor bolts.

(3) After installation, the tank shall be cleaned and washed with water. Then, the tank shall be sterilized by using solution of hypochlorous acid, etc.

(4) The piping related to the tank shall be so supported that weight of the pipes not be applied to the tank.

Flexible joints shall be provided for all respective connecting pipes to the water tank except for the drain pipe and air vent pipe.

7.2.46.3.2.2 Wall Hanging Type Electric Water Heater

The wall hanging type electric water heater shall be set firmly on the wall by using expansion joints.

7.2.46.3.2.3 Sanitary Ware, Accessories and Fittings

(1) General

(a) In case wall hanging fittings are fixed on a concrete wall or brick wall, expansion bolts shall, in principle be used.

(b) In case a metal panel or lightweight steel framed board wall is set, steel plate and worked angle materials or hard wood patch shall be fixed to the sanitary ware in advance.

(c) In case a part of the sanitary ware is embedded in concrete, the portion of the sanitary ware that comes into contact with concrete or mortar shall be covered with asphalt having a thickness of 3mm or over. However, the bottom contact surface of sanitary ware, shall be filled with sand.

(2) Water Closet (Western/European Style)

(a) The upper end of the stool shall be set horizontally in place after deciding the precise setting positions.

(b) Prior to connecting the stool to the drain lead pipe the connecting end of the lead pipe shall be flared up to the diameter of the flange, and after inserting the non drink sealing materials between the external surface of the flange and connecting end the stool shall be connected to the drain lead pipe by nuts fastened from above by flange fittings and bolts. The plate thickness of the external end of the flared lead pipe shall not be less than 2mm.

Moreover, the end of the flange for the lead pipe to be connected to the stool shall be supported sufficiently with hangers etc. so that no load of drain pipe, etc, will act directly on the stool.

(3) Wash Basin

(a) The bracket or back hanger/s shall be firmly set in place, and the sash basins shall be fixed carefully so that the upper surface of the basing will be kept horizontal without exhibiting looseness. In order to eliminate leakage of water, heat resistant non drying sealing materials shall be filled around drain holes of the basins and around openings between the drain pipe fittings.

b) The setting height of the basins shall be 800mm (approximate) from the floor surface to the upper front end of the basins.

(4) Service Sink

The trap shall be set in place without any misalignment, and the connection of the sink to the drain pipe shall be carried out in accordance with the procedures for connection of stool in (2). Setting of back hanger(s) and connection between drain holes of the SINK and drain pipe fittings shall carried out I accordance with the procedures for the above wash basins in (4).

(5) Water Cock

The water cock shall be fixed firmly after precise centering by fully taking into account the convenience of use and harmony witty the surrounding facilities.

A sufficient space for the spout shall be provided between the end of the spout of water cock and the flood level rim of the drain receptacle.

(6) Mirror

The setting height of the upper end of the mirror shall 1,800 mm form the floor surface.

7.2.46.3.2.4 Septic Tank

Reinforced concrete foundation shall be provided and the tank shall be firmly fixed to the foundation so as to withstand upward water pressure.

7.2.46.3.3 Piping

7.2.46.3.3.1 Water Supply and Water Hydrant Piping

(1) General

(a) Prior to execution of piping work, detailed study shall be made on the relationship between other piping and equipment, and all positions for pipe laying shall be decided by taking into account the precise slope of the respective piping.

In the case where piping is laid inside a building, setting of the pipe support fittings and embedding of pipe sleeves shall be carried out without any delay and in accordance with progress of the work.

(b) The flange joints shall be inserted for all main piping at appropriate intervals in order to ensure easy removal of such piping.

(c) In the case where any piping is branched from the main piping, T-joints shall be used.

(d) As air release valve shall be provided at the dead air space portion in piping, and a mud discharge valve shall be provided at the portion where mud is collected. The size of the mud discharge valve shall be the diameter of the related pipe, provided

that the size of the valve shall be 25mm in case the nominal diameter of the pipe exceeds 25mm.

(e) In case any anti-sweat covering is not provided for piping, pipe washers shall be fixed to all portions of piping that penetrate through ceiling, floors, walls etc. and is visible from the outside.

(f) Any openings between the piping that penetrates through fire service areas etc. shall be filled with rock-wool heat insulation or other non-combustible materials. At transformer sites there shall be a manual simplified water spraying facility including water pump, hose pipe, nozzle and necessary piping arrangement so that for external firing of the transformer if happen, the attendant of the sub-station can easily spray water to extinguish fire locally.

(g) In case where a pipe sleeve is used at a place requiring water tightness, lead caulking shall be provided in the opening between the sleeve and pipe.

(h) In the case where any steel pipe and similar materials are laid under the ground, such pipe shall be protected against corrosion by either a double coating of coat tart or a double winding of corrosion proof vinyl tapes (JIS Z 1901 "Protective Polyvinyl Chloride Tapes).

(i) Any repair of steel pipe, cast iron pipe and lead pipe with caulking shall be prohibited.

(j) After completion of piping work, the inside of the piping shall be cleaned by water pressure on the occasion of hydrostatic test of the piping. In the case of piping for drinking water. The piping shall be sterilized until free residual chlorine of 1.2ppm or over has been detected at the end of the piping.

(2) Gradient

In the case of horizontally running pipe, the up feed pipe shall have an upward slope and the down feed pipe shall have a downward slope. In principle, the gradient shall be 1/250.

(3) Support Pitch

(a) The support pitch of the horizontally running pipes shall, in principle, be in accordance with the values in the following table and, wherever necessary , all bent sections and branching sections shall be supported. In the case where steel pipes or similar pipes are supported with hangers, a steady rest shall be provided for each horizontally running pipe in order to avoid looseness of the pipe due to movement at the time of earthquake.

(b) A steady rest shall be provided for indoor vertical pipe at least at one spot on every floor.

Table-12.1 : Maximum Support Pitch of Water Supply Pipe

Nominal pipe diameter	20 or less	25 - 40	50 - 80	100 - 150	200 or more
Support pitch	1.8	2.0	3.0	4.0	4.0

7.2.46.3.3.2 Drainage and Air Vent Pipe

(1) General

(a) All horizontally branched drainage pipes, etc. shall be combined nearly horizontally at an acute angel of less than 45°.

(b) In case bent lead pipe is used, the pipe shall be carefully fabricated so as not to impair its roundness, and no branch drainage pipe shall be taken for protection.

(c) No waste water shall be discharged directly form the form the following equipment.

- Air conditioners
- Drinking water tank
- Pumps

(d) Indirect drainage pipe shall be opened while maintaining a space of over twice the diameter of the pipe from the drain receptacle and flood level rim. In case an obstacle is foreseen in providing the above opening, appropriate measures shall be taken for protection.

(e) The lowest portion of the vertical drainage pipe shall be fixed with a support stand where necessary.

(f) Any air vent pipe shall be run out vertically or at an angle of less than 45° from the horizontally branched drainage pipe and in no case shall the pipe be run out horizontally.

(g) In the case where air vent pipes on floors are connected to vertical air vent pipes, the said pipes shall be connected at the place over 150mm from the flood level rim of the related equipment. Vertical air vent valves shall be connected to the stack vents in accordance with the above procedures.

(h) In case a hump pipe is buried, a pit shall be excavated from the lower ad of the pipe to depth of about 100mm in case the nominal diameter of the pipe is 300mm. After unscrewed crushed stone, unscreened gravel or pike sand has been laid and compacted, the pipe shall be laid. However, the portions where joints are provided shall be excavated further if necessary.

Initial back filling of pipe shall be carried out up to the center line of the pipe to ensure immovability, and after sufficient compaction, the pipe shall finally be buried.

Provisions other than those described in this paragraph shall be in accordance with the general provisions in 12.3.4.1.

(2) Gradient

The gradient of horizontally running drainage pipes said inside a building shall be 1/100. All air vent pipes shall have an upward slope facing the vertical pipes and shall be free from reverse slope and unevenness.

(3) Support Pitch

(a) The support pitch of steel pipes shall be in accordance with the applicable provisions in Table 12.1.

(b) Horizontally running cast iron pipes shall be supported at a pitch of less than 1.6m, and the deformed fittings to be connected shall be supported at a pit of less tan 0.6m, respectively.

7.2.46.3.3.3

(1) Connection of Pipes

(a) All pipes shall be carefully cut at a right angle against the axial center of the pipes so as to avoid any deformation of the sections, and the cut end shall be finished smoothly.

(b) All pipes shall be connected after removing any chips, dust and other foreign matter and after confirming that all such foreign matter has been completely removed form inside the pipes.

(c) In case piping work is temporarily suspended, all pipes shall be sufficiently protected to avoid entry of any foreign matter.

(5) Water Supply Piping

(a) No water supply piping shall in principle, be connected according to an insertion system unless specified otherwise.

(b) Epoxy resin or synthetic rubber rust inhibitors shall be sufficiently coated over the end face of threaded portions and the bottom of threaded portions of joints. All rust inhibitors to be applied for any drinking water piping shall be applied for any drinking water piping shall be harmless to human health and shall cause no harmful effect to the quality of drinking water.

(4) Drainage and Air Vent Piping

(a) Prior to connecting the galvanized steel pipes, the pipes shall be correctly threaded so that a slight clearance is provided between the end face of pipes and the recess of joints in order to obtain the tapered threaded pipe portion. Then, the steel pipes shall be screwed tightly into the joints.

(b) All case iron pipes shall be connected by using rubber rings. In this case, the pipes shall be inserted into the rubber rings until the end of spigot comes into contact with the bottom of socket. Then, the rubber rings that have been inserted into a position near the end of spigot in advance shall be inserted into the pipes carefully so that no twisting will occur in the opening between the socket and spigot. Then, the rubber rings shall be set in close contact with the pipes while uniformly fastening the tap bolts and nuts using a junk ring.

(c) Al rigid PVC pipe shall be carefully connected by a cold working method so that no step will occur between the connected pipes. The flow of water in the piping shall be smooth and uninterrupted.

(d) All centrifugal reinforced concrete pipes shall be connected by using collars.

After both ends of the pipes have achieved tight contact with each other at the central part of the collar and carefully set in place to ensure proper alignment in the surrounding opening, stiff consistency mortar shall be placed into the opening. In this case, all cement and water inside the pipes shall be thoroughly removed. In case one end of a pipe is made into a socket form after connecting a collar to the end with mortar, mortar shall be placed about 10mm away from the pipe end.

7.2.46.3.4 Antisweat Covering

7.2.46.3.4.1 Materials

The anti sweat covering materials, exterior and auxiliary materials shall be as specified in Table below.

Table - 12.2.1 : Antisweat Covering Materials, Exterior and Auxiliary Materials (1/2)

Classification of materials	: Specifications
Heat insulation materials Glass wool heat materials	: The glass wool heat insulation tubes shall be in accordance with JIS A9505 (Glass wool heat insulation materials) or equivalent
Exterior Materials Galvanized Sheets	: The galvanized sheets shall be in accordance with grade 2 in JIS G3302 (Galvanized Sheets.) The standard thickness of original sheet shall be 0.3mm when the sheet is used for insulating pipes, valves, etc. with an outside diameter of 250mm or less, but in other cases, the thickness shall be 0.4mm.
Cotton Cloth	: The weight of cotton cloth shall be 115g or more per $1m^2$ In case, the cloth is used for pipe, etc. it shall be cut into appropriate widths of a tape form.
Glass Cloth	: The glass cloth shall be non-alkali plain glass sloth obtained by processing EP211C into a non-fraying type as stipulated in JIS R3414 (Glass Cloth).
PVC Type (Vinyl Tape)	: The PVC tape shall be non-tacky tape of medium gloss with a thickness of 1.2mm in accordance with JIS Z1901 (Protective Polyvinyl Chloride Tapes).

Waterproofing Temp cloth (Linen)	: The waterproofing linen shall be Hossian cloth No. 7 as stipulated in JIS L 2405, over one side of which blown asphalt, as stimulated in JIS K2207 (Petroleum Asphalt), has been coated. The linen shall be cut into a tape form of an appropriate width in case it is used for waterproofing of pipes etc.

Table -12.2.2 : Antisweat Covering Materials, Exterior and Auxiliary Materials (2/2)

Classification of materials	: Specifications
Auxiliary Materials	
Molding base paper	: The base paper shall be molding base paper of 370g more per m^2.
Asphalt roofing	: The asphalt roofing shall be the one manufactured in accordance with JIS A6006 (Asphalt Roofing Felts) (Fiber Base) (Self-Finished Bitumen Felts), and more than 17kg per roll (21 m^2).
Iron Wire	: The iron wire shall be the one as stipulated in JIS G3532 (Barbed Wires) which has been galvanized.
Steel Frame	: In principle, the steel frame shall be the one made of steel sheet with a standard thickness of the original sheet of 0.4mm or more as stipulated in JIS G 3302 (Galvanized Sheets)
Adhesive PVC Tape	: The adhesive PVC tape shall be in accordance with JIS Z1525 (Pressure Sensitive Adhesive Polyvinyl Chloride Tapes) with a thickness of 0.2mm.
Band and toothed lock washer	: The band toothed lock washer shall have a thickness of 1.2mm or more, and shall be made from the materials in accordance with JIS G4305 (Cold Rolled Stainless Steel Strips), or JIS H3201 (Brass Plates). However, the ones made from brass shall be finished by nickel chromium Plating. The width of band shall be 20mm.
Adhesive	: In principle, acrylic emulsion adhesive shall be used for adhesion of glass cloth, glass filament mat and aluminum glands cloth. Vinyl acetate adhesive shall be used for adhesion of formed polystyrene heat insulation materials, and the chloroprene rubber adhesive for adhesion of rivets.

7.2.46.3.4.2 Execution

(1) General

(a) The thickness of insulation shall be that of the main insulation material and shall not include the thickness of exterior materials and auxiliary materials.

(b) The clearance between mutual insulation materials shall be as small as possible, and in no case shall joints for overlapping sections be provided on the same line.

(c) Band and tube shaped covering shall be tightly bound with galvanized wire. Bands shall be bound at a 50mm pitch and tubes shall have two windings at least three places per tube. All overlapping portions and joints of tubes shall be joined together by using adhesive tapes.

(d) In principle, the width of tape winding shall be 15mm or more, and taint of other overlapping portions shall be 35mm or more. In the case of water-proof linen wrapping, galvanized wire shall be wound twice over the wrapping at an interval of 2m, then asphalt primer shall be coated twice of the windings.

(e) Tapes shall be wounded starting form the lower part and then proceed to the upper part of piping. Should there be any possibility of deviation in case of polyvinyl chloride tape, etc., such deviation shall be eliminated by using adhesive tapes etc.

(f) The lagging plate over the insulation of the pipe shall e carried out in abed over form, and that of the vent section shall be carried out into a fan form.

(g) Shake-proof washers shall be attached to the ends of heat insulation sections for indoor piping, and bands shall be attached to branch and bent sections of the piping.

(h) The ends of heat insulation sections shall be protected as required depending upon the types and purposes of heat insulation materials to be used.

(2) Materials and Sequence of Works according to the types of heat insulation

The materials and the sequence of work according to the types of heat insulation are as indicated in Table 12.3.

Table - 12.3

Type of Covering Work	Materials and Sequence of work	Remarks
	(I) Glass wool heat insulation materials	
A piping	1. Heat Insulation tube	Outdoor exposed
	2. Galvanized Wire	
	3. Rough Paper	
	4. Cotton Cloth	
B	1. Heat Insulation Tube	Inside Ceiling and pipe Shaft
	2. Galvanized Wire	
	3. PVC Tape	

(3) Thickness of the Heat Insulation (Coverings)

The thickness of the insulation shall be as indication in Table 12.4.

Table - 12.4 : Thickness of Insulation

(Unit: mm)

Nominal dia. Type Remarks	10	20	25	32	40	50	65	80	100	
I water supply drainage piping	20	20	20	20	20	20	20	20	25	Glass Wool

(4) Heat Insulation (Coverings) for water supply pipes (including joints and valves)

(a) The materials and sequence of works according to the types of work shall be in accordance with Table 12.3.

(b) The thickness of insulation shall be in accordance with Table -12.4.

Table 12.5

Place of application	Materials and sequence of work	Thickness of Insulation
Indoor exposed piping	a	I
Piping inside ceiling and pipe shaft	a	I

(5) Anti sweat Covering

(a) The materials and the sequence of work according to the types of work shall be in accordance with Table 12.3.

(b) The thickness of the insulation (Covering) shall be in accordance with Table 12.4.

Table - 12.6

Place of application	Materials and sequence of work	Thickness of insulation
Indoor exposed piping	a	I
Piping inside ceiling and pipe shaft	b	I

(6) No insulation shall be provided for the following pipes, valves and flanges.

(a) Devices and piping 9including drainage pipe on the floor below sink) which are considered accessories for sanitary wares.

(b) Piping for water supply and drainage underground or inside concrete.
(c) Water supply piping laid indoors (excluding the piping to be laid inside ceilings and highly humid areas).
(d) Hot water supply piping valves and flanges .

(e) Out door exposed drainage piping.
(f) Air vent piping (excluding the portion of 100mm from the branch point of drainage pipe).
(g) Overflow pipes and drain pipes for various tanks and similar equipment.

7.2.46.3.5 Painting Work

(1) General

All respective equipment and materials, except the following, shall be painted.
Equipment and materials, except those requiring corrosion proof painting to be buried.

(2) Painting
The types of paints and frequency of painting of portions to be painted shall, in principle, be as specified in Table 12.7.

7.2.46.3.6 Civil Works

Items other than those specified in the following shall be in accordance with the specification/s for "Reinforced Concrete Works"

(1) The pit for piping under the ground shall be so excavated that the required gradient can be kept precisely and the piping can be connected easily.

(2) The foundation and pit for tanks, etc. shall be excavated sufficiently taking into account the space for assembly and removal of forms.

Table - 12.7.1 : Types of Paints and Frequency of Painting of Respective Portions (1/2)

Portions to be painted			Frequency of painting			Remarks
Equipment and members	Conditions		Primer Painting	Inter Coating	Face Coating	
Supports, racks and similar fittings (Other than galvanized materials	Exposed	Ready-mixed paint or aluminum paint	2	1	1	The primer coating shall be anti-corrosive pain
	Canceled	Anti-corrosive	1	-	1	
Heat-insulate exterior (cotton and cloth)	Exposed	Ready-mixed paint	1	1	1	The primer coating shall be sealer coating

	Canceled	Sealer coat	1	-	1	
Hear-insulated exterior (Glass cloth)	Canceled	Synthetic resin emulsion paint	1	1	1	After the glass cloth has been precisely bonded and made sufficiently dry, synthetic resin emulsion paint as stipulated in JIS K 5663 shall be used.
	Exposed	Polyvinyl chloride resin enamel	1	1	1	After the glass cloth has been precisely bonded and made sufficiently dry, emulsion putty shall be applied twice and after surface finish with paper file, resin enamel shall be applied.

Table - 12.7.2 : Types of Paints and Frequency of Painting of Respective Portions (2/2)

Portions to be painted			Frequency of painting			Remarks
	Types of paints					
Equipment and members	Conditions		Primer painting	Inter canting	Face Coating	
Heat-insulate exterior(Galvanized iron plate/board)	Exposed	Ready-mixed paint	1	1	1	The primer coating shall be anti-corrosive paint
				2nd		
				Coating		
Lined steel pipes and coated steel pipes including joints	Exposed	Ready-mixed	2	1	1	The primer coating shall anti-corrosive paint.
	Canceled	Anti-corrosive paint	1	-	1	Excluding resin-coating joints.

7.2.46.4 Test

7.2.46.4.1 Hot Water Storage Tank

The hydrostatic test shall be carried out for the instantaneous type electric water heater.

The hydrostatic test pressure shall be 17.5 kg/cm2 (shortest)

7.2.46.4.2 Water Supply Pipes

The hydrostatic test of water supply pipes shall be carried out prior to coating work during piping work or prior to shielding and backfilling or after completion of piping. The minimum pressure retention time shall be 60 minutes.

The test pressure of piping below elevated water tanks shall be twice the pressure equivalent to the static head.

7.2.46.4.3 Drainage Pipes

The water filling test of the drainage pipes shall be carried out prior to coating work during piping work or prior shielding and back filling or after completion of piping. The water passage test of sanitary drain pipes shall be carried out after sanitary wares etc. have been attached. The minimum water retention time in case of water filling test shall be 30minutes or more and that in case of the water passage test shall e 15 minutes or more.

7.2.46.4.4 Test of Raw Water

After the completion of the water receiving tank and water suction pump, the contractor shall test the quantity and quality of the raw water collected form the well.

The test shall be in accordance with article 4 (Water Quality Standard) of water service law of Japan.

The test items shall be as follows :

- Cyanide
- Mercury
- Organism Mercury
- Organism Phosphorus
- Lead
- Chromium
- Arsenic
- Fluorine
- Cadmium
- Nitrogen of nitric acid
- Colon bacilli's

The results of the tests shall be submitted to the Engineer.

7.2.46.4.5 Test of Treated Water

After the completion of drinking water system, the contractor shall test the quality of the treated water collected from the cocks. The test shall be in accordance with article 4 (Water Quality Standard) of water Service Law of Japan.

The test items shall be as follows :

- Turgidity
- Chromatizitat
- Stench
- Taste
- Potential of hydrogen
- Organic matter
- Nitrogen of ammonia
- Chlorine Iron
- Evaporation
- Solvable material
- Total hardness
- Iron
- Manganese
- Copper
- Zinc

The result of the test shall be submitted to the Engineer.

7.2.47 Air Conditioning and Ventilation Equipment Work

7.2.47.1 General

7.2.47.1.1 Scope

This clause covers the performance of all air conditioning and ventilation equipment works in accordance with the drawings and these specifications.

(1) Air Conditioning Equipment

(2) Ventilation Equipment

The contractor shall submit shop drawings of fabricated items to the engineer for approval. The shop drawings shall clearly show the details of fabrication, installations, dimensions, sizes, operation, methods of anchoring and any other pertinent details required for satisfactory installation. The contractor shall submit the result of tests at designated date specified.

7.2.47.1.2 Design Basis of Air Conditioning and Ventilation System

(1) Outdoor

Maximum Temperature	36° C	Dry Bulb
Minimum Temperature	28° C	Wet bulb
Minimum Temperature	12° C	Dry bulb

(2) Indoor
Temperature

	25° C	Dry bulb	Control room
	27° C	Dry bulb	Otherm rooms
(summer)			
	22° C	Dry bulb	Other rooms (winter)

Humidity 60% Control room
(Relative humidity) Other rooms

7.2.47.2 Equipment And Materials

The equipment, materials and accessories as specified herein shall be furnished together with spare parts for three (3) years normal operation except as indicate otherwise.

7.2.47.2.1 Package Air Conditioning Units

(1) The Contractor shall furnish and install the package air conditioning units as shown in the drawings. Package air conditioning units shall be factory built and factory tested products.

(2) In this work, tow types of package air conditioning units shall be installed.

(3) Air heat source heat pump package air conditioner.

(a) Type	Light weight, up right floor standing type.
(b) Cabinet	Synthetic resin paint baked on finished plates.
(c)Insulation	Insulation shall be installed to prevent sweating and to muffle sound, using glass wool on polywreten form.
(d) Condenser	Air source heat pump condenser.
(e) Compressor	Compressor (s) shall be serviceable hermetic type equipped with suitable rubber vibration isolators crank case heaters, liquid line strainer and suction and discharge shut off values.
(f) Air Filter	Permanent washable polyvinyl chloride.

(g) Heat Exchanger Multi pass cross fined tube.
(h) Connections With flare nut or companion flange for field piping.
(i) Outdoor Fan Propeller Fan.
(j) Evaporator Multi pass cross finned tube
(k) Evaporator Fan
Multi-brade centrifugal Fan
AC- 1 (see drawings) direct drive
AC- 2 (see drawings) belt drive

(l) Applicable power supplies
AC 3-phase 400V 50Hz.

(m) Operation switch

3-position push button types and cooling heating selection switch (Ventilating operation, cooling operation or heating operation.

(n) High Pressure Switch

This switch cuts out the operation of compressor when the discharge pressure exceeds the setting.

(o) Accessories

Spare Parts

Refrigerant - for 1 change

V. belt - 1 each

7.2.47.2.2 Fans

(1) The Contractor shall furnish and install the fans as shown in the drawings. Fans shall be factory tested products.

(2) The capacities of the fans shall be in accordance with fan schedules as shown. Unless otherwise directed, the fans shall conform to the layouts as shown the drawings.

(3) All fans shall be statistically and dynamically balanced to avoid vibration and shall have blades to secure quiet efficient operation.

7.2.47.2.3 Ducts

Duct materials shall conform to the followings:

Galvanized steel iron sheet
Shape Steel
Bolt

Nut
Gasket for flange

7.2.47.2.4 Refrigerant Pipe Materials and Accessories

(1) The pipes shall be of copper. The material shall be as specified in JIS H3603 (Phosphorus deoxidized copper seamless pipes and tubes) and the dimensions shall be as specified in ASTM B8858L (Hard materials).

(2) The joints shall be molded products made from the above materials and they shall pass the manufacturer's standards. In locations where removal is required, flair or flanged joints shall be provided.

7.2.47.3 Installation Work

7.2.47.3.1 Foundation Work

(a) Foundation shall be of reinforced concrete construction and shall be able to withstand the weight of equipment and external forces by having sufficient bearing face. Moreover, the foundation shall be constructed on floor or ground having sufficient bearing capacity.
(b) Cement to be used for foundation shall be the standard Portland Portland cement in accordance with BDS 232 (Portland Cement).

(c) In principle, the size of aggregate shall be the following values

Gravel	:	25mm or less
Grousd Stone	:	20mm or less
Sand	:	2.5mm or less

Provisions other than those specified above shall be in accordance with the specifications for "Reinforced Concrete Work"

7.2.47.3.2 Installation Work for Equipment(S)

All equipment's shall be firmly secured to the floor so that the equipment will o move or be damaged due to earthquakes, etc.

7.2.47.3.3 Duct Work

(1) The Contractor shall furnish and install all sheet metal ducts for supply, return, fresh air and exhaust systems as shown in the drawings.

(2) Ducts shall be constructed to standards outlined in the latest HASS Guide. Ducts shall be constructed of galvanized steel gauges as shown Table 13.1.

Table - 13.1

Duct Size	Metal Gauge	Thickness
Less than 450	#26	0.5mm
455 ~ 750	#24	0.6mm
755 ~ 1500	#22	0.8mm
1501 ~ 2250	#20	1.0mm
More than 2260	#18	1.2mm

(3) The contractor shall clean all dirt and rubbish from the interior and exterior of all ducts and other accessories prior to erection.

(4) A flexible connection shall be made between the fan discharge and the adjoining duct work.

(5) Low-velocity ducts shall be installed as follows :

Table - 13.2 : Duct Flanges

			Bolt		Rivet	
Thickness	Shape Steel	Max. Pitch	Dia.	Pitch	Dia.	Pitch
0.5mm	5x25x3	3.6m	8.0mm	100mm	4.5mm	65mm
0.6	5x25x3	3.6	8.0	100	4.5	65
0.8	0x30x3	2.7	8.0	100	4.5	65
1.0	0x40x3	1.8	8.0	100	4.5	65
1.2	0x40x5	1.8	8.0	100	4.5	65

Table - 13.4 : Duct Hangers

Thickness	Shape Steel	Steel Rod Dia.	Max. Pitch
0.5mm	25 x 25 x 3	9mm	3.0m
0.6	25 x 25 x 3	9	3.0
0.8	30 x 30 x 3	9	3.0
1.0	40 x 40 x 3	9	3.0
1.2	40 x 40 x 5	9	3.0

(6) Spiral Duct

(a) The straight portion of the spiral duct shall be fabricated, using a strip of the galvanized steel sheet. The nominal size of the spiral duct shall be based on the inside diameter. The tolerance in inside diameter shall be +0 ~ +2 mm in reference to the nominal size. The thickness of the iron strips to be used shall be as indicated in Table 13.5.

Table - 13.5 : Thickness of Spiral Duct

Air Duct Diameter (mm)	Thickness (Gauge No.) of iron strips
Below 200	0.5mm (#26)
Over 200, but below 600	0.6mm (#24)

Over 600, but below 800	0.8mm (#22)
Over 800, but below 1,000	1.0mm (#20)

The pitch of the side seaming at the straight portion of the spiral duct shall be as indicated in Table 13.6 and the folding width shall be over 6mm.

Table - 13.6 : Side Seaming pitch of spiral Ducts

Air Duct diameter (mm)	Seam Pitch (mm)
Below 100	Below 100
Below 1,000	Below 150

(b) The jointing of one spiral duct to another shall be preformed by applying as many side seaming as required, using galvanized steel strips or welding as many steel strips arranged properly between spiral joints.
The galvanized steel strips shall be applied, in advance, with rust preventive paint on both inner and outer sides.

The nominal size of spiral duct joints shall be based on the outside diameter of the spiral duct joints, and the tolerance in nominal size shall be as indicated in Table 13.7.

Table - 13.7 : Tolerance in spiral duct Joint Diameter

Nominal Size (mm)	Tolerance (mm)
Below 600	- 1.5 - 2.5
Over 600, but below 1,00	- 2.0 - 4.0

The thickness of the galvanized steel strips to be used for the joint between spiral air ducts shall be as indicated in Table 13.8.

Table - 13.8 : Thickness of Galvanized iron Strips and Steel Strips

Nominal Size (mm)	Thickness (Gauge No)
Below 200	0.6mm (#24)
Over 200, but below 600	0.8mm (#22)
Over 600, but below 800	1.0mm (#20)
Over 800, but below 1,000	1.2mm (#18)

The overlapping width between steel strips used for the spiral duct joint shall be as indicate in Table 13.9.

Table : 13.9 : Overlapping width between iron strips or steel strips

Nominal Size (mm)	Overlapping Width (mm)
Below 125	60
Over 125, but below 300	80

Over 300, but below 1,000	100

(c) Spiral duct reinforcement

The reinforcement for spiral ducts shall be as per Table 13.10.

Table : 13.10 : Reinforcement for Spiral ducts

			Rivet	
Air Duct Diameter (mm)	Reinforcing angle steel	Mounting Interval (mm)	Dia. (mm)	Pitch (mm)
Over 600, but below 750	30 x 30 x 3	Below 2,400	4.5	65
Over 750, but below 1.200	30 x 30 x 3	Below 1,800	4.5	65
Over 1,210	40 x 40 x 3	Below 1,200	4.5	65

(7) Air duct support

(a) The hangers and supports for the rectangular air duct shall be made of shape steel or gar steel. The shapes and dimensions of the hangers and supports shall be as per Table 13.4

(b) The hangers and the supports for the circulars hanger shall be as per Table 13.12.

Table - 13.12 : Shape and dimensions of the hangers and supports for the circular air duct

		Hanger		Support	
Dia. Of circular air duct	Flat steel (mm)		Max. mounting interval	Flat Steel (mm)	Max. mounting Interval (mm)
Below 1,500	25x3	Bar steel with a size of 25x3 or 9mmø bar steel	2,700	25 x 3	2,700
Over 1,500	30x3	Bar steel with a size of 30x3 or 12mmø bar steel	2,700	30 x 3	2.700

(8) A canvas sheet shall be used for the connection between the air duct and the air blower or between the air duct and the air exhauster so that the vibrations from the air blower or the air exhauster may not propagate to others.

(9) Where the air duct is install penetrating through a wall, a through part both on the was side and the duct side shall be finished to a good appearance.

(10) The checking access port shall be such as will allow the case of opening and closing and as will permit air leakage. The access port cover shall be made of the galvanized sheet iron having the same thickness as that of the sheet iron for the air duct. Particularly, the access port cover at a location where the air from the air conditioner flows shall have insulating material to the thickness of more than 25mm.

(11) After, the installation, the interior of the air duct shall be cleaned thoroughly and check if there is no interference in the air flow.

(12) Outdoor air intake and exhaust louver

The outdoor intake louver and exhaust louver shall be made of the stainless steel sheet having the thickness of more than no. 20 gauge.

The effective area of the louvers shall be over 40%, and those louvers, which are installed at such locations where they are exposed to weathers, shall be designed and manufactured to be of such a construction as will prevent rain water from getting inside.

(13) Diffusers

(a) The diffusers to be used shall have a good appearance, and they shall by no means be allowed to generate noises during system operation. In addition, the diffusers shall be designed to be capable of providing normal performance.

(b) Universal Type diffuser

The mounting frame of the diffusers of this type shall be fabricated with steel or iron plate having a thickness of more than 1.0mm, and it shall have such a construction as the frame can be mounted to the air duct by means of bolts.

The diffuser blades shall permit the case of adjustment.

The shutter to be employed to the universal type diffuser shall be of the double access door type.

Unless otherwise specified, the diffuser of any type shall be made of galvanized steel sheet and shall be finished with melamine resin baked on the surface of each diffuser unit.

(c) The anemodiffusers to be used shall be used shall have sufficient air diffusing performance and they shall be provide with a damper and an air flow informing device.

7.2.47.3.4 Piping

(1) Cooling medium piping

(a) The insides of the pipes shall be thoroughly cleaned and dried before use.

After cleaning the ends of the pipes shall be sealed by an appropriate method to prevent an foreign matter from entering during the piping work.

(b) The pipes shall be normally cut perpendicular to the pipe center. The cutting shall be such that the pipe diameter is not decreased. The outer surfaces of connecting pipes and the inner surfaces of joints shall be polished sufficiently with a flux brush, etc. After the outer surface of the pipes is coated with flux, they shall be carefully inserted in the joints and fit perfectly while heating.

(c) The discharge and intake gas tubes shall have a minimum downward gradient of at least 1.200.

(d) The piping shall be performed in consideration of expansion and contraction.

(e) In flanged joints, a packing of a thickness within 1.5 mm as specified in JIS R3453 (Compressed asbestos sheet) shall be used.

(f) A by- pass between the pipe diameter and the same diameter shall be provided in cooling medium filters, automatic expansion valves, cooling medium solenoid valves, etc.

(g) The pitch for hoist and support fixture's shall be as shown in table 13.3.4.

Table - 13.13 : Copper Pipe support pitch

Pipe support pitch Nominal Diameter B	6	8	12	16	20	25	32	40	50	65	75	100
Max. Pitch (m)	1.0	1.0	1.0	1.0	1.5	1.5	1.5	2.0	2.5	2.5	3.0	3.0

(h) To prevent the transmission of vibrations, anti-vibration joints, and anti vibration hoist and support fixtures shall be used.

7.2.47.3.5 Insulation Work

7.2.47.3.5.1 Materials

(a) The contractor shall furnish and install all insulation materials required for ductwork as shown in the Drawings.

(b) Specifications for heat insulation coverings.

Table - 13.14

Classification of heat insulation covering		Specifications
Heat insulation materials	Glass wool heat insulation	The glass wool heat insulation board shall be shall be No. 2 40K stipulated in JIS A 9505 (Glass Wool Heat Insulation Material).
Exterior materials	Glass cloth	The glass clothes shall be the non-alkali plain weave clothes stipulated in EP 21C in JIS R3414 (Glass clothes) which have been made free from fraying.
	Aluminum	The glass clothes shall be the flat weave clothes made of aluminum foil with a thickness of 0.02 mm or over stipulated in JIS H 4160 (Aluminum and aluminum Alloy foils), to which the plain weave clothes made of 13 micron glass yarn and 200 single filament yarns according to JIS R3414 with a unit acrylic resin adhesive.

Table - 13.15

Classification of heat insulation coverings		Specifications
Auxiliary	Glass filament Rivet	The glass filament mat shall be made of glass yarn of materials 18 micron of less according to JIS R 3413 and have a unit mat weight of 45 g of over per m2. The rivet shall be made of the washer made of galvanized steel plate to which a nail with a length to be changed depending upon the thickness of heat insulation materials is built in, or the copper plated nail for spot welding, and have a strength sufficient to bear the insulation materials.
	Steel frame	In principle, the steel frame shall be made of steel plate with a standard plate thickness of 0.4 mm or over as stipulated in JIS G 3302 (Galvanized sheets)
	Adhesive	In principle, the acrylic emulsion adhesive shall be used for bonding of glass clothes, glass filament mat and aluminum glass clothes, and the chloroprene

		rubber adhesive shall be used for bonding of rivet.

(3) Materials and procedures depending upon the types of heat insulation work.

Classification of insulation work	Order of insulation work
Insulation of exposed interior	1. Riveting
	2. Heat insulation board with a thickness of 50mm
	3. Corner patch and seal-up
	4. Adhesive
	5. Glass clothes
Indoor concealing	1. Rivet
	2. Heat insulation board with a thickness of 25 mm
	3. Corner patch and seal-up
	4. Adhesive
	5. Aluminum Glass clothes

Note : The galvanized steel plate with a thickness of 0.2 mm or over shall be used for corner patch, and the glass filament mat shall be used for seal- up.

7.2.47.3.5.2 Execution

(1) The mutual clearance between the respective insulation shall not include the thickness of exterior materials or auxiliary materials.

(2) The mutual clearance between the respective insulation shall as small possible, and no overlapping joints shall be provided on the same line.

(3) In principle, two rivets shall be driven into the lower and side surfaces and one rivet into the upper surface of the air duct at intervals of 300mm each.

(4) The portion or air duct penetrating through the floor shall be covered with stainless steel from the floor surface to height of up to 150mm in order to protect the insulation

(5) The outermost ends of the insulation shall be protected as required depending upon the materials and purpose of heat insulation.

(6) Heat insulation work for inspection doors, etc. of equipment requiring such insulation shall be carried out so as not to cause hindrance during opening and closing of such doors, etc. nor deterioration of the said heat insulation.

7.2.47.3.6 Painting Work

7.2.47.3.6.1 General

(1) All equipment and materials, except for the following , shall be painted.

(a) Surfaces other than galvanized surfaces

(b) Galvanized portions which are normally concealed

(2) All equipment and materials requiring inspection shall be painted after inspection.

7.2.47.3.6.2 Painting

The types of paints and frequency of painting of the respective portions shall, in principle, be as specified in Clause 11.3.5 Unless specified in this table, such painting shall be carried out according to similar items taking into account the work purposes, materials and other conditions.

7.2.47.5 Tests

7.2.47.5.1 Piping

(1) The refrigerator shall pass the air-tightness and pressure withstand tests.

(2) The refrigerators shall be test operated in the factory and careful investigations concerning performance, noise, vibrations, etc. shall be performed. After it is confirmed that the tests have been passed, the refrigerator shall be shipped after applying rust-proof paint.

(3) After installation, the refrigerators shall be test operated.

(4) After completing of the refrigerant piping, an air-tightness test shall be performed using carbon dioxide, nitrogen, dry air, etc. After the air-tightness test, the entire system shall under-go high vacuum evaporation to remove all water. After this dehydration treatment, a cooling medium leak test shall be performed according to the inspection of the Engineer.

7.2.47.5.2 Duct

After completing the air duct installation, the air duct system shall have and air blow test in the presence of the Engineer. Unless otherwise specified, all of equipment, materials and execution shall be as stipulated in "Indoor Lighting System".

7.2.48 Secondary-Electrical Wiring

7.2.48.1 General

(1) The contractor shall furnish and install the control panels, switches, receptacles, electrical conduit pipes, wires, outlet box for secondary wiring equipment as shown in the Drawings.

(2) Motors used in cooling equipment, blowers pumps, etc. shall all be included in this equipment work.

(3) Unless otherwise specified, the wire conduit and wiring work in the primary side shall all be performed as separate electrical equipment work. However :

(a) Secondary side wire conduit and wiring work for cooling equipment operating panels and below shall all be part of the work of the equipment concerned.

(b) Wire conduit and wiring work related to the automatic control of air conditioning equipment shall all be part of the work of the equipment concerned.

(c) Insufficient water level alarm equipment for water supply tanks, etc. shall be a part of the work of the equipment concerned.

(4) Unless otherwise indicated in this clause, all of equipment, materials and execution shall be as stipulated in "Indoor Lightening Plug and Telephone Piping System"

7.2.48.2 Equipment And Materials

(1) Cables shall be as shown in Table - 14.1.

Table - 14.1(1)

Items	Code No	Type	Letter
Control cable CVV	JIS C3401	Polyvinyl	Chloride
Insulated and Sheathed control			Cables
Cross-linked Polyethylene Insulated Cable Cable	JIS C3606 CV	Cross-linked	Polyethylene

(2) The electrical equipment and materials shall meet the standards of the Japanese Electrical manufacturers Association (JEM) in addition to these specifications.

(3) Motors

(a) Unless otherwise specified, AC motors shall meet the specifications in Table 14.2.

Motor Specifications	JIS 4201	Low-Voltage Three Phase Induction Motor
Voltage	400 G	
Insulation class	E	

(b) Three-phase induction motors shall be those using the starting equipment in Table 14.3. as standard.

Table 14.3

Area Capacity(kw)	Refrigerating equipment		Blowers	
	Motor	Starting system	Motor	Starting system
37 or more	High voltage wound type	Resister	High voltage wound type	Resister
15 ~ 37	Low voltage special	Y-A	Low voltage special squirrel	Y-A
11 ~ 15	Low voltage special squirrel	Y-A	Low voltage special squirrel	Y-A
5.5 ~ 7.5	Low voltage special squirrel	Direct starting	Low voltage special squirrel	Direct starting
37 or less	Low voltage normal type	Direct starting	Low voltage normal type	Direct starting

7.2.48.3 Test

Upon completion of the work, the whole system shall be proved acceptable by inspections carried out by the Engineer.

7.2.49 Lighting, Plug and Telephone Piping System

Principle of Lighting

The essential features of an efficient lighting system are :

- visual comfort through adequate illumination of the working surface, prevention of glare, and avoidance of shadows,
- ease of maintenance.

The design of a lighting system shall involve :

a) careful planning of the brightness and colour pattern within both the working areas and the surroundings so that attention is drawn naturally to the important areas, detail is seen quickly and accurately, and the room is free from any sense of gloom or monotony,
b) use of directional lighting to assist perception of task detail,
c) controlling direct and reflected glare from light sources to eliminate visual discomfort,

d) minimizing flicker from certain types of lamps and paying attention to the colour rendering properties of the light,
e) the correlation of lighting throughout the building to prevent excessive differences between adjacent areas, so as to reduce the risk of accidents, and
f) the installation of emergency lighting systems, where necessary.

7.2.49.1 Scope of Work

Concealed Electrical wiring by Eastern/BRB cable or equivalent

- European Made MK type Gang switch, socket MCB etc
- Provision for Internet facilities system, Telephone & Intercom wiring.
- Sufficient Earthlings facilities.
- To be used LED Light.

The scope of work under the contract includes supply and installation of lighting fixtures, lighting panel, switches, receptacles, electrical conduit pipes, wires, outlet boxes for telephones, internet, dish cable and other necessary accessories for the indoor lighting system.

7.2.49.2 Design Conditions

7.2.49.2.1 Illumination Level

1) The illumination levels for each room shall be as shown in Table - 15.2.1.

Table - 15.2.1

Name of Room	Normal condition	Emergency condition
Control	500 lx	50 lx
Office	300 lx	10 lx
Relay	300 lx	10 lx
PLC/ SCADA	500 lx	50 lx
Conference	300 lx	10 lx
Battery	100 lx	5 lx
Rectifier Set	100 lx	5 lx
Corridor	100 lx	5 lx
Pump Control	100 lx	5 lx
Cable Control	50 lx	5 lx
B/G	200 lx	5 lx
Lavatory	100 lx	-
Kettle	100 lx	-

(2) Setting Height

(a) Lighting fixtures
Refer to Design Drawings.

(b) Switches
1.25 meters above the floor level, unless otherwise specified.

(c) Receptacles
0.3 meters above the floor level, unless otherwise specified.

(3) Power source voltage

(a) For lighting panel
AC 3 phase 4 wires 415/230 V 50 Hz
DC 2 Wires 110 V
(b) For normal lighting, convenient outlet and ventilation equipment.
AC 1 phase 2 wires 220 V 50 Hz
(c) For emergency lighting
DC 2 Wires 110 V

7.2.49.3 System Description

(1) AC, DC Source and earthling shall be supplied from the primary side.

(2) Standard LED Lamps shall be provided for the control room and all miscellaneous rooms, and shall be designed to be manually activated by means of the switches at the entrance of each room. The lamps in the corridor, Toilet room, office and all electrical rooms shall be sensor based which will automatically switched "ON" and off.

(3) LED Lamp/Incandescent lamps shall be provided in all parts of the control building to serve as emergency lighting. The lamps in the control room, corridor, office and all electrical rooms shall be automatically switched "ON" in case of AC failure.

(4) Outlet boxes for telephones shall be provided for the control room, together with piping from the outlet boxes to the cable tray in the cable control room. The sitting of the telephones and wiring shall be included in the electrical scope of work of Lot IV.

(5) Exit sign light

The exit sign lights shall be mounted above the all exits of the control building.

(6) Spare parts, as indicated below, will be supplied for three (3) years normal operation.

7.2.49.4 Equipment's and Materials

7.2.49.4.1 Wires

Wires shall be as shown in the Table 15.4.1

Table - 15.4.1

Item	Code No.	Type Letter
Vinyl wire	JIS C3307	600 Grade Polyvinyl Chloride Insulated Wires
	IV	
Heat- resistant	JIS C3317	Heat- resistant vinyl Insulated wire
	HIV	

HIV wires shall be used in the DC circuit.

7.2.49.4.2 Wire Connectors

Wire connectors for indoor wiring shall be in accordance with JIS C2810 or equivalent BDS

7.2.49.4.3 Metal Conduit and Fittings

Metal conduit and fittings shall be in accordance with the Table 15.4.3, and the conduit shall be of heavy gauge type.

Table 15.4.3

Item	Code No.	Designation
Conduit	JIS C8305	Rigid metal Conduit (heavy gauge)
Coupling	JIS C8330	Coupling for Rigid Metal Conduit
Normal Bend	JIS C8330	Elbows for Rigid Metal conduit
Bushing	JIS C8331	Bushing for Rigid metal Conduit
Locknut	JIS C8333	Locknuts for Rigid Metal Conduit
Saddle	JIS C8334	Saddles for Rigid Metal Conduit
Universal	JIS C8335	Universal Fittings for Rigid metal Conduit
Outlet Box	JIS C8337	Out Boxes for Rigid metal Conduit
Switch Box	JIS C8337	Switch Boxes for Rigid Metal Conduit
Concrete Box	JIS C8338	Concrete Boxes for Rigid Metal Conduit
Box Cover	JIS C8339	Box covers for Rigid Metal Conduit
Insulated Bushing	JIS C8347	Insulated Bushing for rigid Metal Conduit

7.2.49.4.4 Pull Boxes

Pull boxes shall be made of steel and coated with protective paint, and wherever exposed to view, shall be coated with a finish paint of a color approval by the Engineer.

7.2.49.4.5 Wiring Devices

Wiring devices shall be in accordance with the Table-15.4.5

Table-15.4.6

Items	Code No.	Designation
Fluorescent Lamp General Lighting Service	JIS C7601	Fluorescent Lamps for
Rapid Start	JIS C7602	Instantaneous Start Hot cathode Discharge Fluorescent Lamps (40 W type)
Glow Starter W type	JIS C7607	Glow starters for fluorescent Lamps (Less than 40
Fluorescent fixture Fluorescent Lamps	JIS C8106	Lighting Fitting for
ballasts for Fluorescent lamps		
Incandescent lamp General Use	JIS C7501	Double Filament Lamps for

7.2.49.4.6 Lighting Fixtures

(a) In Principle shapes and dimensions shall be in accordance with the Drawings. Catalogs and shop drawings shall be submitted to the Engineer for approval.

(b) Lighting fixtures for emergency use shall be as specified by BCJ (Articles rated by the Building Center of Japan), or approved equal.

7.2.49.4.7 Lighting Panel

Shapes, electrical characteristics, types capacities of circuit breakers, and the system of operation shall be in accordance with the Drawings.

The panel shall made of steel plate with a thickness of more than 1.6mm (body) and 2.3 mm (door) respectively.

The finish shall be painted with a color approved by the Engineer. Catalogs and shop drawings shall be submitted to the Engineer for approval.

7.2.49.4.8 Over Current Protectors

Molded case circuit breakers and residual current protective devices shall be of European Standard used in the lighting panel

7.2.49.5 Indoor Wiring

7.2.49.5.1 Rigid Metal Conduit

(1) Installation

(a) Imbedding or conduit laying shall be so made that the strength and structure of the building is not affected.
(b) Cut ends of conduit shall be neatly and smoothly finished by instrument such as a reamer.
(c) Conduit shall be bent at a radius of more than six (6) times the internal diameter of the conduit conduit running between outlets and pulling boxes shall not have more than the equivalent of four 90° bends.
(d) A pull box or junction box shall be installed to protect conduit exceeding 30 meters in length and at the points required.
(e) In general, a switch or outlet box shall be used at all points where a switch, receptacle (socket) or lighting fixture is to be provided.
(f) Where low voltage metal conduit is enclose in proximity to or crosses communication wiring, metallic water pipe or gas pipe, the work shall be so done that direct contact is avoided.

(2) Connection of conduits

Conduit and fittings shall be perfectly connected, both physically and electrically, and the conductor resistance shall be preferably dept within 2 ohms between grounding conductor and the end metal conduit.

(3) Pull Boxes and Junction Boxes

(a) Shape and type of these boxes shall suit the place of installation and a steel plate or more than 1.2mm in thickness shall be used.
(b) Boxes shall have adequate dimensions well matching the number or conduits connected and the condition of connecting or pulling wires.
(c) Where the box is covered or concealed in structural material, access to the box shall be made possible to facilitate inspection.

(4) Installation of feeder conduits

(a) Exposed main conduit shall, in principle, run parallel with wall or ceiling.
(b) Metals supports for conduit in concrete building shall have a proper fixing insert or bolt previously embedded in the concrete.
(c) Spacing between metal inserts or bolts to support conduit shall in principle, be approximately 2 meters.

(5) Painting, Protection and cleaning of Conduit

(a) Where the plated or painted surface of conduit, metal support or box has peeled off, it shall be touched up with protective paint.

(b) Conduit shall be sufficiently protected against entry of moisture, water, dust etc. and the cut end of conduit shall be bush be capped, wood plugged or covered with rag, etc. Whenever concrete work is in progress.

(c) Conduit and boxes shall be well cleaned and the conductivity checked after removal of the forms.

(6) Wire Pulling

(a) Connection of wire shall not be made inside metal conduit. Connection shall be made in metal box, junction box or distribution board.

(b) Wire shall be pulled through conduit after the inside of conduit has been cleaned and when each of conduit has been capped with bushing. Cleaning shall be performed in such a manner that walls, ceilings, etc. around the conduit are not stained or spoiled in any way.

(c) In all cases, all wires stemming from one circuit shall be accommodated in the same conduit for A.C circuit work, except where a balanced condition is electro-magnetically attained by accommodating both lines of the same polarity within the same conduit.

7.2.49.6 Installations

7.2.49.6.1 Installation of Lighting Fixtures

(a) Heavy lighting fixtures shall be firmly supported using inserts, studs or bolts, attachments and if necessary shall be provided with a means to prevent swinging by using wood screw, etc.

(b) Lighting fixtures shall be installed horizontally or vertically in a workmanlike manner and shall be so located as to not interfere with inspection of related equipment.

7.2.49.6.2 Installation of Lighting Panel

Lighting panel shall be installed firmly on walls or other surfaces in a workmanlike manner, and shall be so located as to not interfere with inspection of related equipment.

7.2.49.6.3 Test

A performance test shall be made be made after installation of equipment has been completed.

7.2.49.7 Grounding

7.2.49.7.1 Grounding Resistance

Grounding resistance shall be 10 ohms on less, unless otherwise specified.

7.2.49.7.2 Electrical Works to Be Grounded

Except for specific instances, all electrical that the respective grounding resistance values are kept at specified values throughout the year despite seasonal changes.

(a) No grounding is required for steel base, metal box and steel frame of equipment is operated on less than AC150 V (Voltage to ground) and is installed at a dry location.
(b) Metal conduit and metal accessories
(c) Metal enclosure accommodating the discharge lamp ballast and the metal parts or a discharge lamp lighting fixture, except where grounding is required and/or when so directed by Engineer, shall be grounded.

7.2.49.7.3 Sign, Signal & Annotation:

• Integrated Design of Different kind of Indicators like- Acrylic Sign Board, LED Sign Board, Neon Sign Board, Reception Sign Board, Safety Sign, PVC Letters, Glow Sign Board, Customized Display Boards, Overhead Signage, Metal Nameplates, Commercial Sign Boards, Outdoor Signs, Electronic Sign Boards etc. should be provided in the design & construction.
• Digital LED Signboard with the features of excellent visibility (even in daylight); Good quality at reasonable price and light weight; Simple installation, Safe to touch and clean; Changing color for attracting attention; Extremely low power consumption.
• Should be provided the Accessories like Adaptor and chains etc.
LED display screen shall be minimum 1.0 square meter and shall be Compatible with IP65.
Shall be installed at the front side wall of the building
Environmentally friendly display it ensures lower power consumption and longer lifetime.

7.4 PRE-COMMISSIONING TEST OF 2D-BAY EXTENSION

(Test reports and documents required for substation commissioning)

7.4.1 Circuit Breaker (33 kV):

1. Name plate data
2. Insulation Test (Insulation resistance& DAR across open contact, Phase to Ground, Phase to Phase etc. with minimum 5 kV test voltage / Power frequency withstand test (Hipot)/ Leakage current test etc.)
3. Closing/Opening operation check from Remote & Local, Closing Interlock check, Anti-pumping operation check
4. Closing/Opening timing check
5. Contact resistance check
6. Spring charge operation check, heating and illumination circuit functionality check

7.4.2 CT/PT (33 kV):

1. Name plate data
2. Insulation Test (Insulation resistance & DAR across Primary to Ground, Secondary to Ground, Primary to Secondary, Secondary 1 to Secondary 2, Phase to Phase etc. with minimum 5 kV test voltage for primaryand 500 V test voltagefor secondary / Power frequency withstand test (Hipot)/ Leakage current test/ tan δ test etc.)
3. Polarity & Ratio test
4. CT magnetization curve test
5. CT secondary winding resistance check

7.4.3 Control & Relay Protection Panel (33 kV):

1. Name Plate Data
2. Complete Relay test (Over current & Earth fault relay, Directional Over current & Earth fault relay (if applicable), Differential relay etc.
3. Primary injection test (Tripping & indication test of Over current & Earth fault relay, CT core allocation check, Single point earthing check)
4. Differential relay& Restricted Earth Fault relaytripping, indication and stability test
5. Master Trip relay, Trip circuit supervision relay, DC/AC fail relay and all other auxiliary relay functionality check
6. Closing/Opening operation check from CP & SCADA, Closing Interlock check, Anti-pumping operation check
7. Trip logic test
8. Alarm and indication circuit functionality check, Indicative meter and Energy meter check
9. Heating and illumination circuit functionality check
10. Wiring/ Ferrule Number/ Color Coding check as per drawing

7.4.4 Disconnecting Switch/Isolator/Earthing Switch (33 kV):

1. Name plate data
2. Insulation Test (Insulation resistance & DAR across open contact, Phase to Ground, Phase to Phase etc. with minimum 5 kV test voltage / Power frequency withstand test (Hipot)/ Leakage current test etc.)
3. Contact resistance check
4. Closing/Opening operation check, Mechanical Interlock check

7.4.5 Busbar (33 kV):

1. Busbar details (Size, Typeand Capacity etc.)
2. Insulation Test (Insulation resistance & DAR across Phase to Ground, Phase to Phase etc. with minimum 5 kV test voltage / Power frequency withstand test (Hipot)/ Leakage current test etc.)

7.4.6 Underground Cable & Line Conductor (33 kV):

1. Underground Cable& Line Conductor details (Size, Type and Capacity etc.)
2. Insulation Test (Insulation resistance, DAR & PI across Phase to Ground, Phase to Phase etc. with minimum 5 kV test voltage / Power frequency withstand test (Hipot)/ Leakage current test/ tan δ test (for cable only) etc.)
3. Phase Sequence Check

7.4.7 Earthing Resistance Measurement (Desired value < 0.25 Ω):

1. Substation mesh earthing
2. CRP panel & Switchgear panel earthing
3. 33 kV CB/CT/PT/LA/Isolator etc. earthing
4. Power Transformer body & neutral earthing

7.4.8 Attachments:

1. Approved Equipment Layout Drawing (33 kV Switchyard, Control Room).
2. Approved Single Line Diagram along with relay model, CT ratio and load.
3. Approved Schematic diagram of CRP panel and Switchgear panel.
4. Approved General Arrangement (GA) drawing of Front View, Rear View, LHS view, RHS view of the panel.
5. Fault level calculation, CT sizing calculation.
6. Trip Matrix along with detail relay settings and related calculation for Line Feeder, Transformer feeder, Incomer Feeder and Outgoing Feeder.

NB:

1. The above mentioned information and reports must be submitted to the office of the Directorate of Design & Inspection-2, BPDB, Dhaka and SPTC, BPDB, Dhaka at least **15 days** before the expected date of commissioning. Softcopy of the requested information and documents may be emailed to dir.design2@bpdb.gov.bd / se.sptc@bpdb.gov.bd /dir.system.protection@bpdb.gov.bd.
2. The pre-commissioning test must be witnessed by BPDB engineers and must be signed by the testing team members and witnesses.
3. Description of the test equipment for each test shall be mentioned.
4. The relay settings have to be finalized as per BPDB's recommendation.

Section 8. Guaranteed Technical Particular (GTP)

8.01 Guaranteed Technical Particulars for 33 KV Outdoor Type Vacuum Circuit Breaker

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No.	Description	Unit	BPDB's Requirement	Manufacturer's Guaranteed Particulars
1	Manufacturer's Name & Country	-	To be mentioned	
2	Manufacturer's model no.	-	To be mentioned	
3	Maximum Rated Voltage	KV	36	
4	Frequency	Hz	50	
5	Rated Normal current	A	1250A	
6	No. of phase	-	3	
7	No. of break per phrase	-	To be mentioned	
8	Interrupting medium	-	Vacuum	
9	Manufacturer's name and country of vacuum interrupter	-	To be mentioned	
10	Manufacturer's model no. of vacuum interrupter	-	To be mentioned	
11	Class of Circuit Breaker (Supported by Test Report from independent laboratory)	-	E2M2 or better	
12	Designation of Internal Arc Classification (Supported by Test Report from independent laboratory)	-	IAC AFLR 31.5 kA, 1 sec	
13	Impulse withstand on 1.2/50 μs wave	KV	170	
14	Power Frequency Test Voltage (Dry), at 50Hz, 1 min.	KV	70	
15	Short time withstand current, 3 second, rms	KA	31.5	
16	Breaking capacity: a) Symmetrical, rms b) Asymmetrical, rms	 KA KA	 31.5 As per IEC	
17	Short circuit making current, peak	KA	80	
18	First phase to clear factor	-	To be mentioned	
19	Rated transient recovery voltage at 100% rated short circuit breaking current	KVp	To be mentioned	
20	Rated line charging breaking current	A	To be mentioned	
21	Rated cable charging breaking current	A	To be mentioned	
22	Rated out of phase breaking current	A	To be mentioned	
23	Is circuit breaking restrike free?	Yes/No	Yes	
24	Trip coil current	A	To be mentioned	
25	Trip coil voltage	V, DC	110	
26	Is the circuit breaker trip free?	Yes/No	Yes	
27	Type of arc contacts or arc control Device	-	To be mentioned	

28	Main Contact : a) Type of contact b) Material of contact surfaces c) Contract resistance	- - μΩ	To be mentioned To be mentioned Less than 40	
29	Does magnetic effect of load Currents increase contact pressure?	Yes/ No	To be mentioned	
30	Length of each break/ phase	mm	To be mentioned	
31	Length of stroke	mm	To be mentioned	
32	Weight of circuit breaker unit complete, without operating mechanism and structure	Kg	To be mentioned	
33	Weight of circuit breaker complete with all fittings as in service.	Kg	To be mentioned	
34	Maximum shock load imposed on floor or foundation when opening under fault conditions (state compression or tension)	N	To be mentioned	
35	Maximum pressure rise in circuit Breaker due to making or breaking of Rated current in outer chamber	KN/m^2	To be mentioned	
36	Routine pressure test on circuit Breaker tanks or chamber	KN/m^2	To be mentioned	
37	Design pressure type test on circuit Breaker tanks or chamber	KN/m^2	To be mentioned	
	Operating Particulars :			
38	a) Opening time: without current at 100% of rated breaking current b) Breaking time c) Closing time	sec. Cycle ms	0.05 (maximum) <3 To be mentioned	
39	Maximum arc duration of any duty Cycle **as per latest revision of relevant IEC standard**	ms At...%	To be mentioned	
40	Current at which maximum arc duration occurs (critical current)	A	To be mentioned	
41	Make time	ms	To be mentioned	
42	Minimum time for arc extinction to Contract remark when adapted for auto re-closing	ms	To be mentioned	
43	Time from closing of control switch to completion of closing stroke during fault making	ms	To be mentioned	
Constructional Features :				
44	Is an external series break Incorporated in the breaker?	Yes/ No	To be mentioned	
45	Is any device used to limit transient Recovery voltage?	Yes/ No	To be mentioned	
46	Method of closing	-	To be mentioned	
47	Method of tripping	-	To be mentioned	
48	Number of close/ trip operation possible on one spring charge	Nos.	To be mentioned	
49	Rated voltage of spring winding motor for closing	V.AC	230	

50	Spring winding motor current	A	To be mentioned	
51	Closing release coil current	A	To be mentioned	
52	Closing release coil voltage	V.DC	110	
53	Minimum clearance in air :			
	a) Between phase	mm	370	
	b) Phase to earth	mm	325	
	c) Across circuit breaker poles	mm	To be mentioned	
	d) Live conductor to ground level	mm	To be mentioned	
	e) Live insulator to ground level	mm	To be mentioned	
54	Material of tank or chamber	-	To be mentioned	
55	Material of moving contract tension rod	-	To be mentioned	
56	Period of time equipment has been in commercial operation	Year	To be mentioned	
57	No .of tripping coil	Nos.	2	
58	Circuit breaker terminal connectors	-	Copper	
59	Creepage distance (min)	mm/KV	25	
60	Method of indicating VCB ON/ OFF	Mech.& Elect.	To be mentioned	
61	Life of interrupter	Years	To be mentioned	
62	Pressure in vacuum tube for VCB	Bar	To be mentioned	
63	Guaranteed nos. of operation for vacuum Interrupter :			
	a) at rated Current switching (Supported by Test Report from independent laboratory)	Nos.	**10,000**	
	b) at Short circuit current switching	Nos.	≥ 50	
64	Rated operating sequence	-	O-0.3sec-CO-3m-CO	
65	All current carrying parts of VCB Shall be made of	-	Copper	
66	Standard	-	**IEC-60056/ IEC-62271-100**	
67	Manufacturer must comply all the features of Technical Specification (Section 7)		Yes	

Note: All exposed MS parts should be Hot Dip Galvanized

Manufacturer's Seal & Signature **Bidder Seal & Signature**

8.02 Guaranteed Technical Particulars for 33 KV Protection Control and Metering Panel

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl No	Description	Unit	BPDB's Requirement	Bidders Guaranteed value
1.	Manufacturer's Name & Country of origin	-	To be mentioned	
2.	Manufacturer's Model no.	-	To be mentioned	
3.	System nominal voltage	kV	33	
4.	Maximum System Voltage	kV	36	
5.	Rated Frequency	Hz	50	
A. Protection Control & Metering (Transformer Feeder) : Not Applicable				
6.	**Differential Relay**			
	Manufacturer's Name	-	ABB- (Sweden/ Switzerland/ Finland)/ Siemens-(Germany)/ Alstom-(France/UK)/ Schneider-(France/UK)/ NR, China/ SEL, USA	
	Country of Origin	-	Shall be mentioned	
	Manufacture's Model no.	-	Shall be mentioned	
	Type of Relay	-	Numerical programmable	
	Maximum through fault at which the protective equipment is stable with recommend settings:			
	a) Earth faults	rating	Shall be mentioned	
	b) Phase faults	% of CT rating	Shall be mentioned	
	Maximum time delay between initiation of fault and energize of breaker trip circuit.	ms	Shall be mentioned	
	The Relay shall be IEC 61850 protocol type.	-	Yes	
7.	**Restricted Earth Fault Relay (in built function of differential relay)**			
	Manufacture's Name & Country of Origin	-	ABB- (Sweden/ Switzerland/Finland)/ Siemens-(Germany)/ Alstom-(France/UK)/ Schneider-(France/UK)/	

			NR - China/ SEL- USA	
	Manufacture's Model no.	-	Shall be mentioned	
	Type of Relay	-	Numerical programmable	
	Range of current setting:	-	Shall be mentioned	
	a) Phase element	% of CT rating	Shall be mentioned	
	b) Earth fault element		Shall be mentioned	
	Earth fault element Range of timing settings at 10 time CT rating	Sec	Shall be mentioned	
	Burden of relay at 10 time CT rating	VA	Shall be mentioned	
	Percentage of current setting at which relay will reset.	%	Shall be mentioned	
	The Relay shall be IEC 61850 protocol type.	-	Yes	
8	**IDMT Over Current & Earth Fault Relay**			
	Manufacture's Name Country of Origin	-	ABB- (Sweden/Switzerland/ Finland)/ Siemens(Germany)/ Alstom-(France/UK)/ Schneider-(France/UK) / NR, China/ SEL, USA	
	Manufacture's Model no.	-	Shall be mentioned	
	Type of relay	-	Numerical programmable Multifunction	
	The Relay shall be IEC 61850 protocol type.	-	Yes	
	Range of current setting :			
	a) Phase element	% of CT rating	Shall be mentioned	
	b) Earth fault element		Shall be mentioned	
	Range of timing settings at 10 time CT rating	Sec	Shall be mentioned	
	Burden of relay at 10 time CT rating	VA	Shall be mentioned	
	Percentage of current at which relay will reset	%	Shall be mentioned	
	Reset time after removal of 10 times CT rated current	Sec	Shall be mentioned	
9	**Separate Auxiliary Flag Relays for Transformer self-protection (OTA, OTT, WTA, WTT, BA, BT, OLTC Surge, PRD for main tank & OLTC).**			
	Manufacture's Name	-	Shall be mentioned	
	Country of Origin	-	Shall be mentioned	
	Manufacture's Model no	-	Shall be mentioned	

	Type of Relays	-	Shall be mentioned	
10	**Trip Circuit Supervision (TCS) Relay (Separate Relay for each trip coil)**			
	Manufacture's Name	-	Shall be mentioned	
	Country of Origin	-	Shall be mentioned	
	Manufacture's Model no.	-	Shall be mentioned	
	Type of Relay	-	Shall be mentioned	
11	**Trip Relay (Separate Relay) for Differential and O/C & E/F**			
	Manufacture's Name	-	Shall be mentioned	
	Country of Origin	-	Shall be mentioned	
	Manufacture's Model no.	-	Shall be mentioned	
	Operating Time	ms	<10	
	Self-reset type for O/C, E/F protection	-	Yes	
	Hand & Electrical reset type for Differential, REF and Transformer Self-protection	-	Yes	
	Operating coil voltage 110V DC	-	Yes	
12	**Annunciator**			
	Manufacture's Name	-	Shall be mentioned	
	Country of Origin	-	Shall be mentioned	
	Manufacture's Model no.	-	Shall be mentioned	
	Windows	nos.	30 or More.	
	Built in buzzer and buttons for accept, mute, test, reset, etc.	-	Yes	
	AC/DC Dual Supply Provision	-	Yes	
13	**Control Switch**			
	Manufacture's Name& Country	-	Shall be mentioned	
	Manufacture's Model/Type No.	-	Shall be mentioned	
	Separate TNC/Discrepancy switch and Local Remote (L/R) selector switch	-	Yes	
B. Protection Control & Metering (Line Feeder)				
15	**IDMT Over Current & Earth Fault Relay with Directional feature**			
	Manufacture's Name Country of Origin	-	ABB-(Sweden/Switzerland/ Finland)/Siemens-(Germany)/ Alstom-(France/UK)/ Schneider-(France/UK)/ NR, China/ SEL, USA	
	Manufacture's Model no.	-	Shall be mentioned	
	Type of relay	-	Numerical, programmable, Multi-function with both directional and non-directional O/C & E/F	

			protection (IDMT, DMT, Inst.) feature and monitoring functions.	
	Directional Feature can be activated/de-activated	Yes/No	Yes	
	The Relay shall be IEC 61850 protocol type.	-	Yes	
	Range of current setting :			
	a) Phase element	% of CT rating	Shall be mentioned	
	b) Earth fault element		Shall be mentioned	
	Range of timing settings at 10 time CT rating	Sec	Shall be mentioned	
	Burden of relay at 10 time CT rating	VA	Shall be mentioned	
	Percentage of Current setting at which relay will reset	%	Shall be mentioned	
	Reset time after removal of 10 time CT rated current for: a) Phase element (100%) b) E/F element (40%)	 Sec Sec	Shall be mentioned	
16	**Trip Circuit Supervision (TCS) Relay (Separate Relay for each trip coil)**			
	Manufacture's Name	-	Shall be mentioned	
	Country of Origin	-	Shall be mentioned	
	Manufacture's Model no.	-	Shall be mentioned	
	Type of Relay	-	Shall be mentioned	
17	**Trip Relay (Separate Relay)**			
	Manufacture's Name	-	Shall be mentioned	
	Country of Origin	-	Shall be mentioned	
	Manufacture's Model no.	-	Shall be mentioned	
	Operating Time	ms	<10	
	Self-reset type for O/C, E/F protection	-	Yes	
	Operating coil voltage 110V DC	-	Yes	
18	**Annunciator**			
	Manufacture's Name& Country	-	Shall be mentioned	
	Manufacture's Model no.	-	Shall be mentioned	
	Windows	nos.	12	
	Built in buzzer and buttons for accept, mute, test, reset, etc.	-	Yes	
	AC/DC Dual Supply Provision	-	Yes	
19	**Control Switch**			
	Manufacture's Name& Country	-	Shall be mentioned	
	Manufacture's Model/Type No.	-	Shall be mentioned	
	Separate TNC/Discrepancy switch and Local Remote (L/R) selector switch	-	Yes	
20	**Metering and Instrumentation**			
20.1	Energy Meter (Multi Tariff Programmable Meter)			

	Manufacture's Name	-	Shall be mentioned	
	Manufacture's Country		European Country/ North American Country/ Japan/ Australia	
	Manufacture's Model no.	-	Shall be mentioned	
	Type of Meter	-	Numerical programmable Multifunction	
	Class of Accuracy	-	0.2S	
20.2	**Volt Meters with Selector Switch**			
	Manufacturer's Name and Country	-	Shall be mentioned	
	Manufacture's Model no.	-	Shall be mentioned	
	Type of Meter	-	Analogue, 90 degree scale range	
	Class of Accuracy	-	1.0	
20.3	**AMPERE METERS**			
	Manufacturer's Name and Country	-	Shall be mentioned	
	Manufacture's Model no.	-	Shall be mentioned	
	Type of Meter	-	Analogue, 240 degree scale range	
	Class of Accuracy	-	1.0	
	Separate A-meter for each phase	-	Yes	
20.4	**Multifunction Meter**			
	Manufacture's Name	-	Shall be mentioned	
	Manufacture's Country		European Country/ North American Country/ Japan/ Australia	
	Manufacture's Model no.	-	Shall be mentioned	
	Type of Meter	-	Numerical Programmable Multifunction Meter	
	Class of Accuracy	-	1.0	
	Multifunction meter shall be capable of measuring & displaying MW, MVAR, PF, V, I, f, Φ etc with distinguishing import & export operation	-	Shall be mentioned	
21	Marking	-	"BPDB & Contract No."	
22	Manufacturer must comply all the features of Technical Specification (Section 7)	-	Yes	

Manufacturer's Seal & Signature **Bidder Seal & Signature**

8.03 Guaranteed technical particulars of 110V 3x5(6)A, 3-phase, 4-wire, 3-element, solid state indoor type multi tariff programmable meter

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No.	Description		Unit	Required Specification	Manufacture's particulars
1	Reference Standard		-	Relevant ANSI / IEC Standard	
2	Manufacturer's name & address		-	Shall be mentioned	
3	Manufacturer's type & model		-	Shall be mentioned	
4	Construction/connection		-	3-Phase 4-wire solidly grounded neutral	
5	Installation		-	Indoor installation in A socket [for socket type]	
6	Number of element		-	3 (Three)	
7	Rated Voltage		Volt	110V	
8	Minimum Biasing Voltage		Volt	40V	
9	Variation of Frequency		%	± 2%	
10	Variation of Voltage		%	+ 10, -20%	
11	Accuracy class			Accuracy class: 0.2s (point two S)	
12	Rated Current				
	i)	Nominal Current	A	= 5	
	ii)	Maximum Current	A	≥ 6	
13	Resister Type			LCD Display	
14	Number of Digits (Integer with Decimal)		Nos.	8 with 3 (Programmable)	
15	Starting Current		ma	0.1% of Nominal Current	
16	Losses at Nominal Load		Watt	Shall be mentioned	
17	Meter Constant		Imp./	Shall be mentioned	
18	Integration Period		-	30 (Thirty) Minutes	
	Resetting Period		-	1 (one) month	
	Cumulative MD transfer		-	Built in	
	Cycle Timing Device		-	Built in	
19	Size of the Digit of Display		E x H in mm	4 x 8	
20	No. of Terminal		Nos.	10 (Ten) min	

21	Type of socket and country of origin	-	To be mentioned	
22	Battery Service life and shelf Life (minimum)	Year	10 (ten) & 15 (fifteen)	
23	Year of manufacture		Shall be mentioned	
24	List of Recommended spare parts (if any)	any	Shall be mentioned	
25	Warranty	Year	3 (three)	
26	Meter Service Life (Min)	Year	15 (fifteen)	
27	Weight of meter	Kg	Shall be mentioned	
28	Dimensions	mm x mm x mm	Shall be mentioned	
29	Outlines, Drawings & Leaflets		Shall be mentioned	
30	Performance Curve for Balanced & Unbalanced load		Shall be mentioned	
31	Meter sealing condition		Hermetically or Ultrasonic welded	
32	a) Country of Origin b) Place of Manufacture c) Place of Testing		Shall be mentioned	
33	Memory Storage		Shall be mentioned by putting Yes/ No.	
	i) Equipment Identification Code			
	ii) Security code			
	iii) Access code			
	iv) Number of Power Interruption with Date & Time			
	V Latest Power Failure- Time & Date			
	Vi Event logs			
	vii) Cumulative kWh, kVarh (Q_1 + Q_4) Reading for previous two months			
	viii) Load profile with 30 min interval at least 90 days for:			
	KWh, kVarh			

		(Q_1+Q_4)			
		Phase Voltage or Vh			
		Phase Amps or Ah			
	Metering and Indication				
34.	KWh Meter				
34.1	Manufacture's Country		-	European Country/ North American Country/Japan/ Australia	
34.2	Manufacture's Model no.		-	To be mentioned	
34.3	Type of meter		-	Numerical programmable multifunction	
34.4	Class of accuracy		-	0.2S	
35	Indication Volt Meters				
35.1	Manufacturer's Name and Country		-	To be mentioned	
35.2	Manufacture's Model no.		-	To be mentioned	
35.3	Type of meter		-	Analogue	
35.4	Class of Accuracy		-	To be mentioned	
36	Indication Ampere Meters				
36.1	Manufacturer's Name and Country		-	To be mentioned	
36.2	Manufacture's Model no.		-	To be mentioned	
36.3	Type of meter		-	Analogue, 240° Scale Range	
36.4	Class of Accuracy		-	To be mentioned	
37	Manufacturer must comply all the features of Technical Specification (Section 7)			Yes	

Seal & Signature of the Manufacturer

Seal & Signature of the Bidder

8.04 Guaranteed Technical Particulars of 33kV Off-Load Isolator with Earth Blade

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No.	Description	Unit	BPDB's Requirement	Manufacturer' s Guaranteed Particulars
	General Description of Disconnecting Switch			
1.	a) Manufacturer's Name and country	-	To be mentioned	
	b) Standard/Main Source of products/materials/parts should equivalents of EU /UK/Japan/Canada/USA	-	Yes	
2.	Manufacturer's Model	-	To be mentioned	
3.	Frequency	Hz	50	
4.	System Nominal Voltage	kV	33	
5.	System Maximum Voltage	kV	36	
6.	Basic Insulation Level	kV	170	
7.	Rated Normal Current	A	1250	
8.	Power Frequency Withstand Voltage (for 1 min)	kV	70	
9.	Rated short time withstand current (for 3sec.)	kA	31.5	
10.	Installation	-	Outdoor	
11.	Type	-	Single Vertical Break	
12.	a) Construction	-	Open	
	b) Mechanical Endurance Class	-	M1 (Minimum)	
13.	Mounting Position	-	Vertical	
14.	Number of Pole	nos.	3 (Three)	
15.	No. of break per pole	nos.	One	
16.	Air gap between pole of phase	mm	1000	
17.	Insulator Material	-	Porcelain	
18.	Creepage distance of Insulator	mm/KV	25	
19.	Current density at the minimum cross Section of a) Moving Blade b) Terminal Pad c) Contacts d) Terminal Connector	Amps/ Sq.mm	To be mentioned	
20.	Maximum Temp. rise of current carrying parts when carrying rated current continuously (deg. C)		To be mentioned	
Contacts:				
21.	Materials of the current carrying path		Copper with Nickel Plating	
22.	Contract Resistance for DS & ES	μΩ	Less than 50	
23.	**Contact Area:**			

23.1	Moving Blade for DS	mm^2	6×50 mm copper flat bar, Length 750 ± 20 mm – 02 Nos per phase	
23.2	Moving Blade for ES	mm^2	6×50 mm copper flat bar, Length 500 ± 15 mm – 02 Nos per phase	
23.3	Terminal Pad	mm^2	10×60 mm copper flat bar, – 02 Nos per phase	
23.4	Total contact surface area	mm^2	To be mentioned	
24.	Contact type		Spring loaded contact	
25.	Operation	-	Gang	
26.	Type of main DS operating mechanism	-	Manual	
27.	Number of main DS operating mechanism per set	Nos	1	
28.	Type of Earth Switch operating mechanism	-	Manual	
29.	Number of Earth Switch operating mechanism per set	Nos	1	
30.	Nos. of Auxiliary Contracts (NO/NC) For Isolator& Earth Switch	-	Isolator- 4NO-4NC Earth switch – 4NO-4NC	
31.	Locking facility in the operating box in both close and open position	-	Yes	
32.	Mechanical Interlocking facility between main DS and ES	-	Yes	
33.	**Operating GI Pipe Dimensions:**	-		
33.1	For main DS	-	OD- 42 mm, ID – 36 mm, Length – 6 meter	
33.2	For Earth Switch	-	OD- 42 mm, ID – 36 mm, Length – 6 meter	
34.	**MS Solid Square Shaft Dimensions for gang operation (Hot Dip Galvanized)**	-		
34.1	For main DS	-	32x32x3600 mm	
34.2	For Earth Switch	-	25x25x3600mm	
35.	Total weight of Isolator	Kg	To be mentioned	
36.	Total weight of earth switch	Kg	To be mentioned	
37.	Total weight of Unit	Kg	To be mentioned	
38.	Outline Dimensional & Cross-section Drawings of Offered type 33KV Isolator & Mounting Structure	-	To be mentioned	

	Arrangement			
39.	Manufacturer's Printed Catalogue describing Specification & Technical Data of Offered type Equipment.	-	To be mentioned	
40.	Standard		IEC-62271-102 IEC-60273 IEC-62271-1 IEC-60815	
41.	Manufacturer's quality assurance certificates/ Quality Control		ISO 9001 ISO 14001 ISO 45001	
42.	Manufacturer must comply all the features of Technical Specification (Section 7)		Yes	

Note: All exposed MS parts should be Hot Dip Galvanized

Seal & Signature of the Manufacturer **Seal & Signature of the Bidder**

8.05 Guaranteed Technical Particulars of 33 kV Off-Load Isolator without Earth Blade

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No.	Description	Unit	BPDB's Requirement	Manufacturer' s Guaranteed Particulars
	General Description of Disconnecting Switch			
1.	a) Manufacturer's Name and country	-	To be mentioned	
	b) Standard/Main Source of products/materials/parts should equivalents of EU /UK/Japan/Canada/USA	-	Yes	
2.	Manufacturer's Model	-	To be mentioned	
3.	Frequency	Hz	50	
4.	System Nominal Voltage	kV	33	
5.	System Maximum Voltage	kV	36	
6.	Basic Insulation Level	kV	170	
7.	Rated Normal Current	A	1250	
8.	Power Frequency Withstand Voltage (for 1 min)	kV	70	
9.	Rated short time withstand current (for 3sec.)	kA	31.5	
10.	Installation	-	Outdoor	
11.	Type	-	Single Vertical Break	
12.	a) Construction	-	Open	
	b) Mechanical Endurance Class	-	M1 (Minimum)	
13.	Mounting Position	-	Vertical	
14.	Number of Pole	nos.	3 (Three)	
15.	No. of break per pole	nos.	One	
16.	Air gap between pole of phase	mm	1000	
17.	Insulator Material	-	Porcelain	
18.	Creepage distance of Insulator	mm	To be mentioned	
19.	Current density at the minimum cross Section of a) Moving Blade	Amps/ Sq.mm	To be mentioned	

	b) Terminal Pad c) Contacts d) Terminal Connector			
20.	Maximum Temp. rise of current carrying parts when carrying rated current continuously (deg. C)		To be mentioned	
Contacts:				
21.	Materials of the current carrying path		Copper with Nickel Plating	
22.	Contract Resistance	μΩ	Less than 50 μΩ	
23.				
231.	Moving Blade	mm^2	6x50 mm copper flatbar, length mm 20±750 -02 Nos per phase	
232.	Terminal Pad	mm^2	10x60 mm Copper flat bar -02 Nos per phase	
23.3	Total contact surface area	mm^2	To be mentioned	
24.	Contact type		Spring loaded contact	
25.	Operation	-	Gang	
26.	Type of main DS operating mechanism	-	Manual	
27.	Number of main DS operating mechanism per set	Nos	1	
28.	Nos. of Auxiliary Contracts (NO/NC) For Isolator	-	Isolator- 4NO-4NC	
29.	Locking facility in the operating box in both and open position	-	Yes	
30.	**Operating GI Pipe Dimensions :**	-		
	For main DS	-	OD- 42 mm, ID – 36 mm, Length – 6 meter	
31.	**MS Solid Square Shaft Dimensions for gang operation (Hot Dip Galvanized):**	-		
	For main DS	-	32x32x3600 mm	
32.	Total weight of Isolator	Kg	To be mentioned	
33.	Total weight of Unit	Kg	To be mentioned	
34.	Outline Dimensional & Cross-section Drawings of Offered type 33KV Isolator & Mounting Structure Arrangement	-	To be mentioned	
35.	Manufacturer's Printed Catalogue describing Specification & Technical Data of Offered type Equipment.	-	To be mentioned	

36.	Standard		IEC-62271-102 IEC-60273 IEC-62271-1 IEC-60815	
37.	Manufacturer's quality assurance certificates/ Quality Control		ISO 9001 ISO 14001 ISO 45001	
38.	Manufacturer must comply all the features of Technical Specification (Section 7)		Yes	

Note: All exposed MS parts should be Hot Dip Galvanized

Seal & Signature of the Manufacturer **Seal & Signature of the Bidder**

8.06 Guaranteed Technical Particulars of 33 kV Off-Load Fused Isolator for Bus PT

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No.	Description	Unit	BPDB's Requirement	Manufacturer' s guaranteed Particulars
	General Description of Disconnecting Switch			
1.	Manufacturer's Name and country	-	To be mentioned	
2.	Application of the Disconnecting Switch		For BUS PT	
3.	Manufacturer's Model designation	-	To be mentioned	
4.	Frequency	Hz	50	
5.	System Nominal Voltage	kV	33	
6.	System Maximum Voltage	kV	36	
7.	Basic Insulation Level	kV	170	
8.	Rated Normal Current	A	400	
9.	Power Frequency Withstand Voltage (for 1 min)	kV	70	
10.	Rated short time withstand current (for 3sec.)	kA	25	
11.	Installation	-	Outdoor	
12.	Type	-	Single Vertical Break Offload Fused Isolator	
13.	Construction	-	Open	
14.	Mounting Position	-	Vertical	
15.	Number of Pole	nos.	3 (Three)	
16.	No. of break per pole	nos.	One	
17.	Air gap between pole of phase	mm	1000	
18.	Insulator Material	-	Porcelain	
19.	Creepage distance of Insulator	mm	To be mentioned	
20.	Current density at the minimum cross Section of a) Moving Blade b) Terminal Pad	Amps/ Sq.mm	To be mentioned	

	c) Contacts d) Terminal Connector			
21.	Maximum Temp. rise of current carrying parts when carrying rated current continuously (deg. C)		To be mentioned	
Contacts				
22.	Materials of the current carrying path		Copper with Nickel Plating	
23.	Contract Resistance		Less than 50 μΩ	
24.	Contact Area			
24.1	Moving Blade	mm^2	5x30 mm copper flat bar, length 810±20 2 Nos per phase	
24.2	Terminal Pad	mm^2	6x40 mm Copper bar flat 2 Nos per phase	
24.3	Total contact surface area	mm^2	To be mentioned	
25.	Contact type		Spring loaded contact	
Operating Mechanism				
26.	Operation	-	Gang	
27.	Type of main DS operating mechanism	-	Manual	
28.	Number of main DS operating mechanism per set	Nos	1	
29.	Nos. of Auxiliary Contracts (NO/NC) For Isolator	-	Isolator- 4NO-4NC	
30.	Locking facility in the operating box in both and open position		Yes	
31.	Operating GI Pipe Dimensions			
	For main DS		OD- 42 mm, ID – 36 mm, Length – 6 meter	
32.	MS Solid Square Shaft Dimensions for gang operation (Hot Dip Galvanized)			
33.	For main DS		32x32x3600 mm	
34.	Total weight of Unit	Kg	To be mentioned	
Fuse Description				
35.	Rated Fuse Voltage	kV	33	
36.	Fuse type	-	Drop Out Fuse Barrel with Link	

37.	Rated fuse link normal current	A	1 -2 Amperes	
38.	Rated fuse link interrupting current	kA	31.5 kA, RMS Symmetrical	
39.	Fuse link type	No	Two element, slow/fast unit	
40.	Fuse holder type	-	Heavy duty, sealed cap with eye at both ends of fuse holder	
41.	Fuse link co-ordination	-	Shall co-ordinate with existing system protective equipment	
42.	Outline Dimensional & Cross-section Drawings of Offered type 33KV Isolator & Mounting Structure Arrangement	-	To be mentioned	
43.	Manufacturer's Printed Catalogue describing Specification & Technical Data of Offered type Equipment.	-	To be mentioned	
44.	Standard		IEC-62271-102 IEC-60273 IEC-62271-1 IEC-60815	
45.	Manufacturer's quality assurance certificates/ Quality Control		ISO 9001 ISO 14001 ISO 45001	
46.	Manufacturer must comply all the features of Technical Specification (Section 7)		Yes	

Note: All exposed MS parts should be Hot Dip Galvanized

Seal & Signature of the Manufacturer

Seal & Signature of the Bidder

8.07 GUARANTEED TECHNICAL PARTICULARS OF 33 kV Off-Load Isolator without Earth Blade BUS Sectionalizer

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No.	Description	Unit	BPDB's Requirement	Manufacturer' s guaranteed Particulars
	General Description of Disconnecting Switch			
1.	a) Manufacturer's Name and country	-	To be mentioned	
	b) Standard/Main Source of products/materials/parts should equivalents of EU /UK/Japan/Canada/USA	-	Yes	
2.	Manufacturer's Model	-	To be mentioned	
3.	Frequency	Hz	50	
4.	System Nominal Voltage	kV	33	
5.	System Maximum Voltage	kV	36	
6.	Basic Insulation Level	kV	170	
7.	Rated Normal Current	A	1250	
8.	Power Frequency Withstand Voltage (for 1 min)	kV	70	
9.	Rated short time withstand current (for 3sec.)	kA	31.5	
10.	Installation	-	Outdoor	
11.	Type	-	Single Horizontal Break	
12.	a) Construction	-	Open	
	b) Mechanical Endurance Class	-	M1 (Minimum)	
13.	Mounting Position	-	Horizontal	
14.	Number of Pole	nos.	3 (Three)	
15.	No. of break per pole	nos.	One	
16.	Air gap between pole of phase	mm	1000	
17.	Insulator Material	-	Porcelain	
18.	Creepage distance of Insulator	mm	To be mentioned	
19.	Current density at the minimum cross Section of a) Moving Blade b) Terminal Pad	Amps/ Sq.mm	To be mentioned	

	c) Contacts d) Terminal Connector			
20.	Maximum Temp. rise of current carrying parts when carrying rated current continuously (deg. C)		To be mentioned	
Contacts :				
21.	Materials of the current carrying path		Copper with Nickel Plating	
22.	Contract Resistance	μΩ	Less than 50 μΩ	
23.	**Contact Area**			
231.	Moving Blade	mm^2	6x50 mm copper flatbar length mm 20±750 -02 Nos per phase	
232.	Terminal Pad	mm^2	10x60 mm Copper flat -02 Nos per phase	
23.3	Total contact surface area	mm^2	To be mentioned	
24.	Contact type		Spring loaded contact	
25.	Operation	-	Gang	
26.	Type of main DS operating mechanism	-	Manual	
27.	Number of main DS operating mechanism per set	Nos	1	
28.	Nos. of Auxiliary Contracts (NO/NC) For Isolator	-	Isolator- 4NO-4NC	
29.	Locking facility in the operating box in both and open position		Yes	
30.	**Operating GI Pipe Dimensions:**			
	For main DS		OD- 42 mm, ID – 36 mm, Length – 6 meter	
31.	**MS Solid Square Shaft Dimensions for gang operation (Hot Dip Galvanized):**			
	For main DS		32x32x3600 mm	
32.	Total weight of Isolator	Kg	To be mentioned	
33.	Total weight of Unit	Kg	To be mentioned	
34.	Outline Dimensional & Cross-section Drawings of Offered type 33KV Isolator & Mounting Structure	-	To be mentioned	

	Arrangement			
35.	Manufacturer's Printed Catalogue describing Specification & Technical Data of Offered type Equipment.		To be mentioned	
36.	Standard		IEC-62271-102 IEC-60273 IEC-62271-1 IEC-60815	
37.	Manufacturer's quality assurance certificates/ Quality Control		ISO 9001 ISO 14001 ISO 45001	
38.	Manufacturer must comply all the features of Technical Specification (Section 7)		Yes	

Note: All exposed MS parts should be Hot Dip Galvanized

Seal & Signature of the Bidder **Seal & Signature of the Manufacturer**

8.08 GUARANTEED TECHNICAL PARTICULARS OF 33 KV OUTDOOR TYPE SINGLE PHASE CURRENT TRANSFORMER

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No.	Description	Unit	BPDB's Requirement	Manufacturer's Guaranteed Particulars
1	Manufacturer's Name & Country	-	To be mentioned	
2	Manufacturer's Model No.	-	To be mentioned	
3	Application	-	Metering and Protection	
4	Type	-	Induction	
5	Installation	-	Outdoor	
6	Construction	-	Sealed Tank	
7	Insulation	-	Oil	
8	Number of Phase	-	Single	
9	Rated Frequency	Hz	50	
10	Mounting	-	On Supporting Structure	
11	Primary rated voltage (Phase to Phase)	kV	33	
12	Maximum System Voltage (Phase to Phase)	kV	36	
13	System Earthing	-	Effectively Earthed	
14	Basic Insulation Level (1.2/50 Micro-Sec.)	kV	170	
15	Power frequency withstand voltage (1 Min. 50 Hz.)	kV	70	
16	**Ratio for 33KV Line feeder:**	A	400-800/5-5A	
	Ratio for 33KV Transformer feeder:	A	300-600/5-5-5A	
17	Type of Winding:			
	a) Primary	-	Single Winding	
	b) Secondary	-	Double (1 protection & 1 measuring)/Triple winding (2 protection & 1 measuring)	
18	Accuracy Class:			
	a) for measurement	-	0.2 S	
	b) for Protection	-	5P20	
19	R_{CT} at 75°C:			
	a) measuring core	mΩ	To be mentioned	
	b) protection core	mΩ	To be mentioned	
20	Knee point voltage (Supported by Calculation)			
	For Measuring Core	V	To be mentioned	
	For Protection Core	V	To be mentioned	
21	Burden:			
	a) for measurement	VA	30	
	b) for Protection	VA	30	
22	Short Time Current Rating for 3 Sec.	kA	31.5	
23	Extended Current Rating (% of rated current)	%	120	
24	Over Current Rating	A	<10	

25	Creepage Distance	mm/kV (Min.)	25	
26	Rated accuracy limit factor	-	20	
27	Bushing	-	Porcelain outdoor type	
28	Standard	-	IEC 61869-1 & IEC 61869-2	
29	CT Burden shall meet the short circuit current (31.5 kA, 3 Sec)	-	Yes	
30	Manufacturer must comply all the features of Technical Specification (Section 7)		Yes	

Seal & Signature of the Manufacturer

Seal & Signature of the Bidder

8.9 GUARANTEED Technical Particulars OF 33 KV OUTDOOR TYPE SINGLE PHASE POTENTIAL TRANSFORMER

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No.	Description	Unit	BPDB's Requirement	Manufacturer's Guaranteed Particulars
1	Manufacturer's Name & Country or origin	-	To be mentioned	
2	Manufacturer's Model No.	-	To be mentioned	
3	Type	-	Induction Type	
4	Ratio	V	$33000/\sqrt{3}:110/\sqrt{3}:110/\sqrt{3}$	
5	No. of phase	Nos.	Single Phase	
6	Total capacitance at 100 Hz	PF	To be mentioned	
7	50 Hz 1 (One) minute withstand voltage wet	KV	To be mentioned	
8	Impulse withstand (1.2/50 micro sec. wave)	KV	170	
9	Rated burden per phase	VA	30VA	
10	Class of accuracy	-	0.2+3P	
11	Temperature co-efficient of ratio per ^0C	-	To be mentioned	
12	System earthing	-	Effectively Earthed	
13	Creepage Distance	mm/kV	25 (min)	
14	Maximum errors with 5% primary voltage:			
	a) Ratio	%	To be mentioned	
	b) Phase angle	minutes	To be mentioned	
15	Total weight complete	Kg	To be mentioned	
16	Standard	-	IEC 61869-1 & IEC 61869-3	
17	Manufacturer must comply all the features of Technical Specification (Section 7)	-	Yes	

Seal & Signature of the Manufacturer

Seal & Signature of the Bidder

8.10 Guaranteed Technical Particulars of 33KV Single Phase Lightning Arrester

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No.	Description	Unit	BPDB's Requirement	Manufacturer's Guaranteed Particulars
01	Name and address of Manufacturer	-	To be mentioned	
02	Country of origin		To be mentioned.	
03	Place of manufacture		To be mentioned.	
04	Manufacturer's model No.	-	To be mentioned	
05	Type of the Arrester	-	Metal Oxide (ZnO), Gapless-Outdoor (Single Unit, Station Type, To be mounted on Gantry Structure)	
06	Rated Arrester Voltage	kV	36	
07	Continuous Operating Voltage (COV, Uc)	kV	22- 27.5	
08	Nominal Discharge Current (8/20micro sec)	KA	10	
09	Type of Lightning Arrester housing	-	Porcelain/polymer (Hydrophobic silicon)	
10	Power Frequency withstand voltage of the Arrester Housing, Dry & Wet	kV rms	70 (Dry) & 70 (Wet)	
11	Impulse withstand Voltage of the Arrester Housing.	kV (peak)	170	
12	Lightning Impulse Residual Voltage (8/20 micro-second wave)	kV (peak)	80 or better	
13	Maxm. Steep Current Impulse Residual Voltage at 10 KA of 1 micro second front time.	kV (peak)	85 or better	
14	High Current Impulse Withstand Value (4/10 micro second)	KA	100 or better	
15	Temporary Over voltage capability:			
16	a) 0.1 Second	kV (peak)	Shall be mentioned	
	b) 1.0 Second	kV (peak)	Shall be mentioned	
	c) 10 Second	kV (peak)	Shall be mentioned	
	d) 100 Second	kV (peak)	Shall be mentioned	
	Leakage Current at rated voltage	mA	< 1 mA	
17	**Total Creepage distance (minimum)**	mm/ kV	31	
18	Overall dimension :			
19	a) Height	mm	Shall be mentioned	
	b) Diameter	mm	Shall be mentioned	
	Total weight of Arrester	Kg.	Shall be mentioned	
20	Line discharge class	-	Shall be mentioned	
21	Short Circuit Current Withstand duration	Sec	31.5kA, 1 sec	
22	Minimum Energy Discharge capability (KJ/KV) at rated voltage	-	5	
23	Min. Bending load (kgm)		500	
24	Surge Counter /Monitor		Shall be provided	
25	Cable for Connecting Surge Counter		Shall be provided	

26	Reference Standard		IEC 60099-4	
27	Manufacturer must comply all the features of Technical Specification (Section 7)		Yes	

Seal & Signature of the Manufacturer **Seal & Signature of the Bidder**

8.11 Guaranteed Technical Particulars for ACSR MARTIN

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No	Description	Unit	Purchaser's Requirement	Manufacturer's Particulars
1	Name of the Item	-	ACSR MARTIN	
2	Name of the Manufacturer	-	Shall be mentioned	
3	Address of the Manufacturer	-	Shall be mentioned	
4	Standard	-	Performance Design and Testing shall be in accordance to the BS, IEC, ASTM, BDS or equivalent International standards.	
5	Installation	-	Overhead	
6	Type	-	Stranded	
7	Material	-	Hard drawn Aluminium steel reinforced	
8	Overall diameter	mm	36.17	
9	Nominal cross sectional area of conductor	mm^2	772.10	
10	Number/diameter of Aluminium Strand	No./mm	54/4.02	
11	Nominal Aluminium cross sectional area	mm^2	685.40	
12	Number/diameter of Steel Strand	No./mm	19/2.41	
13	Nominal Steel cross sectional area	mm^2	86.70	
14	Weight of conductor	Kg/KM	2590	
15	Drum wound length	M	500	
16	Net weight	Kg	Shall be mentioned	
17	Gross weight	Kg	Shall be mentioned	
18	Maximum DC Resistance of Conductor at 20 °C	Ω/KM	0.0425	
19	Minimum breaking Load of Conductor	Kg	min 11400	
20	Maximum working tension of conductor	KN	Shall be mentioned	
21	Current rating at 35°C rise over 40°C ambient temperature (75°C)	Amps.	Shall be mentioned	
22	Practical (final) modulus of elasticity	hbar	7700	
23	Co-efficient of linear expansion	/°C	shall be mentioned	

24	Aluminum to Steel Ratio		Shall be mentioned	
25	Lay length for Outermost Layer of Aluminium	mm	Shall be mentioned	
26	Lay direction for Outermost Layer of Aluminium	-	Right hand	
27	Lay ratio for Outermost Layer of Aluminium	-	10-14	
28	Treated Wooden Drum Standard	-	AWPA C_1 – 82, C_2 –83, C_{16} –82, P_5 –83.	
29	Manufacturer must comply all the features of Technical Specification (Section 7)	-	Yes	

Seal and Signature of the manufacturer:

Seal and Signature of the Bidder:

8.12 Guaranteed Technical Particulars for Disc Insulator

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No.	Description	Purchaser's Requirement	Manufacturer's Particulars
01.	Name of the Item	Disc Insulator	
02.	Name of Manufacturer & Address	Shall be mentioned	
03.	Manufacturer's Code No.	To be mentioned	
04.	Standard	Performance, Design and Testing shall be in accordance to the BS, IEC, ASTM, BDS or equivalent International standards.	
05.	Installation	Overhead	
06.	Type	Disc	
07.	Material	Porcelain	
08.	Creepage Distance	292 mm	
09.	Flash over voltage Power Frequency, Dry Power Frequency, Wet	 78 kV 45 kV	
10.	Withstand Voltage Power Frequency, Dry Power Frequency, Wet	 70 kV 40 kV	
11.	Power Frequency Puncture Voltage	110 kV	
12.	50% Impulse flashover Positive	120 kV	
13.	50% Impulse flashover Negative	125 kV	
14.	Mechanical Failing Load	70 KN	
15.	Nominal Diameter	255 mm	
17.	Minimum Spacing	146 mm	
18	Dry Arching Distance minimum	171 mm	
19	Coupling Size	16 mm	
20	Weight in Kg	To be mentioned	
21	Manufacturer must comply all the features of Technical Specification (Section 7)	Yes	

Seal and Signature of the manufacturer:

Seal and Signature of the Bidder:

8.13 Guaranteed Technical Particulars of 33 KV Bus bar insulator string

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No.	Description	Unit	BPDB's Requirement	Manufacturer's guaranteed Particulars
1	Manufacturer's Name & Country	-	To be mentioned	
2	Manufacturer's model no.	-	To be mentioned	
3	Insulator material	-	Porcelain	
4	Number of units per string	Nos.	4	
5	Insulator Voltage Class	KV	15	
6	Insulator Materials		Porcelain	
7	Type of Insulator	-	Ball and socket type disc, security clip made of rod brass alloy.	
8	Creepage/ leakage distance (min.)	mm	298	
9	Total creepage distance of string	mm	850	
10	Unit Spacing	mm	146	
11	Dry Arcing distance (minimum)	mm	1968	
12	Diameter of Insulator	mm	256	
13	Withstand Voltage, Minimum : a) Power Frequency, dry (one min.) b) Power Frequency, wet (one min.) c) Impulse 1.2/50 μ sec	 KV KV KV	 70 40 110	
14	Flashover Voltage, Minimum : a) Power Frequency, dry b) Power Frequency, wet c) 50% Impulse 1.2/50 μ sec wave, positive or impulse 1.2/50 μsec wave positive. d) 50% Impulse 1.2/50 μ sec wave Negative	 KV KV KV KV	 80 50 125 130	
15	Power Frequency Puncture Voltage, minimum	KV	110	
16	Radio Influence Voltage Data, minimum			

	a) Power frequency test voltage RMS to Ground b) Maximum RIV at 1,000 Kc	KV μV	10 50	
17	Minimum Mechanical Strength for Suspension :			
	a) Electro-mechanical Breaking Load	Kg	7260	
	b) Mechanical Breaking load	Kg	6800	
	c) Tension Proof Test Load	Kg	3400	
	d) Time Load Test Value	Kg	4536	
	e) Mechanical Impact Strength	mm Kg	630	
18	Minimum Mechanical Strength for Strain Stringing :			
	a) Electro-mechanical Breaking Load	Kg	11340	
	b) Mechanical Breaking load	Kg	11340	
	c) Tension Proof Test Load	Kg	3400	
	d) Time Load Test Value	Kg	4536	
	e) Mechanical Impact Strength	mm Kg	530	
19	Insulator Hardware	-	Insulator hardware for insulator strings or bus-support such shall have UTS-120 KN and galvanized as per BS-729 OR ASTM A-153.	
20	Standard	-	AS per latest editions of IEC-383.	
21	Manufacturer must comply all the features of Technical Specification (Section 7)	-	Yes	

Seal & Signature ofthe Manufacturer

Seal & Signature of the Bidder

8.14 Guaranteed Technical Particulars for H-Type Connector

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No.	Description	Purchaser's Requirement	Manufacturer's Particulars
Compatible for ACSR MARTIN			
1.	Name & Address of the Manufacturer	Shall be mentioned	
2.	Manufacturer's Code No.	Shall be mentioned	
3.	Applicable Standard	Design, Testing & Performance shall be in accordance to BS, IEC, BDS, ANSI, ASTM or equivalent international standards.	
4.	Installation	Outdoor and shall be installed for the above-mentioned conductor.	
5.	Type	H-Type	
6.	Material	Aluminium	
7.	Minimum Continuous Current rating at 35°C rise over 40°C ambient temperature (75°C)	362 Amps (min).	
8.	Length	112 mm	
9.	Weight of 100 nos. in Kg	Shall be mentioned	
10.	Manufacturer must comply all the features of Technical Specification (Section 7)	-	Yes

Seal and Signature of the manufacturer:

Seal and Signature of the Bidder:

8.15 Guaranteed Technical Particulars for Guy/Earth Wire.

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No.	Description	Unit	Purchaser's Requirement	Manufacturer's Particulars
1	Name of the Item	-	Guy/Earth Wire	
2	Name &v Address of the Manufacturer	-	Shall be mentioned	
3	Manufacturer's Code No.	-	Shall be mentioned	
4	Standard	-	Performance Design and Testing shall be in accordance to the BS, BDS or equivalent International standards.	
5	Installation	-	Overhead/Stay	
6	Type	-	Stranded, Solid and Bare	
7	Material	-	High Strength Steel	
8	Overall diameter	Mm	9.50	
9	Number/diameter of each strand	No./mm	7/3.15	
10	Nominal cross sectional area of conductors	mm^2	54.53	
11	Weight of Guy Wire	Kg/KM	430	
12	Ultimate Tensile Strength	KN	62.75	
13	Galvanisation	-	As per ASTM B498-74, Class-A	
14	Modulus of Elasticity	Kg/mm^2	19.7×10^3	
15	Coefficient of linear expansion	/°C	11.3×10^{-6}	
16	Drum wound length	M	1500	
17	Net weight	Kg	Shall be mentioned	
18	Gross weight	Kg	Shall be mentioned	
19	Lay length	Mm	Shall be mentioned	
20	Lay direction	-	Right hand	
21	Lay ratio	-	13-18	
22	Treated Wooden Drum Standard	-	AWPA $C_1 - 82$, C_2 –83, C_{16} –82, P_5 –83.	

23	Manufacturer must comply all the features of Technical Specification (Section 7)	-	Yes	

Seal and Signature of the manufacturer:

Seal and Signature of the Bidder:

8.16 Guaranteed Technical Particulars for PG Clamp

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No.	Description	Purchaser's Requirement	Manufacturer's Particulars
Compatible for ACSR MERTIN to ACSR MERTIN			
1.	Name & Address of the Manufacturer	Shall be mentioned	
2.	Manufacturer's Code No.	Shall be mentioned	
3.	Applicable Standard	Design, Testing & Performance shall be in accordance to BS, IEC, BDS, ANSI, ASTM or equivalent international standards.	
4.	Installation	Outdoor and shall be installed for the above-mentioned conductor.	
5.	Type	Bolted Type	
6.	Material	Aluminium Alloy	
7.	Minimum Continuous Current rating at 35°C rise over 40°C ambient temperature (75°C)	362 Amps (min).	
8.	Dimension	110 mm x 45 mm	
9.	Weight of 100 nos. in Kg	Shall be mentioned	
10.	Manufacturer must comply all the features of Technical Specification (Section 7)	Yes	

Seal and Signature of the manufacturer:

Seal and Signature of the Bidder:

8.17 Guaranteed Technical Particulars of Steel Structure Design

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No.	Description	Unit	BPDB's Requirement	Manufacturer's guaranteed Particulars
1	Manufacturer's Name and Country	-	To be mentioned	
2	Maximum ratio of unsupported length of steel compression to their least radius of gyration:			
	a) Main members	mm	120	
	b) Bracing's	mm	180	
	c) Redundant	mm	180	
3	B.S. 4360 grade 43A steel or other approved standard :			
	a) Elastic limit stress in tension members	Kg/mm^2	To be mentioned	
	b) Ultimate stress in compression members (expressed as function L/R)	Kg/mm^2	$Sc=F/S[\{1+0.00011x (L/R)^2/M\}]$	
4	B.S. 4360 grade 50C steel or other approved standard :			
	a) Elastic limit stress in tension members	Kg/mm^2	To be mentioned	
	b) Ultimate stress in compression members (expressed as function L/R)	Kg/mm^2	$Sc=F/S[\{1+0.000166 x\{(L/R)^2/M\}]$	
5	Formula for calculation of ultimate stress in compression.	-	$SC=F/S[1+\{LE/\pi^2E\}x \{(L/R)^2/M\}]$	
	Where,			
	SC = Ultimate stress in compression	Kg/mm^2	To be mentioned	
	F = Yield strength	Kg	To be mentioned	
	S = Section	mm^2	To be mentioned	
	L/R = Length / Radius of gyration	cm	To be mentioned	
	LE = Elastic limit stress	Mg/mm^2	24 or 36	
	E = Elasticity module	Kg/mm^2	22000	
	M = Rigidity Coefficient at each end	-	To be mentioned	
	M=1 with only one bolt at each end of member	-	To be mentioned	
	M=2 with two bolts at each end of a	-	To be mentioned	

	member			
	M=4 if L/R between 110 and 130	-	To be mentioned	
	M=3 if L/R over to 130	-	To be mentioned	
6	Minimum size of member	mm	45 x 45 x --	
7	Weight of each Column	Kg	To be mentioned	
8	Weight of each Girder	Kg	To be mentioned	
9	Total weight	Kg	To be mentioned	
10	Manufacturer must comply all the features of Technical Specification (Section 7)	-	Yes	

Seal & Signature of the Manufacturer **Seal & Signature of the Bidder**

8.18 Guaranteed Technical Particulars of Shield Wire, Earthing Grid and Earthing Electrode

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No.	Description	Unit	BPDB's Requirement	Manufacturer's guaranteed Particulars
A.	SHIELD WIRES			
1	Manufacturer's name & country	-	To be mentioned	
2	Material	-	High Strength Steel	
3	Grade of Steel	Kg	60000	
4	Nos. of Strand	Nos.	7	
5	Diameter of each strand	mm	3.05	
6	Overall diameter	mm	9.525	
7	Nominal cross -section	mm^2	35	
8	Weight per km length	Kg	407	
9	Maximum rated current (3 seconds)	A	To be mentioned	
10	Maximum working tension of main connection	Kg/m^2	To be mentioned	
11	Resistance of conductors per 1000 meters at 20 c	ohms	To be mentioned	
12	Rated Ultimate Tensile Strength	Kg/mm^2	4900	
13	Maximum permissible span length	m	To be mentioned	
14	Maximum sag under own weight of maximum span	mm	To be mentioned	
15	Co-efficient of liner expansion	cm/ ^{0}C.	To be mentioned	
16	Class of Zinc Coating	-	Class-A	
17	Galvanization	-	As per BS-729 OR ASTM A-153	
B.	EARTHING GRID			
1	Manufacturer's name & country	-	To be mentioned	
2	Material	-	Copper	
3	Overall diameter	mm	To be mentioned	
4	Nominal cross -section			
	a) Interconnecting the earth electrodes	mm^2	To be mentioned	
	b) Connecting equipment to mesh	mm^2	To be mentioned	
6	Area of each earthing grid	m x m	To be mentioned	
7	Depth of bedding of conductor	mm	To be mentioned	
8	Maximum earth fault current for 3 sec.	KA	20	
9	Resistance of conductors per 1000 meters at 20^0c	Ohms	To be mentioned	
C.	EARTHING ELECTRODES			

1	Manufacturer's name & country	-	To be mentioned	
2	Material	-	Copper	
3	Dimensions : a) Dia b) Length	 mm mm	 16 4	
4	Number of electrodes per group	-	As per schedule	
5	Number of earthing point per substation	-	To be mentioned	
6	Calculated resistance of combined earth grid and points	ohm	Less than one (1)	
7	Manufacturer must comply all the features of Technical Specification (Section 7)	-	Yes	

Seal & Signature of the Manufacturer **Seal & Signature of the Bidder**

8.19 Guaranteed TECHNICAL PARTICULARS OF Single-Core, 500 mm^2 33 kV XLPE Insulated Copper Cable

(To be filled up appropriately, then Seal & Signed by both manufacturer and bidder on Manufacturer's Letterhead Pad. Manufacturer & Bidder has to mention only single country of origin as per ITT 6.3 for individual item. Otherwise his bid shall be non-responsive.)

Sl. No.	Description	Unit	Purchaser's Requirement	Manufacturer's Particulars
1	Name of the Item	-	1CX500 mm^2 33 kV XLPE Insulated Copper Cables	
2	Name of the Manufacturer	-	Shall be mentioned	
3	Address of the Manufacturer	-	Shall be mentioned	
4	Standard	-	Performance, Design and Testing shall be in accordance to the BS, IEC, BDS or equivalent International standards.	
5.	Country of Origin	-	Shall be mentioned	
6.	VOLTAGE Voltage between phases of three Phase circuit U U_{max}	 kV kV	 33 36	
7.	Manufacturing Process		CCV/VCV	
8.	CORES Number of Cores	 No.	 one	
9.	CONDUCTOR material cross sectional area Min. No. & Dia of wires	 mm^2 Nos./mm	 Electrolytic annealed copper 500 61/ To be mentioned	
10.	CONDUCTOR SCREEN Material Nominal Thickness Diameter over screen	 mm mm	 semi-conducting XLPE 0.8 To be mentioned	
11.	INSULATION Material Type of dry curing Nominal Thickness Diameter of over Insulation	 mm mm	 XLPE Inert gas 8.0 To be mentioned	
12.	CORE SCREEN Material Nominal Thickness Diameter over screen	 mm mm	 semi-conducting XLPE 0.5	

			To be mentioned	
13.	METALLIC SCREEN Number and diameter of copper screen strands or Copper Wire with helically applied Copper Tape	No./mm or No./mm with Thickness of tape	Based on Design Calculation	
14.	SEPARATION SHEATH Material Thickness of bedding	 mm	 To be mentioned 1.6	
15.	ARMOUR Number & diameter of amour wire or Thickness of Corrugated Aluminum sheath	 No./mm or mm	 Based on Design Calculation	
16.	OUTER COVERING Material Minimum average thickness	 mm	 Black extruded MDPE 2.6	
17.	COMPLETED CABLE Overall diameter Weight per meter Maximum drum length	 mm kg m	 52 6.2 500	
18.	CABLE DRUMS Material Overall diameter Width Gross weight (with cable)	 mm m kg	 Steel To be mentioned To be mentioned To be mentioned	
19.	CONTINUOUS CURRENT CARRYING CAPACITY Based on the conditions specified: One circuit Two circuits Three circuits In Air One circuit	 A A A A	 702 579 504 877	
20.	PERMISSIBLE OVERLOAD In Service Conditions For a period of	 % Hours	 To be mentioned To be mentioned	
21.	MAXIMUM CONDUCTOR TEMPERATURE Laid direct in ground Drawn into ducts Erected in air	 °C °C °C	 90 90 90	

22.	CONDUCTOR SHORT CIRCUIT CURRENT Carrying capacity for one second, Cable load as above prior to Short circuit and final conductor Temperature of 250°C`	KA	71.5	
23.	METALLIC LAYER/SHEATH EARTH FAULT CURRENT Carrying capacity for one second, Cable loaded as above prior to Earth fault	KA	40	(with detail calculation)
24.	MINIMUM RADIUS OF BEND Around which cable can be laid	m	20 times of overall diameter of cable	
25.	MAXIMUM DC RESISTANCE Per km of cable at 20°C of conductor of metallic layer	 Ω Ω	 0.0366 To be mentioned	
26.	MAXIMUM AC RESISTANCE Of conductor per km of cable at Maximum conductor temperature	Ω	0.051	
27.	INSULATION RESISTANCE Per km of cable per core at 20°C at maximum rated temperature	 MΩ MΩ	 400 40	
28.	EQUIVALENT STAR REACTANE Per km of 3 phase circuit at Nominal frequency	Ω/Km	0.122	
29.	MAXIMUM ELECTROSTATIC CAPACITANCE Per Km of cable	µF	0.307	
30.	MAXIMUM INDUCED VOLTAGE On metallic layer/sheath Under fault condition	V	To be mentioned	
31.	MAXIMUM CHARGING CURRENT			

	Per core per meter of cable at Nominal voltage Uo	mA	To be mentioned	
32.	MAXIMUM DIELECTIC LOSS Of cable per meter of 3 phase circuit when laid direct in the ground at nominal voltage Uo and normal frequency at maximum conductor Temperature	W/m	0.33	
33.	METALLIC SHEATH LOSS Of cable per meter of 3 phase circuit, At nominal voltage Uo, normal frequency And at the specified current rating	W	To be mentioned	
34.	Maximum Pulling Tension	kg	3500 Kg	
35	Manufacturer must comply all the features of Technical Specification (Section 7)	-	Yes	

Seal and Signature of the manufacturer:

Seal and Signature of the Bidder:

Section-9. Drawings

Notes on Drawings

Insert here a list of Drawings. The actual Drawings, including site plans, should be attached to this section or annexed in a separate folder. The Drawings shall be dated, numbered and show the revision number.

Invitation for Tenders

[This is the website format and as used for published advertisement. It is included in this document for information only]

1	Ministry/Division	< select >
2	Agency	< select >
3	Purchaser Name	< type in name >
4	Purchaser Code	
5	Purchaser District	< select >
6	Invitation for	< select > < select > < select >
7	Invitation Ref No	< type in name >
8	Date	< select >
9	Procurement Method	< select > < select >
10	Budget and Source of Funds	< select >
11	Development Partners (if applicable)	< type in name >
12	Project / Programme Code (if applicable)	< use MOF code >
13	Project / Programme Name (if applicable)	< use MOF name >
14	Tender Package No.	< type in name >
15	Tender Package Name	< type in name >
16	Tender Publication Date	< select >
17	Tender Last Selling Date	< select >
18	Tender Closing Date and Time	< select > < select >
19	Tender Opening Date and Time	< select > < select >
20	Name & Address of the office(s) - *Selling Tender Document*	< type in name >

	(Principal) *- Selling Tender Document* *(Others)* *NO CONDITIONS APPLY FOR SALE, PURCHASE OR DISTRIBUTION OF TENDER DOCUMENTS*	< type in name >
21	*- Receiving Tender Document* *- Opening Tender Document* Place / Date / Time of Pre-Tender Meeting (Optional)	< type in name > < type in name > < type in name > < select > < select >

22	Eligibility of Tenderer	< type in name >
23	Brief Description of Plant & Equipment	< type in name >
24	Brief Description of Services	< type in name >

25	Price of Tender Document (Tk.)			< type in price >	
	Lot No	Identification of Lot	Location	Tender Security Amount (Tk.)	Completion Time in Weeks / Months
26	1	< type in name >	< type in name >	<type in>	<type in>

30	Name of Official Inviting Tender	< type in name >		
31	Designation of Official Inviting Tender	< type in name >		
32	Address of Official Inviting Tender	< type in name >		
33	Contact details of Official Inviting Tender	< Tel. No.>	<Fax No.>	<e-mail>
34	The Purchaser reserves the right to reject all tenders or annul the Tender proceedings			

<select> : these fields are "pop-up" fields and the Purchaser will only have to select the correct name, address or date in order to complete the form.

<type in name> : these fields are to be completed by typing in the relevant data.

Invitation for Tenders

[for use when there are MULTIPLE lots in a package
This is the website format and as used for published advertisement.
It is included in this document for information only]

1	Ministry/Division	< select >
2	Agency	< select >
3	Purchaser Name	< type in name >
4	Purchaser Code	
5	Purchaser District	< select >
6	Invitation for	< select > < select > < select >
7	Invitation Ref No	< type in name >
8	Date	< select >
9	Procurement Method	< select > < select >
10	Budget and Source of Funds	< select >
11	Development Partners (if applicable)	< type in name >
12	Project / Programme Code (if applicable)	< use MOF code >
13	Project / Programme Name (if applicable)	< use MOF name >
14	Tender Package No.	< type in name >
15	Tender Package Name	< type in name >
16	Tender Publication Date	< select >
17	Tender Last Selling Date	< select >
18	Tender Closing Date and Time	< select > < select >
19	Tender Opening Date and Time	< select > < select >
20	Name & Address of the office(s) - *Selling Tender Document (Principal)*	< type in name >

	- *Selling Tender Document (Others)*	< type in name >
	NO CONDITIONS APPLY FOR SALE, PURCHASE OR DISTRIBUTION OF TENDER DOCUMENTS	
	- Receiving Tender Document	< type in name >
	- Opening Tender Document	< type in name >
21	Place / Date / Time of Pre-Tender Meeting (Optional)	< type in name >
		< select > < select >
22	Eligibility of Tenderer	< type in name >
23	Brief Description of Plant & Equipment	< type in name >
24	Brief Description of Services	< type in name >

25	Price of Tender Document (Tk.)			< type in price >	
	Lot No	Identification of Lot	Location	Tender Security Amount (Tk.)	Completion Time in Weeks / Months
26	1	< type in name >	< type in name >	<type in>	<type in>
27	2	< type in name >	< type in name >	<type in>	<type in>
28	3	< type in name >	< type in name >	<type in>	<type in>
29	4	< type in name >	< type in name >	<type in>	<type in>

30	Name of Official Inviting Tender	< type in name >		
31	Designation of Official Inviting Tender	< type in name >		
32	Address of Official Inviting Tender	< type in name >		
33	Contact details of Official Inviting Tender	< Tel. No. >	< Fax No. >	< e-mail >
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<select> : these fields are "pop-up" fields and the Purchaser will only have to select the correct name, address or date in order to complete the form.

<type in name> : these fields are to be completed by typing in the relevant data.

Signature

Signature